USDA Natural Resources Conservation Service

Ecological site AX003X00D004
Western Middle Cascades Frigid Udic Forest Group

Last updated: 1/24/2025
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General information

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

MLRA notes

Major Land Resource Area (MLRA): 003X–Olympic and Cascade Mountains

The Cascade and Olympic Mountains (MLRA 3) include the west slope and parts of the east slope of the Cascades Mountains in Washington and Oregon. The Olympic Mountains in Washington State are also included. These mountains are part of a volcanic arc located at a convergent plate boundary. Volcanic rocks predominate but metamorphic and sedimentary rocks occur in the North Cascades and Olympic Mountains. Topography is generally dissected and steep, but some areas consist of constructional volcanic platforms and isolated stratovolcanoes. Elevation is usually 500 to 6000 feet but reaches to 14,410 ft at the summit of Mount Rainier. Many areas hosted alpine glaciers or ice sheets during the Pleistocene, and a few remain today.
Climate becomes cooler and moister with increasing elevation and latitude. Low elevations experience a long growing season and mild temperatures. High elevations can accumulate snowpack lasting into summer and frost may occur in any month. Average annual precipitation ranges from 60 to 180 inches in most areas. Most precipitation falls during the fall, winter, and spring during low-intensity frontal storms. Summers are relatively dry. Average annual temperature is 27 to 50 degrees F. The frost-free period is 10 to 180 days.

LRU notes

The Western Cascades land resource unit (LRU E) is located in western Oregon. It is bounded by the Santiam River on the north, the High Cascade volcanic platform on the east, the Rogue-Umpqua Divide on the south, and the Willamette and Umpqua Valleys on the west. This area is equivalent to the area generally known as the “Old Cascades.”
Bedrock consists of basalt and andesite of the Sardine Formation overlying the Little Butte Volcanic Series which contains soft tuff (Orr, et al. 1992). The Sardine Formation “cap” is absent at many locations. Topography is dissected and steep in most areas. Areas of low relief contain ancient and contemporary landslides. Alpine glaciation occurred in headwater basins during the Pleistocene but subsequent mass movement has partially obscured glacial features (Noller, et al. 2016).
Soil moisture regime is udic or aquic. Soil temperature regime ranges from mesic to cryic. Soils in this LRU generally have higher apparent clay content compared with those to the north and Spodosols do not occur. Most soils contain an appreciable amount of volcanic glass. Inceptisols usually have isotic mineralogy. Andisols are usually amorphic and meet the second criteria for andic soil properties (Soil Survey Staff, 2014). Ultisols can occur at the lowest elevations.
Conifer forest is the dominant vegetation. Natural fire is dominantly moderately frequent, mixed-severity (Spies, et al. 2018). Franklin and Spies (1991) noted an increase in tree bole fire scars south of 44.5 degrees latitude in the Oregon Cascades. This LRU hosts small amounts of fire-tolerant species common in the Siskiyou-Trinity Area (MLRA 5) but absent in areas to the north. These species include Pacific madrone (Arbutus menziesii), incense cedar (Calocedrus decurrens), giant chinkapin (*Chrysolepis chrysophylla*), and sugar pine (Pinus lambertiana).
At low to mid elevations, Douglas-fir (*Pseudotsuga menziesii*) is a long-lived, early-seral tree; western hemlock (Tsuga heterophylla) is an associated shade-tolerant tree. Red alder (Alnus rubra) is a short-lived, early-seral tree. It occurs ephemerally on uplands but persists on wet or repeatedly-disturbed sites.
At high elevations, Noble fir (Abies procera) is an early-seral tree; Pacific silver fir (*Abies amabilis*) is an associated

shade-tolerant tree. Sitka alder (Alnus viridis ssp. sinuata) and vine maple (*Acer circinatum*) form persistent shrubfields on sites subject to heavy snowpack or avalanches. Wetlands typically support shrubby or herbaceous vegetation.

Classification relationships

This ecological site group description covers a variety of cool western hemlock plant associations including the following (McCain and Diaz 2002):

• Western hemlock / twinflower
• Western hemlock / devilsclub / Oregon oxalis
• Western hemlock / devilsclub / starry false lily of the valley
• Western hemlock / Pacific rhododendron / salal
• Western hemlock / Pacific rhododendron / twinflower
• Western hemlock / Pacific rhododendron / Cascade barberry
• Western hemlock / Pacific rhododendron / Oregon oxalis
• Western hemlock / Pacific rhododendron / common beargrass
• Western hemlock / Alaska blueberry / bunchberry dogwood ,
• Western hemlock / Alaska blueberry / Oregon oxalis
• Western hemlock / Alaska blueberry - devilsclub

Ecological site concept

This forested site occurs in the cooler portion of the western hemlock zone. Soil temperature regime is frigid, and soil moisture regime is udic. Forest litter turnover and associated nutrient cycling can be slow compared with warmer sites, but rapid compared with colder sites. Elevation is typically 2000 to 4000 feet.

Associated sites

AX003X00B003	**Western Middle Cascades Mesic Udic Forest Group** Lower elevations, drier and warmer sites.
AX003X03F007	**Glaciated Middle Cascades Cryic Udic Forest Group** Higher elevations, cooler and wetter sites.

Similar sites

AX003X03C004	**Glaciated Middle Cascades Frigid Udic Forest Group** Similar position, but on the Glaciated portion of the Western Cascades.

Table 1. Dominant plant species

Tree	(1) *Pseudotsuga menziesii* (2) *Tsuga heterophylla*
Shrub	(1) *Rhododendron macrophyllum* (2) *Vaccinium alaskaense*
Herbaceous	Not specified

Legacy ID

F003XE004OR

Physiographic features

Landform: mountain slopes, landslides
Elevation: 2000 to 4000 feet
Slope: 0 to 90 percent
Aspect: all aspects

Flooding: none
Ponding: none

Table 2. Representative physiographic features

Landforms	(1) Mountain slope (2) Landslide
Flooding frequency	None
Ponding frequency	None
Elevation	2,000–4,000 ft
Slope	0–90%
Aspect	W, NW, N, NE, E, SE, S, SW

Climatic features

Mean annual air temperature: 42 to 45 degrees F
Mean annual precipitation: 60 to 100 inches
Frost free period: 80 to 120 days

Precipitation occurs mainly during fall, winter, and spring. Summers are dry. Snowpack accumulates during winter but melts in early spring.

Influencing water features

None

Wetland description

None

Soil features

Drainage class: well drained or moderately well drained
Parent material: colluvium, residuum, till; mixed with volcanic ash
Restrictive feature(s): shallow to very deep to bedrock
Soil temperature regime: frigid
Soil moisture regime: udic
Soil reaction: strongly or very strongly acid
Soil mineralogy: amorphic or isotic

Soils are usually very deep and well drained, but those with a brief seasonal water table still capable of supporting Douglas-fir (*Pseudotsuga menziesii*) are included in this concept. The rooting zone is usually moist but may be dry up to 45 consecutive days in late summer. Litter layers under mature forest are usually thicker and exhibit a more advanced state of decomposition compared with warmer sites. O horizons associated with this site on the Willamette National Forest were usually 3 to 7 cm thick (inner quartiles, n=63). Organic materials at the surface were slightly decomposed, but 37 percent of pedons contained moderately or highly decomposed plant materials at the boundary with mineral soil (Rand, 2020). Earthworms are absent. Millipedes (especially Harpaphe haydeniana) may be responsible for fragmenting and mixing litter into the A horizon (Moldenke, et al. 2000). Soils usually have umbric epipedons. Andic soil properties derived from the weathering of volcanic ash are usually present. Andisols and Inceptisols are common soil orders. Apparent fine-earth textures are usually loams or silt loams. Apparent clay content usually ranges from 18 to 27 percent.

Table 3. Representative soil features

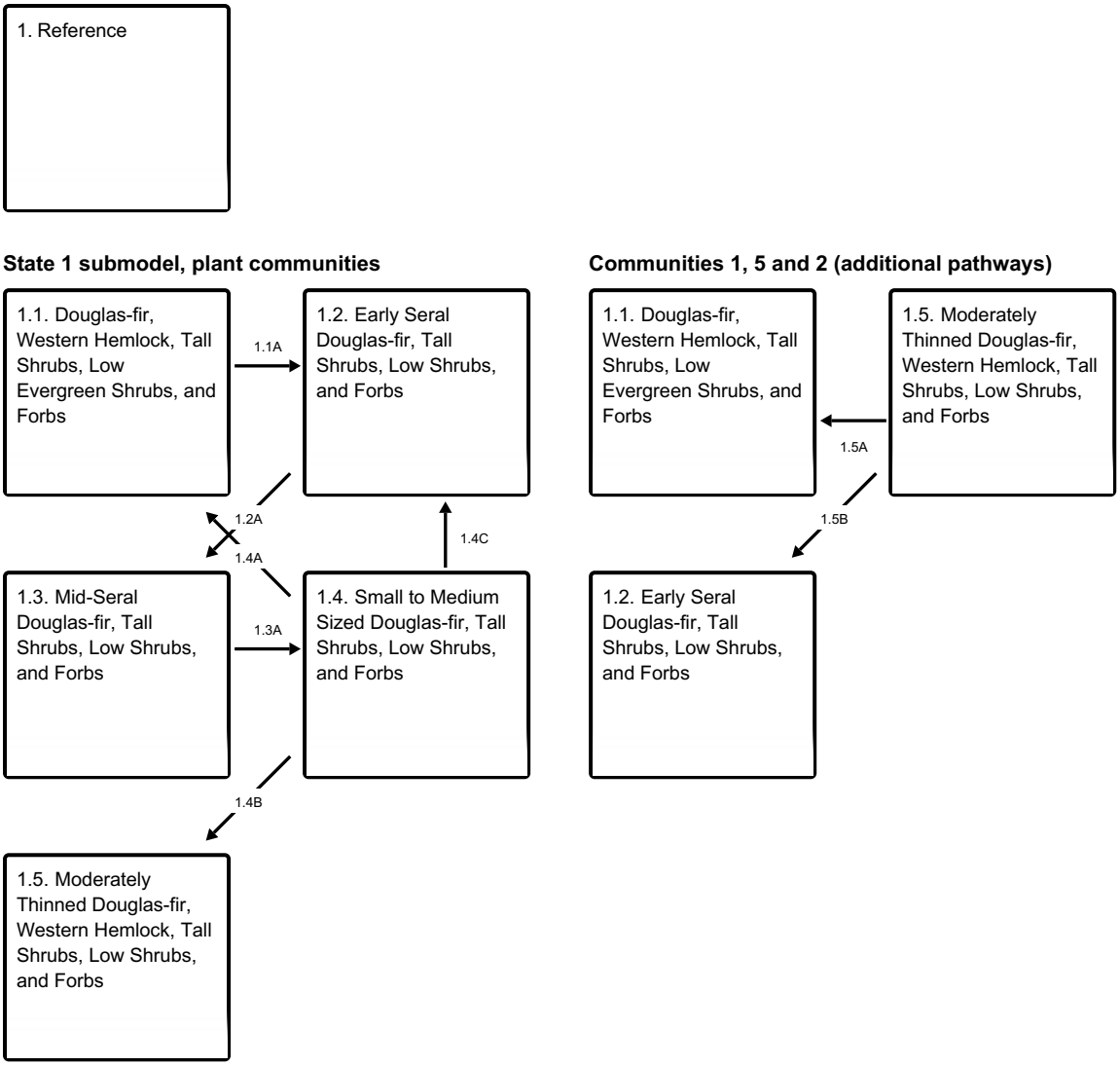
Parent material	(1) Colluvium (2) Residuum (3) Till
Drainage class	Moderately well drained to well drained

Ecological dynamics

Central Concept: This forested site occurs in the cooler portion of the western hemlock zone. Soil temperature regime is frigid, and soil moisture regime is udic. Forest litter turnover and associated nutrient cycling can be slow compared with warmer sites, but rapid compared with colder sites. Elevation is typically 2000 to 4000 feet.
Range in Variability: Duration of dryness linked to local landscape position, aspect, and soil depth may define subtypes with distinctive reference communities. Southern exposures and convex slopes may support drought-tolerant communities. Northern exposures and concave slopes may support moist communities. Soils with a seasonal water table may restrict rooting depth for some species.
Disturbance: Fire is the dominant natural landscape level driver. Mixed severity fires dominate in this vegetation type, with areas of low (< 30%), moderate (30-70%) and high (> 70%) overstory mortality expressed within fires. Historical fire frequency has varied from 50 to 200 years mean fire return intervals (MFRI) (Morrison and Swanson 1990, Tepley et al. 2013, Spies et al. 2018). Wind, insects and pathogens, and infrequent landslides may also shape forest composition and pattern at finer scales. Human management is prevalent in this type, with activities such as regeneration harvest and thinning occurring within its range and dominating phase trajectories over fire (Spies et al. 2013).
Vegetation composition: Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), western hemlock, western redcedar (*Thuja plicata* Donn ex D. Don), and Pacific yew (*Taxus brevifolia* Nutt.) are common tree associates that span most of these types. Giant chinquapin (*Chrysolepis chrysophylla* (Douglas ex Hook.) Hjelmqvist) is found more commonly in the drier portions of this type. Pacific silver fir (*Abies amabilis* (Douglas ex Loudon) Douglas ex Forbes) is found in the cooler portions of this type, often in the transition to higher elevation vegetation types (McCain and Diaz 2002).
Understory shrub species are varied. Tall shrubs such as Pacific rhododendron (*Rhododendron macrophyllum* D. Don ex G. Don) and Alaska blueberry (*Vaccinium alaskaense* Howell) are common and serve as key indicators for this type. Vine maple (*Acer circinatum* Pursh) is a common associate. Red huckleberry (*Vaccinium parvifolium* Sm) is scattered throughout. Low shrubs, such as Cascade barberry (*Mahonia nervosa* (Pursh) Nutt.), and to a lesser extent salal (*Gaultheria shallon* Pursh) occur. Devilsclub (*Oplopanax horridus* (Sm.) Miq) dominated types are found in wetter areas within this zone (McCain and Diaz 2002).
A diverse array of herbs occupies this these sites. Sweet after death (*Achlys triphylla* (Sm.) DC), Columbian windflower (*Anemone deltoidea* Hook.), bride's bonnet (*Clintonia uniflora* (Menzies ex Schult. & Schult. f.) Kunth), bunchberry dogwood (*Cornus canadensis* L.), western rattlesnake plantain (*Goodyera oblongifolia* Raf.), twinflower (*Linnaea borealis* L.), starry false lily of the valley (*Maianthemum stellatum* (L.) Link), western swordfern (*Polystichum munitum* (Kaulf.) C. Presl) and threeleaf foamflower (*Tiarella trifoliata* L.) occur most commonly in this type. Liverleaf wintergreen (*Pyrola asarifolia* Michx), whiteveined wintergreen (*Pyrola picta* Sm) and common beargrass (*Xerophyllum tenax* (Pursh) Nutt.) are found in cooler, drier portions of this type (McCain and Diaz 2002).
Structural Descriptions Used in State and Transition Model: Phases are described by size class, cover class and layering. Size class description refers to either the average diameter of the dominant and co-dominant trees (quadratic mean diameter or qmd) in the state and transition model or the general sizes by species in the following narrative.
Size Class
Grass Forb/Seedling Sapling Pole Small Medium Large/Giant
DBH (inches) NA 0.1-4.9 5-9.9 10-19.9 20-29.9 =30
Canopy Cover Class
Open Moderate Closed
Canopy cover (%) <10 10-60 >60

State and transition model

Ecosystem states



State 1
Reference

Community 1.1
Douglas-fir, Western Hemlock, Tall Shrubs, Low Evergreen Shrubs, and Forbs

Growth from community phase 1. 4 and 1.5 are the dominant pathways producing this condition. Moderate to low severity fire and background mortality (insects, pathogens, wind, etc.) processes also serve to maintain a heterogeneous horizontal and vertical range of compositional and live and dead structural conditions, with multi-layered forest intermixed with gaps of various sizes. Small to giant snags are present, as well as down wood (Mellen-McLean et al. 2017). Dominant and co-dominant large and giant Douglas-fir, with large western hemlock are indicators of reference condition. Small to large western hemlock and Douglas-fir can be found in the mid canopy, depending on fire history and gap dynamics. Other trees, such as coniferous small to large western redcedar, sapling to small Pacific silver fir, and evergreen hardwoods, such as giant chinquapin can be found as well. Shade tolerant western hemlock, western redcedar, Pacific yew and Pacific silver fir, as well as giant chinquapin can regenerate after moderate to low severity fire. Shade intolerant Douglas-fir may regenerate in large gaps, and after moderate severity fire (Tepley et al. 2013). A diverse understory is found in this condition. Vine maple, Pacific rhododendron, and Alaska blueberry are the most common tall shrubs, averaging around 35% cover (10-50%). Low shrubs, dominated by Cascade barberry are found in low to moderate cover, averaging around 20% (averages ranging 10-50%) Low to high cover of a diverse mix of herbs are present, averaging approximately 40% cover (10-65%). Sweet after death, Columbian windflower, bride’s bonnet, bunchberry dogwood, western rattlesnake plantain, twinflower, starry false lily of the valley, western swordfern, and threeleaf foamflower are often found in different combinations in the zone. At the dry, cool end of this type common beargrass and whiteveined wintergreen can be found (McCain and Diaz 2002). CP1.1 Reference Community. Douglas-fir - western hemlock / tall shrubs - low evergreen shrubs / forbs Large/Giant, multi-layered, moderate-closed canopy, scattered diverse

sized gaps, regenerating shade tolerant and intolerant tree species Age class: >100 years

Community 1.2
Early Seral Douglas-fir, Tall Shrubs, Low Shrubs, and Forbs

This community phase is a post-disturbance, early seral condition, resulting from high severity fire or regeneration harvest. Open canopy conditions, with or without legacy structure and tree regeneration characterize this phase. Douglas-fir may exist as scattered live legacy overstory. Post-fire conditions may consist of high densities of small to giant snags, resulting in diverse cover of down wood ((Mellen-McLean et al. 2017). Seedlings of various coniferous species may be present, with Douglas-fir likely dominating. Early seral trees, such as bitter cherry (*Prunus emarginata* (Douglas ex Hook.) D. Dietr.)) may be present (Oakley and Franklin 1998.). Sprouting tall shrubs, such as Pacific rhododendron, Alaska blueberry, vine maple and red huckleberry (*Vaccinium parvifolium* Sm.) persist from pre-disturbance conditions (Schoonmaker and McKee 1998, Brown et al. 2013, Dunn 2015). Evergreen low shrubs, such as Cascade barberry, and salal and deciduous California blackberry (*Rubus ursinus* Cham. & Schltdl) may greatly increase in cover to dominate the ground layer. Early seral shrubs may include thimbleberry (*Rubus parviflorus* Nutt.), redstem ceanothus (*Ceanothus sanguineus* Pursh), snowbrush ceanothus (*Ceanothus velutinus* Douglas ex Hook) and willow species (Salix L.) (Halpern 1988, Brown et al. 2013). Snowbrush ceanothus can dominate the surface layer, especially on south aspects, (Brown et al. 2013, Dunn 2015), potentially affecting seedling establishment (McCain and Diaz 2002). Non-native shrubs such as Scotch broom (*Cytisus scoparius* (L.) Link) may be present in low to moderate cover (McCain and Diaz 2002). Many late seral herb species recover and persist. Early seral native species such as western pearly everlasting (*Anaphalis margaritacea* (L.) Benth), fireweed (*Chamerion angustifolium* (L.) Holub) and Canadian horseweed (*Conyza canadensis* (L.) Cronquist) may be ephemeral dominants (Schoonmaker and McKee 1998; Halpern 1989). Bull thistle (*Cirsium vulgare* (Savi) Ten) and slender false brome (*Brachypodium sylvaticum* (Huds.) P. Beauv.), non-native herbs, may dominate the understory if seed source is present. On cooler, drier sites common beargrass may increase in cover to dominate the understory (McCain and Diaz 2002). CP1.2 Douglas-fir / tall shrubs - low shrubs / forbs Grass, forbs, seedings, single layered, open canopy Age class: 1-15

Community 1.3
Mid-Seral Douglas-fir, Tall Shrubs, Low Shrubs, and Forbs

This mid-seral phase is the result of growth from CP 1.2. Large to giant decayed snags from previous disturbances may persist, although low levels of small snags may be more common. Down wood is variable, with high levels possible in post-fire generated conditions (Mellen-McLean et al. 2017). The live canopy has simple structure, dominated by sapling to pole sized trees, with some stands displaying some large to giant pre-disturbance legacy trees. Douglas-fir likely dominates, with scattered western redcedar, western hemlock, Pacific yew, Pacific silver fir and giant chinquapin present to varying degrees dependent on site conditions. Tree canopy cover is moderate to high. Shrub cover can be variable, depending on the residual sprouting shrubs (e.g. vine maple, Pacific rhododendron) and the degree of snowbrush ceanothus recruitment. This results in minimal to no tree regeneration. Tall shrubs (Pacific rhododendron, Alaska blueberry, vine maple and red huckleberry, thimbleberry, redstem ceanothus, snowbrush ceanothus) and low shrubs (Cascade barberry, salal, California blackberry) may be found Non-native scotch broom may be present in lower cover stands. Native herbs such will persist, and non-native bull thistle and slender false brome may continue to inhabit this phase (Schoonmaker and McKee 1998; Halpern 1989) CP1.3 Douglas-fir / tall shrubs - low shrubs / forbs Sapling/pole-sized, single layered, moderate-closed canopy Age class:15-50

Community 1.4
Small to Medium Sized Douglas-fir, Tall Shrubs, Low Shrubs, and Forbs

Growth from CP1.3 produces this community phase. Large and giant snags and down wood from previous disturbances are likely present but declining in abundance due to decay and fragmentation. Smaller snags are being created from background mortality due to competition, insects, and pathogens (Mellen-McLean et al. 2017). Forest structure is still simple and largely single layered, although some multi-layered development may be beginning to be expressed in scattered openings and in stands with legacy live trees. Canopy cover is generally high and dominated by small to medium sized Douglas-fir. Some legacy large and giant trees may be present in some cases. Scattered western hemlock, western redcedar, Pacific yew, Pacific silver fir and giant chinquapin may be present as well. Regeneration is minimal to none. Tall shrubs (Pacific rhododendron, Alaska blueberry, vine maple and red

huckleberry) are present, with variable cover. Low shrubs, such as Cascade barberry may be found in pockets and gaps and scattered within the stand. Herbs are varied depending on understory light levels. Under very low light levels western swordfern may be the only understory species present. CP1.4 Douglas-fir / tall shrubs - low shrubs / forbs Small/Med, single layered, closed canopy Age class: 51-100

Community 1.5
Moderately Thinned Douglas-fir, Western Hemlock, Tall Shrubs, Low Shrubs, and Forbs

This phase is the result of moderate severity fire or moderate thinning of CP 1.4. Small to medium sized Douglas-fir dominate the overstory canopy layer. Large and giant snags and down wood from previous disturbances are likely present but declining in abundance due to decay and fragmentation. Small and medium snags in varying densities may result from fire and may lead to later recruitment of down wood. (Mellen-McLean et al. 2017). A range of shade tolerant (western hemlock, western redcedar, Pacific yew, Pacific silver fir) and shade intolerant (Douglas-fir, giant chinquapin) trees may be present, depending on the severity and size of the disturbance (Tepley et al. 2013). Regeneration may also include shade tolerant and intolerant species. Shrub species are varied, with tall shrubs such as Pacific rhododendron, Alaska blueberry, and vine maple and low shrubs such as Cascade barberry persisting due to sprouting adaptation. Native and non-native herbs are present, dependent on seed source and disturbance severity. CP1.5 Douglas-fir - western hemlock / tall shrubs - low shrubs / forbs Small/Med, multi-layered, open to closed canopy, abundant diverse sized gaps, regenerating shade intolerant and tolerant Age class: 51-150 years

Pathway 1.1A
Community 1.1 to 1.2

Stand replacing fire is the most common pathway from this condition. Timber management, large scale wind or insects and pathogens may also return this to the early seral phase.

Pathway 1.2A
Community 1.2 to 1.3

Growth is the major process transitioning out of this early seral condition.

Pathway 1.3A
Community 1.3 to 1.4

Growth is the major process transitioning out of this phase. Pre-commercial thinning may also serve to change phases.

Pathway 1.4A
Community 1.4 to 1.1

Growth will serve to transition this phase into the reference condition.

Pathway 1.4C
Community 1.4 to 1.2

Regeneration harvest or stand replacing fire can return this phase back to early seral conditions.

Pathway 1.4B
Community 1.4 to 1.5

Management actions such as thinning can trigger a shift in phases. Mixed severity fire can also result in a transition to more diverse stand conditions.

Pathway 1.5A
Community 1.5 to 1.1

Growth will serve to transition this phase into the reference condition.

Pathway 1.5B
Community 1.5 to 1.2

Regeneration harvest or stand replacing fire can return this phase back to early seral conditions.

Additional community tables

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Approval

Kirt Walstad, 1/24/2025

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	10/05/2023
Approved by	Kirt Walstad
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

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

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

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

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

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

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

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

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

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

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

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

    Dominant:

    Sub-dominant:

    Other:

    Additional:

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:**