

Ecological site F003XA308WA High Cirque Forest mountain hemlock

Last updated: 1/29/2025
Accessed: 05/13/2025

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): 003X—Olympic and Cascade Mountains

This area includes 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 North Cascades land resource unit is located in northwestern Washington primarily along the western slope of the Cascade Range. It bounded by the international boundary with Canada to the north and the Snoqualmie Pass area to the south. To the west is the Puget Sound Trough (MLRA 2) and to the east is the drier eastern slope of the Cascade Range (MLRA 6).

The Skagit River is the largest river to originate in the LRU and is governed by three hydroelectric dams. Other rivers that drain west include the Nooksack, Snohomish, and Skykomish. The Wenatchee River drains east toward the Columbia.

Lithology is the result of numerous accretions from tectonic subduction of the Pacific plate along the margin of the North American plate. The North Cascades are arranged in a west to east series of terranes which are combinations of metamorphized sedimentary or oceanic rock and intrusive volcanic plutons, punctuated by the minorly active Mount Baker and Glacier Peak volcanoes (Washington Geological Survey). Additionally, Pleistocene continental and alpine glaciation covered almost all of the area except the highest peaks in the range and deposited large amounts of glacial sediment. Alpine glaciers still remain active today in the highest elevations.

Soils are primarily Spodosols, Andisols, and Inceptisols.

Vegetation is primarily dense forest with some parkland in subalpine and alpine areas. Douglas-fir (*Pseudotsuga menziesii*) and western hemlock (*Tsuga heterophylla*) are the dominate tree species found at lower elevations; western redcedar (*Thuja plicata*) is quite common. Pacific silver fir (*Abies amabilis*) and mountain hemlock (*Tsuga mertensiana*) are the primary tree species in the higher elevations; subalpine fir (*Abies lasiocarpa*) and Alaska

cedar (*Callitropsis nootkatensis*) can be widespread as well.

Classification relationships

USFS Plant Associations:
mountain hemlock/beargrass-low huckleberry
mountain hemlock/pink mountainheath-Cascade huckleberry
mountain hemlock/Alaska huckleberry

Ecological site concept

This site covers the mountain hemlock areas within LRU A, which span the highest forests, directly below subalpine parklands. These forests have a deep, persistent snowpack and short growing season. Fires occur frequently from lightning strikes. Though most fires are very small, infrequently there are large, stand replacing fires approximately every 300 years. Insects and diseases impact these forests on small scales including heart and butt rot, root rot, bark beetles and others. This site covers the dominant cool, moist condition of the mountain hemlock. At the upper elevations there may be more heath species and avalanches may be a more dominant disturbance, reoccurring in the same areas repeatedly. This ecological site resides on cirque floors and mountain slopes at elevations of 4,000 to 5,700 feet on moderate slopes (15 to 45 percent). Average climate factors include frost free days of 50 to 85 days, mean annual precipitation of 85 to 125 inches, and mean annual air temperature of 37 to 42 degrees Fahrenheit. The harsh site conditions which include a long-lasting snowpack define the ecological site and control the vegetation community with a short growing season. The reference community is predominantly mountain hemlock. Pacific silver fir can be co-dominate in the overstory but, the regenerating layer is always predominately mountain hemlock. The understory can vary from moist rusty menziesia (*Menziesia ferruginea*), Alaska blueberry (*Vaccinium alaskense*), thinleaf huckleberry (*Vaccinium membranaceum*), oval-leaf blueberry (*Vaccinium ovalifolium*), western mountain ash (*Sorbus sitchensis*), bride’s bonnet (*Clintonia uniflora*) to drier site adapted species common beargrass (*Xerophyllum tenax*), dwarf bilberry (*Vaccinium cespitosum*), Cascade azalea (*Rhododendron albiflorum*), strawberryleaf raspberry (*Rubus pedatus*), sidebells wintergreen (*Orthila secunda*) and at the highest elevation pink mountainheath (*Phyllodoce empertriformis*). Soils are commonly Andisols or Spodosols; Inceptisols occur as well. All soils have some measure of andic soil properties; the parent material is primarily volcanic ash over colluvium from andesite. Soil restrictions in some soils range from 10 to 20 inches to a densic or lithic contact. Other soils are greater than 60 inches to a restriction.

Associated sites

F003XA309WA	High Glacial Trough Valleys Parkland - mountain hemlock-subalpine larch-whitebark pine
R003XA304WA	Avalanche Sitka alder (<i>Alnus viridis</i>)

Similar sites

F003XB308WA	High Cirque Walls Forest mountain hemlock
F003XC308WA	High Cirques Forest mountain hemlock

Table 1. Dominant plant species

Tree	(1) <i>Tsuga mertensiana</i> (2) <i>Abies amabilis</i>
Shrub	(1) <i>Menziesia ferruginea</i> (2) <i>Vaccinium alaskaense</i>
Herbaceous	(1) <i>Cornus canadensis</i> (2) <i>Clintonia uniflora</i>

Physiographic features

This ecological site resides on cirque floors and mountain slopes in the mountains at elevations of 4,000 to 5,700 feet moderate slopes (15 to 45 percent).

Table 2. Representative physiographic features

Landforms	(1) Mountains > Mountain slope (2) Mountains > Cirque floor
Elevation	1,372–1,737 m
Slope	15–40%
Aspect	W, NW, N, S, SW

Climatic features

Mean annual air temperature of 37 to 42 degrees Fahrenheit.

Table 3. Representative climatic features

Frost-free period (characteristic range)	50-85 days
Freeze-free period (characteristic range)	
Precipitation total (characteristic range)	2,159-3,175 mm

Influencing water features

This site is not influenced by water from a wetland or stream.

Soil features

Soils are commonly Andisols or Spodosols; Inceptisols occur as well. All soils have some measure of andic soil properties range 0-60 inches but typically 0 to 24 inches depth; the parent material is primarily volcanic ash over colluvium from andesite. Soil restrictions in some soils range from 10 to 20 inches to a densic or lithic contact. Other soils are greater than 60 inches to a restriction.

Table 4. Representative soil features

Parent material	(1) Volcanic ash (2) Colluvium–andesite
Surface texture	(1) Ashy sandy loam (2) Ashy fine sandy loam (3) Medial sandy loam
Family particle size	(1) Ashy over loamy-skeletal (2) Medial over loamy-skeletal
Drainage class	Moderately well drained to well drained
Depth to restrictive layer	25–152 cm
Soil depth	25–152 cm
Surface fragment cover <=3"	0–27%
Surface fragment cover >3"	0–19%
Calcium carbonate equivalent (Depth not specified)	0%
Soil reaction (1:1 water) (Depth not specified)	4.5–6.5

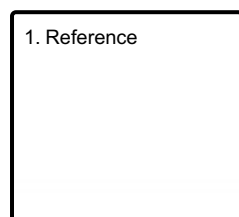
Ecological dynamics

This ecological site spans the highest elevations of closed canopy configuration forests in this LRU. As such, the site conditions of cold temperatures and heavy, persistent snowpack impact vegetation growth. Diseases such as

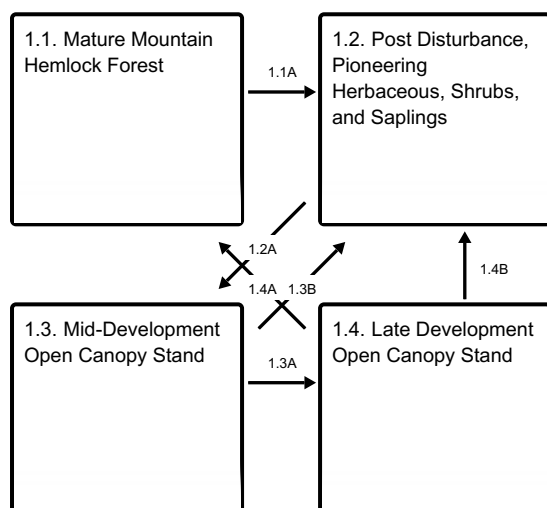
heart, root and butt rot affect tree growth and can lead to small patch disturbances. Other factors can be windthrow, insect damage, and avalanches. Lightning strikes are common at this site, though fire is rare (rotation interval 200 to 500 years) and severe (stand replacing fire). Mountain hemlock in the Pacific Northwest had a fire return interval of 600 years in pre-logging conditions (Fire Effects Information System, USFS, webpage). The predicted fire return interval within The North Cascades LRU is expected to exceed 300 years, though multiple lightning strikes can cause very small patch disturbances. LANDFIRE states that North Pacific Mountain Hemlock has stand replacement fires at intervals of 500 years, mixed severity fire at 2,000 years and all types of fires every 400 years. Mountain hemlock and Pacific silver fir is present in all community phases, though mountain hemlock eventually dominates the overstory and regeneration layers in the reference community. Western hemlock can occur on lower elevations and warmer sites in early and mid-development phases, while western white pine (*Pinus monticola*) can occur infrequently. Sites west of the Cascade crest have a partially maritime-influenced climate and thus longer fire return intervals, while site east of the crest are more continental in climate and have more frequent fire.

State and transition model

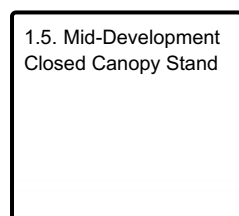
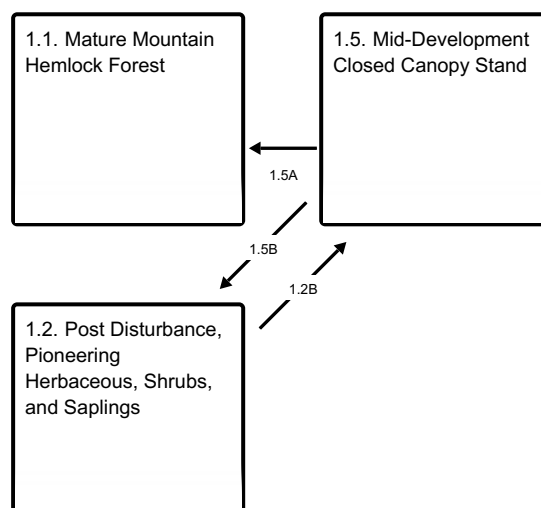
Ecosystem states



State 1 submodel, plant communities



Communities 1, 5 and 2 (additional pathways)



- 1.1A** - Rare, stand-replacement fire that kills significant number of mature trees and top-kills shrubs and herbaceous plants.
- 1.2A** - With time, the tree seedlings and small saplings go to the mid development community and due to the occurrence of mixed severity fire the canopy is in an open configuration.
- 1.2B** - With time, the tree seedlings and small saplings go to the mid development community grow into the closed canopy configuration.
- 1.3B** - Rare, stand-replacement fire that kills significant number of mature trees and top-kills shrubs and herbaceous plants.
- 1.3A** - With time, the pole sized trees develop to large mature trees in the late development phase.
- 1.4A** - With time, the large mature trees develop into the closed configuration of the reference phase without the occurrence of mixed severity fire.
- 1.4B** - Rare, stand-replacement fire that kills significant number of mature trees and top-kills shrubs and herbaceous plants.
- 1.5A** - With time, the large mature trees develop into the closed configuration of the reference phase without the occurrence of mixed severity fire.
- 1.5B** - Rare, stand-replacement fire that kills significant number of mature trees and top-kills shrubs and herbaceous plants.

State 1

Reference

Community 1.1

Mature Mountain Hemlock Forest

The overstory and regeneration layers are dominated by mountain hemlock, though Pacific silver fir may have a high canopy cover. This is a multi-canopy forest. The trees are large (average diameter at breast height is 45 inches) and older (generally 150 to 200 years old or older). The understory is generally dominated by moisture adapted shrub species rusty menziesia, Cascade azalea or Alaska blueberry, though slightly drier sites will have vine maple and vaccinium species. Higher elevation sites will have pink mountainheath. Herbaceous species can include bride's bonnet, oneleaf foamflower and sidebells wintergreen.

Community 1.2

Post Disturbance, Pioneering Herbaceous, Shrubs, and Saplings

The post disturbance phase (0-3 years) is initially dominated by pioneering herbaceous species and resprouting shrubs (Cascade azalea, rusty menziesia, Alaska huckleberry) as well as resident and windblown tree seedlings such as mountain hemlock, Pacific silver fir, lodgepole pine, western hemlock. A shrub dominated phase develops until shaded by tree saplings. This phase generally lasts for fifty years.

Community 1.3

Mid-Development Open Canopy Stand

A mid-development phase of pole sized seral tree species (mountain hemlock, Pacific silver fir, lodgepole pine, western hemlock) dominates in an open canopy configuration due to mixed severity fires, though windthrow, disease and insect damage can occur and cause small patch disturbances. The trees are pole-sized (diameter at breast height is about 20 inches) and generally 50 to 100 years old in this phase. The understory has thinkleaf huckleberry, grouse whortleberry, common beargrass and sedges.

Community 1.4

Late Development Open Canopy Stand

An open canopy of large trees with a mix of mountain hemlock and seral tree species (mountain hemlock, Pacific silver fir, lodgepole pine, western hemlock) with an understory of moisture adapted shrubs and herbaceous species. Trees are larger and older (100 to 200 years old).

Community 1.5

Mid-Development Closed Canopy Stand

A closed canopy of mid-development pole sized trees in the competitive exclusion phase results from the growth of saplings that will eventually develop single to few tree deaths that eventually develop into the reference community. The trees range in age from 50 to 200 years old.

Pathway 1.1A

Community 1.1 to 1.2

Rare, stand-replacement fire that kills significant number of mature trees and top-kills shrubs and herbaceous plants. This disturbance causes a return to the pioneering, herbaceous community with resprouting shrubs.

Pathway 1.2A

Community 1.2 to 1.3

With time, the tree seedlings and small saplings go to the mid development community and due to the occurrence of mixed severity fire the canopy is in an open configuration.

Pathway 1.2B

Community 1.2 to 1.5

With time, the tree seedlings and small saplings go to the mid development community grow into the closed canopy configuration.

Pathway 1.3B

Community 1.3 to 1.2

Rare, stand-replacement fire that kills significant number of mature trees and top-kills shrubs and herbaceous plants. This disturbance causes a return to the pioneering, herbaceous community with resprouting shrubs.

Pathway 1.3A

Community 1.3 to 1.4

With time, the pole sized trees develop to large mature trees in the late development phase.

Pathway 1.4A

Community 1.4 to 1.1

With time, the large mature trees develop into the closed configuration of the reference phase without the occurrence of mixed severity fire.

Pathway 1.4B

Community 1.4 to 1.2

Rare, stand-replacement fire that kills significant number of mature trees and top-kills shrubs and herbaceous plants. This disturbance causes a return to the pioneering, herbaceous community with resprouting shrubs.

Pathway 1.5A

Community 1.5 to 1.1

With time, the large mature trees develop into the closed configuration of the reference phase without the occurrence of mixed severity fire.

Pathway 1.5B

Community 1.5 to 1.2

Rare, stand-replacement fire that kills significant number of mature trees and top-kills shrubs and herbaceous plants. This disturbance causes a return to the pioneering, herbaceous community with resprouting shrubs.

Additional community tables

Other references

Scientific Literature:

WENATCHEE N.F.

Lillybridge, Terry R., et al. "Field guide for forested plant associations of the Wenatchee National Forest." Gen. Tech. Rep. PNW-GTR-359. Portland, OR: US Department of Agriculture, Forest Service, Pacific Northwest Research Station. 335 p. In cooperation with: Pacific Northwest Region, Wenatchee National Forest 359 (1995).
OLYMPIC N.F.

Henderson, Jan A., et al. "Forested plant associations of the Olympic National Forest." (1989).

GIFFORD PINCHOT N.F.

Brockway, Dale G. Plant association and management guide for the Pacific silver fir zone: Gifford Pinchot National Forest. US Department of Agriculture, Forest Service, Pacific Northwest Region, 1983.

Topik, Christopher, Nancy M. Halverson, and Dale G. Brockway. Plant association and management guide for the western hemlock zone: Gifford Pinchot National Forest. US Department of Agriculture, Forest Service, Pacific

Northwest Region, 1986.

Topik, Christopher. Plant association and management guide for the grand fir zone: Gifford Pinchot National Forest. Vol. 6. No. 88. US Department of Agriculture, Forest Service, Pacific Northwest Region, 1989.

Diaz, Nancy M. "Plant association and management guide for the mountain hemlock zone: Gifford Pinchot and Mt. Hood National Forests." (1997).

MT. BAKER-SNOQUALMIE N.F.

Henderson, Jan A. Field guide to the forested plant associations of the Mt. Baker-Snoqualmie National Forest. Vol. 28. No. 91. USDA, Forest Service, Pacific Northwest Region, 1992.

FIRE

Landfire, USFS FEIS.

Contributors

Erik Dahlke

Erin Kreutz

Steve Campbell

Stephanie Shoemaker

Approval

Kirt Walstad, 1/29/2025

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	05/09/2024
Approved by	Kirt Walstad
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. Number and extent of rills:

2. Presence of water flow patterns:

3. Number and height of erosional pedestals or terracettes:

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:
