

Ecological site F003XA309WA

High Glacial Trough Valleys Parkland - mountain hemlock-subalpine larch-whitebark pine

Last updated: 1/29/2025
Accessed: 05/10/2025

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.

Ecological site concept

This ecological site is defined as the highest extent of tree species. It resides at the interface between treeline and the alpine life zone. Soils are typically Spodosols (Inceptisols or Andisols occur as well) with diagnostic features including albic horizons, andic and spodic soil properties, and lithic or densic contacts. Parent material is from volcanic ash over glacial till, colluvium, or residuum. These soils are in the cryic soil temperature and udic soil moisture regimes. This site is on glacial trough valleys and mountain slopes at elevations of 4,250 to 6,000 feet, on moderate to steep slopes (25 to 60 percent) with harsh site conditions of high wind, deep and persistent snowpack, and short growing season that relegates tree species to grow only in clumps within an alpine meadow. Dominant tree species include whitebark pine (*Pinus albicaulis*), mountain hemlock (*Tsuga mertensiana*) and subalpine larch (*Larix lyalli*), though subalpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Pinus engelmannii*) may grow in the center of the tree clump. In general, whitebark pine resides in drier areas and subalpine larch in areas with more severe wind. The understory species are adapted to site conditions and vary from drier areas with eightpetal-avens (*Dryas octopetala*), pinegrass (*Calamagrostis rubescens*), common juniper (*Juniperus communis*), Greenleaf fescue (*Festuca viridis*) and moister areas with western moss heather (*Cassiope mertensiana*), partridgefoot (*Luetkea pectinate*), grouse whortleberry (*Vaccinium scopulorum*), broadleaf arnica (*Arnica latifolia*), Jacob’s-ladder (*Polemonium pulcherrimum*), pink mountainheath (*Phyllodoce empetrifomis*), black alpine sedge (*Carex nigricans*), mountain hairgrass (*Vahlodea atropurpurea*) and Hitchcock’s smooth woodrush (*Luzula hitchcockii*). The site conditions are the main limiting factor to tree growth, though rare stand replacing fire can occur at intervals of 400 years, based on the LANDFIRE models for whitebark pine (*Pinus albicaulis*). Numerous lightning strikes can occur on this site, particularly on ridges, but the lack of continuous tree canopy and low fuels preclude fire spread and severity.

Associated sites

F003XA306WA	East Mountain Slopes Forest subalpine fir
F003XA308WA	High Cirque Forest mountain hemlock
R003XA310WA	High Glacial Valley Walls Alpine

Similar sites

F003XC309WA	Mountain Slopes Parkland and Forest whitebark pine
-------------	--

Table 1. Dominant plant species

Tree	(1) <i>Pinus albicaulis</i> (2) <i>Tsuga mertensiana</i>
Shrub	(1) <i>Vaccinium scoparium</i>
Herbaceous	(1) <i>Luzula glabrata</i> var. <i>hitchcockii</i>

Physiographic features

This ecological site is defined as the highest extent of tree species and occurs at the interface between treeline and the alpine life zone. This site is on glacial trough valleys and mountain slopes at elevations of 4,250 feet to 6,000 feet, on moderate to steep slopes (25 to 60 percent) with harsh site conditions of high wind, deep and persistent snowpack and short growing season that relegates tree species to grow only in clumps within an alpine meadow.

Table 2. Representative physiographic features

Landforms	(1) Mountains (2) Mountains > Mountain slope
Elevation	4,250–6,000 ft

Slope	25–50%
Aspect	W, NW, N, S, SW

Table 3. Representative physiographic features (actual ranges)

Elevation	4,000–8,000 ft
Slope	Not specified

Climatic features

This ecological site is found in cold climatic conditions. The mean annual air temperature is 35 to 40 degrees.

Table 4. Representative climatic features

Frost-free period (characteristic range)	40-70 days
Freeze-free period (characteristic range)	
Precipitation total (characteristic range)	45-85 in

Influencing water features

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

Soil features

Soils are typically Spodosols (Inceptisols or Andisols occur as well) with diagnostic features including albic horizons, andic and spodic soil properties, and lithic or densic contacts. Parent material is from volcanic ash over glacial till, colluvium, or residuum. These soils are in the cryic soil temperature and udic soil moisture regimes. Permeability is very low through dense glacial till. Andic soil properties occur at depths of 0 to 21 inches.

Table 5. Representative soil features

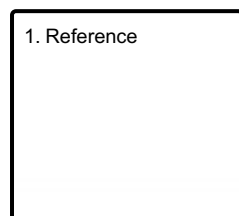
Parent material	(1) Volcanic ash (2) Colluvium (3) Residuum (4) Till
Surface texture	(1) Ashy fine sandy loam (2) Ashy very fine sandy loam
Family particle size	(1) Ashy over loamy-skeletal
Drainage class	Well drained to somewhat excessively drained
Permeability class	Very slow to rapid
Depth to restrictive layer	20–60 in
Soil depth	20–60 in
Surface fragment cover <=3"	0–5%
Surface fragment cover >3"	0–5%
Available water capacity (Depth not specified)	3.5–6.3 in
Calcium carbonate equivalent (Depth not specified)	0%
Soil reaction (1:1 water) (Depth not specified)	4.5–6.5

Ecological dynamics

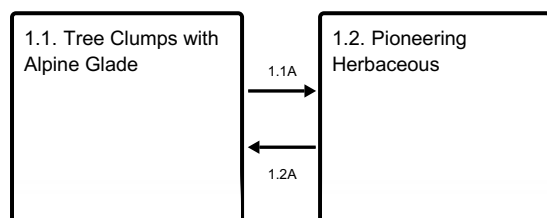
This ecological site is defined by harsh site conditions that preclude continuous tree canopy cover, relegating trees to grow in clumps within an alpine meadow glade with heath shrub species and other shrubs. The main disturbance is burrowing by rodents such as hoary marmots (*Marmota caligata*) or black bear (*Ursus americanus*) scavenging by digging and very rare stand replacing fire. Fire spread and severity would be limited due to lack of continuous tree canopy and low fuels. This site is bounded at higher elevations by the Alpine PES which lacks all tree species, and by the High cirque Forest - Mountain Hemlock PES below.

State and transition model

Ecosystem states



State 1 submodel, plant communities



State 1 Reference

Community 1.1 Tree Clumps with Alpine Glade

This phase has an overstory dominated by Mountain Hemlock, subalpine larch and/or whitebark pine, growing in tree clumps with subalpine fir and Engelmann spruce growing in the protected center of the tree clump. Tree clumps are interspersed within an herbaceous parkland glade of cold adapted species including on drier site conditions. Common species include: pinegrass, eight-petal avens, green fescue, common juniper. On slightly moister site areas the glade consists of western moss heather, partridgefoot, grouse whortleberry and Hitchcock's smooth woodrush.

Community 1.2 Pioneering Herbaceous

Immediately post-fire, on-site and windblown tree seeds establish, shrub and herbaceous plants resprout and pioneering herbaceous plants establish on mineral soil interspaces. Whitebark pine, mountain hemlock, subalpine larch are the most successful regenerating tree species at this site.

Pathway 1.1A Community 1.1 to 1.2

1.1A: This represents rare, stand replacing fire.

Pathway 1.2A Community 1.2 to 1.1

1.2A: Time without disturbance.

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, 2007, Biophysical Settings Model Descriptions, LANDFIRE 1.1.0, U.S. Department of the Interior, USDA Forest service, Accessed 20 April 2020 at <https://www.landfire.gov/bps-models.php>

Rocchio, F. Joseph, and Rex C. Crawford. "Conservation Status Ranks for Washington's Ecological Systems." (2015).

Rocchio, F. J., and R. C. Crawford. "Draft field guide to Washington's ecological systems." Washington Natural Heritage Program, Washington Department of Natural Resources. Olympia, WA (2008).

Franklin, J., & Dyrness, C. Natural vegetation of Oregon and Washington. : Portland, Or., Pacific Northwest Forest and Range Experiment Station, Forest Service, U.S. Dept. of Agriculture.

Contributors

Stephanie Shoemaker

Erik Dahlke

Erin Kreutz

Steve Campbell

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:**
-