USDA Natural Resources
Conservation Service

Ecological site F003XB308WA
High Cirque Walls Forest mountain hemlock

Last updated: 1/29/2025
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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

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 Olympic Mountains land resource unit is composed of the mid to upper elevation areas on the Olympic Peninsula in northwest Washington. It occurs primarily on the eastern side of the peninsula above the warmer, lower Olympic foothills of MLRA 2.

Large amounts of rain and snow contribute to a very moist environment and a considerable stream and river network. Major rivers that have headwaters in the LRU include the Elwha, Wynoochee, and Skokomish Rivers.

Lithology is primarily oceanic sedimentary rock stacked in an accretionary wedge and coastal basalt that has been metamorphosed and vertically uplifted into a large horseshoe shape called the Crescent Formation (Washington Geological Survey). This chaotic collection of rock in many cases has been metamorphosed. These geologic materials were heavily modified by Pleistocene alpine glaciation. Contemporary glaciers which receive copious amounts of yearly snowfall continue to sculpt the dissected valleys with runoff.

Soils are primarily Spodosols, Inceptisols, and unique Andisols developed from non-volcanic materials.

The LRU has a strong rainshadow effect and areas on the northeastern side of the peninsula are considerably drier than near-Pacific western slopes. Vegetation is primarily dense forest. At lower elevations, western hemlock (Tsuga heterophylla) is the dominate tree species; western redcedar (Thuja plicata) is quite common in moist areas and Douglas-fir (Pseudotsuga menziesii) is common in drier areas. 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

Mountain hemlock/Alaska huckleberry, mountain hemlock/Alaska huckleberry/beargrass

Ecological site concept

This ecological site resides on cirques and mountain slopes in the mountain, at elevations of 2,800 to 4,080 feet on slopes 45 to 85 percent. The climate is cold and moist (105 to 125 frost free days, mean annual precipitation of 135 to 205 inches and average annual air temperature of 38 to 41 Fahrenheit). Site conditions are harsh with heavy, persistent, late melting snowpack that results in a short growing season. The soils are primarily Andisols with medial-skeletal textures. Andic soil properties are derived from the extreme weathering environment and higher amounts of organic matter in the soil; volcanic ash influence is minimal. Parent material is primarily colluvium derived from basalt. The soil temperature regime is cryic and the soil moisture regime is udic. Soils have lithic contacts within 40 inches of the soil surface. The reference community overstory is primarily mountain hemlock and Pacific silver fir may have high cover. The understory generally has high cover of Alaska huckleberry (Vaccinium alaskensis) with a diversity of other species including: white avalanche-lily (*Erythronium montanum*), strawberryleaf raspberry (Rubus pedatus), oval-leaf blueberry (Vaccinium ovalifolium), thinleaf huckleberry (Vaccinium membranaceum), deer fern (Blechnum spicant), oneleaf foamflower (Tiarella trifoliata var. unifoliate), common beargrass (Xerophyllum tenax), bride's bonnet (Clintonia uniflora), rusty menziesia (Menziesia ferruginea), and mosses. A variety of seral tree species are present including western hemlock (Tsuga heterophylla), western redcedar (Thuja plicata) on warmer, lower elevation sites and subalpine fir (Abies lasiocarpa) and Alaska cedar (Callitropsis nootkatensis). At the highest elevations, the overstory has only mountain hemlock (Tsuga mertensiana) and the understory has pink mountainheath (Phyllodoce empetriformis), Cascade bilberry (Vaccinium deliciosum), western moss heather (Cassiope mertensiana), oval-leaf blueberry (Vaccinium ovalifolium), common beargrass (Xerophyllum tenax), thinleaf huckleberry (Vaccinium membranaceum), Sitka valerian (Valerian sitchensis). Avalanches can occur on this site. Diseases and insect damage include Annosus root rot, laminated; heart and butt rot, hemlock dwarf mistletoe, or rusty red stringy rot. Lightning strikes are common, though because of snowpack, limited fuels, fires caused by lightning tend to be small, patch disturbances. Stand replacement fires that are very rare occur with a rotational interval of 1000 years in the Olympic Mountains. Generally, mountain hemlock in the Pacific Northwest during pre-logging times had fire rotation intervals of 600 years. 0710411 North Pacific Mountain Hemlock Forest – Wet Biophysical Setting from LANDFIRE is 1000 years.

Associated sites

F003XB307WA	**High Mountain Slopes Forest Pacific silver fir**

Similar sites

F003XA308WA	**High Cirque Forest mountain hemlock**
F003XC309WA	**Mountain Slopes Parkland and Forest whitebark pine**

Table 1. Dominant plant species

Tree	(1) *Tsuga mertensiana* (2) *Abies amabilis*
Shrub	(1) *Vaccinium alaskaense*
Herbaceous	Not specified

Physiographic features

This ecological site resides on cirques and mountain slopes in the mountain, at elevations of 2,800 to 4,080 feet on slopes 45 to 85 percent.

Table 2. Representative physiographic features

Landforms	(1) Mountains > Mountain slope (2) Cirque

Flooding frequency	None
Ponding frequency	None
Elevation	2,800–4,080 ft
Slope	45–85%
Aspect	W, NW, N, S, SW

Climatic features

The climate is cold and moist. The average annual air temperature is 38 to 41 Fahrenheit. Site conditions are harsh with heavy, persistent, late melting snowpack that results in a short growing season.

Table 3. Representative climatic features

Frost-free period (characteristic range)	105-125 days
Freeze-free period (characteristic range)	
Precipitation total (characteristic range)	135-205 in

Influencing water features

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

Soil features

The soils are primarily Andisols with medial-skeletal textures. Andic soil properties are derived from the extreme weathering environment and higher amounts of organic matter in the soil; volcanic ash influence in minimal. Parent material is primarily colluvium derived from basalt. The soil temperature regime is cryic and the soil moisture regime is udic. Soils have lithic contacts within 40 inches of the soil surface.

Table 4. Representative soil features

Parent material	(1) Colluvium–basalt
Surface texture	(1) Extremely gravelly sandy loam (2) Cobbly fine sandy loam
Family particle size	(1) Medial-skeletal (2) Loamy-skeletal
Drainage class	Moderately well drained to well drained
Permeability class	Rapid
Depth to restrictive layer	4–40 in
Soil depth	4–40 in
Surface fragment cover <=3"	7–44%
Surface fragment cover >3"	3–26%
Available water capacity (0-40in)	0.3–3.2 in
Soil reaction (1:1 water) (Depth not specified)	3.5–5.5

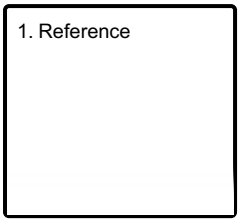
Ecological dynamics

Lightning strikes are common on this site, though cold and moist site conditions combined with low fuel availability limit fire spread. Very rarely, on a rotation of 1,000 years, a stand replacement fire can occur. Diseases such as root rot, butt and heart rot, and insect damage can occur. Avalanches can impact this site. Parklands and Alpine life

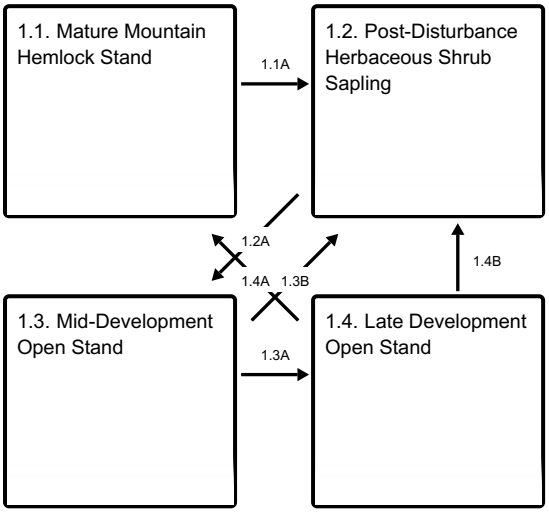
zones occur at elevations above this site with tree growth limited to clumps and krumholtz. At elevations below this ecological site is the Pacific silver fir ecological site with more moderate site conditions.

State and transition model

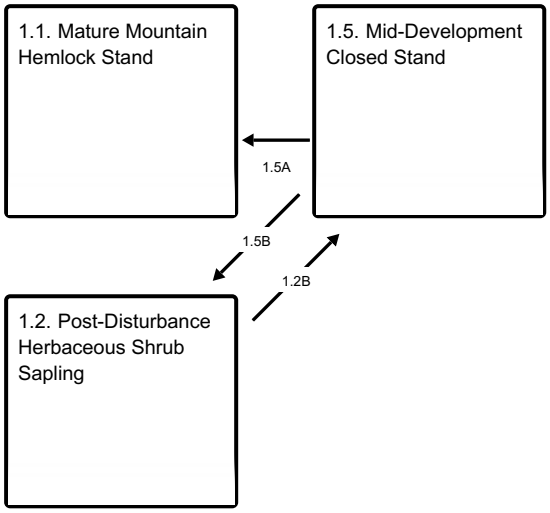
Ecosystem states

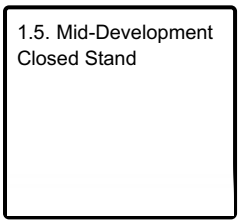


State 1 submodel, plant communities



Communities 1, 5 and 2 (additional pathways)





State 1
Reference

Community 1.1
Mature Mountain Hemlock Stand

This phase has an overstory dominated by Mountain hemlock (at least ten percent overstory canopy cover present) and Pacific silver fir, with numerous lower tree canopies of both and seral species including Subalpine fir, Alaska cedar, western hemlock, wester redcedar. Trees are large (average diameter at breast height is 20-30 inches) and are mature (200 to 250 years or older). The understory consists of tall shrubs, and cool, moist-adapted shrub and herbaceous species (Alaska blueberry, white avalanche lily (*Erythronium montanum*), dwarf dramble, oval-leaf huckleberry, common beargrass, bride's bonnet, rusty menziesia, moss species), though slightly drier sites will have vine mape and vaccinium species. At the highest elevation of the mountain hemlock ecosite, the overstory has at least ten percent canopy cover of mountain hemlock and seral tree species including subalpine fir, Pacific silver fir and Alaska cedar and an understory of pink mountainheath, ovalleaf huckleberry, common beargrass, thinleaf huckleberry, Sitka valerian, western moss heather, Cascade bilberry.

Dominant plant species

- mountain hemlock (*Tsuga mertensiana*), tree
- Pacific silver fir (*Abies amabilis*), tree

- subalpine fir (*Abies lasiocarpa*), tree
- Alaska cedar (*Callitropsis nootkatensis*), tree
- western hemlock (*Tsuga heterophylla*), tree
- western redcedar (*Thuja plicata*), tree
- Alaska blueberry (*Vaccinium alaskaense*), shrub
- strawberryleaf raspberry (*Rubus pedatus*), shrub
- oval-leaf blueberry (*Vaccinium ovalifolium*), shrub
- rusty menziesia (*Menziesia ferruginea*), shrub
- common beargrass (*Xerophyllum tenax*), other herbaceous
- bride's bonnet (*Clintonia uniflora*), other herbaceous
- Moss (*Moss*), other herbaceous

Community 1.2
Post-Disturbance Herbaceous Shrub Sapling

Immediately post-fire, on-site and windblown tree seeds establish, shrub and herbaceous plants resprout and pioneering herbaceous plants establish on mineral soil interspaces. This is a short duration community phase that lasts approximately three years. Following this initial phase, perennial shrubs dominate the understory and stabilize the soil. Shrubs are diverse and can include rusty menziesia, Alaska huckleberry, Cascade azalea and Pacific rhododenron. There may be remnant trees throughout the site. Seedlings mature to saplings and then pole-sized trees up to 100 years. Tree species that may be present include mountain hemlock, Pacific silver fir, subalpine fir, Alaska cedar, western hemlock and western redcedar.

Dominant plant species

- mountain hemlock (*Tsuga mertensiana*), tree
- Pacific silver fir (*Abies amabilis*), tree
- subalpine fir (*Abies lasiocarpa*), tree
- Alaska cedar (*Callitropsis nootkatensis*), tree
- western hemlock (*Tsuga heterophylla*), tree
- western redcedar (*Thuja plicata*), tree
- thinleaf huckleberry (*Vaccinium membranaceum*), shrub
- rusty menziesia (*Menziesia ferruginea*), shrub
- Alaska blueberry (*Vaccinium alaskaense*), shrub
- common beargrass (*Xerophyllum tenax*), other herbaceous

Community 1.3
Mid-Development Open Stand

This phase is dominated by a mix of mountain hemlock, Pacific silver fir, and numerous possible seral tree species (subalpine fir, Alaska cedar, western hemlock, wester redcedar, western white pine) that are pole-sized and are in an open canopy due to the occurrence of mixed severity fire, and insect and/or disease damage. There numerous tree canopies present in the stand. Tree ages are at least fifty years old to 150 years old. The understory is a mix of tall shrubs and moist adapted herbaceous species including Alaska huckleberry, thimbleberry, oval-leaf huckleberry, common beargrass, rusty menziesai, white mountin lily, bride's bonnet and moss species.

Dominant plant species

- mountain hemlock (*Tsuga mertensiana*), tree
- Pacific silver fir (*Abies amabilis*), tree
- subalpine fir (*Abies lasiocarpa*), tree
- Alaska cedar (*Callitropsis nootkatensis*), tree
- western hemlock (*Tsuga heterophylla*), tree
- western redcedar (*Thuja plicata*), tree
- Alaska blueberry (*Vaccinium alaskaense*), shrub
- strawberryleaf raspberry (*Rubus pedatus*), shrub
- oval-leaf blueberry (*Vaccinium ovalifolium*), shrub
- rusty menziesia (*Menziesia ferruginea*), shrub
- common beargrass (*Xerophyllum tenax*), other herbaceous

- bride's bonnet (*Clintonia uniflora*), other herbaceous
- Moss (*Moss*), other herbaceous

Community 1.4
Late Development Open Stand

This phase is dominated by a mix of mountain hemlock, Pacific silver fir, and numerous possible seral tree species (subalpine fir, Alaska cedar, western hemlock, wester redcedar, western white pine) that are pole-sized and are in an open canopy due to the occurrence of mixed severity fire, and insect and/or disease damage. There numerous tree canopies present in the stand, and Pacific silver fir tends to dominate these lower canopies. Tree ages are larger (average diameter at breast height is 20 to 30 inches) and at least 150 years old to 200 years old. The understory is a mix of tall shrubs and moist adapted herbaceous species including Alaska huckleberry, thimbleberry, oval-leaf huckleberry, common beargrass, rusty menziesai, white mountin lily, bride's bonnet and moss species.

Dominant plant species

- mountain hemlock (*Tsuga mertensiana*), tree
- Pacific silver fir (*Abies amabilis*), tree
- subalpine fir (*Abies lasiocarpa*), tree
- Alaska cedar (*Callitropsis nootkatensis*), tree
- western hemlock (*Tsuga heterophylla*), tree
- western redcedar (*Thuja plicata*), tree
- Alaska blueberry (*Vaccinium alaskaense*), shrub
- strawberryleaf raspberry (*Rubus pedatus*), shrub
- oval-leaf blueberry (*Vaccinium ovalifolium*), shrub
- rusty menziesia (*Menziesia ferruginea*), shrub
- common beargrass (*Xerophyllum tenax*), other herbaceous
- bride's bonnet (*Clintonia uniflora*), other herbaceous
- Moss (*Moss*), other herbaceous

Community 1.5
Mid-Development Closed Stand

This plant community is dominated by larger trees that are a mix of mountain hemlock, Pacific silver fir, and some seral tree species (subalpine fir, Alaska cedar, western hemlock, wester redcedar, western white pine) in the overstory in a closed canopy configuration. The closed canopy is due to the lack occurrence of mixed severity fire. The lower tree canopy has Pacific silver fir as well. Trees are pole-sized (average diameter at breast height is ten to twnety inches) and mature approximately 150 to 250 years old.

Dominant plant species

- mountain hemlock (*Tsuga mertensiana*), tree
- Pacific silver fir (*Abies amabilis*), tree
- subalpine fir (*Abies lasiocarpa*), tree
- Alaska cedar (*Callitropsis nootkatensis*), tree
- western hemlock (*Tsuga heterophylla*), tree
- western redcedar (*Thuja plicata*), tree
- rusty menziesia (*Menziesia ferruginea*), shrub
- Alaska blueberry (*Vaccinium alaskaense*), shrub
- thinleaf huckleberry (*Vaccinium membranaceum*), shrub
- common beargrass (*Xerophyllum tenax*), other herbaceous

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.

Avalanches can cause a similar disturbance, in that the community is returned to a pioneering herbaceous one. Avalanches repeat in the same place periodically and advancement of the community will be truncated if avalanches occur (similar to fire).

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 and grow into closed 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. Avalanches can cause a similar disturbance, in that the community is returned to a pioneering herbaceous one. Avalanches repeat in the same place periodically and advancement of the community will be truncated if avalanches occur (similar to fire).

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 tree 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. Avalanches can cause a similar disturbance, in that the community is returned to a pioneering herbaceous one. Avalanches repeat in the same place periodically and advancement of the community will be truncated if avalanches occur (similar to fire).

Pathway 1.5A
Community 1.5 to 1.1

With time, the large mature tree 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. Avalanches can cause a similar disturbance, in that the community is returned to a pioneering herbaceous one.

Avalanches repeat in the same place periodically and advancement of the community will be truncated if avalanches occur (similar to fire).

Additional community tables

Other references

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Contributors

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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):**

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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:**
