USDA Natural Resources
Conservation Service

Ecological site F003XC308WA
High Cirques Forest mountain hemlock

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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 Glaciated Western Cascades land resource unit is located in southwestern Washington primarily along the western slope of the Cascade Range. It is bounded by the Snoqualmie Pass area to the north and the Columbia River 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 major rivers originating in the LRU are the Puyallup and Nisqually Rivers which drain to Puget Sound and the Cowlitz and Lewis Rivers which drain west to the Columbia.

Some of the lithology in the LRU is the result of numerous accretions from tectonic subduction of the Pacific plate along the margin of the North American plate creating combinations of metamorphized sedimentary or oceanic rock and intrusive volcanic plutons. The Cascades in this area have a long history of volcanic activity starting about 55 million years ago. Eruptions have created a complex sequence of low-silica and silica-rich depositions that have been eroded and buried repeatedly (Washington Geological Survey). Mount Rainier, Mount Adams, and Mount Saint Helens are volcanoes and the most notable peaks; Mount Saint Helens continues to vent after the 1980 eruption. Alpine glaciers still remain active at the highest elevations. The area was not influenced by continental glaciation, however Pleistocene alpine glaciation modified much of the dissected terrain and contributed glacial sediment to the complex combination of lithologies and volcanism.

Soils are mainly Spodosols and Andisols.

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

mountain hemlock/rusty menziesia-big huckleberry
mountain hemlock/beargrass-low huckleberry

Ecological site concept

This ecological site resides on mountain slopes, broad tops of ridges, and valley floors in the mountains at elevations of 3,600 to 5700 feet on slopes 25 to 55 percent with cold climatic conditions (average frost free days is 45 to 80 days, mean annual precipitation is 65 to 95 inches and average mean annual air temperature is 38 to 42 degrees Fahrenheit). Soils are mostly Andisols or Spodosols with some Inceptisols. The soils have high amounts of organic material in the upper part and andic soil properites are present in Spodosols and Inceptisols. Parent material is primarily volcanic ash mixed with colluvium from glacial till or igneous or metaphorphic rock. Most soils have a lithic contact withing 40 to 60 inches from the soil surface and have ashy-skeletal or medial-skeletal textures. The soil moisture regime is udic and the soil temperature regime is cryic. This site occurs in the mountain hemlock areas within LRU C, which span the highest closed canopy forests, directly below the open canopy Pinus albicaulis and subalpine parklands. These forests have a deep, persistent snowpack and a short growing season. Fires occur frequently from lightning strikes Although most fires are very small, infrequently there are large stand replacing fires approximately every 300 to 400 years. Insects and diseases impact these forests on small scales including heart and butt rot, root rot, bark beetles, and others. Heath species may be common and avalanches may be a more dominant disturbance in some areas, reoccurring in the same areas repeatedly. The reference community has mountain hemlock (Tsuga mertensiana) and can have high cover of Pacific silver fir (Abies amabilis) and seral trees including subalpine fir (Abies lasiocarpa) and Engelmann spruce (Pinus engelmannii). The shrubby understory typically has rusty menziesia (Menziesia ferruginea), Alaska blueberry (Vaccinium alaskense), Cascade azalea (Rhododendron albiflorum) and common beargrass (Xerophyllum tenax). The highest elevations have heath species such as pink mountainheath (Phyllodoce gladuliflora).

Associated sites

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

Similar sites

F003XB308WA	**High Cirque Walls Forest mountain hemlock**
F003XA308WA	**High Cirque Forest mountain hemlock**

Table 1. Dominant plant species

Tree	(1) *Tsuga mertensiana*
Shrub	(1) *Menziesia ferruginea* (2) *Vaccinium membranaceum*
Herbaceous	(1) *Xerophyllum tenax*

Physiographic features

This ecological site resides on mountain slopes, broad tops of ridges, and valley floors in the mountains at elevations of 3,600 to 5700 feet on slopes 25 to 55 percent.

Table 2. Representative physiographic features

Landforms	(1) Mountains > Mountain slope (2) Mountains > Ridge (3) Mountains > Valley floor

Elevation	1,097–1,737 m
Slope	25–55%
Aspect	W, NW, N, S, SW

Climatic features

Site is affected by cold climatic conditions. The average mean annual air temperature is 38 to 42 degrees Fahrenheit).

Table 3. Representative climatic features

Frost-free period (characteristic range)	45-80 days
Freeze-free period (characteristic range)	
Precipitation total (characteristic range)	1,651-2,413 mm

Influencing water features

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

Soil features

Soils are mostly Andisols or Spodosols with some Inceptisols. The soils have high amounts of organic material in the upper part and andic soil properites are present in Spodosols and Inceptisols. Parent material is primarily volcanic ash mixed with colluvium from glacial till or igneous or metaphorphic rock. Most soils have a lithic contact withing 40 to 60 inches from the soil surface and have ashy-skeletal or medial-skeletal textures. Andic properties can occur from 0 to 60 inches, but typically occur from 0 to 30 inches depth in the soil pedon.
The soil moisture regime is udic, and the soil temperature regime is cryic.

Table 4. Representative soil features

Parent material	(1) Volcanic ash (2) Colluvium (3) Till
Family particle size	(1) Ashy-skeletal (2) Loamy-skeletal (3) Ashy-skeletal over loamy-skeletal
Drainage class	Moderately well drained to well drained
Permeability class	Moderately rapid to rapid
Depth to restrictive layer	51–152 cm
Soil depth	51–152 cm
Surface fragment cover <=3"	0–26%
Surface fragment cover >3"	0–16%
Available water capacity (Depth not specified)	6.86–18.03 cm
Calcium carbonate equivalent (Depth not specified)	0%
Soil reaction (1:1 water) (Depth not specified)	4.5–6.5

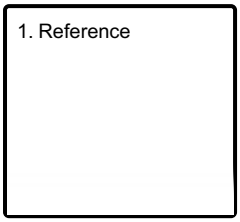
Ecological dynamics

Site climatic conditions are harsh and determine site productivity. Fire is a rare event and usually stand replacing.

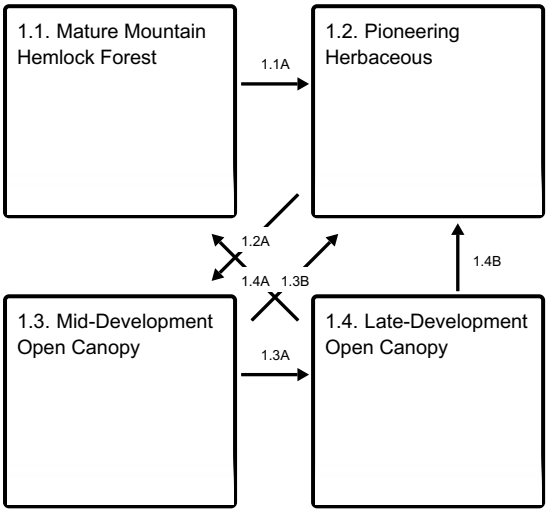
The USFS Fire Effects Information System (FEIS) states that for mountain hemlock in the Pacific Northwest, fire occurred at 600-year intervals in pre-logging situations. In the southern Washington Cascades., fires have a return interval greater than current stand ages of 300 years. LANDFIRE models state that stand replacing fires return every 500 years, mixed severity fires every 2,000 years. This site is also impacted by avalanches, diseases (root, heart and butt rot), and insect damage.

State and transition model

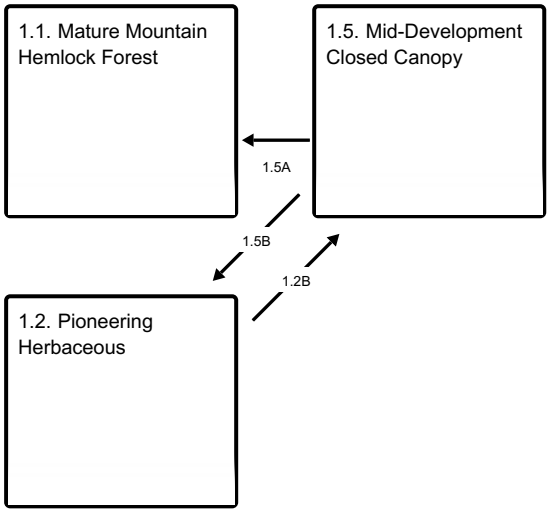
Ecosystem states

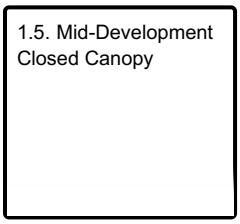


State 1 submodel, plant communities



Communities 1, 5 and 2 (additional pathways)





State 1
Reference

Community 1.1
Mature Mountain Hemlock Forest

This phase has an overstory dominated by Mountain hemlock and Pacific silver fir, with numerous lower tree canopies of both as well as seral species such as western hemlock, Douglas fir and Alaska cedar. The trees are large (average diameter at breast height is 20inches) and mature (at least 150 to 200 years old). The understory consists of tall shrubs, and cool, moisture adapted herbaceous species. Thick, tall and medium statured shrubs include: rusty menziesia, Alaska blueberry, Cascade azalea, and roughfruit berry. Common beargrass is a typical forb but can also have bride's bonnet, oneleaf foamflower, Sitka valerian and moss.

Community 1.2
Pioneering Herbaceous

Pioneering herbaceous community. Immediately post-fire, on-site and windblown tree seeds establish (mountain

hemlock, Subalpine fir, Engelmann spruce, western hemlock, Douglas fir and Alaska cedar), shrub and herbaceous plants resprout, and pioneering herbaceous plants establish on mineral soil interspaces. This is a short duration community phase. This is followed by the perennial shrub community. This plant community contains a high diversity of shrubs. Within fifty years, seedlings mature to saplings and on to pole sized trees.

Community 1.3
Mid-Development Open Canopy

This phase is dominated by a mix of mountain hemlock, Pacific silver fir and seral tree species (western hemlock, western white pine, Douglas fir and Alaska cedar) that are pole sized (generally less than twenty inches at diameter at breast height), generally 50 to 100 years old and develop an open canopy due to the occurrence of mixed severity fire. Insects and disease can also maintain the open canopy. The lower, secondary tree canopy layer is of mountain hemlock and Pacific silver fir.

Community 1.4
Late-Development Open Canopy

This phase is dominated by a mix of mountain hemlock, Pacific silver fir and seral tree species (western hemlock, western white pine, Douglas fir and Alaska cedar) that are larger than pole sized (generally more than twenty inches at diameter at breast height), 100 to 200 years old, and develop an open canopy due to the occurrence of mixed severity fire. Insect and disease may also maintain the open canopy configuration. The lower, secondary tree canopy layer is of Pacific silver fir.

Community 1.5
Mid-Development Closed Canopy

The overstory in this plant community is dominated by a mix of larger mountain hemlock and Pacific silver fir and seral species such as subalpine fir, Engelmann spruce, western hemlock, Douglas fir and Alaska cedar. The closed canopy configuration is due to the lack of occurrence of mixed severity fire. The lower tree canopy has Pacific silver fir. These trees have an average diameter at breast height of twenty inches and are 500 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

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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):**

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:**