USDA Natural Resources Conservation Service

Ecological site R003XN545WA
Southern Washington Cascades Debris Covered Glaciers

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

Steep mountains and narrow to broad, gently sloping valleys characterize this MLRA. A triple junction of two oceanic plates and one continental plate is directly offshore from Puget Sound. Subduction of the oceanic plates under the westerly and northwesterly moving continental plate contributes to volcanic activity in the Cascade Mountains. Movement among these plates has resulted in major earthquakes and the formation of large stratovolcanoes. The Cascade Mountains consist primarily of volcanic crystalline rock and some associated metasedimentary rock. The mean annual precipitation is dominantly 60 to 100 inches, but it is 30 to 60 inches on the east side of the Cascade Mountains.
The soil orders in this MLRA are dominantly Andisols, Spodosols, and Inceptisols and minor areas of Entisols and Histosols. The soils are dominantly in the frigid or cryic temperature regime and the udic moisture regime. The soils generally are shallow to very deep, well drained, ashy to medial, and loamy or sandy. They are on mountain slopes and ridges.

Ecological site concept

This ecological site is on debris-covered termini of alpine glaciers at an elevation of 3,600 to 7,200 feet. Several large glaciers carved steep-sided valleys on Mount Rainier, and the valley walls formed in old moraines that consist of loose andesitic till. Gravity causes the loose till to move downslope onto the termini of the alpine glaciers. Other sources of debris include rockfalls; material released as a result of freezing and thawing, which impacts the availability of water; and waterborne and windborne sediment.
The soils that support this ecological site are in the gelic soil temperature regime and the udic soil moisture regime. They are coarse textured and very low in content of organic matter and have a low cation-exchange capacity. They are about 20 inches deep to permafrost. Because of the permafrost, the subsurface soil temperature is much cooler than that of other soils at similar elevations. Variations in the depth of the soils favor growth of species in early seral communities. The species are highly variable.
The forests and other habitats surrounding the glaciers provide an adequate seed source, which influences the biological diversity of the site. The early seral species become established in the limited debris cover and are affected by frequent disturbances (Fickert, 2007).
The length of the growing season is dependent on factors such as the duration of snow cover, soil temperature, and soil moisture. Areas on south-facing slopes support more drought-sensitive species, such as pearly everlasting and stonecrop (Sedum), and areas on north-facing slopes support species such as purple monkeyflower (*Mimulus lewisii*) and Mertens' rush (*Juncus mertensianus*) (Fickert, 2007). Elevation is not a primary factor affecting the dynamics of the site.

Associated sites

F003XN952WA	**Southern Washington Cascades High Cryic Deciduous Forest** Ecological site R003XN545WA, Southern Washington Cascades Debris-covered Glaciers, share some features to those of site F003XN952WA, Southern Washington Cascades High Cryic Deciduous Forest. Both ecological sites are at high elevations that are subject to extreme disturbance regimes. Both sites are colonized with early seral species that are adapted to the high elevations and poor growing conditions. Ecological site R003XN545WA is uniquely distinguished by glacial conditions and permafrost. Under warmer conditions and glacier retreat, site R003XN545WA may transition to resemble site F003XN952WA.

Similar sites

F003XN951WA	**Southern Washington Cascades High Cryic Coniferous Forest** Over a long period without disturbance, site R003XN545WA, Southern Washington Cascades Debris-covered Glaciers, may transition to a mature forest that resembles that of site F003XN951WA, Southern Washington Cascades High Cryic Coniferous Forest.

Table 1. Dominant plant species

Tree	(1) *Pseudotsuga menziesii* (2) *Tsuga heterophylla*
Shrub	(1) *Alnus viridis ssp. sinuata* (2) *Salix scouleriana*
Herbaceous	(1) *Epilobium hornemannii* (2) *Anaphalis margaritacea*

Physiographic features

This ecological site is on alpine glaciers (3,600 to 7,200 feet) in Mount Rainier National Park. The growing season on this site is shorter as compared to sites at lower elevations. Slope commonly is 5 to 65 percent. This site varies physiologically and is heavily influenced by disturbances.

Table 2. Representative physiographic features

Flooding frequency	None
Ponding frequency	None
Elevation	3,600–7,200 ft
Slope	5–65%
Water table depth	0–75 in
Aspect	W, NW, N, NE, E, SE, S, SW

Climatic features

Most of the annual precipitation is received in October through March. The mean annual precipitation is 88 to 160 inches, and the mean annual air temperature is 33 to 49 degrees F. The microclimate may vary depending on soil temperature and site-specific features. Generally, the summers are cool and dry and the winters are cold and wet.

Table 3. Representative climatic features

Frost-free period (characteristic range)	0-45 days
Freeze-free period (characteristic range)	
Precipitation total (characteristic range)	88-160 in

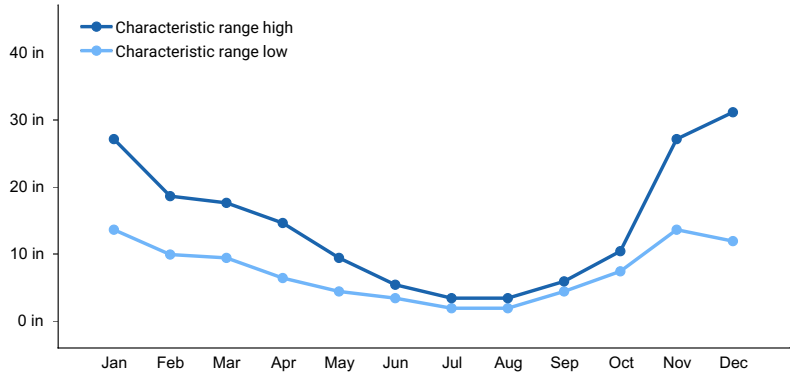


Figure 1. Monthly precipitation range

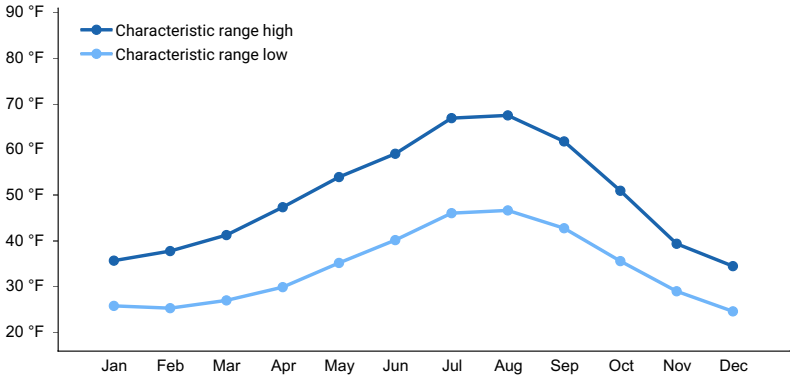


Figure 2. Monthly minimum temperature range

Influencing water features

This site is at middle to high elevations on alpine glaciers in Mount Rainier National Park. It is not subject to flooding or ponding. It does not have a water table during the growing season.

Soil features

Applicable soils: Tamanos

Applicable soil map unit in Mount Rainier National Park: 9263

The Tamanos soils are in the gelic soil temperature regime and the udic soil moisture regime. They are well drained and moderately deep to glacial ice. They are on alpine glaciers and formed in colluvium over ice. These soils do not have a water table during the growing season, and they are not subject to flooding or ponding. The Tamanos soils have more than 35 percent rock fragments in the particle-size control section. They are coarse textured and dominantly ashy loamy sand and ashy sand. None of the horizons has andic soil properties. Cryoturbation is the dominant pedogenic process. Podsolization is not evident in the soils because of the lack of coniferous forest cover. The Tamanos soils have an ochric epipedon.

Parent Material: Colluvium over ice

Table 4. Representative soil features

Surface texture	(1) Loamy sand (2) Sand
Drainage class	Well drained
Soil depth	20–30 in
Surface fragment cover <=3"	5–30%
Surface fragment cover >3"	0–30%

Available water capacity (Depth not specified)	0.5–1 in
Soil reaction (1:1 water) (Depth not specified)	6.1–7
Subsurface fragment volume <=3" (Depth not specified)	15–30%
Subsurface fragment volume >3" (Depth not specified)	10–45%

Ecological dynamics

This ecological site is on the debris-covered termini of alpine glaciers. Abiotic factors that affect this unique site include landscape position, landform, ice, and heavy snowpack. Gravity causes the loose till material to move downslope onto the termini of alpine glaciers. Other sources of debris include rockfalls; material released by freezing and thawing, which impacts the availability of water; and waterborne and windborne sediment.

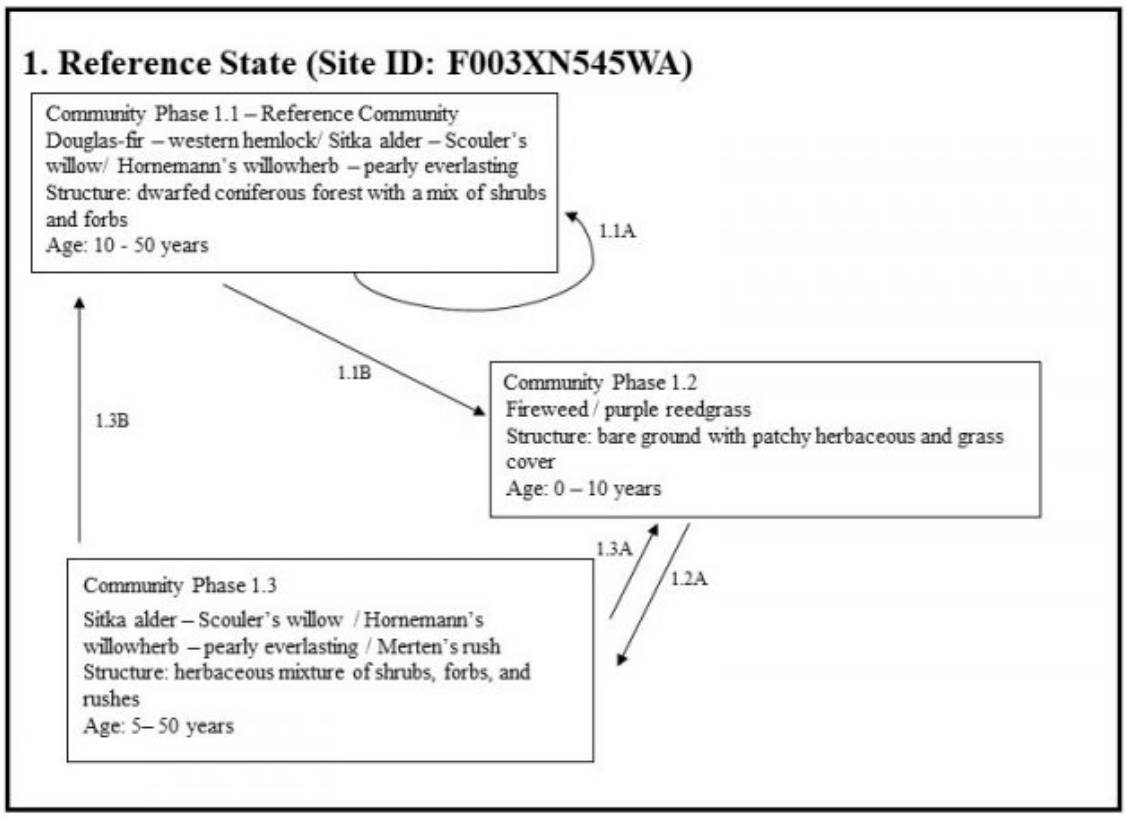
The forests and other habitats surrounding the glaciers provide an adequate seed source that influences the biological diversity of the ecological site. Early seral species affected by frequent disturbances become established on the limited debris cover (Fickert, 2007). The site commonly is disturbed by mass movement, avalanches, and snow and ice cover, which limit the growth of plants to maturity.

Because of the permafrost, the subsurface soil temperature is much cooler than it is in other soils at similar elevations. This cooling effect causes a shift in the plant species composition to that of subalpine and alpine zones. The other major influence on species composition is the constant disturbance from shifting subsurface ice and deposition of loose till material from the valley walls. The variations in the depth of the soils favor growth of species in early seral communities. The species are highly variable.

Seedlings of later seral species such as Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), and Sitka alder (*Alnus viridis* ssp. sinuata) may become established, but they rarely grow to full size. Coniferous trees rarely are more than 3 feet high; however, shrubs are as much as 10 feet high (Fickert, 2007). Common plants include fireweed (*Chamerion angustifolium*), Hornemann's willowherb (*Epilobium hornemannii*), pearly everlasting (*Anaphalis margaritacea*), white hawkweed (*Hieracium albiflorum*), Drummond's rush (*Juncus drummondii*), Mertens' rush (*Juncus mertensianus*), and Scouler's willow (*Salix scouleriana*). The diversity of the species varies depending on the proximity to a seed source.

The length of the growing season is dependent on factors such as the duration of the snow cover, soil temperature, and soil moisture. Areas on south-facing slopes favor more drought-sensitive species such as pearly everlasting and stonecrop (Sedum). Areas on north-facing slopes support species such as purple monkeyflower (*Mimulus lewisii*) and Mertens' rush (Fickert, 2007).

State and transition model



Pseudotsuga menziesii – Tsuga heterophylla/Alnus viridis ssp. sinuata – Salix scouleriana/ Epilobium hornemannii – Anaphalis margaritacea

Douglas-fir – western hemlock/Sitka alder – Scouler's willow/Hornemann's willowherb – pearly everlasting

→ Community Phase Pathway 1.X = Community Phase 1.XY = Pathway (ecological response to natural processes)

State 1
Reference

Community 1.1
Douglas-fir, Western Hemlock, Sitka Alder, Scouler's Willow, Hornemann's Willowherb, and Pearly Everlasting

Structure: Dwarfed coniferous forest with a mix of shrubs and forbs The reference community is comprised of early seral species that have a short lifespan as a result of extreme disturbances and harsh growing conditions. Douglas-fir and western hemlock become established, but the trees rarely are more than 3 feet high. Tree growth is stunted as a result of the ice in the soil profile, which limits root growth; the harsh growing conditions; and disturbances. Woody shrubs such as Sitka alder and Scouler's willow grow slightly more successfully due to their ability to seed in disturbed areas, root in rocky and nutrient-poor areas, and withstand damage from avalanches (Uchytil, 1989). Shrubs typically reach a maximum height of 10 feet. The understory is composed of forbs and rushes, including fireweed, Hornemann's willowherb, pearly everlasting, white hawkweed, Drummond's rush, and Mertens' rush. Minimal data is available on how this ecological site will transition over long periods.

Dominant plant species

- Douglas-fir (*Pseudotsuga menziesii*), tree
- western hemlock (*Tsuga heterophylla*), tree
- Sitka alder (*Alnus viridis ssp. sinuata*), shrub
- Scouler's willow (*Salix scouleriana*), shrub
- fireweed (*Chamerion angustifolium*), other herbaceous
- Hornemann's willowherb (*Epilobium hornemannii*), other herbaceous
- western pearly everlasting (*Anaphalis margaritacea*), other herbaceous
- white hawkweed (*Hieracium albiflorum*), other herbaceous
- Drummond's rush (*Juncus drummondii*), other herbaceous
- Mertens' rush (*Juncus mertensianus*), other herbaceous

Community 1.2
Fireweed and Purple Reedgrass

Structure: Bare ground with patchy herbaceous and grass cover Community phase 1.2 represents an ecosystem that has been disturbed by avalanches, glacial movement, or ice. The vegetation may regenerate or initiate; however, the short growing season limits annual growth. Early seral colonizing species such as fireweed, purple reedgrass, and Merten's rush may become established (Tesky, 1992). Small areas of Sitka alder and Scouler's willow may be present.

Dominant plant species

- purple reedgrass (*Calamagrostis purpurascens*), grass
- fireweed (*Chamerion angustifolium*), other herbaceous

Community 1.3
Sitka Alder, Scouler's Willow, Hornemann's Willowherb, Pearly Everlasting, and Merten's Rush

Structure: Herbaceous mixture of shrubs, forbs, and rushes Community phase 1.3 represents an ecosystem in rapid establishment. Early seral and shade-intolerant species thrive under an open canopy, adequate growing conditions, and soil development. Sitka alder and Scouler's willow mature from seedlings into pockets of bushy,

multi-stemmed shrubs (Uchytil, 1989). Establishment of forbs commonly is determined by the aspect and microsite. Pearly everlasting and Hornemann’s willowherb commonly are adapted to south-facing slopes, and purple monkeyflower may be more prolific on north-facing slopes (Fickert, 2007). Some young Douglas-fir and western hemlock seedlings may sprout. Community phase pathway 1.1A This pathway represents minor disturbances, such as extended snow cover, that maintain the overall structure of the reference community. Deposition of soil material from minor scouring temporarily affects the understory community, but it does not alter the composition of the overstory.

Dominant plant species

- Sitka alder (*Alnus viridis ssp. sinuata*), shrub
- Scouler's willow (*Salix scouleriana*), shrub
- Hornemann's willowherb (*Epilobium hornemannii*), other herbaceous
- Mertens' rush (*Juncus mertensianus*), other herbaceous
- purple monkeyflower (*Mimulus lewisii*), other herbaceous

Pathway 1.1B
Community 1.1 to 1.2

This pathway represents a change in the permanent ice, a powerful avalanche, or a series of avalanches that reclaims the original extent of the glacier.

Pathway 1.2A
Community 1.2 to 1.3

This pathway represents growth during a typical growing season and no significant disturbance. The vegetation is homogeneous and reaches the reference community state.

Pathway 1.3B
Community 1.3 to 1.1

This pathway represents growth over time. Tree species are established and diversification of vegetation cover expands.

Pathway 1.3A
Community 1.3 to 1.2

This pathway represents a change in the permanent ice, a powerful avalanche, or a series of avalanches that reclaims the original extent of the glacier.

Additional community tables

Inventory data references

Other Established Classification
National vegetation classification macrogroup: Vancouverian Subalpine Forest

Type locality

Location 1: Pierce County, WA	
Township/Range/Section	T17N R08E S22
Latitude	46° 56′ 31″
Longitude	121° 47′ 16″

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	05/10/2024

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:

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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:**
