USDA Natural Resources Conservation Service

Ecological site F003XN943WA
Southern Washington Cascades Frigid Coniferous Forest

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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

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 the warm, moist, lower slopes in the Carbon, Ohanapecosh, and Nisqually Valleys of Mount Rainier National Park. Elevation is 1,600 to 4,600 feet, depending on aspect. This site is on debris aprons, mountain slopes, valley walls, and ridges. It is on north- and east-facing slopes at the lower elevations and on south- and west-facing slopes at the higher elevations.
The soils that support this ecological site are in the frigid soil temperature regime and the udic soil moisture regime. They are well drained and are shallow over bedrock to very deep. Soil moisture is not a limiting factor to forest growth on these soils because of the abundance of precipitation and the inherent water-holding properties of soils influenced by volcanic ash.
The most common overstory species are western hemlock (*Tsuga heterophylla*) and Douglas-fir (*Pseudotsuga menziesii*). Western redcedar (*Thuja plicata*), red alder (*Alnus rubra*), and Pacific yew (*Taxus brevifolia*) may be minor components in the overstory. Regeneration is limited by the canopy cover; it commonly is limited to the gaps in the canopy where sunlight is most available.
The most common disturbance on this site is patchy, small pockets of windthrown overstory trees, which commonly occur in conjunction with root-, butt- or stem-rot. Western hemlock is highly susceptible to rot diseases such as Armillaria ostoyae, Heterobasidion annosum, Phellinus weirii, and Echinodontium tinctorium (Tesky, 1992). The historic fire regime for western hemlock consists of low frequency (150 to 300 years or more), moderate- or high-intensity, stand-replacing wildfires.

Associated sites

F003XN947WA	**Southern Washington Cascades Low Cryic Coniferous Forest** Ecological site F003XN947WA, Low Cryic Coniferous Forest is located at higher elevations from F003XN943WA. Vegetation indicators for F003XN947WA include Pacific silver fir, noble fir, and black mountain huckleberry.

Similar sites

F003XN941WA	**Southern Washington Cascades Wet Frigid Coniferous Forest** Ecological site F003XN943WA, Southern Washington Cascades Frigid Coniferous Forest, is similar to site F003XN941WA, Southern Washington Cascades Wet Frigid Coniferous Forest. Ecological site F003XN941WA is in areas that have a higher water table and susceptible to ponding. The vegetation indicators for site F003XN941WA include more wet-adapted species such as western redcedar and American skunkcabbage.
F003XN942WA	**Southern Washington Cascades Moist Frigid Coniferous Forest** Ecological site F003XN943WA, Southern Washington Cascades Frigid Coniferous Forest, is similar to F003XN942WA, Southern Washington Cascades Moist Frigid Coniferous Forest. Site F003XN942WA has a high seasonal water table starting at a depth of 10-20 inches from the soil surface at some point during the growing season.

Table 1. Dominant plant species

Tree	(1) *Tsuga heterophylla* (2) *Pseudotsuga menziesii*
Shrub	(1) *Gaultheria shallon* (2) *Mahonia nervosa*
Herbaceous	Not specified

Physiographic features

This ecological site is on debris aprons, mountain slopes, glacial-valley walls, and ridges. It is at the lower elevations in the Carbon, Ohanapecosh, and Nisqually Valleys of Mount Rainier National Park. This site may be on all slopes, but it commonly is on slopes of 10 to 65 percent.

Table 2. Representative physiographic features

Landforms	(1) Ridge (2) Mountain slope (3) Glacial-valley wall
Flooding frequency	None
Ponding frequency	None
Elevation	1,600–4,650 ft
Slope	0–100%
Water table depth	40–80 in
Aspect	W, NW, N, NE, E, SE, S, SW

Climatic features

Most of the annual precipitation is received in October through April. The mean annual precipitation is 70 to 83 inches, and the mean annual air temperature is 41 to 45 degrees F. Generally, the summers are warm and dry and the winters are cool and wet.

Table 3. Representative climatic features

Frost-free period (characteristic range)	90-130 days
Freeze-free period (characteristic range)	
Precipitation total (characteristic range)	70-83 in

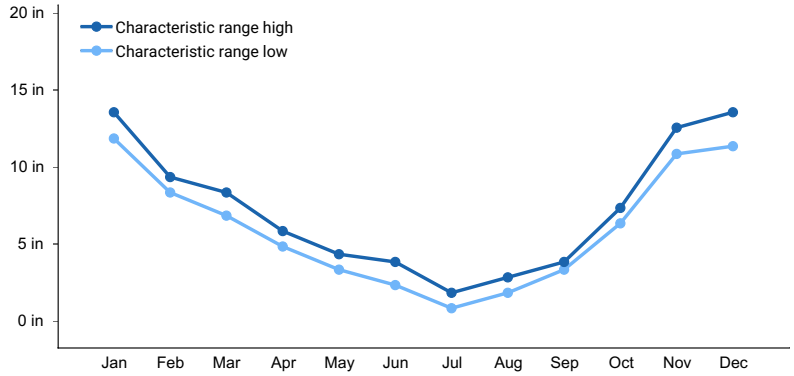


Figure 1. Monthly precipitation range

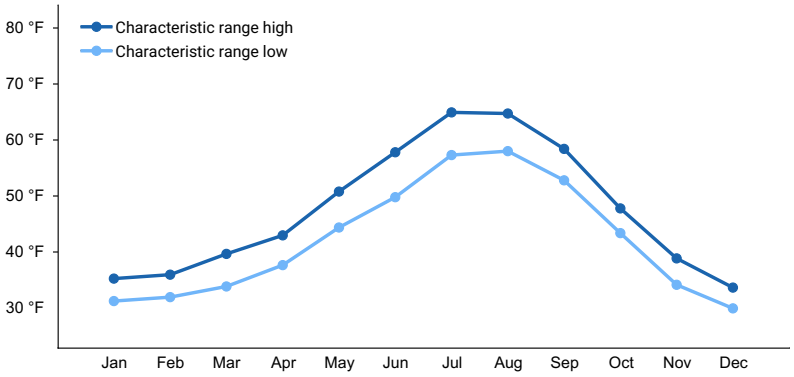


Figure 2. Monthly minimum temperature range

Influencing water features

This ecological site is not influenced by wetland or riparian water features, but it may be on stream terraces or adjacent to wetland and riparian areas. The site is not subject to flooding or ponding.

Soil features

Applicable soils: Kautz, Goldenlakes, Ingraham

Applicable soil map units: 6110, 6120, 6125, 7100, 7110, 7120, 7125

The soils that support this ecological site are in the frigid soil temperature regime and the udic soil moisture regime. They are well drained. The Kautz soils are deep or very deep, the Goldenlakes soils are moderately deep, and the Ingraham soils are shallow. Soil moisture is not a limiting factor for forest growth because of the abundance of precipitation and the inherent water-holding properties of soils influenced by volcanic ash. The soils commonly have a mantle of volcanic ash over colluvium or residuum derived from andesite. The shallow Ingraham soils consist of volcanic ash over andesite. The mantle of volcanic ash is characterized by low bulk density, high available water-holding capacity, gravel-sized pumice pararock fragments, and sandy loam and loamy sand. The subsoil, where present, consists of colluvium derived from andesite. It is sandy loam and has andesite fragments. Podsolization is the dominant pedogenic process in the soils. All of the soils exhibit an albic and a spodic diagnostic horizon. A thin organic horizon consisting of decomposing twigs, needles, and litter is on the soil surface. This horizon helps to protect the soils from wind and water erosion.

Table 4. Representative soil features

Parent material	(1) Colluvium–andesite (2) Volcanic ash–andesite
Surface texture	(1) Ashy sandy loam (2) Paragravelly, ashy sandy loam (3) Paragravelly, ashy loamy sand

Drainage class	Well drained
Soil depth	10–60 in
Surface fragment cover <=3"	0–10%
Surface fragment cover >3"	0–10%
Available water capacity (Depth not specified)	2.5–7 in
Soil reaction (1:1 water) (Depth not specified)	3.5–6
Subsurface fragment volume <=3" (Depth not specified)	5–45%
Subsurface fragment volume >3" (Depth not specified)	0–20%

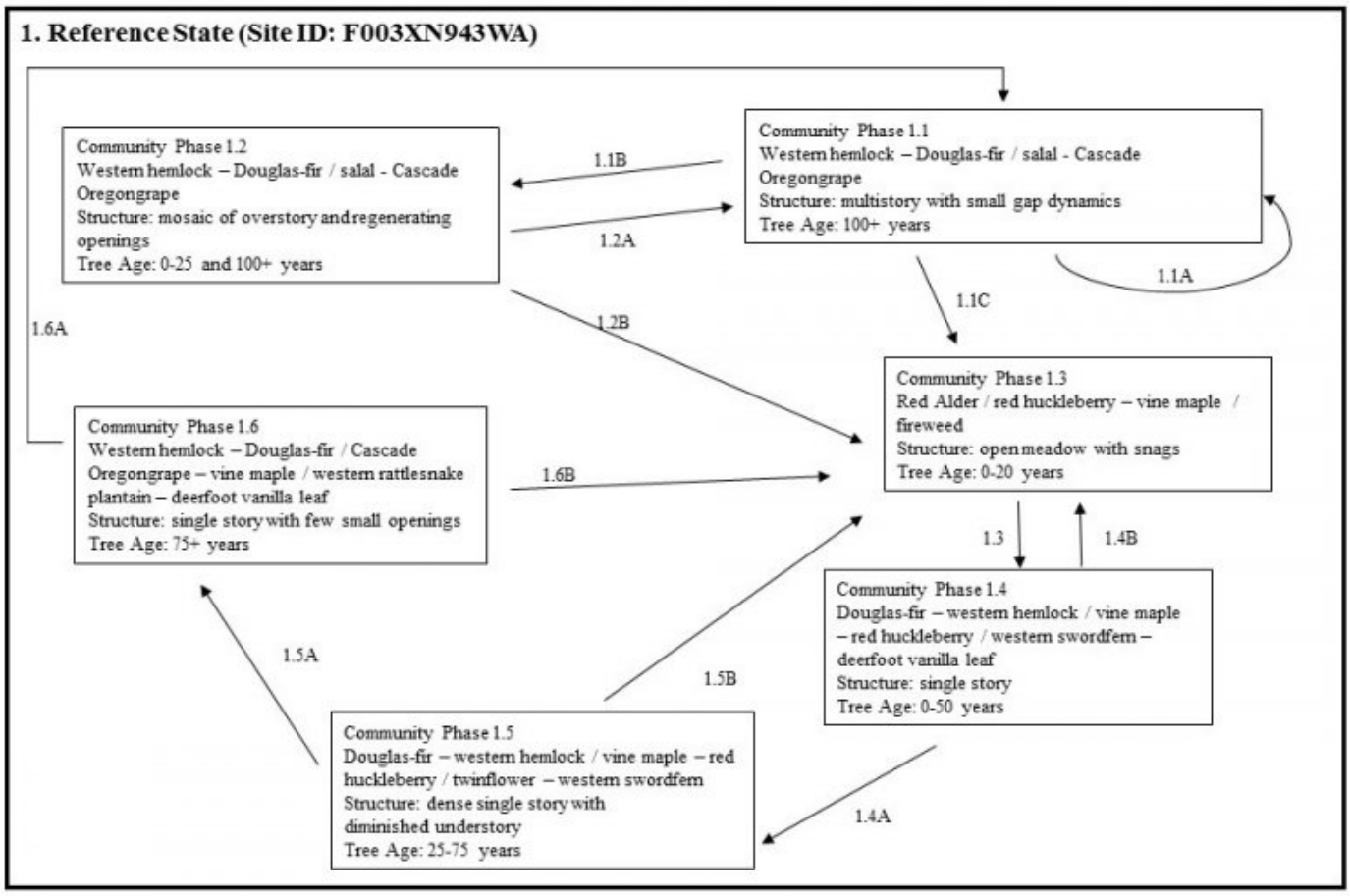
Ecological dynamics

This ecological site is on the warm, moist, lower slopes of Mount Rainier. Elevation ranges to 4,600 feet, depending on aspect. The site is on north- and east-facing slopes at the lower elevations and on south- and west-facing slopes at the higher elevations. Western hemlock (*Tsuga heterophylla*) and Douglas-fir (*Pseudotsuga menziesii*) are the most common overstory species. Western redcedar (*Thuja plicata*) is a minor component in the overstory. Red alder (*Alnus rubra*) and Pacific yew (*Taxus brevifolia*) may be present.

The more open the forest canopy, the more dense and diverse the understory. Cascade Oregon grape (*Mahonia nervosa*), vine maple (*Acer circinatum*), red huckleberry (*Vaccinium parvifolium*), salal (*Gaultheria shallon*), baldhip rose (*Rosa gymnocarpa*), little prince's pine (*Chimaphila menziesii*), and prince's pine (*Chimaphila umbellata*) are the main shrub species in areas where the overstory canopy is open. Western rattlesnake plantain (*Goodyera oblongifolia*), deerfoot vanillaleaf (*Achlys triphylla*), twinflower (*Linnaea borealis*), pioneer violet (*Viola glabella*), and western swordfern (*Polystichum munitum*) are common forbs. The understory species included in the Canopy Cover Summary Table had at least a 40 percent rate of constancy in the 20 inventory plots.

The most common disturbance is the patchy, small pockets of windthrown overstory trees, which commonly occurs in conjunction with root-, butt- or stem-rot. Western hemlock is highly susceptible to rot diseases such as Armillaria ostoyae, Heterobasidion annosum, Phellinus weirii, and Echinodontium tinctorium (Tesky, 1992). The resulting openings in the canopy allow sunlight to reach the forest floor, which benefits the understory. The historic fire regime consists of low frequency (150 to 300 years or more), moderate- to high-intensity fires. The fires are stand-replacing although individual trees or patches of trees survive, providing a seed source for re-establishment.

State and transition model



Tsuga heterophylla – Pseudotsuga menziesii / Gaultheria shallon – Mahonia nervosa

western hemlock – Douglas-fir / salal – Cascade Oregongrape

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

State 1
Reference

Community 1.1
Western Hemlock, Douglas-fir, Salal, and Cascade Oregon Grape

Structure: Multistory with small gap dynamics Western hemlock is the most common overstory species. It is shade tolerant and releases quickly after extended periods of suppression (Packee, 1990). Douglas-fir and western redcedar are present, but regeneration of Douglas-fir is minimal in the absence of canopy openings. Red alder and Pacific yew are minor components of the overstory; they commonly become established in areas that are disturbed and receive more sunlight. The dense canopy created by multiple age groups of hemlocks may block most of the

sunlight from the forest floor, leading to sparse understory in some areas. Thick clumps of vine maple have the same effect. Most of the understory vegetation is in areas where there are gaps in the mid-canopy, which allow sunlight to reach the ground. The understory is more continuous in areas where there is no mid-canopy. The most common natural disturbance on this site is small gap dynamics following the mortality of one or two trees. Community phase pathway 1.1A This pathway represents minor disturbances, such as small pockets of root disease, individual tree mortality, or windthrow, that maintain the overall structure of the reference community. Mortality of individual trees or clusters of trees creates gaps in the overstory, allowing more sunlight to reach the forest floor. This promotes growth of forbs and shrubs and regeneration of overstory species, perpetuating the multi-storied, uneven-aged forest.

Forest overstory. Western hemlock and Douglas-fir make up 50 to 95 percent of the forest canopy cover. The forest has multiple layers. The upper canopy is 90 to 170 feet in height, and it averages 133 feet. The diameter of the trees varies depending on the species, but the average diameter at breast height 23 inches. Alder and western redcedar trees typically are smaller than western hemlock and Douglas-fir trees.

Forest understory. The composition of the understory varies depending on the overstory cover and competition for moisture. Overall cover of shrubs such as Cascade Oregon grape, vine maple, and red huckleberry is 1 to 40 percent, and overall cover of salal is as much as 80 percent in some areas. Overall cover of forbs such as western rattlesnake plantain, deerfoot vanillaleaf, and twinflower is 1 to 25 percent, and overall cover of western swordfern is as much as 45 percent in some areas. Grass species were not recorded for this ecological site.

Dominant plant species

- Douglas-fir (*Pseudotsuga menziesii*), tree
- western hemlock (*Tsuga heterophylla*), tree
- western redcedar (*Thuja plicata*), tree
- red alder (*Alnus rubra*), tree
- Pacific yew (*Taxus brevifolia*), tree
- Cascade barberry (*Mahonia nervosa*), shrub
- salal (*Gaultheria shallon*), shrub
- vine maple (*Acer circinatum*), shrub
- red huckleberry (*Vaccinium parvifolium*), shrub
- dwarf rose (*Rosa gymnocarpa*), shrub
- pipsissewa (*Chimaphila umbellata*), shrub
- little prince's pine (*Chimaphila menziesii*), shrub
- western rattlesnake plantain (*Goodyera oblongifolia*), other herbaceous
- sweet after death (*Achlys triphylla*), other herbaceous
- twinflower (*Linnaea borealis*), other herbaceous
- pioneer violet (*Viola glabella*), other herbaceous
- western swordfern (*Polystichum munitum*), other herbaceous

Community 1.2
Western Hemlock, Douglas-fir, Salal, and Cascade Oregon Grape

Structure: Mosaic of mature overstory and regenerating openings Community phase 1.2 has some areas that resemble community phase 1.1, but it also has moderate-sized openings (2 to 4 acres). Depending on the seed sources present, the overstory species of community phase 1.1 as well as bigleaf maple and grand fir may be in the openings. Many of the shrub species, including vine maple, red huckleberry, Cascade Oregon grape, and baldhip rose, also respond well to increased sunlight. The shrubs may delay or prevent reforestation of the openings.

Dominant plant species

- western hemlock (*Tsuga heterophylla*), tree
- Douglas-fir (*Pseudotsuga menziesii*), tree
- red alder (*Alnus rubra*), tree
- vine maple (*Acer circinatum*), shrub
- Cascade barberry (*Mahonia nervosa*), shrub
- dwarf rose (*Rosa gymnocarpa*), shrub
- salal (*Gaultheria shallon*), shrub

Community 1.3
Red Alder, Red Huckleberry, Vine Maple, and Fireweed

Structure: Open meadow with snags Community phase 1.3 is an early seral plant community that has been impacted by a stand-replacing disturbance such as a wildfire, a large-scale windstorm, a major insect infestation, or mass movement. Only some fire-resistant trees may survive in the understory. The species composition depends on the natural seed sources present and the intensity of the disturbance. Standing and decaying snags are prevalent. After a disturbance, red alder quickly establishes in areas where soil moisture and sunlight are available. Tree seedlings and saplings will begin to establish within 3 to 10 years, depending on severity of the disturbance. Douglas-fir can survive moderately intense fires because of its thick, corky bark. Depending on the severity of the fire and the extent of the damage to the cambium, mature Douglas-fir trees may remain dominant in the overstory. Western redcedar and western hemlock may be at a stage of full stand replacement post fire (Tesky, 1992). After a moderate or severe fire, shrubs commonly outcompete tree seedlings. Vine maple, red huckleberry, salal, baldhip rose, and Cascade Oregon grape, which may have been only moderately abundant previously, recover and spread rapidly when top-killed, slowing successful regeneration of the overstory. Seed sources for tree species are from the surrounding, undisturbed forests and any trees that survived the disturbance. This results in a mixed stand that can include Douglas-fir, western hemlock, red alder, bigleaf maple, western redcedar, and grand fir.

Dominant plant species

- red alder (*Alnus rubra*), tree
- Douglas-fir (*Pseudotsuga menziesii*), tree
- red huckleberry (*Vaccinium parvifolium*), shrub
- vine maple (*Acer circinatum*), shrub
- fireweed (*Chamerion angustifolium*), other herbaceous

Community 1.4
Douglas-fir, Western Hemlock, Vine Maple, Red Huckleberry, Western Swordfern, and Deerfoot Vanillaleaf

Structure: Single story Community phase 1.4 is an early seral forest in regeneration. Scattered remnant mature trees may be present. Red alder begins to be replaced by more shade-tolerant species. Douglas-fir and western hemlock regenerate rapidly and increase in dominance, creating thick patches of saplings. Vine maple and bigleaf maple remain prevalent in the forest openings, and western swordfern begins to re-establish on the forest floor.

Dominant plant species

- Douglas-fir (*Pseudotsuga menziesii*), tree
- western hemlock (*Tsuga heterophylla*), tree
- red alder (*Alnus rubra*), tree
- bigleaf maple (*Acer macrophyllum*), tree
- vine maple (*Acer circinatum*), shrub
- red huckleberry (*Vaccinium parvifolium*), shrub
- western swordfern (*Polystichum munitum*), other herbaceous

Community 1.5
Douglas-fir, Western Hemlock, Vine Maple, Red Huckleberry, Twinflower, and Western Swordfern

Structure: Dense single story with diminished understory Community phase 1.5 is in the competitive exclusion stage of forest development. Scattered remnant mature trees may be present. Individual trees compete for available water and nutrients. The canopy closure is nearly 100 percent, which leads to diminished understory. Some understory species better adapted to partial shade, such as twinflower and red huckleberry, begin to increase in abundance. Over time, the forest begins to self-thin as a result of competition. The species composition depends on the original seed sources available. The forest may be composed of a single species or mixed species, including Douglas-fir, western hemlock, red alder, bigleaf maple, western redcedar, and grand fir.

Dominant plant species

- Douglas-fir (*Pseudotsuga menziesii*), tree
- western hemlock (*Tsuga heterophylla*), tree
- red alder (*Alnus rubra*), tree
- bigleaf maple (*Acer macrophyllum*), tree
- grand fir (*Abies grandis*), tree
- western redcedar (*Thuja plicata*), tree
- vine maple (*Acer circinatum*), shrub
- red huckleberry (*Vaccinium parvifolium*), shrub
- twinflower (*Linnaea borealis*), other herbaceous
- western swordfern (*Polystichum munitum*), other herbaceous

Community 1.6
Western Hemlock, Douglas-fir, Cascade Oregon Grape, Vine Maple, Western Rattlesnake Plantain, and Deerfoot Vanillaleaf

Structure: Single story with few small openings Community phase 1.6 is a maturing forest that is beginning to differentiate vertically. Individual trees are dying due to competition, disease, insects, or windthrow, which allows some sunlight to reach the forest floor. The understory increases in abundance, and the overstory tree species regenerate in some pockets.

Dominant plant species

- Douglas-fir (*Pseudotsuga menziesii*), tree
- western hemlock (*Tsuga heterophylla*), tree
- grand fir (*Abies grandis*), tree
- western redcedar (*Thuja plicata*), tree
- Cascade barberry (*Mahonia nervosa*), shrub
- vine maple (*Acer circinatum*), shrub
- twinflower (*Linnaea borealis*), other herbaceous
- western swordfern (*Polystichum munitum*), other herbaceous

Pathway 1.1B
Community 1.1 to 1.2

This pathway represents disturbances such as a windstorm, an insect infestation, or a pocket of rot. Historically, these disturbances have included pockets of disease, such as annosum root rot (Heterobasidion annosum) or laminated root rot (Phellinus weirii), minor insect infestations, and low- or moderate-intensity fires. Areas of regeneration are 2 to 4 acres in size.

Pathway 1.1C
Community 1.1 to 1.3

This pathway represents a major stand-replacing disturbance such as a high-intensity fire, large-scale windstorm, major insect infestation, or mass movement. The frequency of fire is 150 to 300 years. Volcanic activity has the potential to disrupt the landscape ecology beyond the boundaries of the site and the purpose of this site description.

Pathway 1.2A
Community 1.2 to 1.1

This pathway represents growth over time with no further significant disturbance. The areas of regeneration go through the typical phases of stands, including competitive exclusion, maturation, and understory reinitiation, until they resemble the old-growth structure of the reference community.

Pathway 1.2B
Community 1.2 to 1.3

This pathway represents a major stand-replacing disturbance such as a high-intensity fire, large-scale windstorm, major insect infestation, or mass movement.

Pathway 1.3A
Community 1.3 to 1.4

This pathway represents growth over time with no further major disturbance.

Pathway 1.4B
Community 1.4 to 1.3

This pathway represents a major stand-replacing disturbance such as a high-intensity fire, a large-scale windstorm, a major insect infestation, or mass movement. This leads to the stand initiation phase of forest development.

Pathway 1.4A
Community 1.4 to 1.5

This pathway represents growth over time with no further major disturbance.

Pathway 1.5B
Community 1.5 to 1.3

This pathway represents a major stand-replacing disturbance such as a high-intensity fire, a large-scale windstorm, a major insect infestation, or mass movement. This leads to the stand initiation phase of forest development.

Pathway 1.5A
Community 1.5 to 1.6

This pathway represents growth over time with no further major disturbance.

Pathway 1.6A
Community 1.6 to 1.1

This pathway represents growth over time with no further major disturbance. Continued growth and ongoing

mortality result in more vertical diversification. The community begins to resemble the structure of the reference community, including small pockets of regeneration and a more diversified understory.

Pathway 1.6B
Community 1.6 to 1.3

This pathway represents a major stand-replacing disturbance such as a high-intensity fire, a large-scale windstorm, a major insect infestation, or mass movement.

Additional community tables

Table 5. Community 1.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)	Diameter (In)	Basal Area (Square Ft/Acre)
Tree							
red alder	ALRU2	*Alnus rubra*	Native	–	–	–	–
Douglas-fir	PSME	*Pseudotsuga menziesii*	Native	–	–	–	–
Pacific yew	TABR2	*Taxus brevifolia*	Native	–	–	–	–
western redcedar	THPL	*Thuja plicata*	Native	–	–	–	–
western hemlock	TSHE	*Tsuga heterophylla*	Native	–	–	–	–

Table 6. Community 1.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)
Forb/Herb					
sweet after death	ACTR	*Achlys triphylla*	Native	2–24	1–25
twinflower	LIBO3	*Linnaea borealis*	Native	1–6	1–15
pioneer violet	VIGL	*Viola glabella*	Native	1–6	1–10
western rattlesnake plantain	GOOB2	*Goodyera oblongifolia*	Native	1–12	1–5
Fern/fern ally					
western swordfern	POMU	*Polystichum munitum*	Native	4–48	1–45
Shrub/Subshrub					
salal	GASH	*Gaultheria shallon*	Native	2–36	1–80
vine maple	ACCI	*Acer circinatum*	Native	1–360	1–40
Cascade barberry	MANE2	*Mahonia nervosa*	Native	1–24	1–35
red huckleberry	VAPA	*Vaccinium parvifolium*	Native	2–60	1–20
dwarf rose	ROGY	*Rosa gymnocarpa*	Native	1–36	1–10
pipsissewa	CHUM	*Chimaphila umbellata*	Native	1–8	1–5
little prince's pine	CHME	*Chimaphila menziesii*	Native	1–6	1–5

Animal community

Old-growth western hemlock and Douglas-fir forests are primary habitat for the endangered northern spotted owl. Old growth forests provide nesting and forage habitat, and less mature forests provide key dispersal habitat. This ecological site also provides habitat for a wide variety of migratory songbirds. Woodpeckers and cavity-nesting birds thrive in the dead or dying trees. Douglas-fir has low palatability for elk and deer, but it provides important forage when preferred species are low in abundance (Campbell, 1974). Douglas-fir seeds are highly palatable to small mammals, and they provide an important food source for mice, voles, shrews, and chipmunks (Hemstrom, 1987).

Recreational uses

This area of Mount Rainier National Park is accessible for hiking, camping, bike riding, photography, and sightseeing.

Wood products

The ecological site has moderate accessibility, and it supports a productive forest suitable for commercial forest products. Douglas-fir provides valuable wood commonly used as building material and some high-value poles. Western hemlock is a valuable source of wood fiber, and it is suitable for use as building products, pilings, poles, and railway ties.

Other information

Pathogens
This ecological site is prone to rotting diseases. Annosus, armillaria, and laminated root rots can infest western hemlock and Douglas-fir forests. Echinodotium tinctorium (Indian paint fungus) can cause heart rot in true firs and hemlocks. Root rot and heart rot can result in mortality of individual trees, widespread mortality of several acres, and windthrow.
Annosus root disease (Heterobasidion annosum) can affect nearly all conifer species in the Pacific Northwest. It is a slow-growing pathogen, but it can cause severe root and butt decay in stands. It commonly affects stands in conjunction with armillaria and laminated root rots and precedes infestations of bark beetle.
Signs and symptoms of annosus commonly are difficult to differentiate from those of armillaria. Obvious signs include circular pockets of windthrown trees and canopy dieback. A distinctive fruiting body, called a conk, is in hollow stumps affected by annosus. Other identifying features include a reddish stain, decay, and a spongy texture in the heartwood and roots (Goheen, 2006). Regeneration of conifers may be unsuccessful for several decades, until the soil is void of fungal inoculum. Application of borax on freshly cut tree stumps (within 24 hours) may reduce the spread in managed stands.
Armillaria root disease (Armillaria ostoyae) affects conifer species and shrubs in the Pacific Northwest. It can affect several acres and cause widespread mortality of trees. Western larch, cedar, ponderosa pine, western white pine, and lodgepole pine are susceptible to armillaria, but they commonly are more tolerant of the disease in mixed conifer stands. The disease is most devastating in young regenerating stands (less than 30 years old), and it can delay the maturation and succession of these stands.
Armillaria produces a distinct white mycelial fan between the wood and bark. Rhizomorphs, or brown shoestrings of fungal mycelia, are common under the bark and roots of trees (Goheen, 2006). High resin flow and excessive sapping are also common.
Hemlock and Douglas-fir forests in the Cascade Mountains of Washington and Oregon are susceptible to laminated root rot (Phellinus weirii), which causes moderate disturbances and results in openings in the forests. The fungus can cause severe root rot and butt decay, resulting in stunted growth and mortality. Western hemlock, Pacific silver fir, subalpine fir, and noble fir may be affected by laminated root rot, but these species rarely are killed by the disease.
Signs and symptoms of laminated root rot include pockets of dead and fallen trees that are broken at or near ground level. Decay is identified by brown to reddish-brown speckled stains in the sapwood and by separations in the wood along the growth rings. Regeneration of highly susceptible species typically is unsuccessful in areas infected by the fungus (Goheen, 2006).
Indian paint fungus (Echinodontium tinctorium) affects true firs and hemlocks. It is common in the mixed conifer forests in Washington. The decay commonly is in the mid-trunk of an infected tree and occurs as a distinctive hoof-shaped conk. Breakage of trees is common. This disease can affect 25 to 50 percent of hemlocks and true firs in old-growth stands. Management is limited to plantings of alternative conifer species (Goheen, 2006).

Table 7. Representative site productivity

Common Name	Symbol	Site Index Low	Site Index High	CMAI Low	CMAI High	Age Of CMAI	Site Index Curve Code	Site Index Curve Basis	Citation
western hemlock	*TSHE*	95	140	222	314	60	–	–	
Douglas-fir	*PSME*	100	120	136	175	90	–	–	

Inventory data references

Other Established Classifications

National vegetation classification: G240—North Pacific Maritime Douglas-fir Western Hemlock Forest group
U.S. Department of Agriculture, Forest Service, plant association:
• TSHE/POMU-GASH
• TSHE/POMU-BENE
• TSHE/GASH-BENE
• TSHE/GASH
• TSHE/ACCI-BENE
• TSHE/BENE
• TSHE/BENE-CHME
U.S. Department of the Interior, National Park Service, plant association:
• PSEMEN-TSUHET/GAUSHA/POLMUN
• PSEMEN-TSUHET/MAHNER/POLMUN
• PSEMEN-TSUHET/GAUSHA-MAHNER
• PSEMEN-TSUHET/GAUSHA-VACPAR
• PSEMEN-TSUHET/MAHNER
• PSEMEN-TSUHET/ACHTRI

Type locality

Location 1: Lewis County, WA	
Township/Range/Section	T15N R10E S33
Latitude	46° 44′ 27″
Longitude	121° 34′ 5″

Other references

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Approval

Kirt Walstad, 1/30/2025

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):**

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5. **Number of gullies and erosion associated with gullies:**

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6. **Extent of wind scoured, blowouts and/or depositional areas:**

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7. **Amount of litter movement (describe size and distance expected to travel):**

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

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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):**

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:**