Ecological site AX002X01X004
Puget Lowlands Forest

Last updated: 12/03/2024
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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): 002X–Willamette and Puget Sound Valleys

The Willamette and Puget Sound Valleys Major Land Resource Area (MLRA 2) is in western parts of Washington and Oregon. It occupies a forearc basin between the Coast Ranges and the Cascade Mountain volcanic arc. The northern part contains Pleistocene drift, outwash, and lacustrine and glaciomarine deposits associated with continental glaciers. The southern part contains Late Pleistocene deposits from glacial outburst floods (Missoula Floods). Climate is mild and moist, and the growing season is long. Mean annual precipitation ranges from 20 to 60 inches, received mostly in fall, winter, and spring. Summers are dry. The soil temperature regime is mesic, and the soil moisture regimes are xeric and aquic. Most sites in this MLRA can support forested vegetation, but some were maintained as prairie, savanna, or woodland through cultural burning prior to Euro-American settlement. Puget Sound has a moderating effect on temperatures, and humidity can be higher in the northern part of the MLRA. Douglas-fir (Pseudotsuga menziesii) is widespread throughout. Oregon white oak (Quercus garryana) is common on uplands in the south and on warm, exposed or droughty sites in the north. Pacific madrone grows in areas close to saltwater. Western hemlock (Tsuga heterophylla) is codominant with Douglas-fir in the north. Flood plains typically contain Brayshaw black cottonwood (Populus balsamifera ssp. trichocarpa) and red alder (Alnus rubra). Oregon ash (Fraxinus latifolia) is typical of forested wetlands in the south. Forestry, urban development, and cultivated agriculture are currently the most extensive land uses (USDA, Agriculture Handbook 296, 2022).

LRU notes

The Puget Sound Trough Lowlands Land Resource Unit (LRU) is bounded to the north by the Frasier River Valley at the international border with Canada and extends south to the Cowlitz River. To the west lie Puget Sound and the Strait of Juan De Fuca; to the east lie the foothills of the Cascade Range. The LRU is affected by the proximity of climate-moderating saltwater. Modest annual swings in temperature, winters that seldom experience freezing temperatures, adequate rainfall, and warm, dry summers support small-scale agriculture and forestry. This climate also supports the largest population and highest population density in the Northwest. Aside from isolated areas affected by local rain shadows and marine-influenced fog, the climate is consistent throughout the Puget Lowlands. The LRU represents the furthest southern extent of repeated advances of continental glaciers in western Washington. Glacial drift is the predominant parent material. The LRU also includes intermittent areas of glacially modified, resistant bedrock and several alluvial systems. Volcanic ash is present but intermittent. Soil moisture varies considerably over short distances. This variability creates a mosaic of small plant communities. Soil drainage can be restricted by dense glaciomarine sediments or till. This restriction can create widespread areas of seasonal high water tables and ponding. In places, soils that developed in deep, unconsolidated, coarse-textured sandy drift or in bedrock-restricted colluvium have low available water capacity. South-facing areas near shorelines and minor outwash plains are typically some of the drier areas in the LRU. Precipitation increases with elevation and distance from Puget Sound.

Ecological site concept

The soil moisture control section of this ecological site is dry for 60 to 75 consecutive days a year. Most of the annual precipitation is received from October through April, primarily as rain. Snow is rare. This ecological site is widespread in Puget Sound on soils with variable drainage. The extensive plant community is supported by the consistent maritime climate and soils derived from continental glacial parent materials throughout Puget Sound. It is the most common plant community in much of the Washington portion of MLRA 2. It is typically on bedrock hills, glacially modified hills, and glacial terraces. It is also in some areas between the dry, warm shoreline of Puget Sound and the cooler, wetter areas bordering the Cascade and Coast Range foothills. This site can be compared to the Portland Basin and Hills Forest site in LRU B, which is similar but has a higher summer temperature and lower amounts of summer precipitation. Drier conditions during the growing season are possible in LRU B, leading to a longer recovery between disturbances and higher fire frequency than in LRU A.

Associated sites

AX002X01X006	**Puget Lowlands Dry Prairie**
AX002X01X007	**Puget Lowlands Wet Hemlock Forest**
AX002X01X008	**Puget Lowlands Riparian Forest**

Similar sites

F002XN902WA	**Western hemlock - Douglas-fir/Cascade Oregongrape**
F002XN906WA	**Western hemlock-western redcedar/red huckleberry-salal/western swordfern**
AX002X02X004	**Portland Basin Forest**

Table 1. Dominant plant species

Tree	(1) *Tsuga heterophylla* (2) *Pseudotsuga menziesii*
Shrub	(1) *Mahonia nervosa* (2) *Gaultheria shallon*
Herbaceous	(1) *Polystichum munitum*

Legacy ID

F002XA004WA

Physiographic features

This site is on slopes of bedrock hills, glacially modified hills, and glacial terraces.

Table 2. Representative physiographic features

Flooding frequency	None to rare
Ponding frequency	None
Elevation	0 – 310 m

Slope	10 – 30 %
Aspect	W, NW, N, NE, E, SE, S, SW

Table 3. Representative physiographic features (actual ranges)

Flooding frequency	Not specified
Ponding frequency	Not specified
Elevation	0 – 610 m
Slope	0 – 90 %

Climatic features

Mean annual air temperature: 48 to 52 degrees Fahrenheit

Table 4 Representative climatic features

Frost-free period (characteristic range)	160-240 days
Freeze-free period (characteristic range)	
Precipitation total (characteristic range)	510-1,780 mm

Influencing water features

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

Soil features

Surface textures: Gravelly sandy loams, sandy loams, loams, and silt loams
Soil family textures: Sandy, fine-loamy, coarse-loamy, loamy-skeletal, and sandy-skeletal
Parent material: Glacial drift, including outwash or till, colluvium, residuum are most typical. Alluvium and some volcanic ash can are also possible.
Soil depth: 20 to more than 60 inches. Lithic or densic contacts are possible restrictions.
Soil drainage: Somewhat poorly drained to somewhat excessively drained. Moderately well drained and well drained are most common.
Available water capacity in the top 40 inches: 1 to 10 in/in
pH in water: 4.5 to 7.3
Soil is dry in all parts from 60 to 75 consecutive days.

Ecological dynamics

Fire, wind and storm damage are important disturbance agents in this ecological site. Wind and storm damage occurs regularly in winter, causing small patches of seedbed to be exposed by uprooted trees and small earthflows, and providing release to sub-dominant species in shaded understories. Western hemlock and Douglas-fir are the dominant trees. Douglas-fir is not as shade tolerant as western hemlock and western redcedar (Hermann and Lavender 1990). Because of this, western hemlock and western redcedar often develop in sub-dominant canopy positions alongside faster growing Douglas-fir after major disturbances. The more shade tolerant conifers can also

establish in the understory and persist until minor disturbances cause overstory mortality and allow narrow gaps for them to grow into (Minore 1990, Packee 1990). Lodgepole pine and western white pine are infrequent but when present are often pioneering species after canopy opening fires. Western white pine can persist longer than lodgepole pine within stands until it is overcome by greater height potential of Douglas-fir and western hemlock. Douglas-fir can persist in the overstory for very long periods due to its great height, thick fire-protective bark, and longevity (800+years), but it also requires disturbances that cause greater canopy openings and exposure of mineral soil to establish in abundance (Hermann and Lavender 1990). During longer fire free intervals stand composition tends to shift in favor of highly shade tolerant western hemlock and western red cedar as Douglas-fir is intolerant of deep shade (Munger 1940, Henderson et al. 1989). In contrast to Douglas-fir and pines, western hemlock is very successful germinating on organic matter in the understory, such as duff or rotten logs (Packee 1990). Thus, exposure of mineral soil is not a requirement for its regeneration in this site.
In the dry range of this ecological site, plant species common to the Puget Lowlands Dry Douglas-fir can occur, such as Pacific madrone and oceanspray (Holodiscus discolor). In moister areas plants common to the Puget Lowlands Moist Forest may occur, such as western redcedar and evergreen huckleberry (Vaccinium ovatum). Grand fir, bigleaf maple, and western white pine may also be present. In some cases, bigleaf maple can come to dominate the overstory by resprouting after a disturbance, such as fire or logging, and temporarily outpace growth of conifers. It will persist for variable lengths of time depending on how quickly conifers establish and the time required for them to surpass the maple canopy. Sword fern, red huckleberry, and salal are common in the understory.
There is strong agreement in the research community that fire is a critical determinant of stand structure and composition in Puget Lowlands Forest (Munger 1940, Henderson et al. 1989, Agee 1993, Wetzel and Fonda 2000). Historic fire frequency in western Oregon and Washington conifer-dominated forests is an ongoing topic of debate with recent research suggesting that assigning a long-interval (150+ year), stand-replacing fire regime to these forests (as has been the long-held view) is inaccurate, or at least over-simplified (Wendel and Zabowskl 2010, Tepley et al. 2013). In general, fire in this ecological site is likely to have occurred in the past with relatively long (75+ year) mean fire return intervals (MFRI) but with great variability in behavior and effects. While an individual point location (such as a tree or plot) may be unlikely to experience fire at quick intervals, when considered at a watershed scale, fire occurred often, burning different areas at different times (Agee 1993, Wetzel and Fonda 2000, Wendel and Zabowskl 2010). Fires also displayed varying behavior including infrequent stand-replacing events alongside lower intensity events that cause small patch or individual tree mortality and leave many surviving overstory trees, particularly Douglas-fir (Wetzel and Fonda 2000). This variable, rotational pattern supports high structural and compositional diversity. Much of the area where this ecological site occurs has experienced little fire between the early 20th century and time of this writing (2024) due to active fire suppression, and most research suggests a trend toward more western hemlock and less Douglas-fir on unmanaged lands where fire is excluded (Munger 1940, Huff 1995, Henderson et al. 1989, Wendel and Zabowskl 2010).

State and transition model

Additional community tables

Table 5. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 6. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 7. Community 1.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 8. Community 1.4 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 9. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 10. Community 2.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 11. Community 2.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 12. Community 3.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 13. Community 3.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 14. Community 3.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Inventory data references

Relationship to Other Established Classifications: This site is related to plant associations PICO-PSME/GASH, PSME-ABGR/FEOC, PSME-ABGR/HODI/POMU, PSME-ARME/GASH, PSME-ARME/HODI/LOHI, PSME/GASH-HODI, SPME/HODI-SYAL, SPME/ROGY-HODI, and QUGA-PSME/SYAL/POMU in Chappell, C.B. (2006). Chappell, C.B. 2006. Upland plant associations of the Puget Trough ecoregion, Washington. Natural Heritage Rep. 2006-01. Washington Department of Natural Resources, Natural Heritage Program, Olympia, WA. https://file.dnr.wa.gov/publications/amp_nh_upland_puget.pdf (accessed 29 January 2021).

Other references

Agee, J.K. 1993. Fire ecology of Pacific Northwest forests. Island Press. Covelo, CA. ISBN: 978-1559632300.

Henderson, J.A., Peter, D.H., Lesher, R.D. and Shaw, D.C., 1989. Forested plant associations of the Olympic National Forest.

Hermann and Lavender, 1990. Pseudotsuga menziesii. In: Burns, R.M. and Honkala, B.H., 1990. Silvics of North America. Volume 1. Conifers.

Huff, M.H., 1995. Forest age structure and development following wildfires in the western Olympic Mountains, Washington. Ecological Applications, 5(2), pp.471-483.

Minore, D. 1990. Thuja plicata. In: Burns, R.M. and Honkala, B.H., 1990. Silvics of North America. Volume 1. Conifers.

Munger, T.T., 1940. The Cycle form Douglas Fir to Hemlock. Ecology, 21(4), pp.451-459.

Packee, E.C. 1990. Tsuga heterophylla. In: Burns, R.M. and Honkala, B.H., 1990. Silvics of North America. Volume 1. Conifers.

Perry, D.A. 1994. Forest ecosystems. The Johns Hopkins University Press. Baltimore, MD. ISBN: 0-8018-4760-5.

Tepley, A.J., Swanson, F.J. and Spies, T.A., 2013. Fire?mediated pathways of stand development in Douglas?fir/western hemlock forests of the Pacific Northwest, USA. Ecology, 94(8), pp.1729-1743.

U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. 2019. Fire Effects Information System (FEIS). https://www.feis-crs.org/feis/ (accessed 8 January 2021).

Wendel, R. and Zabowskl, D., 2010. Fire history within the lower Elwha river watershed, Olympic National Park, Washington. Northwest Science, 84(1), pp.88-97.

Wetzel, S.A. and Fonda, R.W., 2000. Fire history of Douglas-fir forests in the Morse Creek drainage of Olympic National Park, Washington. Northwest science., 74(4), pp.263-279.

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Approval

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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	09/17/2026
Approved by	
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:**

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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):**

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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:**
