USDA Natural Resources
Conservation Service

Ecological site R002XC012OR
Red Hill Group

Last updated: 11/27/2024
Accessed: 05/20/2025

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): 002X–Willamette and Puget Sound Valleys

The Willamette and Puget Sound Valleys Major Land Resource Area (MLRA 2) is located in western Washington and Oregon. It occupies a forearc basin between coast ranges and the Cascade Mountain volcanic arc. The northern part contains Pleistocene drift, outwash, 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, with a long growing season. Mean annual precipitation ranges from 20 to 60 inches, falling mostly in fall, winter, and spring. Summers are dry. Soil temperature regime is mesic and 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 (*Arbutus menziesii*) occurs in areas close to salt water. Western hemlock (Tsuga heterophylla) is codominant with Douglas-fir in the north. Floodplains usually contain 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 (Soil Survey Staff, 2006).

LRU notes

The Willamette Valley land resource unit (LRU C) is located in northwestern Oregon. It is bounded by the Portland Basin to the north and the Umpqua Valley to the south.

Topography is generally flat to hilly. Major landforms include floodplains and alluvial terraces, glaciolacustrine terraces, hills, and foothills. The valley floor is underlain by Pleistocene fluvial deposits (Rowland Formation). Valley borders and foothills are underlain by Eocene to Pliocene sedimentary rocks (Yamhill, Spencer, and Nestucca Formations) or, in some western areas, Eocene pillow basalts (Siletz River Volcanics). Other hills consist of Miocene Columbia River Basalt (Yeats et al., 1996; Orr et al., 1992). Locations below 400 feet elevation are covered with late Pleistocene silts deposited by the Missoula Floods (Willamette Silts).

Mean annual precipitation ranges from 35 to 60 inches. Most falls as rain between October and May. The frost-free period ranges from 160 to 210 days. Snowfall occasionally occurs in winter, but snow cover rarely lasts longer than a few days. Ice storms usually occur at least once each winter. Winter storm winds come from the south. Fair-weather winds during summer come from the north.

Prior to Euro-American settlement, fire was used in this LRU to maintain early-seral plant communities for food and fiber. General Land Office (GLO) land surveys conducted between 1851 and 1910 documented widespread prairies and savannas (Hulse et al., 2002). Fire exclusion since Euro-American settlement allowed many of these to succeed to forested communities (Johannessen et al., 1971; Day, 2005). Historic prairies and savannas were less common at the north end of the Willamette Valley, but an island of these types occurred in the Tualitan Valley. In general, fire frequency decreased with distance from human settlements (Christy and Alverson, 2011).

Presence of Oregon white oak and absence of western hemlock distinguish this area from the coast range (MLRA 1) and Cascade mountains (MLRA 3). This LRU is distinguished from Portland Basin and Hills (LRU B) by low-frequency occurrence of species common in the Umpqua and Rogue valleys, including California black oak (Quercus kelloggii), Pacific madrone (*Arbutus menziesii*), incense cedar (Calocedrus decurrens), and white alder (Alnus rhombifolia) (Franklin and Dyrness, 1973).

Classification relationships

This ecological site group is similar to following USDA Forest Service Plant Associations (McCain and Diaz, 2001) which emphasize late-successional plant communities:

- grand fir / poison oak (CWS622)
- grand fir / California hazel / inside-out flower (CWS555)
- grand fir / oceanspray / sword fern (CWS529); grand fir / vine maple / sword fern (CWS527)
- Douglas-fir / poison oak (CDC124)
- Douglas-fir / California hazel - snowberry / sword fern (CDS312)
- Douglas-fir / oceanspray - snowberry (CDS217)

This ecological site group fits within the following LANDFIRE Biophysical Setting (BpS):

- LANDFIRE Biophysical Setting: Willamette Valley Upland Prairie and Savanna (0211200)

Ecological site concept

This site occurs on hills. Soils are reddish, well drained, highly-weathered, clayey, and acidic. The rooting zone is dry 45 to 60 consecutive days during the summer.

Table 1. Dominant plant species

Tree	(1) *Pseudotsuga menziesii* (2) *Quercus garryana*
Shrub	Not specified
Herbaceous	(1) *Festuca idahoensis ssp. roemeri* (2) *Forb, perennial*

Physiographic features

Landform: hills
Parent material: residuum from igneous or sedimentary rocks
Elevation: 400 to 1500 feet
Slope: 0 to 60 percent
Flooding: none
Ponding: none

This site occurs on the Eola geomorphic surface (Balster and Parsons, 1968; Reckendorf, 1993).

Table 2. Representative physiographic features

Landforms	(1) Hill
Flooding frequency	None
Ponding frequency	None
Elevation	122–457 m
Slope	0–60%

Climatic features

Mean annual air temperature: 50 to 54 degrees F
Mean annual precipitation: 40 to 60 inches
Frost free period: 165 to 210 days

Influencing water features

None

Wetland description

None

Soil features

Drainage class: well drained
Parent material: residuum from igneous or sedimentary rocks
Soil restrictive feature(s): none
Soil moisture regime: xeric
Soil moisture subclass: typic
Soil temperature regime: mesic
Particle-size family(s): fine
Soil mineralogy: mixed
Cation exchange capacity: active
Soil reaction: moderately acid to very strongly acid (pH decreases with depth)

Soils have red to reddish hues. These are old soils forming in residuum on geomorphically stable portions of hills. The rooting zone is usually dry 45 to 60 consecutive days during the summer which is typical of upland sites in this LRU. Soils classify as Ultisols. Organic matter is relatively high for this soil order. Native fertility is low compared with valley-floor sites due to acid soil reaction and clay minerals with low cation-exchange capacity.

Soils correlated with this site include Jory, Nekia, Bellpine, and Gelderman.

Table 3. Representative soil features

Parent material	(1) Residuum–igneous and sedimentary rock
Family particle size	(1) Fine
Drainage class	Well drained

Ecological dynamics

Central Concept

This site occurs on hills. Soils are reddish, well drained, highly-weathered, clayey, and acidic. The rooting zone is dry 45 to 60 consecutive days during the summer which is typical for upland sites in this LRU. Conifer forest tends to develop, but the reference plant community is a savanna maintained through cultural burning. This savanna consists of Douglas-fir - Oregon white oak / Roemer's fescue - forbs.

Range in Variability

Variation in soils and landscape position define subtypes with distinct reference

communities. Thilenius (1968) recognized characteristic understory communities occurring within the range of settings described by this ecological site group: a beaked hazelnut/swordfern community on moist north aspects; a poison oak community on dry south aspects; and a Saskatoon serviceberry-common snowberry community in intermediate positions. Buechling et al. (2008) concluded that succession to conifer forest is most rapid on moist, well drained sites. Grand fir may be able to regenerate in the forest understory at some locations, but not in others (McCain and Diaz 2001). Soils located on landslide deposits tend to have brownish hue, higher pH, and higher base saturation (Parsons and Balster, 1966).

Disturbance

This site developed under a cultural burning regime. Fire return interval was approximately 1 to 10 years (Christy and Alverson, 2011). At some locations supporting this site, General Land Office (GLO) surveys described woodlands located between savannas and upland forest. Woodland may have been an ecotone resulting from cultural fire which only occasionally escaped from valley locations. Frequency of cultural burning generally decreased with distance from human settlements (Christy and Alverson, 2011). In all cases, fire frequency decreased following Euro-American settlement which began around 1850. Tree-throw occurs in forested communities. Camas pocket gophers (Thomomys bulbivorus) make burrows and mounds in early-seral communities (Oregon Department of Fish and Wildlife).

Plant Composition

Savanna (prairie with scattered trees) was typical prior to Euro-American settlement, but forested vegetation tends to develop in the absence of fire. Agee (1993) suggested 20 trees per acre as the maximum tree density for savannas in the Pacific Northwest. Day (2005) found as few as 7 trees per acre in savannas located on the Willamette National Forest.

Representative native plants are listed below. Not all species are present within the same community phase. Plant lists (especially for grasses, grasslikes, and forbs) are incomplete. An asterisk (*) indicates plant species representative of the pre-settlement reference community (Christy and Alverson, 2011).

GRASSES:
Roemer's fescue (Festuca roemeri) *
Sandberg bluegrass (*Poa secunda*) *
prairie Junegrass (*Koeleria macrantha*) *
Lemmon's needlegrass (*Achnatherum lemmonii*) *
slender wheatgrass (*Elymus trachycaulus*) *
California oatgrass (*Danthonia californica*) *

FORBS:
small camas (*Camassia quamash* ssp. maxima) *
Suksdorf's large camas (*Camassia leichtlinii* ssp. suksdorfii) *
brodiaea (Brodiaea spp.) *
triteleia (Triteleia spp.) *
checker lily (*Fritillaria affinis*) *
desertparsley (Lomatium spp.) *
yampah (Perideridia spp.) *
tarweed (Madia spp.) *
balsamroot (Balsamorhiza spp.) *

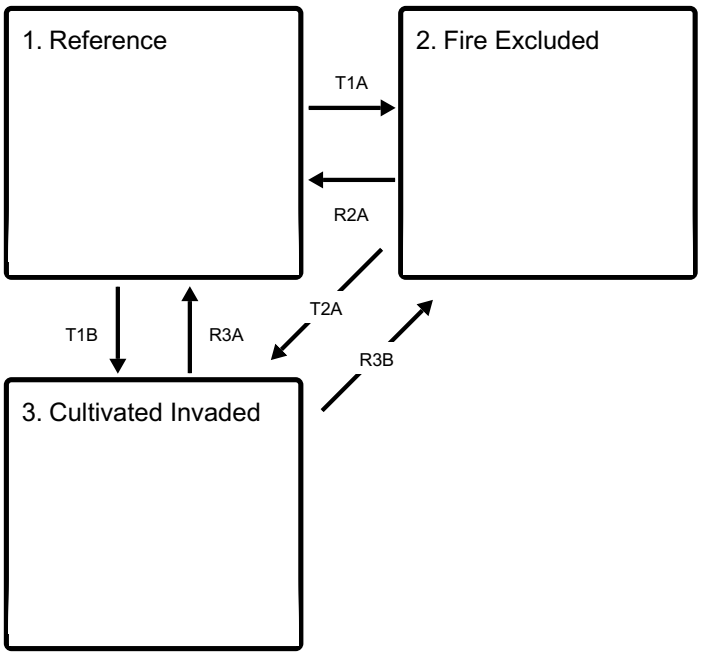
TREES:
Douglas-fir (*Pseudotsuga menziesii*) *
Oregon white oak (*Quercus garryana*) *
ponderosa pine (*Pinus ponderosa*) *
bigleaf maple (*Acer macrophyllum*)
grand fir (*Abies grandis*)
Pacific madrone (*Arbutus menziesii*)
cascara buckthorn (*Frangula purshiana*)

SHRUBS:
common snowberry (*Symphoricarpos albus*)
creeping snowberry (*Symphoricarpos mollis*)
Saskatoon serviceberry (*Amelanchier alnifolia*)
beaked hazelnut (*Corylus cornuta*)
Indian plum (*Oemleria cerasiformis*)
rose (Rosa spp.)
California blackberry (*Rubus ursinus*)
black hawthorn (*Crataegus douglasii*)
Pacific poison oak (*Toxicodendron diversilobum*)
oceanspray (*Holodiscus discolor*)
hollyleaved barberry (*Mahonia aquifolium*)

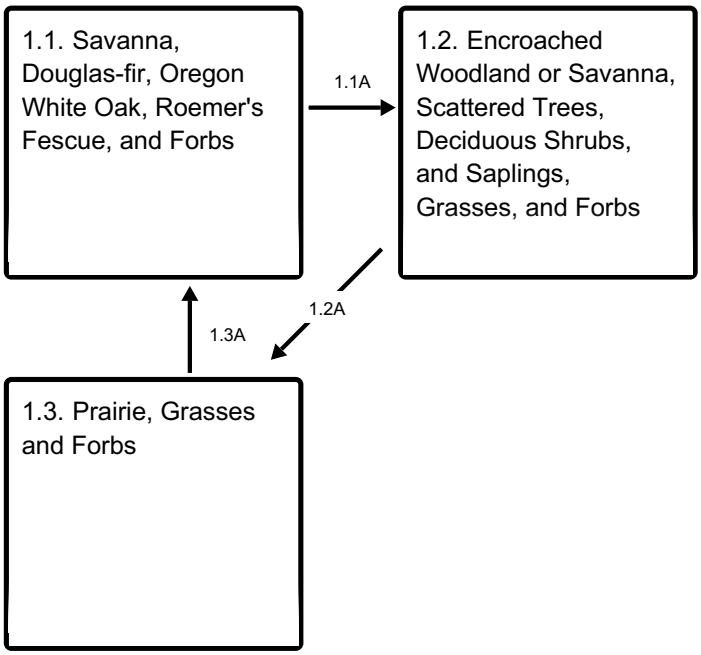
Relationship to Other Established Classifications
This ecological site group is similar to following USDA Forest Service Plant Associations (McCain and Diaz, 2001) which emphasize late-successional plant communities:
• grand fir / poison oak (CWS622)
• grand fir / California hazel / inside-out flower (CWS555)
• grand fir / oceanspray / sword fern (CWS529); grand fir / vine maple / sword fern (CWS527)
• Douglas-fir / poison oak (CDC124)
• Douglas-fir / California hazel - snowberry / sword fern (CDS312)
• Douglas-fir / oceanspray - snowberry (CDS217)

State and transition model

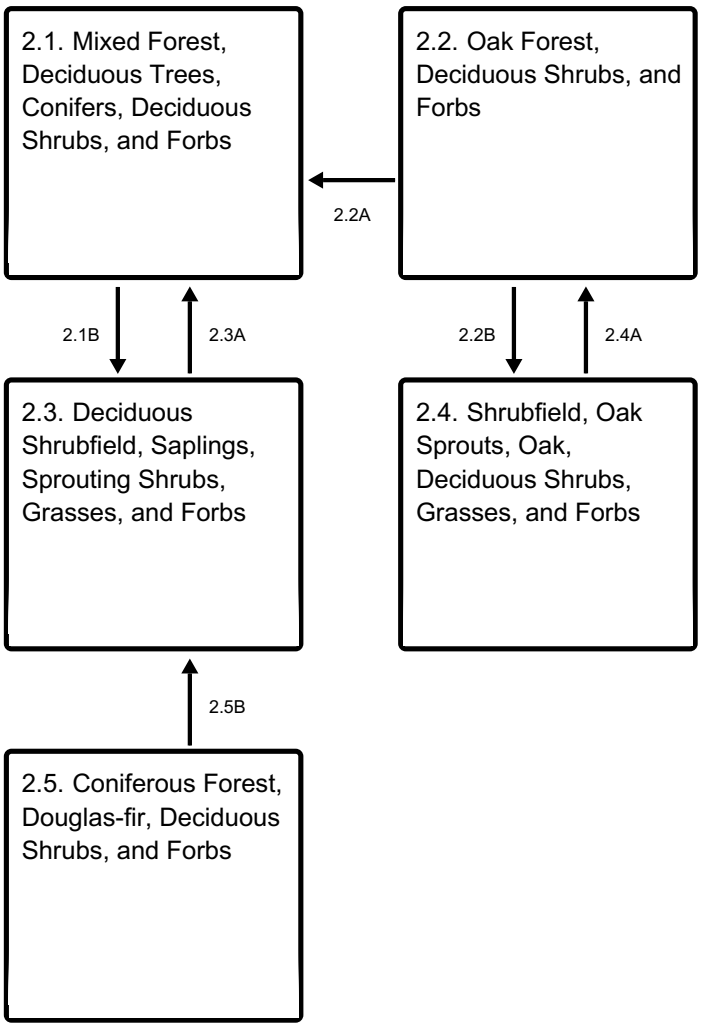
Ecosystem states



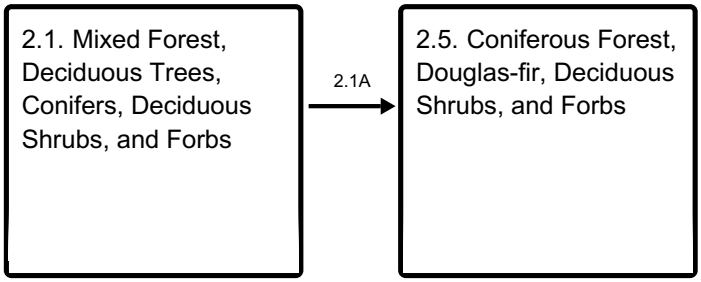
State 1 submodel, plant communities



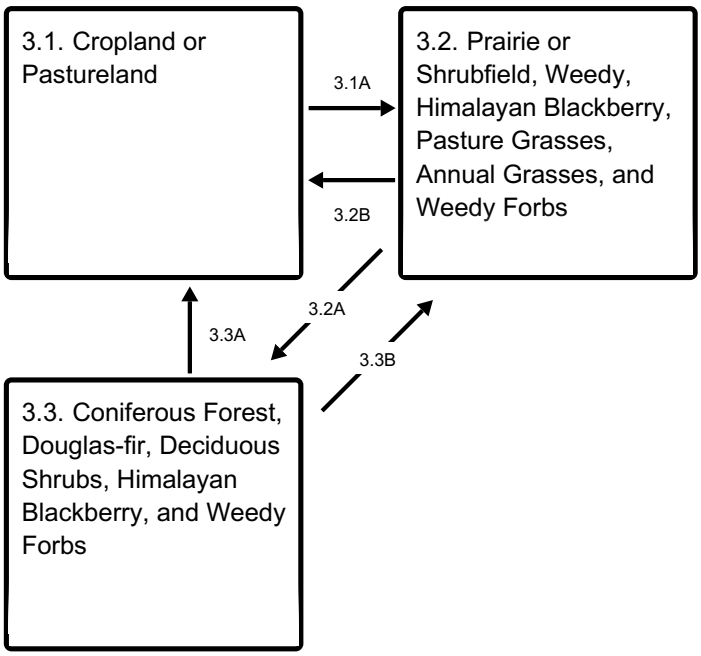
State 2 submodel, plant communities



Communities 1 and 5 (additional pathways)



State 3 submodel, plant communities



State 1
Reference

This state represents the disturbance regime prior to Euro-American settlement and the absence of invasive plant species. Typical fire return interval is approximately 1 to 10 years.

Community 1.1
Savanna, Douglas-fir, Oregon White Oak, Roemer's Fescue, and Forbs

Structure: grasses and forbs with scattered, mature fire-tolerant trees (savanna) Cool-season perennial grasses including Roemer’s fescue, are abundant. Shade-intolerant forbs are also present. Mature Douglas-fir and Oregon white oak are scattered across the site. Ponderosa pine can also occur. GLO records indicate bearing (witness) trees of all species were typically 41-61 cm (16-24 inches) in diameter (Christy and Alverson, 2011). Fire return interval 1-10 years

Community 1.2
Encroached Woodland or Savanna, Scattered Trees, Deciduous Shrubs, and Saplings, Grasses, and Forbs

Structure: Encroached savanna or woodland. Grasses, forbs, deciduous shrubs, young trees and saplings, with scattered mature trees. Deciduous shrubs and saplings grow from seed and sprouts. Conifer saplings regenerate from seed. However, grasses and forbs present in the Reference Community persist and are not completely shaded out.

Community 1.3
Prairie, Grasses and Forbs

Structure: prairie Grass and forb vigor is renewed by the removal of litter, competition, and shade.

Pathway 1.1A
Community 1.1 to 1.2

This pathway represents an unusually long period without fire during which woody vegetation begins to grow within the savanna.

Pathway 1.2A
Community 1.2 to 1.3

This pathway represents renewed cultural burning. Woody vegetation fuels fire severe enough to kill mature savanna trees.

Pathway 1.3A
Community 1.3 to 1.1

This pathway represents a return to typical cultural burning frequency. Scattered trees growing from seed or sprout survive to the age of fire tolerance, but the development of woody vegetation is generally prevented.

State 2
Fire Excluded

This state results from fire-exclusion with minimal ground disturbance. The impact of invasive species is small.

Community 2.1
Mixed Forest, Deciduous Trees, Conifers, Deciduous Shrubs, and Forbs

Structure: closed mixed forest This community contains an overstory of deciduous trees and conifers. Large savanna trees are crowded by fast-growing Douglas-fir and bigleaf maple. Antecedent savanna oaks, firs, and pines can be recognized by a spreading habit and large lower branches. The understory consists of shade-tolerant deciduous shrubs, saplings (especially in canopy gaps), and shade-tolerant forbs.

Community 2.2
Oak Forest, Deciduous Shrubs, and Forbs

Structure: closed oak forest This community contains an even-aged oak overstory. Unlike oaks that developed in savannas, these crowded trees have a narrow and tall habit. The understory consists of shade-tolerant deciduous shrubs and forbs. Light penetrating the thick oak canopy may be sufficient for grand fir but insufficient for Douglas-fir

establishment. On sites too dry for grand fir or lacking a seed source, Community Phase 2.2. may last a long time until canopy oak die or fall over. Investigation is needed to substantiate this idea.

Community 2.3
Deciduous Shrubfield, Saplings, Sprouting Shrubs, Grasses, and Forbs

Structure: deciduous shrubfield This community consists of deciduous shrubs and saplings, some conifer regeneration, and shade-intolerant grasses and forbs. Deciduous tree re-sprouting depends on quantity of deciduous trees in the pre-existing community.

Community 2.4
Shrubfield, Oak Sprouts, Oak, Deciduous Shrubs, Grasses, and Forbs

Structure: deciduous shrubfield (oak sprouts) This community consists of vigorously resprouting oak bushes, shade-intolerant deciduous shrubs, grasses and forbs.

Community 2.5
Coniferous Forest, Douglas-fir, Deciduous Shrubs, and Forbs

Structure: closed conifer forest This community consists of an overstory of conifers (Douglas-fir with or without grand fir) and an understory of shade-tolerant shrubs and forbs. This is the late-successional community expected to develop in the absence of disturbance. However, naturally-developed pure conifer stands are rarely observed. Community Phase 2.1 (featuring a deciduous overstory component) may persist for a long time. In some cases, grand fir is the most shade-tolerant conifer but it may be absent on hot, dry sites (McCain and Diaz, 2001).

Pathway 2.1B
Community 2.1 to 2.3

This pathway represents tree removal.

Pathway 2.1A
Community 2.1 to 2.5

This pathway represents growth over time.

Pathway 2.2A
Community 2.2 to 2.1

This pathway requires conifer establishment and growth over time. Length of time required is unknown.

Pathway 2.2B
Community 2.2 to 2.4

This pathway represents tree removal.

Pathway 2.3A
Community 2.3 to 2.1

This pathway represents growth over time.

Pathway 2.4A
Community 2.4 to 2.2

This pathway represents growth over time.

Pathway 2.5B
Community 2.5 to 2.3

This pathway represents tree removal.

State 3
Cultivated Invaded

This state represents post-cultivation conditions that may best fit within land-use models in future work. Weedy invasive species are usually present and competitive. Fire is excluded. Hydrology is not altered by draining or filling.

Community 3.1
Cropland or Pastureland

Structure: annual or perennial crop, tame pasture, or orchard

Community 3.2
Prairie or Shrubfield, Weedy, Himalayan Blackberry, Pasture Grasses, Annual Grasses, and Weedy Forbs

Structure: weedy shrubfield or prairie This community consists mainly of weeds such as Himalayan blackberry (*Rubus armeniacus*), naturalized pasture grasses, or non-native annual grasses. Himalayan blackberry is aggressive following ground disturbance. Introduced perennial pasture grasses including tall fescue (*Schedonorus arundinaceus*) and creeping bentgrass (*Agrostis stolonifera*) are competitive in open conditions. Winter-annual grasses such as ripgut brome (*Bromus diandrus*) are common in frequently-disturbed areas. Forbs such as Canada thistle (*Cirsium arvense*) and bull thistle (*Cirsium vulgare*) are common. Scotch broom (*Cytisus scoparius*) is characteristic of clearcut

forest.

Community 3.3
Coniferous Forest, Douglas-fir, Deciduous Shrubs, Himalayan Blackberry, and Weedy Forbs

Structure: Closed conifer forest The overstory is dominated by Douglas-fir. Shade-tolerant sweet cherry (*Prunus avium*) may form a subordinate overstory component. The understory has low species diversity and consists of weedy, shade-tolerant shrubs and forbs. Himalayan blackberry may persist under forest canopy. Shining geranium (*Geranium lucidum*) and slender false brome (*Brachypodium sylvaticum*) invade forest understories. English holly (*Ilex aquifolium*) and sweet cherry do not require ground disturbance in order to establish. English ivy (*Hedera helix*) is also shade-tolerant.

Pathway 3.1A
Community 3.1 to 3.2

This pathway represents abandonment. Tillage and other management ceases.

Pathway 3.2B
Community 3.2 to 3.1

This pathway represents resumed tillage and agricultural management.

Pathway 3.2A
Community 3.2 to 3.3

This pathway represents continued abandonment and growth over time. Soils develop a litter layer consisting mainly of conifer needles and twigs.

Pathway 3.3A
Community 3.3 to 3.1

This pathway represents tree and stump removal with resumed tillage and agricultural management.

Pathway 3.3B
Community 3.3 to 3.2

This pathway represents tree removal alone.

Transition T1A
State 1 to 2

T1A: This pathway represents cessation of fire over a period long enough that grasses and forbs present in the reference community do not recover dominance following removal of woody vegetation. Tree seedlings, including conifers, establish and begin to cast shade, leaf, and needle litter. Soils develop a litter layer. Consequently, forbs shift to mesic, shade-tolerant species (Thilenius, 1964). T1B: This pathway is similar to Transition Pathway T1A with additional conditions favoring the development of a pure oak forest stand. Thilenius (1964, 1968) points out from early records that savannas briefly converted to wheat production or cleared for forage were abandoned by the mid-1880's and "reverted to oak scrub." Top-growth removal without root destruction promotes sprouting and could have led to dense, monotypic oak forest stands. It is also possible that a cohort of dense oak trees developed from seed once fires ceased. Along this transition pathway, oaks regenerate and begin to cast shade, leaf, and needle litter. Soils develop a litter layer. Consequently, the forb layer succeeds to mesic, shade-tolerant species (Thilenius, 1964).

Transition T1B
State 1 to 3

This pathway represents tree and stump removal and tillage to the extent that root systems and seed banks of native plants are depleted.

Restoration pathway R2A
State 2 to 1

R2A: This pathway represents tree thinning, prescribed fire or mowing, seeding native grass. R2B: This pathway represents tree thinning (or oak renewal by cutting and leaving stumps intact), prescribed fire or mowing, seeding native grass, and weed control.

Transition T2A
State 2 to 3

This pathway represents tree and stump removal and tillage to the extent that root systems and seed banks of native plants are depleted. Soil litter layer is removed.

Restoration pathway R3A
State 3 to 1

This pathway represents controlling weeds, seeding native grasses, replanting savanna trees, and prescribed fire or mowing.

Restoration pathway R3B
State 3 to 2

This pathway represents weed control and replanting forest trees.

Additional community tables

Other references

Agricultural Climate Information System. (2007). WETS Station Data for Corvallis State University, OR, 1971-2000. [Online]. Available at http://agacis.rcc-acis.org/?fips=41003 (accessed on 5/7/2020).

Agee, J. K. (1993). Fire ecology of Pacific Northwest forests. Island Press, Washington, D.C.

Balster, C.A., and Parsons, R.B. (1968). Geomorphology and soils Willamette Valley, Oregon. Oregon State University Experiment Station Special Report 265. https://ir.library.oregonstate.edu/downloads/mg74qm961

Buechling, A., Alverson, E., Kertis, J., and Fitzpatrick, G. (2008). Classification of oak vegetation in the Willamette Valley. Oregon Natural Heritage Information Center, Oregon State University. Portland, OR. https://ir.library.oregonstate.edu/concern/technical_reports/hq37vt243

Christy, J., and Alverson, E. (2011). Historical vegetation of the Willamette Valley, Oregon, circa 1850. Northwest Science. 85(2):93-107. https://doi.org/10.3955/046.085.0202

Christy, J.A., Alverson, E.R., Dougherty, M.P., Kolar, S.C., Alton, C.W., Hawes, S.M., Ashkenas, L., and Minear, P. (2011). GLO historical vegetation of the Willamette Valley, Oregon, 1851-1910. ArcMap shapefile, Version 2011_04. Oregon Biodiversity Information Center, Portland State University. Available at http://www.pdx.edu/sites/www.pdx.edu.pnwlamp/files/glo_willamette_2011_04.zip (accessed on 11/14/2019).

Darris, D.C., and Gonzalves, P. (2018). California Oatgrass. [Online] Available at https://plants.usda.gov/plantguide/pdf/pg_daca3.pdf (accessed on 5/11/2020).

Day, J.W. (2005). Historical savanna structure and succession at Jim's Creek, Willamette National Forest, Oregon. M.S. thesis. University of Oregon, Eugene. https://pages.uoregon.edu/bartj/current_research/oak_sav_plan_rest/Day_thesis.pdf

Franklin, J., and Dyrness, C. (1973). Interior valleys of western Oregon. p. 110-129. In Natural Vegetation of Oregon and Washington. United States Department of Agriculture Forest Service, Pacific Northwest Forest and Range Experiment Station. General Technical Report PNW-8.

Hulse, D., Gregory, S., and Baker, J. (2002). Presettlement Vegetation circa 1850. p. 38-39. In Pacific Northwest Ecosystem Research Consortium (ed.) Willamette River Basin Planning Atlas: Trajectories of Environmental and Ecological Change. [Online]. Available

at
http://www.fsl.orst.edu/pnwerc/wrb/Atlas_web_compressed/4.Biotic_Systems/4b.presetveg_web.pdf (accessed on 9/28/2015).

Johannessen, C. L., Davenport, W.A., Millet, A., and McWilliams, S. (1971). The vegetation of the Willamette Valley. Annals of the Association of American Geographers. 61(2):286-302.

Kagan, Jimmy. (2005). Willamette Valley Upland Prairie and Savanna. p. 133-138. In LANDFIRE Biophysical Setting Model Descriptions. [Online]. Available at https://www.landfire.gov/national_veg_models_op2.php (accessed on 9/14/2020).

McCain, C., and Diaz, N. (2001). Field guide to the forested plant associations of the westside central Cascades of northwest Oregon. United States Department of Agriculture Forest Service, Pacific Northwest Region. Technical Paper R6-NR-ECOL-TP-02-02. https://ecoshare.info/2009/12/16/plant-associations-of-the-west-central-cascades/

Oregon Department of Fish and Wildlife. Pocket Gophers. [Online]. Available at https://myodfw.com/wildlife-viewing/species/pocket-gophers (accessed on 5/21/2020).

Orr, E., Orr, W., and Baldwin, E. (1992). Willamette Valley. p. 203-221. In Geology of Oregon. 4th ed. Kendall/Hunt Publishing Company.

Parsons, R.B., and Balster, C.A. (1966). Morphology and genesis of six “red hill” soils in the Oregon Coast Range. Soil Science Society of America Journal, 30(1), pp.90-93. https://acsess.onlinelibrary.wiley.com/doi/pdf/10.2136/sssaj1966.03615995003000010031x

Reckendorf, F. (1993). Geomorphology, stratigraphy, and soil interpretations, Willamette Valley, Oregon. p. 178-199. In J.M. Kimble (ed.) Proceedings of the Eighth International Soil Management Workshop: Utilization of Soil Survey Information for Sustainable Land Use. Oregon, California, and Nevada. 11-24 July 1992; May 1993. United States Department of Agriculture Soil Conservation Service National Soil Survey Center.

Schoeneberger, P.J., Wysocki, D.A., Benham, E.C., and Soil Survey Staff. (2012). Field book for describing and sampling soils, Version 3.0. Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. (2006). Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin. Agricultural Handbook 296. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_050898.pdf

Soil Survey Staff. (2014). Keys to Soil Taxonomy, 12th ed. USDA-Natural Resources Conservation Service, Washington, DC.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Official Soil Series Descriptions. Online. Available at https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053587 (accessed 2019 to 2020).

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Soil Survey Geographic (SSURGO) Database for Oregon (multiple counties). [Online]. Available at https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm (accessed in 2020).

Thilenius, J.F. (1964). Synecology of the white-oak (*Quercus garryana* Douglas) woodlands of the Willamette Valley, Oregon. Ph.D. diss. Oregon State University, Corvallis. https://ir.library.oregonstate.edu/downloads/0c483m76v

Thilenius, J.F. (1968). The *Quercus garryana* forests of the Willamette valley, Oregon. Ecology, 49(6), pp.1124-1133. https://esajournals.onlinelibrary.wiley.com/doi/pdf/10.2307/1934496

Yeats, R.S., Graven, E.P., Werner, K.S., Goldfinger, C. and Popowski, T. (1996). Tectonics of the Willamette Valley, Oregon. p. 183-222. In Rogers, Albert M., Walsh, Timothy J., Kockelman, William J., and Priest, George R. (ed.) Assessing earthquake hazards and reducing risk in the Pacific Northwest. US Geological Survey Professional Paper 1560.

Approval

Kirt Walstad, 11/27/2024

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	10/03/2023
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:**