USDA Natural Resources Conservation Service

Ecological site AX002X01X006
Puget Lowlands Dry Prairie

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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.

This MLRA includes a variety of ecological sites. Many are characterized by forest vegetation, but some were maintained as prairie, savanna, or oak woodland through cultural burning prior to Euro-American settlement. Reference conditions for these non-forest and oak woodland sites have become rare due to changes in land management including the urban and agricultural development of many low-lying prairies, and a sharp reduction in fire frequency across the MLRA. In the northern reach of this MLRA Puget Sound has a moderating effect on temperature and boosting effect on humidity, resulting in a cooler and moister northern extent as compared to the south. Douglas-fir (Pseudotsuga menziesii) is widespread throughout. Oregon white oak (Quercus garryana) is common on valley bottoms and surrounding slopes in the south. In the north its historic extent is more limited, occurring on warm aspects, with exposed and droughty conditions, and areas affected by rain shadowing from local ranges, particularly east and south of the Olympic Mountains. Big leaf maple (Acer macrophyllum) is common as a codominant or sub canopy tree across many sites, including those dominated by either conifers or oaks. Pacific madrone grows in areas close to saltwater, or within oak woodlands and other droughty areas with very well drained soils. Western hemlock (Tsuga heterophylla) and western red cedar (Thuja plicata) are more common 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

This ecological site occurs across MLRA 002 in both the Puget Sound Trough Lowlands and the Portland Basin and Hills Land Resource Units (LRUs). 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 Portland Basin and Hills Land Resource Unit (LRU B) is in southwestern Washington and northwestern Oregon. The LRU extends north to the Cowlitz River and transitions to the Willamette Valley in the south. The Columbia River Gorge limits the eastern extent, and influence of tidewater at Cathlamet identifies the northwestern extent.

These LRUs are affected by the proximity to the Pacific Ocean. 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 in the Seattle Metro area. Aside from isolated areas affected by local rain shadows and marine-influenced fog, the climate is fairly consistent throughout MLRA 002 and both these LRUs. Mean annual precipitation ranges from 35 to 60 inches and most falls as rain between October and May. Precipitation increases with elevation. Occasional snowfall occurs between 1000- and 2000-feet elevation but is usually not persistent; below 1000 feet snow is uncommon. The frost-free period ranges from 160 to 220 days. Locations near the Columbia River Gorge experience strong winds and infrequent ice storms with little winter snow. Average daily maximum temperatures in summer at Vancouver, Washington, are 1 to 3 degrees F warmer compared to Seattle or Olympia, Washington (Agricultural Climate Information System, 2007a, 2007b).
Elevation ranges from sea level to about 2,000 feet. Major landforms include glaciofluvial terraces along the Columbia River, as well as residual hills and foothills surrounding the Portland Basin. Areas of Columbia River flood plain are present in southern Washington and more extensively in Oregon. In the Portland Basin and Hills LRU Residual hills are composed primarily of Quaternary-Pliocene and Tertiary volcanic and sedimentary rocks. The lower-relief basin is composed primarily of sediment from catastrophic Quaternary glacial flooding from Glacial Lake Missoula. The Puget Sound Trough Lowlands LRU represents the furthest southern extent of repeated advances of continental glaciers in western Washington. Here, glacial drift is the predominant parent material. There are also 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.

Ecological site concept

This site is dominated by grasslands that were historically and prehistorically maintained as prairies by fire. Typical native plant species on the site include Roemer's fescue (*Festuca idahoensis* var. roemeri), camas (Camassia quamash), blue wildrye (Elymus glaucus), slender wheatgrass (Elymus trachycaulus), common woolly sunflower (Eriophyllum lanatum), field chickweed (Cerastium arvense ssp. Strictum), and Oregon white oak (Quercus garryana). The site is typically on plains and glacial terraces in soils that developed from glacial outwash. The soils are usually coarse textured in the upper part. Fire, both human and lightning caused, influenced the development of those grassland soils that have an umbric or mollic epipedon. For many generations Native American tribes in the area used fire in dry periods of the year to help maintain this ecological site and manage resources that often occurred solely in these ecosystems or were more productive in them (Norton 1979, Boyd 1986, Agee 1993). One of the most important objectives was to stimulate the growth of carbohydrate-rich forbs (especially species of the genus Camassia [camas]) that were harvested as a major food source (Garibaldi and Turner 2004, Tomeck 2009). Acorns from scattered open grown Oregon white oaks (Quercus garryana) and berry species were also important food sources, as were the game animals that utilized this habitat (Norton 1979, Tomeck 2009). Early accounts also place ponderosa pine in a much wider range within this ecological site than at present (Davies 1981). Because much of this ecological site occurs in the most inhabitable and arable parts of the Pacific Northwest, little of it has been preserved in its reference state and much has been developed for urban or agricultural use; or has transitioned to conifer forest in the absence of frequent fire that is needed to prevent conifer establishment (Crawford and Hall 1997, Dunwiddie and Bakker 2011). These succeeding conifer forests are often privately owned and managed for timber resources. Once transitioned to conifer forest, immense effort is required to return them to open prairie, and development of the reference state condition that was common prior to European settlement may not be possible. Many introduced invasive plant species hinder restoration efforts due to their tenacity and ability to thrive in frequently disturbed areas, which is something this ecological site requires in its reference state. These invasive species are likely to remain a component of this ecological site despite the most dedicated restoration efforts (Dennehy et al 2011, Dunwiddie et al 2014). Much area that was formerly occupied by these prairies exists in an urban state or as farmland or grazing land. In grazed land and croplands, restoration of the reference state would mean current agricultural producers would need to shift objectives and develop new commodity markets or new revenue streams that can support a different vegetation cover and land use system. Given the vast area of this ecological site currently under urban, agricultural, or timberland use, recovery of its reference state and associated functions at large scales is unlikely. True reference examples are likely to only exist as smaller patches within a matrix of alternative land uses.

Associated sites

AX002X01X004	**Puget Lowlands Forest**
AX002X02X001	**Portland Basin Dry Douglas-fir Forest**

Similar sites

R002XN502WA	**Xeric Prairie**

Table 1. Dominant plant species

Tree	(1) *Quercus garryana*
Shrub	Not specified
Herbaceous	(1) *Festuca idahoensis ssp. roemeri*

Legacy ID

R002XA006WA

Physiographic features

Table 2. Representative physiographic features

Landforms	(1) Outwash plain (2) Terrace (3) Hillslope
Flooding frequency	None
Ponding frequency	None
Elevation	30–152 m
Slope	0–15%
Water table depth	30–152 cm
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	30–457 m
Slope	Not specified
Water table depth	Not specified

Climatic features

Mean annual air temperature: 48 to 52 degrees Fahrenheit

Table 4. Representative climatic features

Frost-free period (characteristic range)	150-240 days
Freeze-free period (characteristic range)	
Precipitation total (characteristic range)	635-1,524 mm

Influencing water features

Soil features

Surface textures: gravelly loam; gravelly sandy loam, and loamy fine sand
Soil family textures: Sandy and sandy-skeletal
Parent material: Glacial outwash
Soil depth: More than 60 inches
Soil drainage: Somewhat excessively drained
Available water capacity in the top 40 inches: 0.6 to 3.5 in/in.
pH in water: 5.1 to 7.3

Ecological dynamics

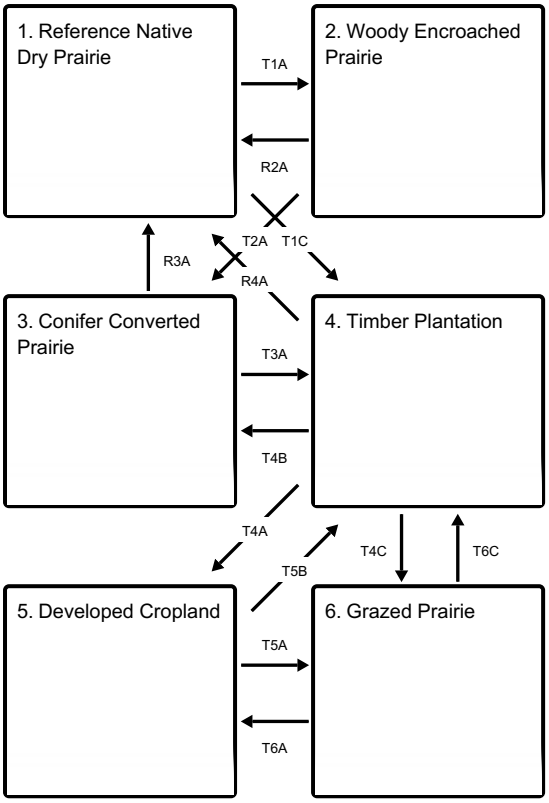
Frequent disturbance is essential to the persistence of the reference state for this ecological site. The primary disturbance that maintained herbaceous dominance of this site historically was fire. Though some lightning ignitions likely occurred, fire was much more frequent in this ecological site due to its use by Native American tribes across the Puget Sound region who were highly skilled at applying it to enhance and maintain resources they relied on in these open prairies. In addition to fire, soil perturbation and careful tending during the regular harvest of bulbs and rhizomes by local tribes had a strong historic influence on plant composition and soil condition. These important activities have largely been removed from this ecological site where its reference state historically occurred, resulting in the conversion to forest or to other land uses such as urban development or post-European settlement style agriculture.

Solitary and small groups of Oregon white oak and native shrubs occur naturally in the reference plant communities for this ecological site. If no disturbance occurs, these plant communities are quickly invaded by trees and shrubs, transitioning from prairie to woodland or forest rapidly. Initial native tree species to invade this site include Douglas-fir, grand fir and lodgepole pine. In some historic cases, an increase in Oregon white oak density may have preceded development of conifer forest where a large acorn mast or a dense pre-existing oak seedling layer was present at the precise time when burning cessation occurred. The further the departure from the last fire event, the more advanced the encroachment becomes, ultimately to a point where the succeeding conifer forest, typically dominated by Douglas-fir, is difficult to discern from adjacent areas where conifers are the dominant cover for the reference state. Vast areas of this ecological site exist across MLRA 002 today as mature conifer forest or have been subject to development for urban or cropland agricultural use, and the reference for lowland prairie only exists in a few carefully protected and managed sites such as at Joint Base Lewis-McChord in the South Sound.

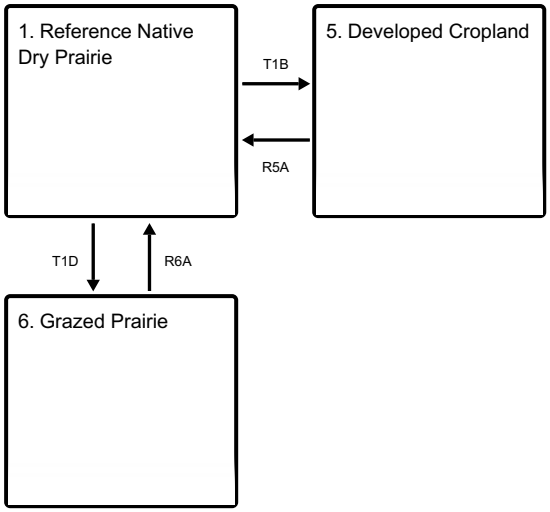
Reestablishment of plant communities that mimic the reference state for this ecological site is possible in areas of suitable soils and where management objectives and resources allow. In places that have become conifer forest, harvest of conifer trees must precede successive restorative actions. Native prairie species must be replanted and carefully tended so that they mature and can produce seed and perpetuate themselves on the site. In all cases, fire must be used frequently to prevent re-invasion of trees. Nonnative species are typically present in this ecological site where it has not transitioned to conifer forest. Due to their inherent adaptability to fire and frequent disturbance, some of these species tend to persist despite efforts to control them with fire, chemical or mechanical treatment. Their dominance in the community is affected by the type and intensity of disturbance employed. Careful management can reduce their cover, but elimination of these species altogether is unlikely. Thus, a pathway to full recovery of the reference state for this ecological site is uncertain.

State and transition model

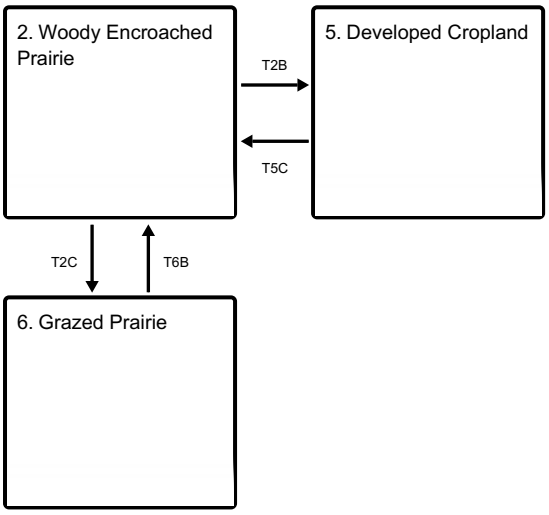
Ecosystem states



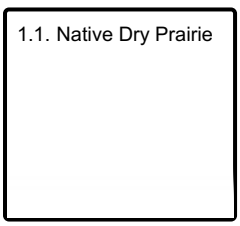
States 1, 5 and 6 (additional transitions)



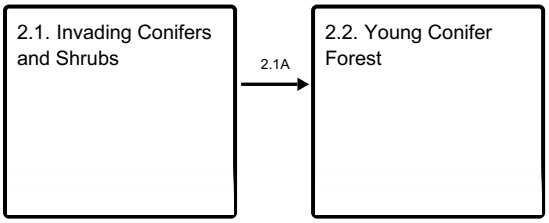
States 2, 5 and 6 (additional transitions)



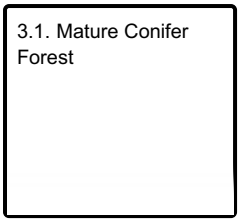
State 1 submodel, plant communities



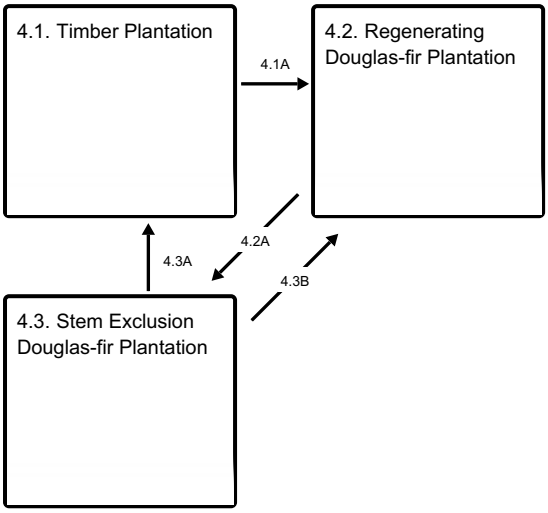
State 2 submodel, plant communities



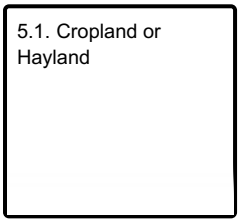
State 3 submodel, plant communities



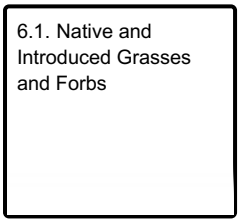
State 4 submodel, plant communities



State 5 submodel, plant communities



State 6 submodel, plant communities



State 1
Reference Native Dry Prairie

Community 1.1
Native Dry Prairie

A native grassland community including abundant carbohydrate-rich forbs and a rich mix of native herbaceous species. Woody vegetation is limited to few scattered oaks and in some places, ponderosa pines. Shrubs and other tree species are rare. Native conifers such as Douglas fir or grand fir may occasionally be present as isolated individuals if able to escape frequent fires.

Dominant plant species

- Oregon white oak (*Quercus garryana*), tree
- Idaho fescue (*Festuca idahoensis*), grass
- camas (*Camassia*), other herbaceous

State 2
Woody Encroached Prairie

Community 2.1
Invading Conifers and Shrubs

This community consists of a dense cover of establishing young trees and shrubs throughout a native prairie. Invading woody vegetation is composed of a mixture of native trees and native and non-native shrubs species. Douglas-fir is the most common encroaching tree, but grand fir and lodgepole pine may also invade in abundance. Non-native herbaceous species are introduced to the site and quickly become well-established or dominant. Occasional oaks and ponderosa pines remain emergent above encroaching tree seedlings and shrubs. Tree seedlings and shrubs are beginning to cause declines in cover of herbaceous species.

Dominant plant species

- Oregon white oak (*Quercus garryana*), tree
- Douglas-fir (*Pseudotsuga menziesii*), tree
- Idaho fescue (*Festuca idahoensis*), grass

Community 2.2
Young Conifer Forest

This community consists of dense, young conifer trees. Shrubs and herbaceous species have been largely outcompeted by establishing conifers which have substantially shaded the site. Oaks and ponderosa pines are still present in the canopy but are beginning to suffer declines in vigor and crown die-back due to competition with ascending invasive conifer trees. Only small patches of the reference herbaceous plant community remain.

Dominant plant species

- Douglas-fir (*Pseudotsuga menziesii*), tree
- Oregon white oak (*Quercus garryana*), tree

Pathway 2.1A
Community 2.1 to 2.2

This pathway represents the continued absence of fire or other disturbances. This pathway occurs if disturbances that can kill or clear woody vegetation, such as fire (natural or prescribed), mowing, or grazing continue to be absent from the site. This includes intentional omission of woody vegetation clearing activities and active suppression of fire.

State 3
Conifer Converted Prairie

Community 3.1
Mature Conifer Forest

Large, mature, Douglas-fir dominates the community by shading nearly all the understory and forming a continuous canopy. Other encroaching conifers may be present. Forbs and grasses are severely constrained to very few spots where there are gaps in the canopy or are eliminated from the site. Overstory oaks are overtopped, and many have died from lack of access to sunlight. Ponderosa pines may rival encroaching conifers in height but struggle to compete for light due to side-shading from adjacent conifers and many of these have also died. If any oaks and ponderosa pines remain, they are very few and are in poor health with very little living crown remaining. Shade tolerant shrubs and ferns may begin to establish.

Dominant plant species

- Douglas-fir (*Pseudotsuga menziesii*), tree
- salal (*Gaultheria shallon*), shrub
- red huckleberry (*Vaccinium parvifolium*), shrub

- western swordfern (*Polystichum munitum*), other herbaceous

State 4
Timber Plantation

Community 4.1
Timber Plantation

This community is the management-controlled climax condition for a Douglas-fir plantation. The overstory is even-aged and exclusively or near exclusively Douglas-fir. Trees are usually less than 100 years old. Trees are relatively evenly spaced, owing to their having been artificially established on a tight grid; there are typically no significant canopy gaps and little complexity in canopy structure. Stock used for planting is skewed to heavily favor Douglas-fir. Other conifers may be included in planting or occur naturally from adjacent seed sources depending on management objectives. Hardwoods such as maple, madrone and oak are typically less abundant due to efforts to control them and increase space for and growth of desired conifers. The understory may be somewhat sparse to relatively well-vegetated with a mix of highly shade-tolerant shrubs and herbaceous species, especially western sword fern or salal (*Gaultheria shallon*). Large snags are very few or absent.

Dominant plant species

- Douglas-fir (*Pseudotsuga menziesii*), tree
- salal (*Gaultheria shallon*), shrub
- red huckleberry (*Vaccinium parvifolium*), shrub
- western swordfern (*Polystichum munitum*), other herbaceous

Community 4.2
Regenerating Douglas-fir Plantation

Structure is single story small trees and shrubs. This community consists of regenerating conifer forest over a large area that has been opened by timber harvest. Species composition is strongly controlled by management actions. The site is typically planted with Douglas-fir. Non-timber shrubs and trees are controlled to facilitate planted seedling survival, resulting in a dense, young conifer forest. Shrubs and mixed herbaceous species typically occupy space between planted saplings. These may include oceanspray, salal, red huckleberry, western sword, salmonberry and mixed native and non-native grasses and forbs. Introduced Himalayan blackberry (*Rubus armeniacus*) and Scotch broom (*Cytisus scoparius*) are often present and may be abundant, usually at the expense of native shrubs or planted trees. Snags are very few or absent. Downed woody debris may be abundant or limited depending on thoroughness of its reduction during the prior timber harvest.

Dominant plant species

- Douglas-fir (*Pseudotsuga menziesii*), tree
- western hemlock (*Tsuga heterophylla*), tree
- salal (*Gaultheria shallon*), shrub
- Himalayan blackberry (*Rubus armeniacus*), shrub
- Scotch broom (*Cytisus scoparius*), shrub

Community 4.3
Stem Exclusion Douglas-fir Plantation

Structure is single story forest of even-aged conifer trees. This community phase is the interim point in a Douglas-fir plantation between regeneration and the mature state. Composition is exclusively or near exclusively Douglas-fir, and the stand is very dense, having been artificially established on a grid and tended with weed control methods to maximize conifer survival. The conifers may be present at a lower frequency. A pre-commercial thin may be applied at or shortly before this phase to reduce inter-tree competition and maintain high growth rates. The understory is often very sparse, particularly if pre-commercial thinning is not performed, owing to the very limited light that reaches the forest floor. Only highly shade tolerant species occur, if present at all. Snags are very few or absent. Downed woody debris may be abundant or limited depending on thoroughness of its reduction during the prior timber harvest.

Dominant plant species

- Douglas-fir (*Pseudotsuga menziesii*), tree
- salal (*Gaultheria shallon*), shrub
- western swordfern (*Polystichum munitum*), other herbaceous

Pathway 4.1A
Community 4.1 to 4.2

This pathway represents even-aged harvest of a mature Douglas-fir plantation followed by conifer planting. This pathway may also result from a stand-replacing fire followed by a salvage harvest and replanting. Site preparation and removal of woody material to limit fire hazard is usually performed prior to planting.

Pathway 4.2A
Community 4.2 to 4.3

This pathway represents growth of an even-aged Douglas-fir plantation alongside active weed controls to limit competition with undesired species. Thinning of conifer saplings and pruning may or may not occur, depending on stand density or fire hazard concerns. Disturbances, such as fire, pests, and disease, are discouraged and controlled if possible.

Pathway 4.3A
Community 4.3 to 4.1

This pathway represents growth of an even-aged Douglas-fir plantation that is maturing and dominates the overstory. Light thinning may or may not occur, depending on stand density or fire hazard concerns. Disturbances, such as fire, pests, and disease, are discouraged and controlled if possible.

Pathway 4.3B
Community 4.3 to 4.2

This pathway results from a stand-replacing fire or a major pest or disease event that kills all or nearly all trees, followed by replanting of conifers. Salvage harvesting may occur if there is sufficient commercially viable material in the stand. Site preparation and removal of woody material to limit fire hazard is usually performed prior to planting.

State 5
Developed Cropland

Community 5.1
Cropland or Hayland

Structure is annual or perennial non-native species monoculture. This community consists of a range of crops, including annually planted species, short-lived perennial species, and more permanent perennial crops. Hay and grasses and legumes for silage are included in this community.

State 6
Grazed Prairie

Community 6.1
Native and Introduced Grasses and Forbs

Structure is annual and perennial grasses and forbs, few scattered trees. Community 6.1 is a livestock grazed grassland dominated by a mix of perennial grasses and forbs. Introduced weedy species may be present on the site, and desired non-native forage grasses may be abundant. Native species are often intermixed and can be abundant in some areas. Oaks and pines are typically retained, although regeneration of these is limited by grazing activity or intentional suppression to retain open conditions for forage species. The site is grazed, mowed or burned often enough to prevent re-establishment of forest. Dominant shrubs are typically invasive rhizomatous species that

form thickets such as Himalayan blackberry (*Rubus armeniacus*) or those that develop a robust seedbank and flourish in open conditions such as Scotch broom (*Cytisus scoparius*). Some tougher native shrub species such as California blackberry (*Rubus ursinus*) and salmonberry may be interspersed. Areas where ponding or brief inundation occurs commonly support non-native rhizomatous grasses. Between shrub thickets introduced pasture species such as tall fescue (*Schedonorus arundinaceus*), orchardgrass (*Dactylis glomerata*), redtop (*Agrostis gigantea*) and red fescue (*Festuca rubra*) are common. Native Roemer's fescue (*Festuca idahoensis* ssp romeri) and other prairie reference species may be found but are usually not dominant.

Dominant plant species

- Himalayan blackberry (*Rubus armeniacus*), shrub
- salmonberry (*Rubus spectabilis*), shrub
- California blackberry (*Rubus ursinus*), shrub
- orchardgrass (*Dactylis glomerata*), grass
- tall fescue (*Schedonorus arundinaceus*), grass
- red fescue (*Festuca rubra*), grass
- Idaho fescue (*Festuca idahoensis*), grass
- redtop (*Agrostis gigantea*), grass

Transition T1A
State 1 to 2

This transition represents the absence of fire or other disturbances. It occurs if disturbances that can kill or clear woody vegetation, such as fire (natural or prescribed), mowing, or grazing continue to be absent from the site. This includes intentional omission of woody vegetation clearing activities and active suppression of fire. Historically, this transition occurred primarily due to the cessation of Native American burning and root resource harvesting and tending.

Transition T1C
State 1 to 4

Transition T1B
State 1 to 5

This transition represents a shift of land use from the reference native prairie state to a cropland agriculture state. Trees are cleared and the site is tilled to support cropping activity. Amendments are added to soil and the site is irrigated, as needed. Crops grown may be perennial or annual.

Transition T1D
State 1 to 6

This transition is caused by the addition of livestock to the site and intentional establishment of mixed grass and forb species that support a grazed grassland system. Living oaks and pines may be retained for shade for livestock. Soil amendments and irrigation may or may not occur.

Restoration pathway R2A
State 2 to 1

This restoration transition represents a disturbance, such as fire, selective cutting or mowing, or herbicide treatment (or a mix of those) that removes encroaching woody vegetation, allowing herbaceous species to recover and dominate the site. The restoration of complete cover of native species is unlikely as non-native herbaceous species are likely to persist despite efforts to eradicate them. Overstory oaks and pines are minimally affected by disturbances, but a majority native cover can be attained by intensive, frequent management. This transition can be initiated from any community phase in state 2.

Transition T2A
State 2 to 3

This transition represents the continued absence of fire or other disturbances. This transition occurs if disturbances that can kill or clear larger woody vegetation, such as fire (natural or prescribed), mechanical harvesting of trees or chemical treatment continue to be absent from the site or are not employed. This includes intentional omission of woody vegetation clearing activities and active suppression of fire. This transition can be initiated from community 2.2 in state 2.

Transition T2B
State 2 to 5

This transition is caused by development of an intensive cropping or haying agricultural management system. Trees are cleared and the site is tilled to support cropping activity. Amendments are added to soil and the site is irrigated, as needed. Crops grown may be perennial or annual. This transition can be initiated from any community in state 2.

Transition T2C
State 2 to 6

This transition is caused by the removal of young conifers, brush and shrubs to restore open space, followed by the establishment of mixed grass and forb species that support a grazed grassland system. Living oaks may be retained for shade for livestock. Soil amendments and irrigation may or may not occur.

Restoration pathway R3A
State 3 to 1

This restoration represents invading conifer tree removal followed by planting of native prairie forbs and grasses. Oaks and ponderosa pines also require planting to be restored to the site. Conifer tree removal consists of a timber harvest or chemical or girdling treatments which kill conifers in place. Activities to restore the original plant community include removal of non-native grass, forb, and shrub species and prescribed fire, brush control, invasive plant control, mowing, thatching, grazing, and soil aeration and reseeding. The restoration of complete cover of native species is unlikely as non-native herbaceous species are likely to persist despite efforts to eradicate them, but a majority native cover can be attained by intensive, frequent management.

Transition T3A
State 3 to 4

This transition represents a shift of land use from an unmanaged, conifer converted prairie to a managed conifer plantation. A rotation of timber harvest and regeneration is implemented, and prairie oaks and pines are further reduced by intention or as casualties of heavy competition in a heavily shaded timber management system and collateral damage from harvesting actions and equipment.

Restoration pathway R4A
State 4 to 1

This restoration represents a change in land management system from timber plantation to an open prairie. It is achieved through plantation conifer tree removal followed by planting of native prairie forbs and grasses. Oaks and ponderosa pines also require planting to be restored to the site. Conifer tree removal most often consists of a timber harvest, though in rare cases chemical or girdling treatments which kill conifers in place may be used. Activities to restore the original plant community include removal of non-native grass, forb, and shrub species and prescribed fire, brush control, invasive plant control, mowing, thatching, grazing, and soil aeration and reseeding. The restoration of complete cover of native species is unlikely as non-native herbaceous species are likely to persist despite efforts to eradicate them, but a majority native cover can be attained by intensive, frequent management.

Restoration pathway T4B
State 4 to 3

This transition represents the cessation of timber management after the site has been managed previously for timber. This transition retains the conifer dominance of the site, and the forest is allowed to persist and continue to age beyond what is typical in a timber management rotation in the absence of actions that would open the site for

prairie species, such as fire, mechanical treatment or chemical treatments. This transition can be initiated from any community phase in state 4.

Transition T4A
State 4 to 5

This transition is caused by an intentional clearing of land, or a stand replacing fire in state 4, followed by development of an intensive cropping or haying agricultural management system that prevents trees from re-establishing. This transition can be initiated from any community phase in state 4.

Transition T4C
State 4 to 6

This transition is caused by an intentional clearing of trees, followed by establishment of mixed grass and forb species that support a grazed grassland system. Improvements including soil amendments or irrigation may or may not be utilized. This transition can be initiated from any community in state 4.

Restoration pathway R5A
State 5 to 1

This restoration represents a change in land management system from cropland agriculture to prairie. It is achieved through cessation of conventional tilling and crop rotation management, and planting of native prairie forbs and grasses. Oaks and ponderosa pines also require planting to be restored to the site. Activities to restore the original plant community include removal of non-native grass, forb, and shrub species and prescribed fire, brush control, invasive plant control, mowing, thatching, grazing, and soil aeration and reseeding. The restoration of complete cover of native species is unlikely as non-native herbaceous species are likely to persist despite efforts to eradicate them, but a majority native cover can be attained by intensive, frequent management.

Restoration pathway T5C
State 5 to 2

This transition is caused by a cessation of cropland agriculture and lack of disturbance activities. Various native and non-native trees, herbaceous plants, and shrubs naturally establish throughout the site due to lack of significant disturbance or control.

Restoration pathway T5B
State 5 to 4

This transition represents a shift of land use from a cropland state to a managed conifer plantation. Conifer trees are intentionally established by planting throughout cropped site. A rotation of timber harvest and regeneration is implemented, and species composition is heavily controlled to favor conifers.

Transition T5A
State 5 to 6

This transition is caused by establishment of mixed grass and forb species that support a grazed grassland system.

Restoration pathway R6A
State 6 to 1

This restoration represents an effort to restore the native prairie plant community and control invasive and other non-natives species. It is achieved through planting of native prairie forbs and grasses, and suppression of non-native species. Oaks and ponderosa pines also require planting to be restored to the site if they were previously removed. Activities to restore the original plant community include removal of non-native grass, forb, and shrub species and prescribed fire, brush control, invasive plant control, mowing, thatching, grazing, and soil aeration and reseeding. The restoration of complete cover of native species is unlikely as non-native herbaceous species are likely to persist despite efforts to eradicate them, but a majority native cover can be attained by intensive, frequent

management. It may be possible to continue grazing on the site if carefully controlled to prevent decline of native species.

Restoration pathway T6B
State 6 to 2

This transition is caused by a cessation of grazing and lack of other disturbance activities. Various native and non-native trees, herbaceous plants, and shrubs naturally begin to establish throughout the site due to lack of significant disturbance or control.

Restoration pathway T6C
State 6 to 4

This transition represents a shift of land use from a grazed grassland state to a managed conifer plantation. Conifer trees are intentionally established by planting throughout cropped site. A rotation of timber harvest and regeneration is implemented, and species composition is heavily controlled to favor conifers.

Restoration pathway T6A
State 6 to 5

This transition is caused by development of an intensive cropping or haying agricultural management system. Trees and shrubs are cleared and the site is tilled to support cropping activity. Amendments are added to soil and the site is irrigated, as needed. Crops grown may be perennial or annual.

Additional community tables

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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	12/09/2024
Approved by	Kirt Walstad
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

2. **Presence of water flow patterns:**

3. **Number and height of erosional pedestals or terracettes:**

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):**

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

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

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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):**

---

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:**
