

# Ecological site group R008XG455WA

## Loamy, North Aspect, 14-20" ppt., Goldendale Prairie

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### Key Characteristics

None specified

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.

### Physiography

Hierarchical Classification

Major Land Resource Area (MLRA): 8 – Columbia Plateau

LRU – Common Resource Areas (CRA):

8.5 - Moist Yakima Folds

Site Concept Narrative:

Note: for MLRA 8 there are two ecological sites with the name 'North Aspect':

1. One specifically for grasslands on the Goldendale Prairie (Klickitat Co.)
2. One for other grassland areas in MLRA 8 including
  - a. SE portion of MLRA 8 includes portions of Adams, Franklin, Walla Wall, Asotin, Columbia and Garfield counties
  - b. Area above Coulee Dam in Douglas Co.

The North Aspect ESD below is for grasslands on the Goldendale Prairie in Klickitat Co.

Diagnostics:

This upland ecological site occurs on north- and northeast-facing slopes on the Goldendale Prairie in Klickitat Co. Soils are 20 inches and deeper with a loamy surface texture and limited rock fragments (generally 10% or less) in the root-growing portions of the soil profile. Silt loam is most common, but a variety of soils and landforms are possible.

Note: due to historic farming and grazing the Goldendale Prairie has been heavily disturbed. No pristine remnant is known, so the reference state has been reconstructed based on experience in MLRA 8.

The Goldendale Prairie is a grassland steppe area and has not had sagebrush for more than 50 years and is not expected to have sagebrush. Threetip sagebrush is not found on the Goldendale Prairie as this area does not have sagebrush, nor bitterbrush, and no rabbitbrush except for one small area in a road cut.

North Slope would have a shift in plant community composition, with Idaho fescue as the dominant reference state species. Bluebunch wheatgrass would be sub-dominant while Eriogonum species and other forbs would fill the interspaces.

Principle Vegetative Drivers:

The vegetative expression of this productive site is driven by two factors: (1) moderately deep to deep soil depth provides unrestricted rooting for most species, and (2) the north aspect which has more effective precipitation. This ecological site has cooler temperatures year-round and longer lasting snowpack than adjacent ecological sites. North Slope provides crucial water to the vegetation at the hottest time of the growing season allowing this ecological site more resilience when impacted by disturbances. Also, being wetter, North Slope supports a denser plant cover than the Loamy ecological site.

#### Influencing Water Features:

A plant's ability to grow on a site and overall plant production is determined by soil-water-plant relationships

1. Whether rain and melting snow runs off-site or infiltrates into the soil
2. Whether soil condition remain aerobic or become saturated and become anaerobic
3. Water drainage and how quickly the soil reaches wilting point

This ecological site is cooler and moister than surrounding sites due to microclimatic effects. North slopes have less direct solar radiation and reduced evapotranspiration than adjacent uplands or south facing slopes and may retain snow cover longer into the growing season. Deep soils on the north slopes and extensive subsurface root systems of the dominant grasses also provide greater soil moisture infiltration and retention compared with other areas.

Compared to other upland ecological sites, North Slope has more available soil moisture. The north and northeast slopes mean cooler temperatures. Closer spacing of plants mean less evaporation and less runoff. Idaho fescue is especially linked to the additional soil moisture on this ecological site. Bluebunch wheatgrass, is not as linked to the additional soil moisture.

#### Physiographic Features:

The landscape is part of the Columbia basalt plateau. Loamy, north aspect, 14-20" ppt., Goldendale Prairie sites are most commonly found on north and northeast-facing hillslopes in Klickitat County, Washington.

Physiographic Division: Intermontane Plateau

Physiographic Province: Columbia Plateau

Physiographic Sections: Walla Walla Plateau Section

Landscapes: Hills and plateaus

Landform: Sideslopes, terraces, alluvial fans

Elevation: Dominantly 800 to 3,500 feet

Central tendency: 1,400 to 3,000 feet

Slope: Total range: 2 to 65 percent

Central tendency: 2 to 30 percent

Aspect: Dominantly northern aspects

#### Geology:

This MLRA is almost entirely underlain by Miocene basalt flows. Columbia River basalt is covered in many areas with as much as 200 feet of loess and volcanic ash. Small areas of sandstones, siltstones, and conglomerates of the Upper Tertiary Ellensburg Formation are along the western edge of this area. Some Quaternary glacial drift covers the northern edge of the basalt flows, and some Miocene-Pliocene continental sedimentary deposits occur south of the Columbia River, in Oregon.

A wide expanse of scablands in the eastern portion of this MLRA, in Washington, was deeply dissected about 16,000 years ago, when an ice dam that formed ancient glacial Lake Missoula was breached several times, creating catastrophic floods. The geology of the northernmost part of this MLRA is distinctly different from that of the rest of the area. Alluvium, glacial outwash, and glacial drift fill the valley floor of the Okanogan River and the side valleys of

tributary streams. The fault parallel with the valley separates pre-Tertiary metamorphic rocks on the west, in the Cascades, from older, pre-Cretaceous metamorphic rocks on the east, in the Northern Rocky Mountains. Mesozoic and Paleozoic sedimentary rocks cover the metamorphic rocks for most of the length of the valley on the west.

## **Climate**

Grasslands do not have shrubs because they receive more spring precipitation especially in March (Daubenmire). The micro-climate on the north facing slopes provides cooler temperatures and allows Idaho fescue to thrive. Grasslands do not have shrubs because they receive more spring precipitation especially in March (Daubenmire). The climate is characterized by moderately cold, wet winters, and hot, dry summers, with limited precipitation due to the rain shadow effect of the Cascades. Taxonomic soil climate is xeric moisture regime with a mesic temperature regime.

Mean Annual Precipitation:

Range: 14 – 20 inches

Seventy to seventy-five percent of the precipitation comes late October through March as a mixture of rain and snow. June through early October is mostly dry.

Mean Annual Air Temperature:

Range: 46 to 52 F

Central Tendency: 48 – 50 F

Freezing temperatures generally occur from late-October through early-April. Temperature extremes are 0 degrees in winter and 110 degrees in summer. Winter fog is variable and often quite localized, as the fog settles on some areas but not others.

Frost-free Period (days):

Total range: 110 to 170

Central tendency: 120 to 150

The growing season for Loamy, north aspect, 14-20" ppt., Goldendale Prairie is March through the end of July.

## **Soil features**

Edaphic:

Loamy, north aspect, 14-20" ppt., Goldendale Prairie occurs with Loamy, 14-20" ppt., Goldendale Prairie and Very Shallow ecological sites.

Representative Soil Features:

This ecological site components are dominantly Ultic and Pachic taxonomic subgroups of Haploxerolls and Argixerolls great groups of the Mollisols taxonomic order. Soils are moderately deep to very deep. Average available water capacity of about 7.0 inches (17.8 cm) in the 0 to 40 inches (0-100 cm) depth range.

Soil parent material is dominantly loess mixed with colluvium and residuum with influence of volcanic ash possible.

The associated soils are Goldendale, Kiakus, Lorena, Swalecreek and similar soils.

Dominant soil surface is silt loam.

Dominant particle-size class is clayey to fine-loamy.

Fragments on surface horizon > 3 inches (% Volume):

Minimum: 0

Maximum: 5

Average: 0

Fragments within surface horizon > 3 inches (% Volume):

Minimum: 0  
Maximum: 10  
Average: 0

Fragments within surface horizon  $\leq 3$  inches (% Volume):  
Minimum: 0  
Maximum: 10  
Average: 3

Subsurface fragments  $> 3$  inches (% Volume):  
Minimum: 0  
Maximum: 10  
Average: 1

Subsurface fragments  $\leq 3$  inches (% Volume):  
Minimum: 0  
Maximum: 15  
Average: 5

Drainage Class: Dominantly well drained  
Water table depth: Greater than 60 inches

Flooding:  
Frequency: None

Ponding:  
Frequency: None

Saturated Hydraulic Conductivity Class:  
0 to 10 inches: Moderately high  
10 to 40 inches: Moderately high

Depth to root-restricting feature (inches):  
Minimum: 20  
Maximum: Greater than 60 inches

Electrical Conductivity (dS/m):  
Minimum: 0  
Maximum: 0

Sodium Absorption Ratio:  
Minimum: 0  
Maximum: 0

Calcium Carbonate Equivalent (percent):  
Minimum: 0  
Maximum: 0

Soil Reaction (pH) (1:1 Water):  
0 - 10 inches: 5.6 to 7.3  
10 - 40 inches: 5.6 to 7.3

Available Water Capacity (inches, 0 – 40 inches depth):  
Minimum: 3.1  
Maximum: 8.3  
Average: 7.0

## Vegetation dynamics

### Ecological Dynamics:

Loamy, north aspect, 14-20" ppt., Goldendale Prairie produces about 1000-1400 pounds/acre of biomass annually

The line between sagebrush steppe and true grasslands has been discussed and debated for many years. Daubenmire states that the line has nothing to do with pre-settlement as native ungulates played no significant role in the evolution of ecotypes. He also says that there is no evidence that the distribution of vegetative types is related to fire. And he also says there is no useful correlation between soil classification and the line between grasslands and sagebrush steppe.

The ecotones between Daubenmire's vegetation types can be defined on the basis of consistent differences in climate and consistent differences in vegetation. Higher spring precipitation, especially in March, favors grasses over sagebrush. The grassland area of southeastern Adams and eastern Franklin counties have more precipitation in March. The same for the grasslands in Walla Walla, Asotin and Garfield counties. The Goldendale Prairie and the high elevation grassland above Coulee Dam in Douglas county also have higher spring precipitation. So, the grassland areas of MLRA 8 are consistent with Daubenmire's findings.

Loamy, north aspect, 14-20" ppt., Goldendale Prairie would have a shift in plant community composition, with Idaho fescue the featured species and bluebunch wheatgrass sub-dominant. Idaho fescue is shorter and has a dense clump of shoots, while bluebunch wheatgrass is taller and is less dense. Both species are long-lived bunchgrasses. Bluebunch has an awned spike seed head while Idaho fescue has an awned panicle seed head. The ratio of Idaho fescue to bluebunch wheatgrass plants on any site can vary due to aspect and elevation.

Both grasses provide a crucial and extensive network of roots to the upper portions (up to 48" deep in soils with no root-restrictive horizons) of the soil profile. These roots create a massive underground source to stabilize the soils, provide organic matter and nutrients inputs, and help maintain soil pore space for water infiltration and water retention in the soil profile. The extensive rooting system of mid-sized bunchgrasses leave very little soil niche space available for invasion by other species. This drought resistant root can compete with, and suppress, the spread of exotic weeds.

The stability and resiliency of the reference communities is directly linked to the health and vigor of Idaho fescue and bluebunch wheatgrass. Research has found that the community remains resistant to medusahead if the site maintains at least 0.8 mid-sized bunchgrass plant/sq. ft. (K. Davies, 2008). These two bunchgrasses hold the system together. If we lose either or both bunchgrass the ecosystem begins to unravel.

The natural disturbance regime for grassland communities is periodic lightning-caused fires. Ponderosa pine communities have the shortest FRI of about 10-20 years (Miller). The FRI increases as one moves to wetter forested sites or to drier shrub steppe communities. Given the uncertainties and opinions of reviewers, a mean of 75 years was chosen for Wyoming sagebrush communities (Rapid Assessment Model). This would place the historic FRI for grassland steppe around 30-50 years

The effect of fire on the community depends upon the severity of the burn. With a light to moderate fire there can be a mosaic of burned and unburned patches. Bunchgrasses thrive as the fire does not get into the crown. Idaho fescue and bluebunch wheatgrass exhibit rapid tillering when there is light severity fires and favorable soil moisture. Largely, the community is not affected by lower intensity fire.

A severe fire puts stress on the entire community. Spots and areas that were completely sterilized are especially vulnerable to exotic invasive species. Sterilized spots must be seeded to prevent invasive species (annual grasses, tumble mustard) from totally occupying the site. Bluebunch wheatgrass and basin wildrye will have weak vigor for a few years but generally survive. Idaho fescue plants are very much at risk with a severe burn coupled with wind. The result can be "black holes" or ash 2-3 inches into the crown. The death of Idaho fescue and Cusick bluegrass plants creates holes in the community, and the opportunity for exotic species to colonize. Needle and thread is one native species that can increase via new seedlings.

Spring burning can be especially damaging to Idaho fescue.

Grazing is another common disturbance that occurs to this ecological site. Grazing pressure can be defined as heavy grazing intensity, or frequent grazing during reproductive growth, or season-long grazing (the same plants grazed more than once). As grazing pressure increases the plant community unravels in stages:

1. Cusick bluegrass is eliminated. Adjacent natives fill the void
2. Idaho fescue declines while bluebunch wheatgrass increases
3. Both Idaho fescue and bluebunch wheatgrass decline
4. With further decline invasive species colonize the site
5. The site can become an invasive grass community

Managing grassland to improve the vigor and health of native bunchgrasses begins with an understanding of grass physiology. New growth each year begins from basal buds. Given the opportunity Idaho fescue readily produces new seedlings while bluebunch wheatgrass plants rely principally on tillering. During seed formation, the growing points of bluebunch wheatgrass become elevated and are vulnerable to damage or removal. Idaho fescue has weak stems and is much more sensitive to grazing than bluebunch wheatgrass.

If defoliated during the formation of seeds, bluebunch wheatgrass has limited capacity to tiller compared with other, more grazing resistant grasses (Caldwell et al., 1981). Repeated critical period grazing (boot stage through seed formation) is especially damaging. Over several years each native bunchgrass pasture should be rested during the critical period two out of every three years (approximately April 15–July 15). And each pasture should be rested the entire growing-season every third year (approximately March 1 – July 15).

In the spring each year it is important to monitor and maintain an adequate top growth: (1) so plants have enough energy to replace basal buds annually, (2) to optimize regrowth following spring grazing, (3) to protect the elevated growing points of bluebunch wheatgrass, and (4) to avoid excessing defoliation of Idaho fescue with its weak stems.

These grasses remain competitive if:

- (1) Basal buds are replaced annually,
- (2) Enough top-growth is maintained for growth and protection of growing points, and
- (3) The timing of grazing and non-grazing is managed over a several-year period. Careful management of late spring grazing is especially critical

For more grazing management information refer to Range Technical Notes found in Section I Reference Lists of NRCS Field Office Technical Guide for Washington State.

In Washington, Idaho fescue – bluebunch wheatgrass communities provide habitat for a variety of upland wildlife species.

#### Supporting Information:

##### Associated Sites:

In the Goldendale Prairie portion of MLRA 8, North Aspect and Loamy (both 14-20" ppt.) are closely associated. Stony Foothills, Stony Foothills South Aspect, Very Shallow and Riparian Complex may also be nearby.

##### Similar Sites:

Loamy, North Aspect has higher precipitation (14-20") with more Idaho fescue than other North Aspect sites in MLRA 8 Columbia Plateau. North Aspect, dwarf shrub in MLRA 9 Palouse Prairie has a high amount of Idaho fescue but also has the dwarf shrub component that North Aspect Goldendale does not have.

##### Inventory Data References (narrative):

Data to populate Reference Community came from several sources: (1) NRCS ecological sites from 2004, (2) Soil Conservation Service range sites from 1980s and 1990s, (3) Daubenmire's habitat types, and (4) ecological systems from Natural Heritage Program

## Major Land Resource Area

MLRA 008X

Columbia Plateau

## **Subclasses**

- R008XY455WA—Loamy North Aspect 14-20 PZ Goldendale Prairie

## **Stage**

Provisional

## **Contributors**

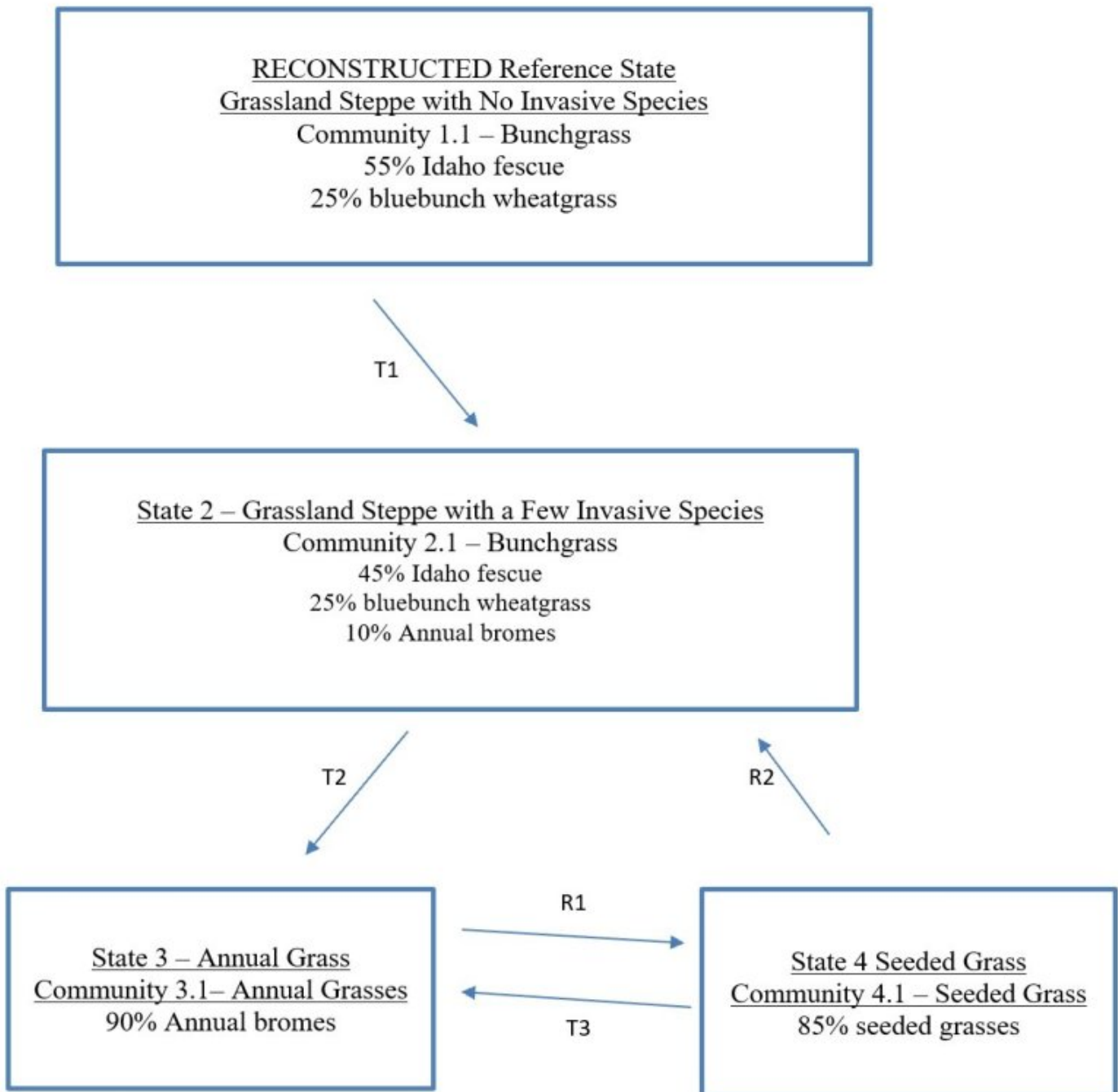
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## **State and transition model**

## State and Transition Diagram for Loamy, north aspect, 14-20" ppt., Goldendale Prairie in MLRA 8:

This state and transition model (STM), explains the general ecological dynamics for the Loamy, north aspect, 14-20" ppt., Goldendale Prairie ecological site. The STM illustrates the common plant communities that can occur on the site. Boxes around each state represent the ecological threshold, which if crossed, is not reversible without human intervention. Arrows within a state represent the pathway between plant communities, while the arrows between states represent the transition or recovery between the states. Plant species composition is represented as a percentage of total annual production (pounds). The composition of pristine sites can vary somewhat due to variations in site conditions.





**RECONSTRUCTED Reference Community 1.1 for Loamy, north aspect, 14-20” ppt., Goldendale Prairie in MLRA 8**

Plant species composition is represented as a percentage of total annual production (pounds). The composition of pristine sites can vary somewhat due to variations in site conditions. Pounds listed below are the maximum allowable for Similarity Index. Many numbers have been rounded to not show more precision than our current state of knowledge.

Similarity Index		Similarity Index	
		<b>Sprouting Shrubs – Minor</b>	
		less than 5% 50 lbs.	
		RIBES currant	
		ROSA5 rose	
<b>Dominant Mid-Size Bunchgrasses</b>		<b>Other Mid-Size Bunchgrasses – Minor</b>	
80%		5% 70 lbs.	
FEID	Idaho fescue 55% 750 lbs.	POCU3	Cusick’s bluegrass
PSSP6	bluebunch wheatgrass 25% 350 lbs.	ACOC/ACNE	Nelson’s or western needlegrass
		LECI4	basin wildrye
		KOMA	prairie junegrass
<b>Short Grass – Minor</b>		<b>Grasslike</b>	
5-10% 150 lbs.			
POSE	Sandberg bluegrass		
<b>Native Forbs – Minor</b>		5-10% 150 lbs.	
BASA3	arrowleaf balsamroot	MICRO6	microseris
LUPIN	lupine	ALLIU	wild onion
CREPI	hawksbeard	CALOC	Mariposa lily
PHLO2	longleaf phlox	ERIGE2	fleabane
PHHO	spiny phlox	LOMAT	lomatium / biscuitroot
LIPU1	granite gilia	ERIOG	buckwheat species
ASTRA	milkvetch / locoweed	CASTI2	paintbrush
ANDI2	low pussytoes	ACMI2	yarrow
HIERA	hawkweed	COLLO	collomia
DELPH	larkspur	PLPA2	woolly plantain
LIRU4	stoneseed	FRPU2	yellowbells
		Below	Normal
<b>Estimated Production (pounds / acre)</b>		1000	1200
			Above
			1400

**State 1  
Reconstructed Reference State**

Note: most sites on the Goldendale Prairie have already crossed the threshold into State 3 State 1 Narrative: State 1 represents grassland steppe with no invasive or exotic species. All the functional, structural groups have one or more species. The Goldendale Prairie has no sagebrush or bitterbrush, and except for a spot along a road cut, also has no rabbitbrush. Reference State Community Phases: 1.1 Reference Idaho fescue-bluebunch wheatgrass Dominate Reference State Species: Idaho fescue, bluebunch wheatgrass At-risk Communities: • Note: most sites on the Goldendale Prairie have already crossed the threshold into State 3 Pathways within State 1 There are no pathways in Reference State for this grassland steppe Loamy, north aspect, 14-20” ppt., Goldendale Prairie ecological site.

**Resilience management.** Note: most sites on the Goldendale Prairie have already crossed the threshold into State 3

## **Community 1.1**

### **Bunchgrass**

Communities 1.1 is stable with a high cover of Idaho fescue/bluebunch wheatgrass and moderate cover of forbs. There is also a minor amount of threadleaf sedge which is native, but also rhizomatous. But when the dominant bunchgrasses exhibit low vigor and decline, threadleaf sedge increases and Japanese brome colonizes the disturbed sites.

**Resilience management.** Note: most sites on the Goldendale Prairie have already crossed the threshold into State 3

## **State 2**

### **Grassland Steppe with a Few Invasive Species**

Note: most sites on the Goldendale Prairie have already crossed the threshold into State 3 State 2 Narrative: State 2 represents grassland steppe with the inclusion of invasive annual grasses such as Japanese brome or cheatgrass. All the native functional, structural groups are still represented by one or more species. Annual grasses are a minor component in State 2. Once a community has been invaded by cheatgrass the chance of going back to State 1 is small. Dominate State 2 Species: Idaho fescue and bluebunch wheatgrass Community Phases for State 2: 2.1 Bunchgrass Bluebunch wheatgrass Pathways within State 2 There are no pathways in State 2 for this grassland steppe North Slope ecological site.

## **Community 2.1**

### **Bunchgrass**

In Community 2.1, the reference community has been invaded by some annual grasses such as annual bromes. Annual grasses are a minor component in State 2. Once a community has been invaded by cheatgrass the chance of going back to State 1 is small.

## **State 3**

### **Annual Grasses**

State 3: Annual Grasses Note: most sites on the Goldendale Prairie have already crossed the threshold into State 3 State 3 Narrative: State 3 represents sites dominated by invasive annual species and has crossed a biological threshold. As State 1 or State 2 unravels the dominant bunchgrasses decline while invasive grasses become more and more prominent. Virtually all the native functional, structural groups are missing in State 3. Community Phases for State 3: 3.1 Annual Grass annual bromes Dominate State 3 Species: Cheatgrass Pathways within State 3 There are no pathways in State 3 for this grassland steppe Loamy North Slope ecological site. There is only one community, and thus, no pathways within State 3

## **Community 3.1**

### **Annual Grass**

## **State 4**

### **Seeded Grasses**

State 4 Narrative: State 4 represents a site that has been seeded to desirable grasses such as Secar. Snake River wheatgrass, Sherman big bluegrass, or intermediate wheatgrass. State 4 is stable if 0.8 plant per sq. ft. or greater of the desired bunchgrasses is maintained. Community Phases for State 4: 1.1 Seeded Grasses Dominate State 4 Species: Desirable seeded grasses with or without legumes Pathways within State 4: There are no pathways in State 4 for this grassland steppe North Slope ecological site.

## **Community 4.1**

### **Seeded grass**

## **Transition T1**

## **State 1 to 2**

Note: most sites on the Goldendale Prairie have already crossed the threshold into State 3 Transitions from State to State T1 Result: transition from Reference State to State 2 (grassland steppe w/ a few annuals). The Reference State does not have invasive species. State 2 has the same communities but with minor additions of invasive annual grasses such as annual bromes. Ecological process. Most sites in the Reference State have some scattered annual grass seed that has blown onto the site. This seed is waiting for seed-to-soil contact to enable germination. Primary Trigger: Soil disturbances from rodents or badgers. Indicators: The occurrence of annual grasses on sites where they had been absent.

## **Transition T2 State 2 to 3**

T2 Result: Transition from State 2 to State 3 which is dominated by annuals. This transition occurs once the cover of Idaho fescue-bluebunch wheatgrass decline to less than 10% while invasive species cover is 40% or more. Primary Trigger: Chronic heavy grazing, season-long grazing, or late spring grazing. Note: chronic season-long grazing in 1880s-1940s created thousands of acres of annual grass dominated communities. Ecological Process: Consistent defoliation pressure to bluebunch wheatgrass and Idaho fescue causes poor vigor, shrinking crowns and plant mortality. Native species are all but eliminated while invasive species such as annual bromes have the competitive advantage. With more and more of the soil surface and upper soil rooting surface open, opportunistic, exotic weeds take advantage of the available niche space to colonize and expand until they dominate the community. The site has lost its primary species that stabilize and protect the soil from wind and water erosion and has also lost the ability to retain sufficient soil moisture for many of the native perennial species. Indicators: Decreasing cover of bluebunch wheatgrass and Idaho fescue, increasing cover of invasive annual species. Increasing distance between bunchgrass plants. Decreasing soil organic matter, soil water retention, limited water infiltration and percolation in the soil profile.

## **Restoration pathway R1 State 3 to 4**

R1 Result: Shift from State 3 (a community dominated by invasive annual species) to State 4, which is predominately desirable seeded grasses. This restoration transition does not occur without significant time and inputs to control weeds, prepare a seedbed, seed desirable species, and post-seeding weed control and management. This requires a commitment of two years or more for weed control. Care must be taken to maintain soil structure so that the seedbed has many safe-sites for the seed. Seed placement must be managed to achieve seed-soil contact at very shallow depth (about 1/8 inch is desired). Proper grazing management is essential to maintain the stand post-seeding. Secar Snake River wheatgrass, thickspike wheatgrass, Sherman big bluegrass, Sandberg bluegrass, and intermediate wheatgrass are typical species seeded on North Slope ecological site. The actual transition occurs when the seeded species have successfully established and are outcompeting the annual species for cover and dominance of resources.

## **Restoration pathway R2 State 4 to 2**

R2 Result: Shift from State 4 back to State 2. This restoration transition does not occur without a significant commitment of time & resource inputs to restore ecological processes, native bunchgrasses and native forb species. Shifting from State 3 to State 4: If the goal is to restore back to a native plant community, State 3 must first be shifted to State 4. It will take two years or longer to kill annual species and to exhaust the seedbank of invasive species. Site will then need to be seeded to perennial species such as Snake River wheatgrass to restore soil properties before native species can survive and thrive on site. The seeded species rebuild some of the basic soil properties including increased soil organic matter, increased soil moisture, and likely would also require the soil's pore spaces, bulk density and soil microorganisms to return before the native species that used to survive in this ecological site can return. The site would also need several years of no significant fires and proper grazing management as well. See narrative for R1 transition above. Shifting from State 4 to State 2: This assumes that the shift from State 3 to State 4 has been successful. State 4 stand must be killed before proceeding. The seeding of native species should occur in two steps: (1) a seeding of native bunchgrasses so that broadleaf weeds may be controlled, (2) a re-introduction of native forbs. The site would also need several years of no significant fires and proper grazing management as well to ensure plant establishment and vigor.

## **Transition T3**

### **State 4 to 3**

T3 Result: shift from seeded grass State 4 to State 3 which is dominated by invasive annual species. Primary Trigger: This transition occurs when chronic heavy grazing has removed too much of the perennial bunchgrass cover allowing invasive annual species to colonize the site. As this continues the competitive advantage goes to the exotic species which are opportunistic and take most of the site's resources. Little of the resources remain for the desirable species. Secondary Trigger: Frequent fires or a severe fire that removes too much of the perennial bunchgrass cover and gives the competitive advantage back to the invasive species. Indicators: shrinking crowns and mortality of desirable species, increasing caps gaps between perennial species, increasing cover by annual grasses. References: Boling M., Frazier B., Busacca, A., General Soil Map of Washington, Washington State University, 1998 Daubenmire, R., Steppe Vegetation of Washington, EB1446, March 1968 Davies, Kirk, Medusahead Dispersal and Establishment in Sagebrush Steppe Plant Communities, Rangeland Ecology & Management, 2008 Environmental Protection Agency, map of Level III and IV Ecoregions of Washington, June 2010 Miller, Baisan, Rose and Pacioretty, "Pre and Post Settlement Fire regimes in mountain Sagebrush communities: The Northern Intermountain Region Natural Resources Conservation Service, map of Common Resource Areas of Washington, 2003 Rapid Assessment Reference Condition Model for Wyoming sagebrush, LANDFIRE project, 2008 Rocchio, Joseph & Crawford, Rex C., Ecological Systems of Washington State. A Guide to Identification. Washington State Department of Natural Resources, October 2015. Pages 156-161 Inter-Mountain Basin Big Sagebrush. Rouse, Gerald, MLRA 8 Ecological Sites as referenced from Natural Resources Conservation Service-Washington FOTG, 2004 Soil Conservation Service, Range Sites for MLRA 8 from 1980s and 1990s Tart, D., Kelley, P., and Schlafly, P., Rangeland Vegetation of the Yakima Indian reservation, August 1987, YIN Soil and Vegetation Survey

## **Citations**