

# Ecological site group R008XG536WA

## Loamy, South Aspect, Columbia Hills

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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 four ecological sites with the name 'Loamy'.

1. One for the sagebrush steppe region
2. One specifically for grasslands on Goldendale Prairie (Klickitat Co.)
3. One specifically for grasslands on south side of Columbia Hills (Klickitat Co.)
4. One for other grassland regions in MLRA 8 including
  - a. SE portion of MLRA 8 includes portions of Adams, Franklin, Walla Walla, Asotin, Columbia and Garfield counties
  - b. Area above Coulee Dam in Douglas Co.

The Loamy ESD below is for grasslands on the south side of Columbia Hills in Klickitat Co. (see 3 above).

Diagnostics:

The soils for this grassland steppe upland site are 20 inches & 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 south side of the Columbia Hills has been heavily disturbed. No pristine remnant is known, so the reference state has been reconstructed based on experience in MLRA 8.

The south side of the Columbia Hills is a grassland steppe area and has not had sagebrush for more than 50 years and is not expected to have sagebrush. This area does not have sagebrush, nor bitterbrush, and no rabbitbrush except for one small area near the Columbia River.

Perennial bunchgrasses would dominate the reference state. Cool-season bunchgrasses form two distinct layers. Bluebunch wheatgrass is the dominant bunchgrass in the top grass layer, while Sandberg bluegrass is the major grass of the lower grass layer. Native forbs fill the interspaces.

## Principle Vegetative Drivers:

The moderately deep to deep silt loam soils and the south aspect drive the vegetative expression of this productive site. Most species have unrestricted rooting on this 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

With adequate cover of live plants and litter, there are no restrictions on Loamy sites with water infiltrating into the soil. These sites are well drained and are saturated for only a short period.

## Physiographic Features:

The landscape is part of the Columbia basalt plateau. Loamy, south aspect, Columbia Hills sites occur on broad ridges and plateaus, stream terraces, and east-facing hillslopes of the Columbia Hills in Klickitat County.

Physiographic Division: Intermontane Plateau

Physiographic Province: Columbia Plateau

Physiographic Sections: Walla Walla Plateau Section

Landscapes: Hills and plateaus

Landform: Sideslopes

Elevation: Dominantly 300 to 3,200 feet

Central tendency: 300 to 2,800 feet

Slope: Total range: 0 to 65 percent

Central tendency: 10 to 50 percent

Aspect: Dominantly southern aspects, but can occur on all 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 climate is characterized by moderately cold, wet winters, and hot, dry summers, with limited precipitation due to the rain shadow effect of the Cascades. Winter fog is variable and often quite localized, as the fog settles on some areas but not others. Compared to the rest of MLRA 8, the south side of the Columbia Hills is dry and hot.

Taxonomic soil climate is xeric moisture regime with a mesic temperature regime.

Mean Annual Precipitation:

Range: 10 – 14 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 54 F

Central Tendency: 48 – 52 F

Freezing temperatures generally occur from late-October through early-April. Temperature extremes are 0 degrees in winter and 110 degrees in summer.

Frost-free Period (days):

Total range: 110 to 160

Central tendency: 120 to 150

The growing season for Loamy, south aspect, Columbia Hills is March through mid-May.

## **Soil features**

Edaphic:

The Loamy, south aspect, Columbia Hills ecological site commonly occurs with Shallow Stony, Very Shallow and Sands ecological sites.

Representative Soil Features:

This ecological site components are dominantly Ultic and Typic taxonomic subgroups of Argixerolls and Haploxerolls great groups of the Mollisols taxonomic order. Soils are moderately deep to very deep. Average available water capacity of about 6.0 inches (15.2 cm) in the 0 to 40 inches (0-100 cm) depth range.

Soil parent material is dominantly mixed loess over colluvium and residuum.

The associated soils are Fisherhill, Stacker, Walla Walla and similar soils.

Dominate soil surface is silt loam.

Dominant particle-size class is fine-loamy to coarse-silty.

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

Minimum: 0

Maximum: 2

Average: 0

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

Minimum: 0

Maximum: 5

Average: 0

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

Minimum: 0

Maximum: 5

Average: 1

Subsurface fragments > 3 inches (% Volume):

Minimum: 0

Maximum: 10

Average: 1

Subsurface fragments  $\leq$  3 inches (% Volume):

Minimum: 0

Maximum: 15

Average: 2

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

Electrical Conductivity (dS/m):

Minimum: 0

Maximum: 2

Sodium Absorption Ratio:

Minimum: 0

Maximum: 0

Calcium Carbonate Equivalent (percent):

Minimum: 0

Maximum: 5

Soil Reaction (pH) (1:1 Water):

0 - 10 inches: 6.1 to 8.4

10 - 40 inches: 6.1 to 9.0

Available Water Capacity (inches, 0 – 40 inches depth):

Minimum: 4.9

Maximum: 8.3

Average: 6.0

## **Vegetation dynamics**

Ecological Dynamics:

Loamy, south aspect, Columbia Hills produces about 600-900 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.

Bluebunch wheatgrass would be dominant in the reference state. It is a long-lived, mid-sized cool-season bunchgrass with an awned or awnless seed head arranged in a spike. Bluebunch provides 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 bluebunch wheatgrass. Refer to page 8 for more details about bluebunch physiology. 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). It is bluebunch that holds the system together. If we lose the bluebunch the ecosystem crashes or unravels.

The natural disturbance regime for grassland communities is periodic lightning-caused fires. The fire return intervals (FRI) listed in research for sagebrush steppe communities is quite variable. 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 sagebrush steppe (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. With adequate soil moisture bluebunch wheatgrass can make tremendous growth the year after the fire. Largely, the community is not affected by lower intensity fire. Needle and thread is one native species that can increase via new seedlings following a 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.

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. Bluebunch wheatgrass declines while Sandberg bluegrass and needle and thread increase
2. As bluebunch wheatgrass continues to decline, invasive species such as cheatgrass and knapweed colonize the site
3. With further decline the site can become a cheatgrass community

Managing grasslands to improve the vigor and health of native bunchgrasses begins with an understanding of grass physiology. New growth each year begins from basal buds. Bluebunch wheatgrass plants rely principally on tillering, rather than establishment of new plants through natural reseeding. During seed formation, the growing points become elevated and are vulnerable to damage or removal.

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, and (3) to protect the

elevated growing points of bluebunch wheatgrass.

Bluebunch wheatgrass remains 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, bluebunch wheatgrass communities provide habitat for a variety of upland wildlife species.

Supporting Information:

Associated Sites:

Loamy, south aspect, Columbia Hills is associated with other ecological sites in the grassland steppe areas of MLRA 8, including Shallow Stony and Sands. Very Shallow may also be nearby.

Similar Sites:

Loamy, south aspect, Columbia Hills on south side of Columbia Hills is a bluebunch wheatgrass site. Shrubs and Idaho fescue are nonexistent. The other Loamy ecological sites in MLRA 8 Columbia Plateau have sagebrush or Idaho fescue.

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**

- R008XY536WA—Loamy South Aspect Columbia Hills

## **Stage**

Provisional

## **Contributors**

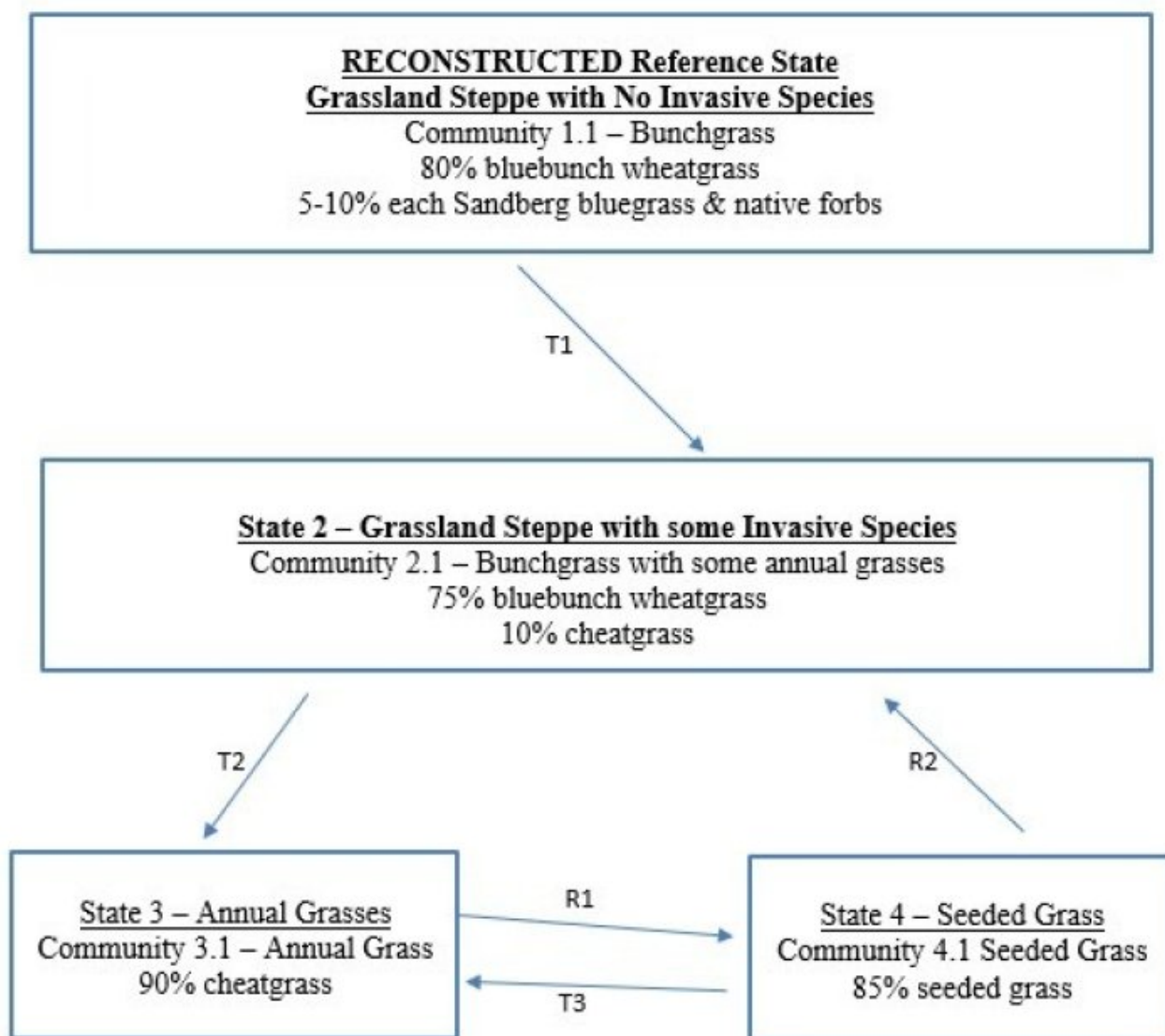
Provisional Site Author: Kevin Guinn

Technical Team: K. Moseley, G. Fults, R. Fleenor, W. Keller, C. Smith, K. Bomberger, C. Gaines, K. Lefferts

## **State and transition model**

**State and Transition Diagram for Loamy, south aspect, Columbia Hills in MLRA 8:**

This state and transition model (STM), explains the general ecological dynamics for the Loamy, south aspect, Columbia Hills 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, south aspect, Columbia Hills 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% 30 lbs.		
		RIBES currant ROSA5 rose		
<b>Dominant Mid-Size Bunchgrasses</b>		<b>Other Mid-Size Bunchgrasses – Minor</b>		
80% 700 lbs.		less than 5% 30 lbs.		
PSSP6 bluebunch wheatgrass		ELEL5 bottlebrush squirreltail ACTH7 Thurber needlegrass HECO26 needle and thread ACNE9 Nelson needlegrass		
<b>Short Grasses – Minor</b>		<b>Grass Like</b>		
5%-10 100 lbs.				
POSE Sandberg bluegrass VUOC Sixweeks fescue				
<b>Native Forbs – Minor</b>		5-10% 100 lbs.		
BASA3 arrowleaf balsamroot		LOMAT lomatium / biscuitroot		
LUPIN lupine		ASTRA milkvetch / locoweed		
CREPI hawksbeard		ERIGE2 fleabane		
PHLO2 longleaf phlox		HIERA hawkweed		
PHHO spiny phlox		PLPA woolly plantain		
LIPU11 granite gilia		MICRO6 microseris		
ERIOG buckwheat		LIRU stoneseed		
CASTI2 paintbrush		CALOC Mariposa lily		
ACMI2 yarrow		ANDI2 low pussytoes		
COLLO collomia, trumpet		DELPH larkspur		
FRPU yellowbells				
		Below	Normal	Above
<b>Estimated Production (pounds / acre)</b>		600	750	900

**State 1**

**Reconstructed Reference State**

Note: most Loamy sites on the south side of the Columbia Hills have already crossed the threshold into State 3  
 State 1 Narrative: State 1 represents grassland steppe with no invasive or exotic weed species. Each functional, structural group would have one or more native species. The south side of the Columbia Hills has no sagebrush or bitterbrush, and except for a spot along the Columbia River, the south side of the Columbia Hills also has no rabbitbrush. Reference State Community Phases: 1.1 Bunchgrass Bluebunch wheatgrass Dominate Reference State Species: would be bluebunch wheatgrass At-risk Communities: • Any community in the reference state is at risk of moving to State 2. The seed source of cheatgrass is nearby and blowing onto most sites annually.

**Community 1.1**



## **Bunchgrass**

The Reference Community 1.1 would be dominated by bluebunch wheatgrass. Native forbs are also present.

## **State 2**

### **Grassland Steppe with Invasive Species**

Note: most Loamy sites on the south side of the Columbia Hills have already crossed the threshold into State 3  
State 2 Narrative: State 2 represents native grassland steppe with minor inclusion of invasive annual grasses such as cheatgrass. All the native functional, structural groups would be represented by one or more species. Cheatgrass would be a minor component in State 2. Once a community has been invaded by cheatgrass the chance of going back to State 1 is small. Community Phases for State 2: 2.1 Bunchgrass Bluebunch wheatgrass

## **Community 2.1**

### **Bunchgrass - Bluebunch wheatgrass**

The Reference Community 2.1 would be dominated by bluebunch wheatgrass. Native forbs are also present.

## **State 3**

### **Annual Grasses**

Note: most Loamy sites on the south side of the Columbia Hills 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 begins to unravel 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 cheatgrass

## **Community 3.1**

### **Annual Grass**

Dominate State 3 Species: Annual grasses such as cheatgrass. The main species can include other annual bromes, medusahead, ventenata, mustard, prickly lettuce and diffuse knapweed.

## **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 crested 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: 4.1 Seeded Grasses

## **Community 4.1**

### **Seeded grass**

Dominate State 4 Species: Desirable seeded grasses with or without legumes

## **Transition T1**

### **State 1 to 2**

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 is the same as Reference State but with minor addition of invasive annual grasses such as cheatgrass. Primary Trigger: soil disturbances (rodents, badgers) create openings in the community or a high moisture year causes a micro-burst of cheatgrass and is the principle means of colonization. Loss of soil biological crusts contribute to the invasion. Ecological process. Annually cheatgrass or other annual grass seed blows onto most Reference State sites. With seed-soil contact this seed germinates and competes with the native species for space, light and moisture. The loss of soil biological crusts also contributes to the invasion. Even pristine communities in the Reference State are susceptible to colonization by invasive annual grasses. Indicators: The occurrence of annual grasses on sites where they had been absent.

## **Transition T2**

### **State 2 to 3**

T2 Result: shift from State 2 with a few annuals to State 3 which is dominated by annual grasses. This transition would occur once the cover of bluebunch wheatgrass declines to less than 10% and invasive species cover is greater than 40%. Primary Trigger: Due to chronic heavy grazing, season-long grazing, or late spring grazing, dominant species are all but eliminated. Annuals such as cheatgrass have gained the competitive advantage. 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. Note: chronic season-long grazing in 1880s-1940s created thousands of acres of annual grass-sagebrush community, and then fire turned that into annual grasses. Ecological process: the unraveling of the native plant community begins with consistent defoliation pressures to bluebunch wheatgrass. This causes poor vigor, shrinking crowns and plant mortality. With more and more of the soil surface and upper soil rooting surfaces open, opportunistic weeds that take advantage of the available niche space and expand. The invasive annual grasses in State 2 communities make a dramatic increase to dominate the community. Secondary Trigger: Repeated fire does the same thing. In Washington, chronic season-long grazing caused more acres of State 2 than repeated fire. Repeated fire is a much more common event in south Central Washington than elsewhere in MLRA 8. Indicators: Decreasing vigor and cover of bluebunch wheatgrass and increasing cover of invasive annual species. Increasing distance between perennial species. Decreasing soil organic matter, soil water retention, limited water infiltration and percolation in the soil profile.

## **Restoration pathway R1**

### **State 3 to 4**

R1 Transition 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 Loamy 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. Attention needs to be paid to each step of the process: weed control, seedbed preparation, seeding and planting operations and post-seeding management. 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 with 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. This transition occurs when the desirable seeded grasses become minor to the dominant annual grasses. 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. Ecological process: the unraveling of the seeded grass community begins with consistent defoliation pressures to seeded grasses. This causes poor vigor, shrinking crowns and plant mortality. With more and more of the soil surface and upper soil rooting surfaces open, opportunistic weeds that take advantage of the available niche space and expand. The invasive annual grasses in State 2 communities make a dramatic increase to dominate the community. Indicators: shrinking crowns and mortality of desirable species, increasing caps gaps between desirable 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**