Ecological site group R009XG450WA
North Aspect, Bunchgrass, 15-18" ppt.

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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): 9 – Palouse Prairie

LRU – Common Resource Areas (CRA):
9.3 - Dissected Loess Uplands
9.4 - Deep Loess Foothills

Site Concept Narrative:
Diagnostics:

North aspect, bunchgrass, 15-18” ppt. is an upland grassland site in the loess hills portion of MLRA 9 (Common Resource Areas 9.3 dissected loess uplands and 9.4 deep loess foothills). This site also occurs within Daubenmire’s Agropyron-Fescue and Fescue-Rose vegetative zones. The Agropyron-Fescue zone is dissected by the lower Snake River. The Agropyron-Poa zone along the Snake River is included in MLRA 8 and not MLRA 9. Note that the genus Agropyron is now Pseudoroegneria.

Soils are loamy and loamy skeletal, and moderately deep (20-40”) to deep (40-60”). Silt loam is the most common texture. This site occurs only on north to northeast aspects.

North aspect, bunchgrass, 15-18” ppt. is a classic bunchgrass site. Perennial bunchgrasses dominate the reference state, while rabbitbrush is only a minor presence. Forbs are more prominent on north slopes than on other aspects. Cool-season bunchgrasses form two distinct layers. Idaho fescue, and less frequently bluebunch wheatgrass, form the top layer, while Sandberg bluegrass is the major grass of the lower layer. The north aspect in the loess hills have a larger forb component than other aspects. The shrub layer consists of few, scattered rabbitbrush plants, typically knee- to waist-high.

The loess hills and the Agropyron-Fescue zone have rabbitbrush but no sagebrush. North slopes in the loess hills may have some rose. This ecological site differs from shrub steppe with the absence of sagebrush. However, some sage does occur on the lee slopes of the Blue Mountains, a remnant of the Pleistocene climate (Daubenmire, 1970).

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. The north aspect favors Idaho fescue.

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

The North aspect, bunchgrass, 15-18” ppt. 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.

Physiographic Features:

The landscape is part of the Columbia basalt plateaus and Northern Rocky foothills. MLRA 9 is south of the Okanogan Highlands and Spokane Valley, east of the Columbia Basin, includes only the wet end of the Channeled Scablands and forms a horseshoe around the Blue Mtns. Loess Hills North Slope sites are found only on north to northeastern slopes of hills, canyons and ridges throughout the loess hills. Topographic position may be more important than parent material in defining this site.

MLRA 9 has three distinct geographical types:
(1) the Palouse Hills on the east side
(2) the loess hills to the south and west
(3) the Channeled Scabland-loess islands in the northwest

Note for MLRA 9 there are four ecological sites with “North Slope” in the name:
1. North aspect, dwarf shrub, 18-24” ppt. occurs in the Palouse Hills
2. North aspect, bunchgrass, 15-18” ppt. occurs in the loess hills

The ecological site description below is for the North aspect, bunchgrass, 15-18” ppt. which occurs only in the loess hills.

Physiographic Division: Intermontane Plateau
Physiographic Province: Columbia Plateau
Physiographic Sections: Walla Walla Plateau

Landscapes: hills and foothills
Landform: Dominantly hills, plateaus, canyons

Elevation: Dominantly 1,200 to 5,000 feet
Slope: Total range: 0 to 90 percent
Aspect: Dominantly occurs on north slopes

Geology:

MLRA 9 is almost entirely underlain by Miocene basalt flows. Columbia River basalts are covered by wind-blown loess and volcanic ash with a thickness up to 250 feet thick. The oldest layer of loess accumulated between 2 and 1 million years ago, while the uppermost layers of Palouse Loess accumulated between 15,000 years ago and modern times. The mid layers of loess were deposited episodically between 77,000 years and 16,000 years ago. During the Pleistocene era the channeled scablands, the northwest portion of MLRA 9, were scoured of topsoil by the Lake Missoula Floods about 15,000-17,000 years ago. Flows removed topsoil from exposed ridges and basalt rims in canyons.

Climate

The loess hills are drier and warmer than the Palouse Hills and warmer than the channeled scabland. The climate across MLRA 9 is characterized by moderately cold, wet winters, and relatively dry summers.

Mean Annual Precipitation:
Range: 15 – 18 inches: (extended range is 16-24")

Winter precipitation, primarily snow, occurs during low-intensity, Pacific-frontal storms. During winter these storms produce occasional rains that fall on frozen or thawing ground surfaces. High intensity, convective thunderstorms produce some rain during the growing season. Precipitation is evenly distributed throughout fall, winter and spring.

Mean Annual Air Temperature:
Range: 42 to 52 F
Central Tendency: 47 to 50 F
Freezing temperatures generally occur from late-October through early-April. Temperature extremes are -10 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: 90 to 180
Central tendency: 110 to 150
The growing season for Loess Hills Loamy is generally March through mid-July
Mean Annual precipitation

Soil features

Edaphic:

The North aspect, bunchgrass, 15-18” ppt. ecological site occurs with Loamy, bunchgrass, 15-18” ppt., Stony south aspect, Shallow Stony and Very Shallow ecological sites. Soils are principally formed in loess on the lee (north) sides of hills and canyons due to prevailing regional winds, and with colluvial materials where basalt flows provide the underlying bedrock.

Representative Soil Features:

This ecological site components are dominantly Pachic, Ultic taxonomic subgroups of Argixerolls and Haploxerolls taxonomic great group of the Mollisols taxonomic order, with a minority of Calcic taxonomic subgroup. Soils are dominantly very deep but can range to deep. Average available water capacity of about 6.5 inches (16.5 cm) in the 0 to 40 inches (0-100 cm) depth range.

Soil parent material is dominantly loess, colluvium and residuum derived from basalt.

The associated soils are Athena, Palouse, Geoconda, Lawyer, Linville, Palouse, Powwahkee and similar soils.

Dominate soil surface is silt loam to silty clay loam.

Fragments on surface horizon > 3 inches (% Volume):
Minimum: 0
Maximum: 0

Fragments within surface horizon > 3 inches (% Volume):
Minimum: 0
Maximum: 5
Average: 1

Fragments within surface horizon ≤ 3 inches (% Volume):
Minimum: 0
Maximum: 15
Average: 5

Subsurface fragments > 3 inches (% Volume):
Minimum: 0
Maximum: 20
Average: 5

Subsurface fragments ≤ 3 inches (% Volume):
Minimum: 0
Maximum: 30
Average: 10

Drainage Class: Dominantly well drained
Water table depth: Dominantly 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: Dominantly greater than 60, but bedrock can occur up to 40 inches occurrences
Maximum: greater than 60

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

Sodium Absorption Ratio:
Minimum: 0
Maximum: 0

Calcium Carbonate Equivalent (percent):
Minimum: 0
Maximum: dominantly 0
Some soils with calcic horizons have been included in this site. In those cases, the range for $CaCO_3$ would be 0-35 at lower depth of subsoil

Soil Reaction (pH) (1:1 Water):
0 - 10 inches: 5.6 to 7.8
10 - 40 inches: 5.6 to 9.0

Available Water Capacity (inches, 0 – 40 inches depth):
Minimum: 2.8
Maximum: 8.3
Average: 6.5

Vegetation dynamics

Ecological Dynamics:

North aspect, bunchgrass, 15-18” ppt. produces about 1200-1700 pounds/acre of above-ground biomass annually

The line between sagebrush steppe and true grasslands has been discussed and debated for many years. Rexford Daubenmire, a professor and plant ecologist at Washington State University for 29 years, in his 1970 publication, Steppe Vegetation of Washington, makes the following conclusions. There is no evidence that the distribution of vegetative types is related to fire. And the line has nothing to do with pre-settlement as native ungulates played no significant role in the evolution of ecotypes. He also says there is no useful correlation between soil classification and the line between grasslands and sagebrush steppe.

Daubenmire states that the ecotones between grassland and sagebrush steppe can be defined on consistent differences in climate and consistent differences in vegetation. Higher spring precipitation, especially in March, favors grasses over sagebrush. Shrubs common to the most arid portion of this steppe rely on moisture deeper in the soil profile, particularly in summer after cool season grasses have gone dormant. The loess hills and Palouse Prairie regions of MLRA 9 have greater total precipitation, higher spring precipitation, and a longer growing season than the sagebrush steppe, consistent with Daubenmire's findings.

Three grasses are especially important to the loess hills portion of MLRA 9. The breaks of the Snake River have both bluebunch wheatgrass and Snake River wheatgrass. Idaho fescue, the third important grass, is shorter and has a dense clump of shoots, while bluebunch and Snake River wheatgrass are taller and less dense. All three grasses are long-lived, mid-sized, cool-season bunchgrasses. Idaho fescue's inflorescence is arranged in a panicle, while the inflorescence for bluebunch and Snake River is arranged in a spike. Snake River wheatgrass and Idaho fescue are awned while bluebunch wheatgrass can be awned or awnless.

On the North aspect, bunchgrass, 15-18" ppt. ecological site, Idaho fescue is dominant while bluebunch or Snake River wheatgrass is sub-dominant. The presence and relative abundance of Idaho fescue is an indicator of the comparatively mesic environment for this site. The ratio of Idaho fescue to bluebunch wheatgrass plants on any site can vary due to aspect and elevation.

In healthy communities, these mid-sized 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. This root-network stabilizes the soils, provides organic matter and nutrients, and helps to maintain soil pore space for water infiltration and retention in the soil profile. The extensive rooting system of mid-sized grasses leave very little space for invasion by other species. This drought resistant root mass 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. Refer to page 8 for more details about bunchgrass 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). The relationship between bunchgrasses and other invasive species should be similar. These two bunchgrasses hold the system together. If we lose Idaho fescue 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 dries shrub steppe
communities. The fire return intervals (FRI) listed in research for sagebrush steppe communities is quite variable. 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 perhaps, and even as short as 5-10 years in some locations.

The effect of fire on the community depends upon both the severity and season of the burn. See Vallentine's Range Improvement for more detail. 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. Rabbitbrush and rose are sprouting shrubs and may increase following fire. Snowberry is a rhizomatous sprouter after fire. Largely, the community is not affected by lower intensity fire

A severe fire puts stress on the entire community. Rabbitbrush is likely to increase by crown sprouting. Bluebunch wheatgrass and Snake River wheatgrass, both fire-resilient grasses, will have weak vigor for a few years but generally survive. Reduced vigor of these grasses allows weeds to become established. Some spots and areas can be completely sterilized. Under windy conditions, a fire can burn into the crown of Idaho fescue, leaving behind "black holes" or nothing but ash where fescue plants were incinerated. Sterilized spots and dead Idaho fescue plants makes the site vulnerable to exotic invasive species, so seeding should be strongly be considered. Bluebunch wheatgrass keeps the site resistant to change, while Idaho fescue makes the site more at risk.

Spring burning can also 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. Idaho fescue declines while bluebunch & Snake River wheatgrasses, rabbitbrush, yarrow, and other unpalatable forbs increase
2. All grasses decline while rabbitbrush and unpalatable forbs continue to increase. Invasive species such as cheatgrass and yellow star-thistle colonize the site
3. As grazing progressively thins the native perennials, the alien species take their place. finally becoming dominant.

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.

Supporting Information:

Associated Sites:
North aspect, bunchgrass, 15-18” ppt. is associated with Loamy, bunchgrass, 15-18” ppt., Very Shallow and Shallow Stony

Similar Sites:
North Aspect, bunchgrass, 15-18” ppt. is similar to MLRA 8 North Aspect grassland.

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 009X
Palouse and Nez Perce Prairies

Stage

Provisional

Contributors

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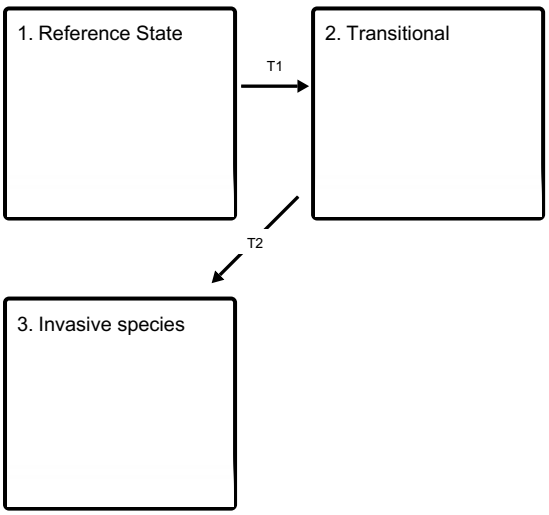
State and transition model

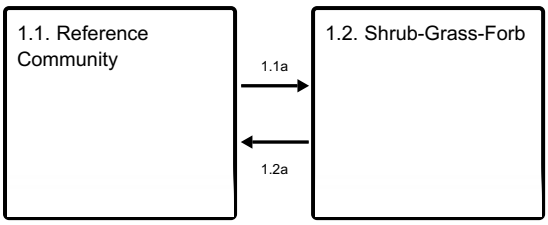
Ecosystem states



T1 - grazing pressure

T2 - grazing pressure

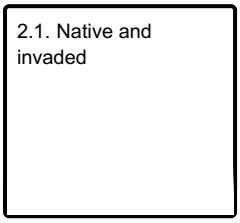
State 1 submodel, plant communities



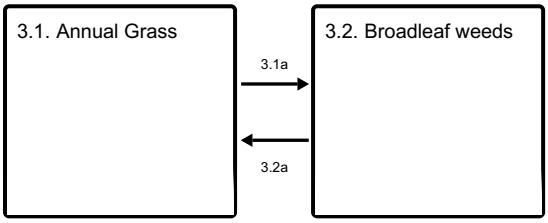
1.1a - grazing pressure

1.2a - major rabbitbrush die-off

State 2 submodel, plant communities



State 3 submodel, plant communities



3.1a - precipitation

3.2a - precipitation

State 1
Reference State

State 1 Narrative: State 1 represents grassland steppe with no invasive or exotic weed species. Grassland sites have no sagebrush and no bitterbrush. Rabbitbrush and forbs are minor species in the reference State. Some rose may be present as well on north slopes. All the functional, structural groups have one or more native species present. Reference State Community Phases: 1.1 Reference Idaho fescue 1.2 Shrub – Bunchgrass – Forb Rabbitbrush – bluebunch wheatgrass Dominant Reference State Species: Idaho fescue with bluebunch wheatgrass/Snake River wheatgrass as sub-dominant At-risk Communities: • Different communities have different degrees of risk • All communities in the reference state are at risk of invasive species • All communities in the reference state are at risk of moving to State 2. The seed source of invasive species is nearby and moving onto most sites annually. • Any community is at risk when fire kills Idaho fescue plants. The holes could quickly be filled by invasive grass or weeds • A community has moved to State 2 when cheatgrass or broadleaf weeds have colonized the site • Any community becomes at-risk of moving to State 3 when Idaho fescue and bluebunch have low cover and cheatgrass or broadleaf weeds have colonized the site

Community 1.1
Reference Community

ference Community 1.1 for North Aspect, bunchgrass, 15-18" ppt. in LRA 9

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

		Similarity Index				Similarity Index	
				Sprouting Shrubs – Minor			
						less than 5%	50 lbs.
				CHVI8	yellow rabbitbrush		
				ERNA10	rubber rabbitbrush		
				RIBES	currant		
				ROSA5	rose		
				SYAL	snowberry		
ominant Mid-Size Bunchgrasses				**Other Mid-Size Bunchgrasses**			
		75%				5%	100 lbs.
SSP6	bluebunch	20%	350 lbs.	ACNE9	Columbia (Nelson's) needlegrass		
EID	Idaho fescue	55%	950 lbs.	KOMA	prairie junegrass		
				POSEJ	big bluegrass		
				ELGL	blue wildrye		
hort Grass							
		<5%	50 lbs.				
DSE	Sandberg bluegrass						
ative Forbs							
						15%	250 lbs.
CMI2	yarrow			ERIOG	buckwheat		
ASA3	arrowleaf balsamroot			GEUM	old man's whiskers		
UPIN	lupine			PHLOX	phlox		
OMAT	lomatium / biscuitroot			ASTRA	milkvetch / locoweed		
RIGE2	fleabane			ALLIU	onion		
LPA2	woolly plantain			LITHO2	woodland star		
RGRG2	large-flowered brodia			CASTI2	paintbrush		
IVE	death camas			COLLO	collomia		
RPU2	yellow fritillary			CALOC	mariposa lily		
PILO	willow herb						
timated Production (pounds / acre)						Below	Normal	Above
						1200	1500	1700

Community 1.1 has high cover of Idaho fescue and bluebunch wheatgrass, and low cover of rabbitbrush. Forbs, while a minor presence, have more cover than forbs on Loess Hills Loamy Idaho fescue 55% Idaho fescue 20% bluebunch wheatgrass/Snake River wheatgrass 15% native forbs <5% rabbitbrush, rose

Community 1.2
Shrub-Grass-Forb

Community 1.2 happens when the dominant bunchgrasses exhibit low vigor and reduced cover. As the bunchgrasses decline rabbitbrush and forbs increase. Rabbitbrush – bluebunch wheatgrass 10% Idaho fescue 35% bluebunch wheatgrass/Snake River wheatgrass 25% unpalatable forbs 30% rabbitbrush, rose

Pathway 1.1a
Community 1.1 to 1.2

1.1a Result: shift from Reference Community 1.1 to Community 1.2 Shrub – Bunchgrass – Forb. Moderate reduction in bunchgrasses and a moderate increase in rabbitbrush and unpalatable native forbs Primary Trigger: grazing pressure (heavy grazing intensity, season long grazing or frequent late spring grazing) to bluebunch wheatgrass/Snake River and Idaho fescue Ecological process: consistent defoliation pressure causes poor vigor and shrinking crowns. Rabbitbrush and forbs gain the competitive edge and take advantage of released resources and niche space to set new seedlings. Indicators: increasing rabbitbrush canopy, increasing forb cover and declining Idaho fescue and bluebunch wheatgrass cover.

Pathway 1.2a
Community 1.2 to 1.1

1.2a Result: shift from Community 1.2 Shrub – Bunchgrass – Forb to Reference Community 1.1. Rabbitbrush and forbs decline while bunchgrasses increase Primary Trigger: periodically some unknown vector (disease, insects) causes a major rabbitbrush die-off. Ecological process: Good grazing management promotes improved vigor and gives bunchgrasses the competitive edge. Idaho fescue expands via new seedlings and bluebunch wheatgrass by

tillering. Indicators: decreased rabbitbrush canopy and forb cover, and increasing cover of bluebunch wheatgrass

State 2
Transitional

State 2 Narrative: State 2 represents a moderate invasion by invasive species and is the transition between State 1 and State 3. Native species are present and dominant, but invasive species have gained a foothold that they do not easily relinquish. Grazing pressure weakens the stand of native species allowing the invasive species to colonize and establish themselves in the community. The invasion can be either cheatgrass or broadleaf weeds (yellow star thistle, chervil, etc.).

Community 2.1
Native and invaded

Native community with: 20% annual bromes, or 20% broadleaf weeds

State 3
Invasive species

State 3 represents the situation where invasive species and rabbitbrush dominate the plant community. Based on opportunity, State 3 is dominated by either cheatgrass or alien broadleaf weeds. Opportunity refers to what seeds are in the seedbank and moisture available from year to year. Soil disturbances by rodents or badgers allow invasive species to colonize. In State 3 native bunchgrasses which were dominant in the reference state are virtually missing and the other native, functional-structural groups have been altered. Community Phases for State 3: 3.1 Annual Grass – Shrub Cheatgrass – Rabbitbrush 3.2 Broadleaf Weeds – Shrub Yellow star-thistle, etc. – Rabbitbrush Dominant Species in State 3: Cheatgrass or broadleaf weeds (yellow star-thistle, etc.) and rabbitbrush

Community 3.1
Annual Grass

Cheatgrass – Rabbitbrush 60% cheatgrass 30% rabbitbrush, rose

Community 3.2
Broadleaf weeds

Yellow starthistle, etc. – Rabbitbrush 60% broadleaf weeds 30% rabbitbrush, rose

Pathway 3.1a
Community 3.1 to 3.2

3.1a Result: there is a natural fluctuation between communities 3.1 and 3.2. Primary Trigger: wetter years favor the introduced forbs/weeds Ecological process: in State 3 the seedbank of annual grasses and introduced forbs/weeds is full. In any given year one or more invasive species will have the opportunity to expand to become dominant or co-dominant. The next year a different species may have a similar opportunity.

Pathway 3.2a
Community 3.2 to 3.1

3.2a Result: there is a natural fluctuation between communities 3.1 and 3.2. Primary Trigger: drier years favor the annual grasses Ecological process: in State 3 the seedbank of annual grasses and introduced forbs/weeds is full. In any given year one or more invasive species will have the opportunity to expand to become dominant or co-dominant. The next year a different species may have a similar opportunity.

Transition T1
State 1 to 2

T1 Transition from Reference State with no invasive species to State 2 transitional is a stand of native plants with

some invasive species. Previously the stand has not had alien species. The result of this transition is the presence of invasive species. Depending on seeds in the soil bank and what is growing nearby, either cheatgrass of broadleaf weeds enter the stand of native species. Also, in State 2 rabbitbrush makes a significant increase. Primary Trigger: grazing pressure (heavy grazing intensity, season long grazing or frequent late spring grazing) to bluebunch/Snake River wheatgrass and other palatable species. Ecological process: consistent defoliation pressure to bluebunch wheatgrass and other palatable species results in poor vigor, shrinking crowns and some plant mortality. The release of resources and niche space allows invasive species such as cheatgrass, yellow star thistle and chervil to colonize and establish Indicators: decreasing cover of bluebunch wheatgrass and the presence of invasive species. Increasing gaps between bluebunch wheatgrass plants.

Transition T2
State 2 to 3

T2 Result: shift from native species with some invasive plants in State 2 to State 3 which is dominated by invasive species. T2 can go two directions, to annual greases Community 3.1 or to broadleaf weeds Community 3.2. Wetter years favor broadleaf weeds while drier years favor annual grasses. Rabbitbrush occurs on both communities. Primary Trigger: grazing pressure (heavy grazing intensity, season long grazing or frequent late spring grazing) to bluebunch wheatgrass and other palatable species Ecological process: consistent defoliation pressure to bluebunch wheatgrass and other palatable species results in poor vigor, shrinking crowns and some plant mortality. The release of resources and niche space allows rabbitbrush and invasive species such as cheatgrass, yellow star thistle and chervil to colonize and establish. This takes place in a series of retrogressions. The native species are weakened, the invasive species increase to fill the void, and an equilibrium at a lower ecological level has been reached. This continues until the community is dominated by rabbitbrush and invasive species rather than natives. Indicators: decreasing cover of native species and increasing cover of invasive species, rabbitbrush and rose. References: Boling M., Frazier B., Busacca, A., General Soil Map of Washington, Washington State University, 1998 Daubenmire, R., Steppe Vegetation of Washington, EB1446, 1970 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 Liston, A, B.L. Wilson, W.A. Robinson, P.S. Doescher, N.R. Harris, and T. Svejar. 2003. The Relative Importance of Sexula Reproduction Versus Clonal Spread in an Arid Bunchgrass. Oecologia 137:216-225 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 Ogle, Dan, Henson, James and Stannard, Mark. Plant guide for Idaho Fescue. Natural Resources Conservation Service, 2002 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 Vallentine, John F. 1971. Range Development and Improvement. BYU Press, Provo, UT.

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