Ecological site group R008XG130WA
Loamy, sagebrush

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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):
8.1 - Channeled Scablands
8.2 - Loess Islands
8.3 - Okanogan Drift Hills
8.4 - Moist Pleistocene Lake Basins
8.5 - Moist Yakima Folds
8.7 - Okanogan Valley

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
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 the sagebrush steppe areas of MLRA 8 (see 1 above).

Diagnostics:

This upland site occurs in the sagebrush region on 20 inches & deeper non-skeletal loamy soils. Soils have a loamy surface texture and limited rock fragments (generally 10% or less) in the root-growing portions of the soil profile. Silt loam, fine sandy loam and sandy loam are most common, but a variety of soils and landforms are possible.

As one moves across MLRA 8, the landscape position for Loamy changes. At 9 inches of precipitation Loamy occurs on all but the north to northeast slopes. But at 12 inches of precipitation Loamy may be found only on south to southwest slopes. Since Aridic soils in MLRA 8 are 9-12 inches of precipitation, Loamy could be considered an Aridic ecological site.

Fire-sensitive shrubs dominate the reference state overstory, while perennial bunchgrasses and forbs fill the interspaces. The shrub layer is typically waist- to shoulder-high Wyoming sagebrush. The natural fire regime

maintains a patchy distribution of shrubs. Depending on the time interval since the last fire, the shrub canopy can be as little 0-3% or as much as 40%. 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.

Disclaimer Statement:

Loamy, sagebrush ecological site concept covers a variety of soils and site conditions. There are at least four consistent and unifying factors across most of MLRA 8: (1) geology is largely basalt and loess, (2) soils are largely loessal, loess over basalt or loess-influenced, (3) similar climate of moderately cold, wet winters and hot, dry summers, and with limited precipitation, (4) dominant plant species (Wyoming sagebrush and bluebunch wheatgrass for example) that are adapted to a wide variety of soils and site conditions.

With the information and knowledge currently available, the technical team determined that site responses to disturbances, and species composition are similar enough to maintain a single Loamy ecological site across sagebrush steppe areas. If it is later determined that there are significant differences across the variation that must be addressed, this Loamy ecological site will be split into two or more separate ecological sites.

Principle Vegetative Drivers:

The moderately deep to deep silt loam soils 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 run off-site or infiltrate into the soil
2. Whether soil condition remain aerobic or become saturated and anaerobic
3. How quickly the soil reaches the 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.

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

Landscapes: Hills, valleys and plateaus
Landform: Sideslopes, terraces, benches, alluvial fans

Elevation: Dominantly 800 to 4,000 feet
Central tendency: 1,000 to 3,000 feet
Slope: Total range: 0 to 90 percent
Central tendency: 2 to 30 percent
Aspect: Occurs 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

The Wyoming sagebrush-bluebunch wheatgrass areas are both warmer and drier than grasslands or other shrub steppe sites (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 either xeric (12 – 16 inches PPT) or aridic moisture regimes (10 – 12 inches PPT) with a mesic temperature regime.

Mean Annual Precipitation:
Range: 10 – 16 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: 44 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. 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 210
Central tendency: 120 to 160
The growing season for loamy, sagebrush is March through mid-July.

Soil features

Edaphic:

The Loamy, sagebrush ecological site commonly occurs with Stony, sagebrush, Very Shallow, Cool Loamy and Loamy Bottom ecological sites.

Representative Soil Features:

This ecological site components are dominantly Aridic, Xeric, Calcic and Vitrandic taxonomic subgroups of Haploxerolls, Durixerolls, Palexerolls, Argixerolls and Haploxerepts great groups of the Mollisols and Inceptisols taxonomic orders, with Aridisols occurring as well. Soils are moderately deep to very deep. Average available water capacity of about 5.5 inches (14.0 cm) in the 0 to 40 inches (0-100 cm) depth range.

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

The associated soils are Alstown, Bagdad, Benwy, Caliralls, Cashmere, Colockum, Dougville, Ellisforde, Manastash, Mikkalo, Newbon, Palerf, Ralock, Renslow and similar soils.

Dominate soil surface is clay loam to very fine sandy loamy, with ashy modifier sometimes occurring as well.

Dominant particle-size class is fine to coarse-silty

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

Fragments within surface horizon > 3 inches (% Volume):
Minimum: 0
Maximum: 30
Average: 5

Fragments within surface horizon ≤ 3 inches (% Volume):
Minimum: 0
Maximum: 30
Average: 10

Subsurface fragments > 3 inches (% Volume):
Minimum: 0
Maximum: 60
Average: 10

Subsurface fragments ≤ 3 inches (% Volume):
Minimum: 5
Maximum: 50
Average: 15

Drainage Class: Dominantly well drained, but some somewhat excessively drained
Water table depth: Greater than 60 inches

Flooding:
Frequency: None

Ponding:
Frequency: None

Saturated Hydraulic Conductivity Class:
0 to 10 inches: High to moderately low
10 to 40 inches: High to moderately low

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

Electrical Conductivity (dS/m):
Minimum: 0
Maximum: 10

Sodium Absorption Ratio:
Minimum: 0
Maximum: 10

Calcium Carbonate Equivalent (percent):
Minimum: 0
Maximum: 25

Soil Reaction (pH) (1:1 Water):
0 - 10 inches: 5.1 to 9.6

10 - 40 inches: 5.1 to 9.0

Available Water Capacity (inches, 0 – 40 inches depth):
Minimum: 1.7
Maximum: 9.7
Average: 5.5

Vegetation dynamics

Ecological Dynamics:

Loamy, sagebrush produces about 600-1200 pounds/acre of biomass annually.

Wyoming big sagebrush and bluebunch wheatgrass are at the core of the Loamy ecological site and warrant a degree of understanding.

Wyoming sagebrush in a long-lived, multi-branched, evergreen shrub. Size varies from 3 feet to 5 feet depending on soil and site conditions. Wyoming big sagebrush has a significant rooting system, composed of a two-part rooting structure with a primary deep taproot, and a shallow extensive network of finer roots that spread laterally. This rooting system allows Wyoming big sagebrush to survive in the hottest and driest portions of the sagebrush range by tapping into groundwater sources deep into the soil profile itself. This also allows Wyoming big sagebrush to be more competitive with bunchgrasses when the landscape positions and/or soils are less ideal for grass species to maintain the competitive advantage.

Bluebunch wheatgrass is a long-lived, mid-sized bunchgrass with an awned or awnless seed head arranged is 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 invasion 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 dries shrub steppe communities. Given the uncertainties and opinions of reviewers, a mean of 75 years and a range of 50-100 was chosen for Wyoming sagebrush communities (Rapid Assessment Model).

Some fires are spotty or do not burn hot enough to fully remove the sagebrush. Fires with light severity will remove less sagebrush and open smaller patches for grass and forb recovery, whereas the more severe fires will remove almost all the sagebrush and leave vast areas open to return to bunchgrass dominance. This is how the patchy distribution occurs. Rabbitbrush and horsebrush are sprouting shrubs and may also increase following fire.

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 of sagebrush. Sagebrush can return to pre-burn conditions quickly. Bunchgrasses thrive as the fire does not get into the crown. With adequate soil moisture Idaho fescue and bluebunch wheatgrass can make tremendous growth the year after the fire. Other than impacting the sagebrush layer, the community is not affected.

A severe fire puts stress on the entire community. The sagebrush layer is completely removed. Spots or patches with heavy sagebrush are sterilized by the fire and 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 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.

For most of MLRA 8, Wyoming sagebrush does not recover easily after fire. The sagebrush in Douglas County, however, returns much more readily. For reasons that have not been clearly established, Douglas County may have a genetically different strain of sagebrush or be enough cooler and wetter, to receive more snowpack to get favorable responses. After disturbances sagebrush often becomes very dense and weedy in nature. Research indicates that microbes in the soil profile are essential for sagebrush success from seed.

The longer the site goes without fire and the more grazing pressure added, the more sagebrush cover increases, and the more bunchgrasses decline. As sagebrush cover increases bluebunch wheatgrass cover declines but individual plants may persist underneath the sagebrush. And, the dense sagebrush community phase is more vulnerable to outside pressures. Invasive species take advantage of available soil rooting spaces. The once extensive grass roots are largely absent. Soils are no longer receiving the organic inputs, and there is less surface cover by grass litter. Both water infiltration into the soil, and water percolation through the soil, are affected, leaving open soil space that is drier and more vulnerable to wind and water erosion, and invasion by undesirable species. Once these undesirable species have colonized, the site is at high risk of crossing a threshold if a disturbance such as fire were to occur.

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 plant grazed more than once). As grazing pressure increases the plant community unravels in stages:
1. Cusick bluegrass, a highly desirable and palatable bunchgrass, declines and is eliminated. Adjacent native species fill the void.
2. Bluebunch wheatgrass declines while Sandberg bluegrass, needle and thread and sagebrush increase
3. As bluebunch wheatgrass continues to decline, invasive species such as cheatgrass and knapweed colonize the site
4. With further decline the site can become a sagebrush-cheatgrass community

Managing sagebrush steppe 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, Wyoming sagebrush – bluebunch wheatgrass communities provide habitat for a variety of upland wildlife species.

Supporting Information:

Associated Sites:
Loamy is associated with other ecological sites in the sagebrush steppe areas of MLRA 8, including Shallow Stony, Stony, Cool Loamy, Stony Foothills and Stony Foothills South Slope. It is also associated with Very Shallow, Mound-Intermound Complex, Loamy Bottom, Alkali Terrace, Sodic Flat, and Riparian Complex.

Similar Sites:
Loamy sagebrush in MLRA 8 Columbia Plateau is a bluebunch wheatgrass – Wyoming sagebrush ecological site. Loamy in MLRA 7 Columbia Basin is also a similar shrub steppe site.

In MLRA 8 the other Loamy ecological sites – Loamy Goldendale Prairie, Loamy grassland and Loamy South Aspect Columbia Hills do not have sagebrush.

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

- R008XY130WA–Loamy sagebrush

Stage

Provisional

Contributors

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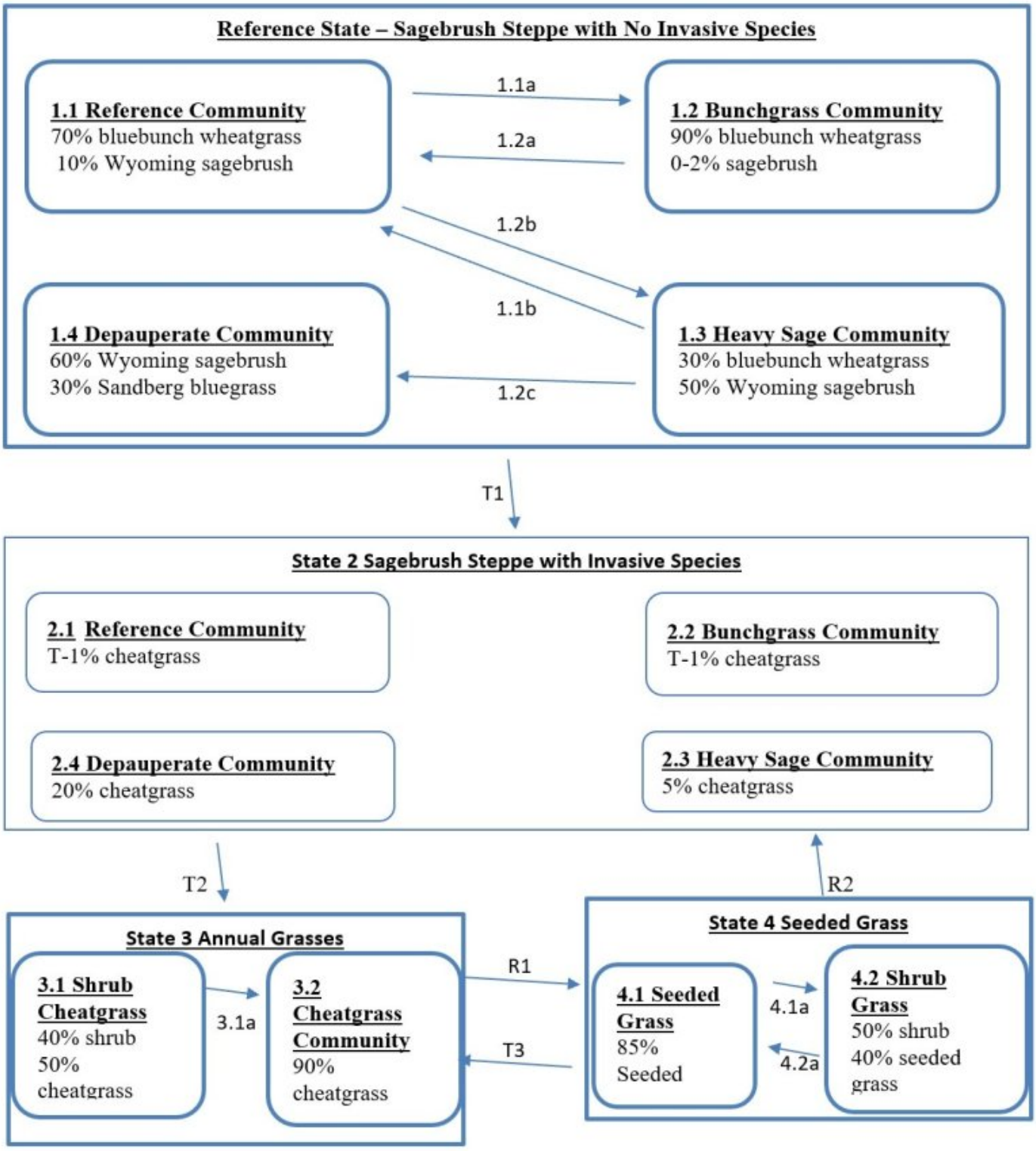
State and transition model

State and Transition Diagram for Loamy, sagebrush in MLRA 8:



Reference Community 1.1 for Loamy, sagebrush 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.

The maximum allowable pounds for Similarity Index are a range for this ecological site. For drier sites use the low value and the high value for wetter sites. Many numbers have been rounded to not show more precision than our current state of knowledge.

	Similarity Index		Similarity Index
Non-Sprouting Shrubs – Subdominant (3-7% canopy)	10% 90-120 lbs.	**Sprouting Shrubs – Minor**	less than 5% 20-50 lbs.
ARTRW8 Wyoming sagebrush ARTRT basin big sagebrush PUTR2 bitterbrush		CHRYS rabbitbrush RIBES currant ROSA5 rose	
Dominant Mid-Size Bunchgrasses	70% 650-850 lbs.	**Other Mid-Size Bunchgrasses – Minor**	less than 5% 20-50 lbs.
PSSP6 bluebunch wheatgrass		FEID Idaho fescue ELEL5 bottlebrush squirreltail ACTH7 Thurber needlegrass HECO26 needle and thread ACNE9 Nelson's needlegrass	
Short Grass – Minor	5-10% 90-120 lbs.		
POSE Sandberg bluegrass			

Native Forbs – Minor				5- 10% 90-120 lbs.
BASA3	arrowleaf balsamroot	ERIGE2	fleabane	
LUPIN	lupine	LOMAT	lomatium / biscuitroot	
CREPI	hawksbeard	ASTRA	milkvetch / locoweed	
PHLO2	longleaf phlox	PLPA2	woolly plantain	
PHHO	spiny phlox	LIRU4	stoneseed	
LIPU11	granite gilia	CALOC	Mariposa lily	
ERIOG	buckwheat	COLLO	collomia	
CASTI2	paintbrush	ANDI2	low pussytoes	
ACMI2	yarrow	MICRO6	microseris	

Estimated Production (pounds / acre)	Below	Normal	Above
Drier sites & south slopes	600	750	900
Wetter sites	800	1000	1200

State 1
Reference State - Sagebrush Steppe with No Invasive Species

State 1 Narrative: State 1 represents sagebrush steppe with no invasive or exotic weed species. All the functional, structural groups have one or more native species. A diverse native perennial community is more resistant to invasive annual species such as cheatgrass. Reference State Community Phases: 1.1 Reference Bluebunch wheatgrass-Wyoming sagebrush 1.2 Bunchgrass Bluebunch wheatgrass 1.3 Heavy sage Wyoming sagebrush-bluebunch wheatgrass 1.4 Depauperate Wyoming sagebrush-Sandberg bluegrass Dominate Reference State Species: Wyoming big sagebrush, bluebunch wheatgrass At-risk Communities: • All communities in the reference state are at risk of moving to State 2. The seed source of cheatgrass is nearby and blowing onto most sites

annually • Community Phase 1.4, the depauperate community (sagebrush-Sandberg bluegrass), has little to no bluebunch wheatgrass, and is therefore, at considerable risk of moving to State 3 which is dominated by annual species • Any Loamy community is at risk when bluebunch cover is low (< 10%) and cheatgrass cover is becoming co-dominant (40% or more). • Any community is at risk when sagebrush cover is high (40%+) and there is little to no bluebunch • Community 1.4, and any site with low cover of bluebunch wheatgrass, and any site with moderate to heavy cover of cheatgrass should be seeded after a fire

Community 1.1
Reference

Reference Community 1.1 is dominated by bluebunch wheatgrass with some sagebrush. Communities 1.1, 1,2 and 1.3 have enough bluebunch wheatgrass to shift to the other two communities and back again. These three community phases have high amounts of bunchgrass cover and are at low risk of moving to State 3

Community 1.2
Bunchgrass

Community 1.2 is even more strongly bunchgrass dominated.

Community 1.3
Heavy Sage

Community 1.3 has a heavy sage canopy but bluebunch remains a vital component in the community.

Community 1.4
Depauperate

Community 1.4, Depauperate, is dominated by sagebrush with Sandberg bluegrass as sub-dominate. The are no invasive species in Community 1.4, but there is not enough bluebunch wheatgrass remaining for community 1.4 to shift back to the other communities in the reference state.

Pathway 1.1a
Community 1.1 to 1.2

1.1a Result: Shift from reference community to bunchgrass community. Sagebrush cover is all but eliminated, while bluebunch wheatgrass has a moderate increase. The community shifts from a shrub steppe to a bunchgrass appearance. Primary Trigger: Moderate-severity fire consumes above-ground plant biomass and kills almost all the sagebrush. For bunchgrasses and forbs there is no impact to their crowns and these species return post-fire with good vigor. Post-fire the bunchgrasses are now more susceptible to grazing damage. Burned rangeland pastures will need two growing seasons recovery prior to resuming grazing, or to be lightly grazed but only during dormant season the first two years post-fire. Beyond two years for the bunchgrasses to expand, the grazing plan must promote light to moderate grazing intensity, and both critical period & growing season deferments must be implemented on burned pastures. Ecological process: Fire kills sagebrush and it does not have any sprouting ability. A few sagebrush plants remain, but only in patches that did not burn. The reduction in sagebrush releases resources and increases light for grasses and forbs. Bluebunch wheatgrass and other bunchgrasses have good vigor post-fire and expand via tillering and new seedlings.

Pathway 1.2b
Community 1.1 to 1.3

1.2b Result: shift from reference community to heavy sage community. There is a moderate increase in sagebrush while bluebunch wheatgrass has a corresponding moderate decrease. Primary Trigger: With excessive grazing pressure (heavy grazing intensity, season long grazing or frequent late spring grazing) and a period of no fire, sagebrush increases its cover while bluebunch wheatgrass suffers a big decline. Ecological process: Due to consistent defoliation pressure bluebunch wheatgrass has low vigor, shrinking crowns and some mortality. This gives sagebrush the opportunity to set new seedlings and expand its cover. Increased shade from the new sagebrush plants also plays a role in this process.

Pathway 1.2a
Community 1.2 to 1.1

1.2a Result: Shift from bunchgrass community to reference community. There is a moderate reduction of bluebunch wheatgrass cover and a minor increase of sagebrush. Primary Trigger: Over time with no fire, sagebrush will re-enter the community even with good bunchgrass vigor. Ecological process: Spots with soil disturbance receive sagebrush seed from remnant plants in unburned patches or from adjacent sites, seed germinates in the spring and a few sagebrush seedlings establish. For most locations it may take up to 10 years for sagebrush to re-enter the community. But in Douglas County the re-entry period may only be 2-5 years. With a slight increase in shade perennial bunchgrasses experience a slight decline.

Pathway 1.1b
Community 1.3 to 1.1

1.1b Result: Shift from heavy sage community to reference community. There is a major decrease in sagebrush cover and a considerable increase in the cover of bluebunch wheatgrass. The community shift is from sagebrush dominance to bunchgrass dominance. Primary Trigger: Moderate-severity fire is patchy, dependent on temperature, wind, fuel load and fuel moisture. In areas that burn the fire is complete enough and hot enough to remove most sagebrush. Fire conditions and post-fire grazing management allows bluebunch wheatgrass and other bunchgrasses to thrive and expand. Some areas burn complete while other areas are unburned to lightly burned and fire is not hot enough to affect soil conditions. Fire removes surface vegetation but has no impact on the root crown of bunchgrasses. So, bunchgrasses and forbs return post-fire with good vigor. Post-fire the bunchgrasses are now more susceptible to grazing damage. Burned rangeland pastures will need two growing seasons recovery prior to resuming grazing, or to be lightly grazed but only during dormant season the first two years post-fire. Beyond two years, for the bunchgrasses to expand, the grazing plan must moderate grazing intensity, and both critical period & growing season deferments must be implemented on burned pastures. Ecological process: Fire kills sagebrush and it does not have any sprouting ability. Some sagebrush remains, but only in patches that did not burn. The reduction in sagebrush releases resources and increases light for grasses and forbs. Bluebunch wheatgrass and other bunchgrasses have good vigor post-fire and expand via tillering and new seedlings

Pathway 1.2c
Community 1.3 to 1.4

1.2c Result: Shift from heavy sage community to depauperate community. Sagebrush has a moderate increase while bluebunch is all but eliminated from the community. Invasive annual grasses have not invaded, but Community 1.4 is most at risk to invasion and is the segue between States 1 & 2, and States 1 & 3. Pathway 1.2c is a continuation of the process that started with Pathway 1.2b. Primary Trigger: With excessive grazing pressure (heavy grazing intensity, season long grazing or frequent late spring grazing) and a period of no fire, sagebrush increases its cover while bluebunch wheatgrass bunchgrasses suffers a big decline. Grazing animals selectively target the remaining bluebunch wheatgrass plants eliminating most of the bluebunch wheatgrass plants from the community. Ecological process: Due to consistent defoliation pressure bluebunch wheatgrass has low vigor, shrinking crowns and a lot of mortality giving sagebrush opportunity to set new seedlings and expand its cover. A few bluebunch wheatgrass plants may survive.

State 2
Sagebrush Steppe with Invasive Species

State 2 Narrative: State 2 represents a gradation along the transition between Reference State and State 3. State 2 is sagebrush steppe with the inclusion of invasive annual grasses such as cheatgrass. All the native functional, structural groups are still represented by one or more species. Cheatgrass seed blows onto most sites annually seeking an opportunity to invade and colonize. With each loss of a native perennial plant, the site becomes less and less resistant to invasion. When cheatgrass makes seed for the next generation, the site has been colonized and will likely remain a component of the community. The loss of biological soil crusts is also a contributing factor to the invasion by cheatgrass. For communities 2.1, 2.2, and 2.3 the amount of cheatgrass is minor. Cheatgrass is more prominent in community 2.4. Once a community has been invaded by cheatgrass the chance of going back to State 1 is small. This state can occur with or without sagebrush. Community Phases for State 2: Same as Reference State. Dominate State 2 Species: Wyoming big sagebrush – bluebunch wheatgrass Pathways within State 2 The

pathways in State 2 are basically the same as in the Reference State. Community 2.4 is most at risk of transitioning to State 3.

Community 2.1
Reference

Community 2.2
Bunchgrass

Community 2.3
Heavy Sage

Community 2.4
Depauperate

State 3
Annual Grasses

State 3 Narrative: State 3 represents communities dominated by invasive annual species and has crossed a biological threshold. Virtually all the native functional, structural groups are missing. This state can occur with or without sagebrush. Community Phases for State 3: 3.1 Shrub – Annual Grass Sagebrush – cheatgrass 3.2 Annual Grass Cheatgrass Dominate State 3 Species: Cheatgrass with or without sagebrush The main species can include cheatgrass, Japanese brome, medusahead, ventenata, mustard, prickly lettuce and diffuse knapweed. This state can occur with or without sagebrush.

Community 3.1
Shrub Cheatgrass

Community 3.2
Cheatgrass

Pathway 3.1a
Community 3.1 to 3.2

3.1a Result: shift from shrub-cheatgrass to cheatgrass. Causes: Moderate intensity fire kills most or all sagebrush. Ecological Process: With the shrubs mostly eliminated, and with few native herbaceous species remaining, invasive species have no competition and totally dominate the community.

State 4
Seeded Grass

State 4 Narrative: State 4 represents a site that has been seeded to desirable grasses such as Secar Snake River wheatgrass, Sherman big bluegrass, crested wheatgrass or intermediate wheatgrass. State 4 has two community phases that are stable if they maintain 0.8 plant / sq. ft. or greater of the desired bunchgrasses Community Phases for State 4: 4.1 Seeded Grasses 4.2 Shrub – Seeded Grasses Dominate State 4 Species: Desirable seeded grasses with or without sagebrush and legumes

Community 4.1
Seeded Grasses

Community 4.2
Shrub Grass

Pathway 4.1a
Community 4.1 to 4.2

4.1a Result: Shift from seeded grass to shrub – seeded grass community. Shrubs colonize the site and increase cover and density while seeded grasses decline Causes: Heavy grazing pressure on seeded grasses reduce their plant vigor. Ecological process: Consistent defoliation pressures that reduced plant vigor to such a degree that that grass roots begin to die, bunchgrass crowns shrink, and some seeded grasses die. This opens the soil for seedling shrubs to establish.

Pathway 4.2a
Community 4.2 to 4.1

4.2a Result: Shift from shrub-grass to seeded grass community. Shrubs are decreased to all but eliminated and grasses increase to dominate the community. Causes: (1) For communities with fire sensitive shrubs (sagebrush, bitterbrush) and a good population of desirable grasses, the best course of action is to reduce the shrubs by fire, chemical or mechanical treatment, and to use proper grazing management to ensure grasses can expand its cover. (2) For communities with fire tolerant shrubs (rabbitbrush, three-tip sage) and a good population of desirable grasses, the best course of action is to reduce the shrubs by chemical treatment and to use proper grazing management to ensure grasses can expand its cover. (3) Communities that do not have much remaining seeded grasses will require a seedbed to be prepared and a seeding operation. Seedbed preparation can use a combination of fire, mechanical tillage and chemical application. Post-seeding the site will need 2 growing seasons of rest while the seeded grasses are established. Broadleaf weed control may also be necessary. Afterward, proper grazing must be used to maintain the stand. Ecological Process: with removal of the shrub layer the vigorous seeded grasses increase via tillering and new seedlings

Transition T1
State 1 to 2

T1 Result: transition from Reference State to State 2 (shrub 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 cheatgrass. Ecological process. Most sites in the Reference State have some scattered cheatgrass seed. This seed is waiting for enough moisture to germinate and to compete with the native species for space, light and moisture. When the right year happens even pristine communities in the Reference State are susceptible to colonization by cheatgrass. Primary Trigger: The transition occurs during a high moisture year that causes a micro-burst of cheatgrass and is the principle means of colonization. A second trigger would be spots of soil disturbance. 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 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-sagebrush community, and then fire turned that into annual grasses. Ecological Process: Consistent defoliation pressure to bluebunch wheatgrass 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 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 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 the desirable species, and post-seeding, to control weeds and manage grazing.

This requires a commitment of two years or more for weed control and seedbed preparation. 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 crested or 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 3 back to State 2. This restoration transition does not occur without a significant commitment of time & resource inputs to restore ecological processes, native bunchgrasses, Wyoming sagebrush 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 crested 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 to establish and maintain desirable species plant vigor. 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. Introduce grasses must be killed before native species are seeded. 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 sagebrush and 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. See narrative for R1 transition above.

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 grazing pressure has removed too much of the seeded 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: Consistent defoliation pressure to seeded grasses cause poor vigor, shrinking crowns and plant mortality. With more and more of the soil surface and upper soil rooting surface open, opportunistic, exotic weeds that take advantage of the available niche space to colonize and expand until the dominate the community. Indicators: shrinking crowns and mortality of desirable species, increasing gaps between seeded plants, and 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

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