Ecological site group R007XG130WA
Loamy

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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): 7 – Columbia Basin

LRU – Common Resource Areas (CRA):
7.1 – Sandy Missoula Flood Deposits
7.2 – Silty Missoula Flood Deposits
7.3 – Dry Loess Islands
7.4 – Dry Yakima Folds
7.5 – Yakima Valley – Pleistocene Lake Basins

Site Concept Narrative:
Diagnostics:
At 8 to 10 inches precipitation, Loamy ecological site is extensive on the landscape but much more limited at 6 to 7 inches precipitation. At lower elevation and lower precipitation, the Loamy ecological site may be found only on north aspects. Loamy does not occur at 4 to 5 inches precipitation.

Loamy ecological site is an upland site occurring on 20 inches and deeper non-skeletal loamy soils. Soils have a loamy surface texture and limited rock fragments (generally 10 percent 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.

Fire-sensitive shrubs dominate the reference state overstory, while perennial, cool-season 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 to 3 percent or as much as 40 percent. 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.

The Loamy ecological site is the same as the Stony ecological site, except it is a little more productive. In some areas, the Stony ecological site is found on west-facing slopes and the Loamy ecological site on east-facing slopes.

Carey balsamroot is a common marker for MLRA 007X (less than 10 inches of precipitation).

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. Loamy sites occur on broad ridges and plateaus, stream terraces, and east-facing hillslopes.

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

Landscapes: Basin and hills
Landform: Terraces, hillslopes, foot slopes, nose slopes, outwash plains, plateaus

Elevation:
Range: 200 to 3,500 feet
Central tendency: 1,000 to 2,000 feet

Slope:
Range: 0 to 60 percent
Central tendency: 2 to 30 percent

Aspect: Occurs on all slopes.

Geology:
This is almost entirely underlain by Miocene basalt flows. Columbia River basalt is covered in most areas with as much as 200 feet of eolian, lacustrine, and alluvial deposits. This basin generally corresponds to the vast temporary lakes created by floodwaters from glacial Lakes Missoula and Columbia. Most of the fluvial and lacustrine sediments were deposited about 16,000 years ago, when an ice dam on the ancient Columbia River burst and when glacial Lake Missoula periodically emptied, creating catastrophic floods.

Climate

MLRA 007X is the lowest, driest and hottest portions of the entire Columbia River region and the sagebrush-bluebunch wheatgrass zone. The Wyoming sagebrush-bluebunch wheatgrass areas are both warmer and drier than grasslands or other sites with threetip sagebrush or bitterbrush (Daubenmire).

The climate across MLRA 007X is characterized by moderately cold, wet winters, and hot, dry summers, with limited precipitation due to the rain shadow effect of the Cascades. The average annual precipitation Loamy is mostly between 6 and 9 inches. Seventy to seventy-five percent of the precipitation comes late-October through March as a mixture of rain and snow. For drier sites and lower elevations, precipitation that comes after March is not as effective for plant growth. But at higher elevations and higher precipitation, April and May rains make the difference between average and great production years. June through early-October is dry. Freezing temperatures generally occur from late-October through early-April. Temperature extremes are -10 degrees Fahrenheit in winter and 110 degrees Fahrenheit in summer. Winter fog is variable and often quite localized, as the fog settles on some areas but not others.

Mean Annual precipitation
Range: 6 - 9 inches (6 - 10 inch zone)
Soil moisture regime is aridic.

Mean Annual Air Temperature
Range: 46 to 54 F

Central Tendency: 48 – 52 F
Soil temperature regime is mesic.

Frost-free period (days)
Total range: 115 to 200
Central tendency: 140 to 170
The growing season for Loamy is March through June.

Soil features

Edaphic:
The Loamy ecological site commonly occurs with Stony, Very Shallow and Cool Loamy ecological sites.

REPRESENTATIVE SOIL FEATURES
This ecological site components are dominantly Xeric taxonomic subgroup of Haplocambids, Haplodurids, Haplocalcids great group of the Aridisols taxonomic orders. Soils are dominantly deep and very deep but can range to moderately deep. Average available water capacity of about 6.5 inches (16.5 cm) in the 0 to 40 inches (0 to 100 cm) depth range.

Soil parent material is dominantly eolian, loess and lacustrine deposits.

The associated soils are Burke, Kiona, Malaga, Neppel, Prosser, Royal, Sagehill, Sagemoor, Scooteney, Shano, Taunton, Warden, Wiehl and similar soils.

Dominate soil surface is silt loam to very fine sandy loam.

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

Fragments on surface horizon > 3 inches (% Volume):
Minimum: 0
Maximum: 2
Average: 0

Fragments within surface horizon > 3 inches (% Volume):
Minimum: 0
Maximum: 15
Average: 2

Fragments within surface horizon ≤ 3 inches (% Volume):
Minimum: 0
Maximum: 15
Average: 10

Subsurface fragments > 3 inches (% Volume)
Minimum: 0
Maximum: 15
Average: 5

Subsurface fragments ≤ 3 inches (% Volume):
Minimum: 0
Maximum: 35
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 and high
10 to 40 inches: Moderately high and 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: 2

Calcium Carbonate Equivalent (percent):
Minimum: 0
Maximum: 30
Central tendency: less than 15 within 15 inches of surface, can go higher with depth

Soil Reaction (pH) (1:1 Water):
0 - 10 inches: 6.1 to 9.0
10 - 40 inches: 6.1 to 9.0

Available Water Capacity (inches, 0 – 40 inches depth)
Minimum: 2.1
Maximum: 8.3
Average: 6.5

Vegetation dynamics

ECOLOGICAL DYNAMICS:
Vegetation Dynamics:
Loamy produces about 600 to 1200 pounds per 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 three to five 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 seedhead arranged is a spike. Bluebunch provides a crucial and extensive network of roots to the upper portions (up to 48 inches 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. Further details about bluebunch physiology described later in the document. Research has found that the community remains resistant to medusahead invasion if the site maintains at least 0.8 plants per square foot of mid-sized bunchgrass (K. Davies, 2008). It is bluebunch wheatgrass that holds the system together. If we lose the bluebunch wheatgrass, 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 to 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 to 100 years 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 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. Needle and thread is one native species that can increase via new seedlings.

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. 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. Bluebunch wheatgrass declines while Sandberg bluegrass, needle and thread and sagebrush 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 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 1–June 30). And each pasture should be rested the entire growing-season every third year (approximately
March 1 – June 30).

In the spring each year it is important to monitor and maintain an adequate topgrowth: (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 MLRA 7, including Stony, Cool Loamy, Dry Loamy, Sandy and Sandy Loam. It is also associated with Very Shallow, Loamy Bottom and Alkali Terrace.

Similar sites:
Loamy sagebrush in MLRA 8 Columbia Plateau is similar. Loamy grassland in MLRA 9 Palouse Prairie does not have sagebrush but is similar otherwise.

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

State Correlation: Washington

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 Paciorettty, "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

Site Development and Testing Plan
Future work, as described in a Project Plan, to validate the information in this Provisional Ecological Site Description is needed. This will include field activities to collect low, medium and high intensity sampling, soil correlations, and analysis of that data. Annual field reviews should be done by soil scientists and vegetation specialists. A final field review, peer review, quality control, and quality assurance reviews of the ESD will be needed to produce the final document.
Annual reviews of the Project Plan are to be conducted by the Ecological Site Technical Team.

Major Land Resource Area

MLRA 007X
Columbia Basin

Subclasses

- R007XY130WA–Loamy

Stage

Provisional

Contributors

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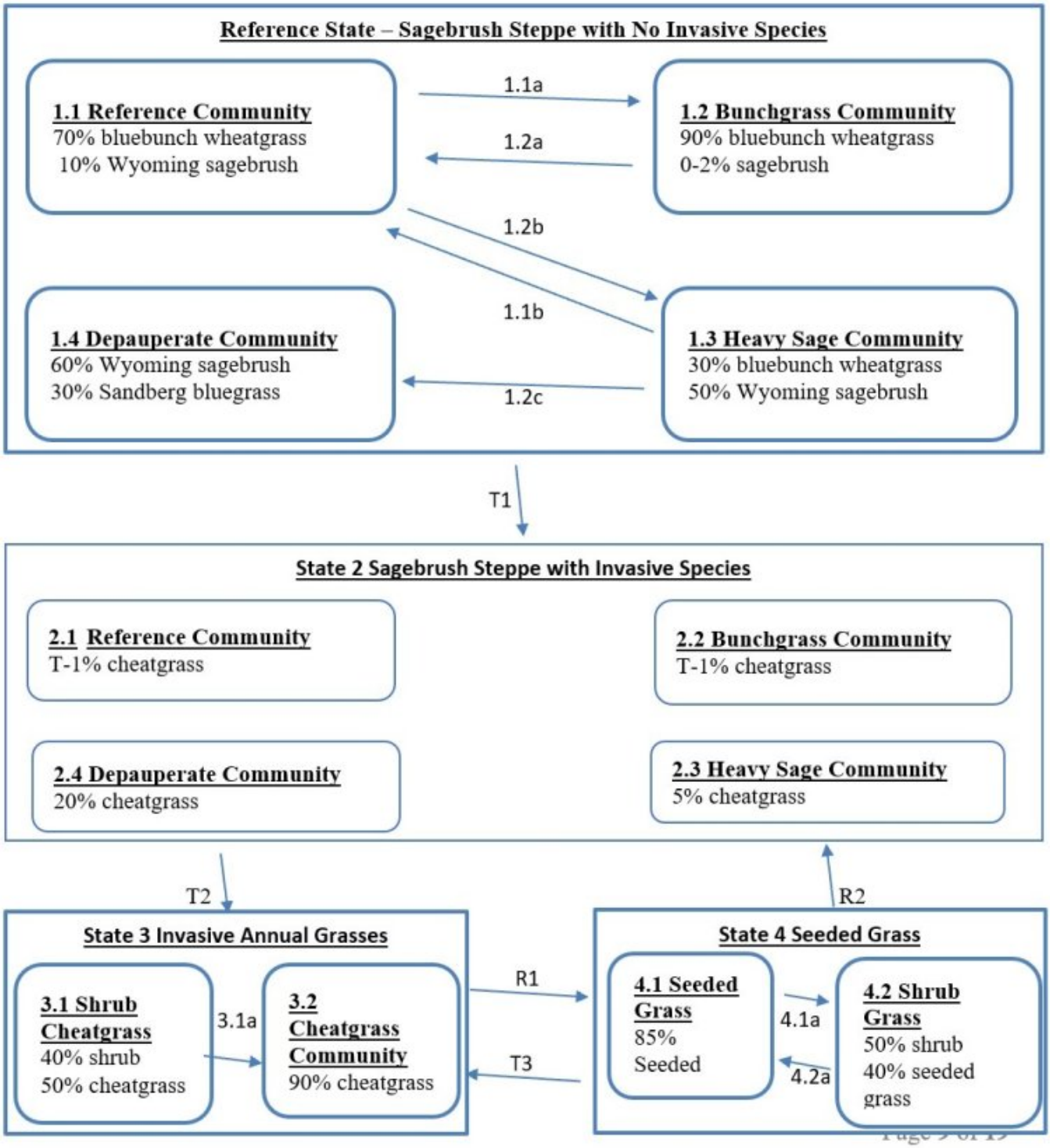
State and transition model

State and Transition Diagram for Loamy:

This state and transition model (STM), explains the general ecological dynamics for the Loamy 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.



Reference Community 1.1 for Loamy in MLRA 7

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
Non-Sprouting Shrubs – Subdominant (3-7% canopy)	10% 80 lbs.	**Sprouting Shrubs – Minor**	less than 5% 25 lbs.
ARTRW8 Wyoming sagebrush ARTRT basin big sagebrush PUTR2 bitterbrush		CHRYS rabbitbrush ERSP7 rock buckwheat ERHE2 Wyeth buckwheat	
Dominant Mid-Size Bunchgrass	70% 550 lbs.	**Other Mid-Size Bunchgrasses – Minor**	less than 5% 25 lbs.
PSSP6 bluebunch wheatgrass		ELEL5 bottlebrush squirreltail ACTH7 Thurber needlegrass HECO26 needle and thread ACNE9 Nelson's needlegrass ELLA Thickspike wheatgrass	
Short Grass – Minor	5-10% 80 lbs.		
POSE Sandberg bluegrass			
Native Forbs – Minor			10% 80 lbs.
BACA3 Carey's balsamroot HECU2 Cusick's sunflower SPMU2 globemallow LUPIN lupine CREPI hawksbeard PHLOX phlox PHLO2 longleaf phlox PHHO spiny phlox LPU11 granite gilia ERIOG buckwheat CASTI2 paintbrush ACMI2 yarrow		LOMAT lomatium / biscuitroot ERIGE2 fleabane ASPU9 woollypod locoweed ASTRA milkvetch / locoweed PLPS whorled plantain PLPA2 woolly plantain MICRO6 microseris LIRU4 stoneseed CALOC Mariposa lily ANDI2 low pussytoes COLLO collomia	
		Below	**Normal**	**Above**
Estimated Production (pounds / acre)		**500**	**600**	**800**

State 1
Reference State: Sagebrush Steppe (Fire-Sensitive Shrubs)

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 community is more resistant to invasive annual species such as cheatgrass. Reference Community 1.1 is dominated by bluebunch wheatgrass with some sagebrush. Community 1.2 is even more strongly bunchgrass dominated. Community 1.3 has a heavy sage canopy but bluebunch wheatgrass remains a vital component in the community. 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 1.4, depauperate, is dominated by sagebrush with Sandberg bluegrass as co-dominate. There is not enough bluebunch wheatgrass

remaining for community 1.4 to shift back to the other communities in the reference state. 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 wheatgrass cover is low (less than 10 percent) and cheatgrass cover is becoming co-dominant (40 percent or more). • Any community is at risk when sagebrush cover is high (40 percent or more) and there is little to no bluebunch wheatgrass • 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 Community: Bluebunch wheatgrass-Wyoming big sagebrush

Reference Community 1.1 is dominated by bluebunch wheatgrass with some sagebrush.

Community 1.2
Bunchgrass Community: Bluebunch wheatgrass

Community 1.2 is even more strongly bunchgrass dominated.

Community 1.3
Heavy sagebrush community: Wyoming big sagebrush-bluebunch wheatgrass

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

Community 1.4
Depauperate Community: Wyoming big sagebrush-Sandberg bluegrass

Community 1.4, depauperate, is dominated by sagebrush with Sandberg bluegrass as co-dominate. There is not enough bluebunch wheatgrass remaining for Community 1.4 to shift back to the other communities in the Reference State.

Pathway P1.1a
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 in cover. Primary Trigger: Moderate-severity fire is complete enough and hot enough to remove almost all sagebrush. Most areas burn complete while other areas are unburned to lightly burned. Fire is not hot enough to affect soil conditions. Fire removes surface vegetation but has no impact on the 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 promote light to moderate grazing intensity, and both critical period and 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. Fire conditions and post-fire grazing management allows bluebunch wheatgrass and other bunchgrasses to thrive and expand.

Pathway P1.2b
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: With consistent defoliation pressures bluebunch wheatgrass experiences poor plant vigor to such a degree that grass roots begin to die. So, bluebunch wheatgrass experiences 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 P1.2a
Community 1.2 to 1.1

1.2a Result: Shift from bunchgrass community to reference community. There is a minor reduction of bluebunch wheatgrass cover and a corresponding increase of sagebrush. Primary Trigger: Over time with no fire, sagebrush will re-enter the community even with good bunchgrass vigor. For most locations it may take up to 10 years for sagebrush to re-enter the community. With a slight increase in shade and some grazing pressure, perennial bunchgrasses experience a slight decline. 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. With a slight increase in shade perennial bunchgrasses experience a slight decline.

Pathway P1.1b
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. Most 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 and 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. Fire conditions and post-fire grazing management allows bluebunch wheatgrass and other bunchgrasses to thrive and expand via tillering and new seedlings.

Pathway P1.2c
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 and 2, and States 1 and 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: With consistent defoliation pressure bluebunch wheatgrass has low vigor, shrinking crowns and a lot of mortality. This gives 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 contributing to invasion by cheatgrass. For communities 2.1, 2.2, and 2.3 the amount of cheatgrass is minor. Cheatgrass is more prominent in community 1.4. 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.

State 3
Invasive Annual Grasses

State 3 Narrative: State 3 is represented by invasive annual grasses with cheatgrass as the main culprit. 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 annual bromes, Russian thistle, mustard, prickly lettuce and diffuse knapweed, and sagebrush.

Community 3.1
Shrub – Annual Grass: Sagebrush – cheatgrass

Community 3.2
Annual Grass: Cheatgrass

Pathway 3.1a
Community 3.1 to 3.2

3.1a Result: shift from shrub-cheatgrass to cheatgrass. Primary Trigger: Moderate intensity fire kills most or all sagebrush. Cheatgrass and other invasive species fully occupy the site.

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, crested wheatgrass or Siberian wheatgrass. State 4 has two community phases that are stable if they maintain 0.8 plant per square foot 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 – Seeded Grasses

Pathway P4.1a
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 Primary Trigger: site has not burned. Heavy grazing pressure on seeded grasses reduce plant vigor. Grass root crowns shrink in size and some grasses die allowing shrubs to enter the site.

Pathway P4.2a
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. Primary Trigger: community treatment activities. (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 use proper grazing management to ensure grasses recover. (2) For communities with fire tolerant shrubs (rabbitbrush, threetip sagebrush) and a good population of desirable grasses, the best course of action is to reduce the shrubs by chemical treatment and use proper grazing management to ensure grasses recover. (3) Communities that do not have much seeded grass remaining will need to be re-seeded, which requires existing stand to be killed and a proper seedbed to be prepared. Seedbed preparation can use a combination of fire, mechanical tillage and chemical application. Seeding operation should ensure very shallow seed-soil contact (1/8 inch depth). Post-seeding the site will need up to two years 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.

Transition T1
State 1 to 2

T1 Result: transition from Reference State to State 2 (shrub steppe with 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-flush of cheatgrass and is the principle means of colonization. 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 percent while invasive species cover is at least 40 percent. This transition can occur with or without sagebrush in the community. Community 2.4 has limited amount of bluebunch wheatgrass and is the community most at risk and is also the pathway for crossing the threshold from State 2 into State 3. Community 2.4 is the segue between State 2 and State 3. Primary Trigger: Chronic heavy grazing, season-long grazing, or late spring grazing. Native species are all but eliminated. 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. Annuals such as cheatgrass have 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. 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 007X. Ecological Process: Consistent defoliation pressure to bluebunch wheatgrass causes 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: Decreasing 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 crested 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 and 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 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. 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.

Transition T3
State 4 to 3

T3 Result: shift from seeded grasses of State 4 to State 3 which is dominated by invasive annual species. Primary Trigger: chronic grazing pressure has significantly reduced seeded grasses 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: A series of frequent fires or, a severe fire that burnt into the root crown of the seeded grasses and gives the competitive advantage 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 perennial species, and increasing cover by annual grasses.

Citations