Ecological site group R008XG220WA
Stony Foothills, bitterbrush

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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:
Diagnostics:

Stony foothills, bitterbrush is an upland shrub-steppe site occurring in the foothill areas below the lower tree-line of MLRA 6 (East Slope of Cascades). This site occurs on both flat and north facing slopes.

The soils are deep (60 inches or greater), coarse textured and rocky. Textures are mostly sandy loam and sand with some loams. Soils are often gravelly to very gravely to extremely stony. Soils are well drained.

Fire sensitive, bitterbrush dominates the reference state overstory, while perennial bunchgrasses such as Idaho fescue and bluebunch wheatgrass are dominant in the herbaceous understory. The shrub layer is typically waist- to shoulder-height bitterbrush with a mix of other shrub steppe species scattered throughout including Wyoming sagebrush, rabbitbrush, and current.

Bitterbrush areas in MLRA 8 are east of or adjacent to the Ponderosa pine forests including: Klickitat and Yakima counties, then from central Kittitas County northward to the Canadian border.

Principle Vegetative Drivers:

The coarse soils and neutral to north aspect drive the vegetative expression of this site. Bitterbrush prefers well drained, coarse soils, while the neutral or north slopes are good for both bluebunch and 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

With adequate plant cover and litter, there water infiltrates into Stony foothills, bitterbrush readily. These sites are well drained and are saturated for only a short period.

Physiographic Features:

The landscape is part of the Columbia basalt plateau. Stony foothills, bitterbrush sites are most commonly found on benches, plateaus and hillslopes, but not on south slopes.

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 700 to 4,000 feet
Central tendency: 1,500 to 3,000 feet

Slope: Total range: 0 to 90 percent
Central tendency: 2 to 30 percent
Aspect: Occurs on all aspects except southernly slopes

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 bitterbrush-Idaho fescue areas tend to be both cooler and wetter than Wyoming sagebrush-bluebunch wheatgrass areas (Daubenmire). Stony Foothills, which favors Idaho fescue, has a cooler micro-climate than the south facing Stony Foothills South slope. 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: 45 to 52 F
Central Tendency: 47 – 50 F
Freezing temperatures generally occur from late-October through early-April. Temperature extremes are 0 degrees in winter and 110 degrees in summer. Winter fog is variable and often quite localized, as the fog settles on some areas but not others.

Frost-free Period (days):
Total range: 110 to 190
Central tendency: 120 to 160
The growing season for Stony foothills, bitterbrush is April through end of July.

Soil features

Edaphic:

The Stony foothills, bitterbrush ecological site occurs with Stony foothills south aspect bitterbrush, Cool Loamy, Stony, and Loamy ecological sites.

Representative Soil Features:

This ecological site components are dominantly Aridic, Ultic and Vitrandic taxonomic subgroups of Haploxerolls, Durixerolls and Argixerolls great groups of the Mollisols taxonomic orders. Soils are moderately deep to very deep. Average available water capacity of about 5.0 inches (12.7 cm) in the 0 to 40 inches (0-100 cm) depth range.

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

The associated soils are Cashmont, Conconully, Haploxerolls, Sienna and similar soils.

Dominate soil surface is very stony silt loam to sandy loam, with ashy modifier sometimes occurring as well.

Dominant particle-size class is ashy to sandy-skeletal.

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

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: 15

Subsurface fragments > 3 inches (% Volume)
Minimum: 0
Maximum: 25
Average: 15

Subsurface fragments ≤ 3 inches (% Volume):
Minimum: 0
Maximum: 40
Average: 10

Drainage Class: Dominantly well drained to 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: Very high to moderately low

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

Electrical Conductivity (dS/m)
Minimum: 0
Maximum: 2

Sodium Absorption Ratio
Minimum: 0
Maximum: 2

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

Soil Reaction (pH) (1:1 Water):
0 - 10 inches: 5.6 to 9.0
10 - 40 inches: 6.1 to 9.0

Available Water Capacity (inches, 0 – 40 inches depth)
Minimum: 1.3
Maximum: 9.7
Average: 5.0

Vegetation dynamics

Ecological Dynamics:

Stony foothills, bitterbrush produces about 1000-1400 pounds/acre of biomass annually.

Antelope bitterbrush, Idaho fescue and bluebunch wheatgrass are at the core of the Stony Foothills ecological site and warrant a degree of understanding.

Antelope bitterbrush is a very palatable, high quality shrub for big game and livestock. It is adapted to a wide range of soils and precipitation. Bitterbrush is usually 2-6 feet in height and up to 8 feet in width. Rodents normally cache bitterbrush seed within 50-75 feet of an existing seed source. Following a fire, the rodent seed caches become an important source of regeneration. Another important source of regeneration are pockets of unburned rangeland that provide much needed seed to the system.

Idaho fescue is shorter and has a dense clump of shoots, while bluebunch wheatgrass is taller and is less dense. Both species are long-lived bunchgrasses. Bluebunch has an awned or awnless seed head arranged in a spike while Idaho fescue has an awned seed head arranges in a panicle. The ratio of Idaho fescue to bluebunch wheatgrass plants on any site can vary due to aspect and elevation.

Both grasses provide a crucial and extensive network of roots to the upper portions (up to 48” deep in soils with no

root-restrictive horizons) of the soil profile. These roots create a massive underground source to stabilize the soils, provide organic matter and nutrients inputs, and help maintain soil pore space for water infiltration and water retention in the soil profile. The extensive rooting system of mid-sized bunchgrasses leave very little soil niche space available for invasion by other species. This drought resistant root can compete with, and suppress, the spread of exotic weeds.

Needle and thread is another perennial bunchgrass on Stony Foothills. It produces erect, unbranched stems about 3 feet in height. The sharp-pointed seeds have a 4 to 5-inch long twisted awn. With wetting and drying needle and thread seed drills itself into the ground. Thus, needle and thread is one of the best seeders in the reference plant community. With grazing pressure on the dominant bunchgrasses, needle and thread increases.

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

The effect of fire on the main species is mixed for the Stony Foothills site. Bitterbrush is very susceptible to fire kill and is considered a weak sprouter. Bluebunch wheatgrass and needle and thread are fire tolerant, but Idaho fescue is much more sensitive to fire. Under windy conditions, a fire can burn into the crown of Idaho fescue, leaving behind “black holes” or nothing but ash. When a site loses its Idaho fescue, the holes will be filled by vigorous native species or exotic weeds. Bluebunch wheatgrass keeps the site resistant to change, while bitterbrush and Idaho fescue makes the site more at risk.

How one answers fire return intervals for bitterbrush communities depends on the frame of reference used. Currently conditions for Stony Foothills are communities often dominated by dense canopies of bitterbrush. These shrubs are 50-100 years old or older due to fire suppression. These bitterbrush plants do not readily re-sprout following fire. Germinating seeds, especially from rodent caches is the primary source to bitterbrush re-establishment. The framework of current conditions suggests a fire return interval of 50-100 years or longer.

Miller et al, paint a totally different picture for pre-settlement mountain big sage-bitterbrush-fescue communities. These communities were dominated by the herb layer. Shrubs were widely scattered and patchy. The fire regime was high frequency (10-20 years), low severity, low intensity. The landscape would have been a mosaic of burned and unburned patches. In any given fire some bitterbrush plants would have survived the fire. Also, bitterbrush plants were likely much younger (10-30 years old), more vigorous and more likely to sprout following fire. In recent years sprouting bitterbrush after low severity fire supports the notion of sprouting bitterbrush. Seedlings from rodent caches would have also been important for the recovery of the shrub layer.

A low intensity, high frequency fire regime favors bitterbrush sprouting and rapid tillering by both Idaho fescue and bluebunch wheatgrass. A high intensity, low frequency fire regime hinders recovery – Idaho fescue plants may be devastated, bluebunch wheatgrass set back, and bitterbrush regeneration limited to seedlings.

Fires with light severity will remove less bitterbrush and open smaller patches for grass and forb recovery, whereas the more severe fires will remove almost all the bitterbrush and leave vast areas open to return to bunchgrass dominance. This is how the patchy distribution occurs. So, fire resets the competitive advantage back to the bunchgrasses by removing much of the overstory. This, in turn, maintains the stability and overall resilience of the site. However, this is not always true as some fires are spotty or do not burn hot enough to fully remove the bitterbrush. Rabbitbrush and horsebrush are sprouting shrubs and may also increase following fire.

The longer the site goes without fire and the more grazing pressure added to the bunchgrasses, the more bitterbrush cover increases, and the more bunchgrasses decline. This leaves the dense bitterbrush community phase more vulnerable to outside pressures. Invasive species take advantage of the available soil rooting spaces in the interspaces. 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 (same plants grazed more than once). As grazing pressure increases the plant community unravels in stages:
1. Cusick bluegrass is eliminated. Adjacent natives fill the void
2. Idaho fescue declines while bluebunch wheatgrass and threetip sage increase
3. Both Idaho fescue and bluebunch wheatgrass decline while threetip sage and threadleaf sedge increase
4. With further decline invasive species colonize the site
5. The site can become a shrub-annual grass community

Managing shrub 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. Given the opportunity Idaho fescue readily produces new seedlings while bluebunch wheatgrass plants rely principally on tillering. During seed formation, the growing points of bluebunch wheatgrass become elevated and are vulnerable to damage or removal.

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 is especially damaging. Over several years each native bunchgrass pasture should be rested during the critical period two out of every three years (approximately April 15 – July 15). And each pasture should be rested the entire growing-season every third year (approximately March 1 – July 15).

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

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

For more grazing management information refer to Range Technical Notes found in Section I Reference Lists of NRCS Field Office Technical Guide for Washington State.
Antelope bitterbrush is an important browse species for big game animals and needs special management consideration with livestock in mind. There is no problem with spring grazing as livestock do not focus their attention to bitterbrush in the spring. Fall is a different story. Feeding some alfalfa every second or third day helps minimize livestock use of bitterbrush in the fall.

In Washington, antelope bitterbrush / Idaho fescue /bluebunch wheatgrass communities provide habitat for big game and sharp-tailed grouse.

Supporting Information:

Associated Sites:
Stony Foothills bitterbrush is associated with Stony Foothills South Aspect, Loamy, Stony and Very Shallow ecological sites in MLRA 8 Columbia Plateau, and also with Stony Foothills South Aspect in MLRA 6 East Slope of the Cascades.

Similar Sites:
Stony Foothills South Aspect in MLRA 8 and Stony Foothills South Aspect in MLRA 6 East Slope of the Cascades, and Stony Foothills in MLRA 9 Palouse Prairie are also bitterbrush sites.

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

- R008XY220WA–Stony Foothills bitterbrush

Stage

Provisional

Contributors

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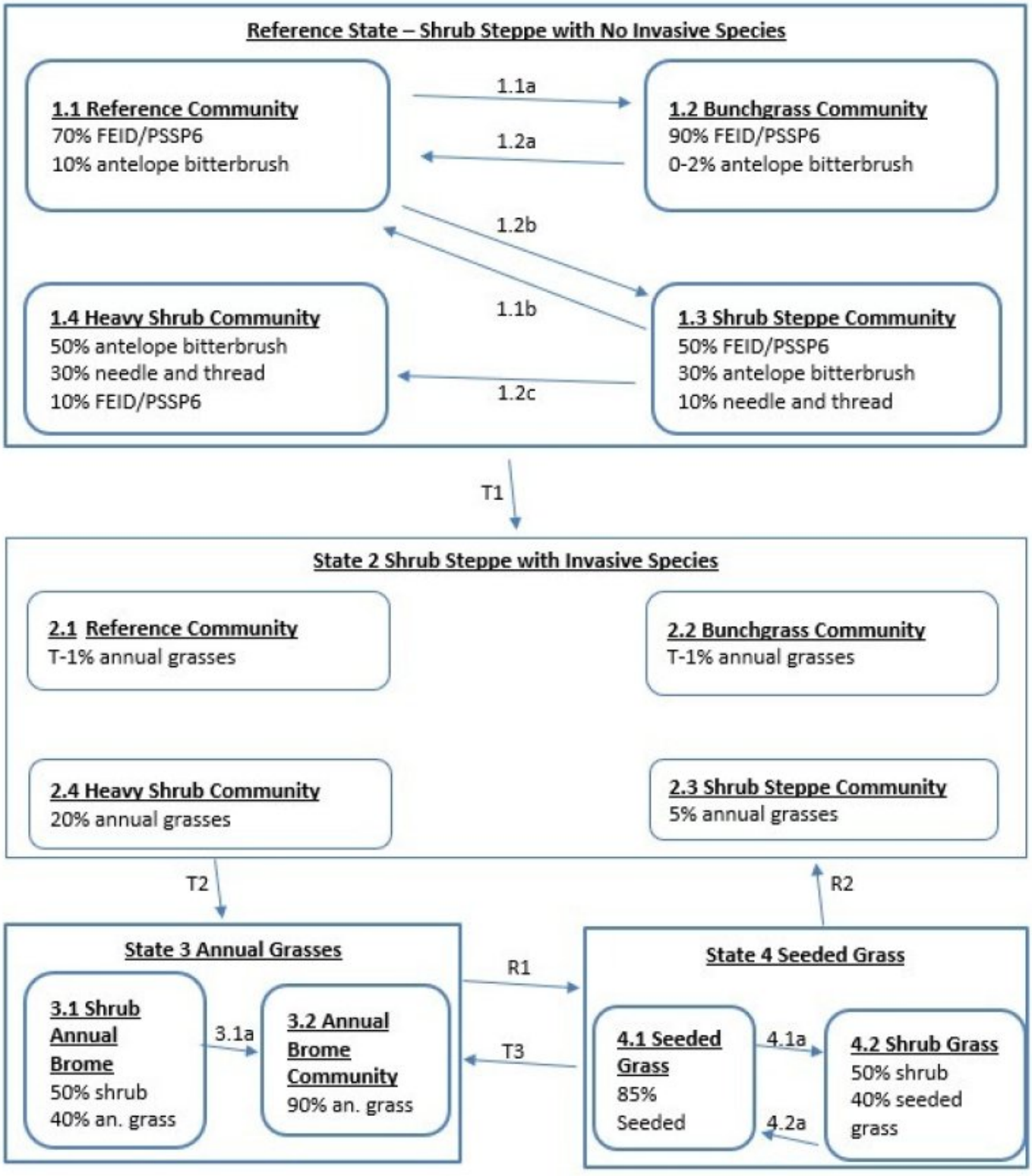
State and transition model


Reference State – Shrub Steppe with No Invasive Species
1.1 Reference Community
70% FEID/PSSP6
10% antelope bitterbrush
1.1a
1.2a
1.2 Bunchgrass Community
90% FEID/PSSP6
0-2% antelope bitterbrush
1.2b
1.1b
1.4 Heavy Shrub Community
50% antelope bitterbrush
30% needle and thread
10% FEID/PSSP6
1.2c
1.3 Shrub Steppe Community
50% FEID/PSSP6
30% antelope bitterbrush
10% needle and thread
T1
State 2 Shrub Steppe with Invasive Species
2.1 Reference Community
T-1% annual grasses
2.2 Bunchgrass Community
T-1% annual grasses
2.4 Heavy Shrub Community
20% annual grasses
2.3 Shrub Steppe Community
5% annual grasses
T2
R2
State 3 Annual Grasses
3.1 Shrub Annual Brome
50% shrub
40% an. grass
3.1a
3.2 Annual Brome Community
90% an. grass
R1
T3
State 4 Seeded Grass
4.1 Seeded Grass
85% Seeded
4.1a
4.2a
4.2 Shrub Grass
50% shrub
40% seeded grass

Reference Community 1.1 for Stony Foothills, bitterbrush in MLRA 8

Plant species composition is represented as a percentage of total annual production (pounds). The composition of pristine sites can vary somewhat due to variations in site conditions.

Pounds listed below are the maximum allowable for Similarity Index. Many numbers have been rounded to not show more precision than our current state of knowledge.

	Similarity Index			Similarity Index
Non-Sprouting Shrubs – Subdominant (3-7% canopy)	10%	150 lbs.	**Sprouting Shrubs – Minor**	less than 5% 50 lbs.
PUTR2 bitterbrush			CHRYS rabbitbrush	
ARTRW Wyoming sagebrush			RIBES currant	
ARTRT basin big sagebrush			ROSA5 rose	
			ARTR4 three-tip sage	
Dominant Mid-Size Bunchgrasses	70%	1000 lbs.	**Other Mid-Size Bunchgrasses – Minor**	less than 5% 50 lbs.
PSSP6 bluebunch wheatgrass			ELEL5 bottlebrush squirreltail	
FEID Idaho fescue			ACTH7 Thurber needlegrass	
			HECO26 needle and thread	
			POCU3 Cusick's bluegrass	
			LECI4 basin wildrye	
			KOMA prairie junegrass	
Short Grass – Minor	less than 5%	50 lbs.	**Tall Grass – Minor**	less than 5% 50 lbs.
POSE Sandberg bluegrass			LECI4 basin wildrye	
			Grass-Like – Trace	
			CAFI threadleaf sedge	Trace
Native Forbs – Minor				10% 150 lbs.
BASA3 arrowleaf balsamroot			MICRO6 microseris	
LUPIN lupine			CALOC Mariposa lily	
CREPI hawksbeard			PHLO2 longleaf phlox	
ERIGE2 fleabane			LOMAT lomatium / biscuitroot	
ERIOG buckwheat			ASTRA milkvetch / locoweed	
CASTI2 paintbrush			ANDI2 low pussytoes	
LIPU11 granite gilia			COLLO collomia	
ACMI2 yarrow			LIRU4 stoneseed	
PLPA2 woolly plantain			ACMI2 yarrow	

	Below	Normal	Above
Estimated Production (pounds / acre)	1000	1200	1400

State 1
Reference State - Shrub Steppe with No Invasive Species

State 1 Narrative: State 1 represents shrub steppe with no invasive or exotic weed species. All the functional, structural groups are represented by one or more native species. Reference State Community Phases: 1.1 Reference Idaho fescue-bluebunch wheatgrass – bitterbrush 1.2 Bunchgrass Idaho fescue-bluebunch wheatgrass. 1.3 Shrub Steppe Bitterbrush – Idaho fescue-bluebunch wheatgrass 1.4 Heavy Shrub Bitterbrush – needle and thread Dominate Reference State Species: Antelope bitterbrush – Idaho fescue – 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 Phases 1.1, 1.2 and 1.3 have high amounts of Idaho fescue and bluebunch wheatgrass cover and are at low risk of moving to State 3 • Community Phase 1.4 is at-risk because of low density for Idaho fescue and bluebunch wheatgrass. Community 1.4 should be

seeded after fire • Communities with more than 40% bitterbrush cover • When fire kills the Idaho fescue plants, these sites should be seeded after fire • Community 1.4, and any site with low cover of Idaho fescue/bluebunch wheatgrass, and any site with moderate to heavy cover of cheatgrass should be seeded after fire

Community 1.1
Reference

Community 1.2
Bunchgrass

Community 1.3
Shrub Steppe

Community 1.4
Heavy Shrub

Community 1.4, heavy shrub, is dominated by bitterbrush with needleandthread as co-dominate. There is not enough Idaho fescue or bluebunch 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. Shrub cover (bitterbrush and sagebrush) is all but eliminated, while Idaho fescue and bluebunch wheatgrass have a moderate increase in cover. The community shifts from a shrub steppe to a bunchgrass appearance. Causes: Moderate-severity fire is complete enough and hot enough to remove most of the shrubs. Fire is not hot enough to affect the soil conditions. The 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, 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 shrub steppe community. There is a moderate increase in bitterbrush while bluebunch wheatgrass and Idaho fescue have a moderate corresponding decrease. Also, needle and thread becomes more prominent in the community. Causes: With excessive grazing pressure (heavy grazing intensity, season long grazing or frequent late spring grazing) and a period of no fire, bitterbrush and sagebrush increase its cover while bluebunch wheatgrass suffers a big decline. The increased shade and grazing pressure cause lower bunchgrass vigor and a decline. Ecological process: With consistent defoliation pressure plant vigor decreases to such a degree that grass roots begin to die. So, Idaho fescue and bluebunch wheatgrass experience shrinking crowns and some plant mortality. The open niche space allows bitterbrush and sagebrush to set new seedlings and expand. Needle and thread, a prolific seeder, expands with many seedlings.

Pathway 1.2a
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 bitterbrush. Causes: Over time with no fire, bitterbrush and sagebrush will re-enter the community. With a slight increase in shade and some grazing pressure, perennial bunchgrasses experience a slight decline. Ecological process: With some consistent defoliation pressure Idaho

fescue and bluebunch wheatgrass have lower vigor and shrinking crowns. Bitterbrush and sagebrush set new seedlings and expand. Rodents cache bitterbrush seed in the soil. Post-fire some of this cached seed will germinate. Also, 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.

Pathway 1.1b
Community 1.3 to 1.1

1.1b Result: Shift from shrub steppe community to reference community. Shrub cover is reduced by two-thirds which is coupled with a significant increase in the cover of native bunchgrasses. Causes: Moderate-severity fire is patchy, dependent on temperature, wind, fuel load and fuel moisture. Some areas burn completely while other areas are unburned to lightly burned. Fire is not hot enough to affect the soil conditions. Fire removes surface vegetation but has no impact on the root crown of bunchgrasses. So, bunchgrasses and forbs return post-fire. 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 continue to expand, the grazing plan must consider moderate grazing intensity, and both critical period & growing season deferments. Ecological process: Idaho fescue and bluebunch wheatgrass have good vigor post-fire and expand via tillering and new seedlings. The reduction in bitterbrush releases resources and increases light for grasses and forbs. Bunchgrasses must have high vigor both pre- and post-fire, to expand its cover.

Pathway 1.2c
Community 1.3 to 1.4

1.2c Result: Shift from shrub steppe community to heavy shrub community. Bitterbrush and needleandthread have a big increase in cover while Idaho fescue and bluebunch wheatgrass are reduced significantly. Invasive annual grasses have not invaded but Community 1.4 is most at risk and is the segue between Reference State and States 2 & 3. Causes: With no fire, more shade and grazing pressure (heavy grazing intensity, season long grazing or frequent late spring grazing), the bunchgrasses experience weakened vigor and declining crowns. Grazing animals selectively target and eliminate most of the remaining Idaho fescue and bluebunch wheatgrass plants from the community. Bitterbrush and needleandthread both expand. Ecological process: With consistent defoliation pressure plant vigor decreases to such a degree that grass roots die. Bluebunch wheatgrass and Idaho fescue experience shrinking crowns and a lot of plant mortality. Bitterbrush and needleandthread, however, set new seedlings and expand. The open niche space gives bitterbrush and sagebrush opportunity to set new seedlings. Needleandthread, a prolific seeder, expands with many seedlings.

State 2
Shrub Steppe with Invasive Species

State 2 Narrative: State 2 represents invasion by annual grasses and is the gradation between Reference State and State 3. State 2 is shrub steppe with the inclusion of invasive annual grasses such as cheatgrass. The loss of soil biological crusts and annual grass seed blowing onto the site annually contributes to the annual grass invasion. All the native functional, structural groups are still represented by one or more species. Annual brome 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 the annual grasses make 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. For communities 2.1, 2.2, and 2.3 the amount of invasive annual grasses is minor. Annual grasses are more prominent in community 2.4. Once a community has been invaded by an annual brome the chance of going back to State 1 is small. This state can occur with or without bitterbrush. Community Phases for State 2: Same four communities as Reference State Dominate Species for State 2: Antelope bitterbrush, Idaho fescue and 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
Shrub Steppe

Community 2.4
Heavy Shrub

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 shrubs. Important species can include cheatgrass, Japanese brome, medusahead, ventenata, mustard, prickly lettuce and diffuse knapweed. Community Phases for State 3: 3.1 Shrub – Annual Grass Bitterbrush – Annual bromes 3.2 Annual Grass Annual bromes Dominate Species for State 3: Cheatgrass or other annual grasses with bitterbrush

Community 3.1
Shrub Annual Grass

Community 3.2
Annuals Grass

90% annual grass

Pathway 3.1a
Community 3.1 to 3.2

3.1a Result: shift from shrub-annual brome community to annual brome community Causes: Moderate intensity fire kills most or all bitterbrush and sagebrush. Annual bromes and other invasive species fully occupy the site. 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 Grasses

State 4 Narrative: State 4 represents a site that has been seeded to desirable grasses such as Snake River wheatgrass, Sherman big bluegrass, 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 4.1 is dominated by the desirable seeded species. State 4 has two community phases: Seeded grass phase and shrub – seeded grass phase. Community 4.2 is a shrub-grass community. Community Phases for State 4: 4.1 Seeded grasses 4.2 Shrub – Seeded Grasses Dominate Species for State 4: Desirable seeded grass and legume species with or without shrubs and legumes.

Community 4.1
Seeded Grasses

Community 4.2
Shrub Grass

Pathway 4.1a
Community 4.1 to 4.2

Pathways within State 4 4.1a Result: Shift from seeded grass to shrub-grass community. Shrubs colonize the site and increase cover and density while seeded grasses decline Causes: Excessive grazing pressure (heavy grazing

intensity, season long grazing or frequent late spring grazing) on seeded grasses reduce plant vigor. Grass root crowns shrink in size and some grasses die allowing shrubs to re-enter the site. Ecological Process: With consistent defoliation pressures seeded grasses experiences poor plant vigor to such a degree that grass roots begin to die. So, the seeded grasses experience shrinking crowns and some mortality. This gives shrubs 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 4.2a
Community 4.2 to 4.1

4.2a Result: Shift from shrub-grass to seeded grass community. The shrub layer is 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 recover. (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 recover. (3) Communities that do not have much seeded grass remaining 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 1-2 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. Ecological Process: for this community shift to occur the seeded grasses must have good plant vigor. When the shrubs are killed the grasses can expand to occupy the open niche space.

Transition T1
State 1 to 2

T1 Result: Transition from Reference State to State 2 with a few annual grasses. Primary trigger: Soil disturbances from rodent or badger activity provide great opportunity for invasive annual species. Fire, drought and grazing pressure can also create holes in the plant community. Loss of soil biological crusts also contributes. Ecological process: Annual grass seeds blow onto the site awaiting an opportunity to colonize. Seeds germinate and have enough moisture to establish plants and seed for the next generation. Indicators: A few annual grasses have colonized the site.

Transition T2
State 2 to 3

Result: Transition from State 2 with a few annuals to State 3 which is dominated by annual grasses. This transition occurs once the cover of bunchgrasses (Idaho fescue and bluebunch wheatgrass) declines to less than 10% and invasive species cover is greater than 40%. Primary trigger: Grazing pressure (heavy grazing, season long grazing or frequent late spring grazing) causes low vigor and reduced cover of Idaho fescue and bluebunch wheatgrass. Initially both needleandthread and the annual grasses increase. As the grazing pressure continues, needleandthread will also decrease. allowing the annual grasses to become dominate. Grazing pressure is defined as heavy grazing, season long grazing or frequent late spring grazing. Secondary trigger would be a severe fire which can eliminate virtually every Idaho fescue plant from the community. This void is quickly filled by the annual grasses. Repeated fire which is not a common occurrence in MLRA 8 as another possibility. Ecological process: With consistent defoliation pressures bluebunch wheatgrass, Idaho fescue and needleandthread experience poor plant vigor to such a degree that grass roots begin to die. So, bunchgrasses have shrinking crowns and some mortality. This gives invasive annual grasses opportunity to expand its cover to a position of dominance. Indicators: Significant decline in vigor and cover of one or more of the dominant reference state species – Idaho fescue, bluebunch wheatgrass, bitterbrush. Increasing cover of annual grasses. Increasing canopy gaps between bunchgrasses (Idaho fescue & bluebunch).

Restoration pathway R1
State 3 to 4

Equipment limitations from surface rock and rock in the profile will cause issues and some treatment options may not be feasible on some sites. R1 Result: Shift from State 3 dominated by annual grasses to State 4 seeded

grasses. This restoration transition is not likely to occur without significant time and inputs for weed control, seedbed preparation, seeding operation and post-seeding management & weed control. Two years of weed control, 1-2 years of deferment post-seeding, and proper grazing management afterward.

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, bitterbrush and native forb species. Attention needs to be paid to each step of the process: weed control, seedbed preparation, seeding and planting operations and post-seeding management. Shifting from State 3 to State 4: If the goal is to restore back to a native plant community, State 3 must first be shifted to State 4. It will take two years or longer to kill annual species and to exhaust the seedbank of invasive species. Site will then need to be seeded to perennial species such as 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. To make the switch from State 4 to state 2, all introduced grasses must be killed first. 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. Shrubs and native forbs should not be planted until broadleaf weeds have been controlled.

Transition T3
State 4 to 3

T3 Result: Transition from State 4 seeded grass to State 3 annual grasses. This transition occurs when the desirable seeded grasses become minor to the dominant annual grasses. Primary trigger: grazing pressure on the seeded grasses reduce the vigor and density of key bunchgrass species. Ecological process: consistent defoliation pressure causes weakened vigor, roots dying and less cover for the seeded grasses. Invasive annual grasses colonize the site and become more and more common with the loss of each bunchgrass plant. Indicators: shrinking crowns and mortality of desirable species, increasing caps gaps between seeded plants, increasing cover by annual grasses References: Boling M., Frazier B., Busacca, A., General Soil Map of Washington, Washington State University, 1998 Daubenmire, R., Steppe Vegetation of Washington, EB1446, March 1968 Davies, Kirk, Medusahead Dispersal and Establishment in Sagebrush Steppe Plant Communities, Rangeland Ecology & Management, 2008 Environmental Protection Agency, map of Level III and IV Ecoregions of Washington, June 2010 Miller, Baisan, Rose and Pacioretty, "Pre and Post Settlement Fire regimes in mountain Sagebrush communities: The Northern Intermountain Region Natural Resources Conservation Service, map of Common Resource Areas of Washington, 2003 Rapid Assessment Reference Condition Model for Wyoming Sagebrush, LANDFIRE project, 2008 Rocchio, Joseph & Crawford, Rex C., Ecological Systems of Washington State. A Guide to Identification. Washington State Department of Natural Resources, October 2015. Pages 156-161 Inter-Mountain Basin Big Sagebrush. Rouse, Gerald, MLRA 8 Ecological Sites as referenced from Natural Resources Conservation Service-Washington FOTG, 2004 Soil Conservation Service, Range Sites for MLRA 8 from 1980s and 1990s Tart, D., Kelley, P., and Schlafly, P., Rangeland Vegetation of the Yakima Indian reservation, August 1987, YIN Soil and Vegetation Survey

Citations