Ecological site group R009XG930WA
Loamy Bottom

Last updated: 11/22/2023
Accessed: 10/12/2024

Key Characteristics

None specified

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

Physiography

Hierarchical Classification
Major Land Resource Area (MLRA): 9 – Palouse and Nez Perce Prairie

LRU – Common Resource Areas (CRA):
9.1 - Channeled Scablands
9.12 - Moist Loess Islands
9.2 - Palouse Hills
9.3 - Dissected Loess Uplands
9.4 - Deep Loess Foothills
9.5 - Warm Canyons and Dissected Uplands

Site Concept Narrative:

In the upland setting ecological sites are often expansive, and thus, can be delineated and separated on aerial photos. But in the landscape position of bottoms, basins and depressions this is rarely the case as small changes in soil chemistry, the water table and elevation or aspect results in significant changes in plant community composition. In short distances there are often big swings of available water holding capacity, and soils can go from hydric to non-hydric, or from saline-sodic to not. So, in bottoms, riparian areas and depressions, ecological sites and community phases occur as small spots, strips and patches, or as narrow rings around vernal ponds. And generally, in a matter of steps one can walk across several ecological sites. On any given site location, two or more of these sites occur as a patchwork – Loamy Bottom, Alkali Terrace, Sodic Flat, Wet Meadow, Herbaceous Wetland and Riparian Woodland. These ecological sites may need to be mapped as a complex when doing resource inventory.

Diagnostics:

The first thing you notice about Loamy Bottom is the much taller vegetation and vastly more production than any upland site. The tall, upright bunchgrasses can be taller than 6 feet. Another striking feature of Loamy Bottom is that it provides excellent protection from wind for livestock and wildlife, and good habitat (hiding cover, nesting cover, standing winter forage).

Loamy Bottom is part of the lentic (standing water) ecosystem, but this site is not a wetland, nor or the soils hydric. It occurs on moisture receiving sites such as bottoms, draws, basins and depressions. This site also occurs as a narrow zonal ring around ponds, lakes and vernal pools. Loamy bottom is an important “hinge site” as it connects upland sites with riparian areas, wetlands and saline-sodic sites.

Soils are deep and unrestricted for plant growth. The soils are silt loam or sandy loam texture and are not saline or sodic, and not hydric. In addition, the landscape position of this site could be conducive to soils possibly containing

andic soil properties, i.e. volcanic ash. These andic soil properties can be important for productivity in that they retain larger amounts of water compared to other parent materials (higher water-holding capacity (AWC)), have high cation exchange capacity (CEC) and high availability of organically bound plant nutrients.

Across the sagebrush steppe region in MLRA 8, this site is a basin wildrye-sagebrush site. Within MLRA 9, Loamy Bottom has several variations with basin wildrye as the constant in all instances. In the channel scablands area threetip sagebrush and basin big sagebrush are prevalent. But in the loess hills, the only shrub, rabbitbrush, is a minor component, and the site is exclusively dominated by basin wildrye in the reference condition. In the Palouse Hills basin wildrye with rose and snowberry are present. The variations are lumped into one ecological site because Loamy Bottom represents only a fraction of the landscape and basin wildrye is dominant in every variation. Also, use, management and production are similar across all variations.

While tall bunchgrasses dominate the reference state overstory, mid-sized bunchgrasses and forbs fill the interspaces. The overstory layer is head-high or taller basin wildrye. Cool-season bunchgrasses form one or two distinct understory layers. Bluebunch wheatgrass or Nelson's needlegrass, if present, form the mid-grass layer, while Sandberg bluegrass is the shortest grass layer.

Virtually all the Loamy Bottom sites have been farmed in the Palouse. Loamy Bottom in the channeled scabland and loess hills have been heavily disturbed as well.

Principle Vegetative Drivers:

The vegetative expression of Loamy Bottom is driven by three situations. First, this site receives both surface runoff and discharging groundwater from adjacent upland ecological sites. Second, the soils are deep and have unrestricted rooting. Third, the soils are well drained and remain in an anaerobic condition for only a short period of time. This makes Loamy Bottom far more productive than any upland 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

Loamy Bottom receives both surface runoff and discharging groundwater from nearby upland sites. The soils are deep, well drained, and unrestricted, and thus, remain saturated for only a short period in late winter to early spring. With adequate cover of live plants and litter, there are no water infiltrating restrictions on Loamy Bottom.

Physiographic Features:

The landscape is part of the Columbia basalt plateaus and Northern Rocky foothills.

In the upland setting ecological sites are often expansive, and thus, can be delineated and separated on aerial photos. But in the landscape position of bottoms, basins and depressions this is rarely the case as small changes in soil chemistry, the water table and elevation or aspect results in significant changes in plant community composition. In short distances there are often big swings of available water holding capacity, and soils can go from hydric to non-hydric, or from saline-sodic to not. So, in bottoms, riparian areas and depressions, ecological sites and community phases occur as small spots, strips and patches, or as narrow rings around vernal ponds. And generally, in a matter of steps one can walk across several ecological sites. On any given site location, two or more of these sites occur as a patchwork – Loamy Bottom, Alkali Terrace, Sodic Flat, Wet Meadow, Herbaceous Wetland and Riparian Woodland. These ecological sites may need to be mapped as a complex when doing resource inventory.

Loamy bottom covers all three geographic areas covered in PESs of MLRA 9; Channeled Scablands, Palouse Hills, and Loess Hills.

Physiographic Division: Intermontane Plateau and Northern Rocky Mountain System
Physiographic Province: Columbia Plateau and Northern Rocky Mountains

Physiographic Sections: Walla Walla Plateau and Blue Mountain Section

Landscapes: hills and plateaus
Landform: floodplains, drainageways, terraces

Elevation: Dominantly 1,000 to 4,000 feet
Slope: Total range: 0 to 5 percent
Central tendency: 0 to 3 percent
Aspect: Occurs on all aspects

Geology:

MLRA 9 is almost entirely underlain by Miocene basalt flows. Columbia River basalt is covered by wind-blown loess with a thickness up to 246 feet thick. The oldest layer of loess accumulated between 2 and 1 million years ago, while the uppermost layers of Palouse Loess accumulated between 15,000 years ago and modern times. The mid layers of loess were deposited episodically between 77,00 year and 16,00 years ago. The Palouse Loess largely consists of the wind-blown sediments eroded from the Hanford formation that were periodically deposited by repeated Missoula Floods within the Eureka Flats area.

Climate

The climate across MLRA 9 is characterized by moderately cold, wet winters, and relatively dry summers. 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 primarily a xeric moisture regime and mesic temperature regime.

Mean Annual Precipitation:
Range: 16 – 28 inches
Winter precipitation, primarily snow, occurs during low-intensity, Pacific-frontal storms. During winter these storms produce occasional rains that fall on frozen or thawing ground surfaces. High intensity, convective thunderstorms produce some rain during the growing season. Precipitation is evenly distributed throughout fall, winter and spring.

Mean Annual Air Temperature:
Range: 42 to 52 F
Central Tendency: 47 – 50 F
Freezing temperatures generally occur from late-October through early-April. Temperature extremes are -10 degrees in winter and 110 degrees in summer. Winter fog is variable and often quite localized, as the fog settles on some areas but not others.

Frost-free Period (days):
Total range: 60 to 180
Central tendency: 100 to 140
The growing season for Loamy Bottom is March through August.

Soil features

Edaphic:

The soils are deep, well drained and formed in loess. Loamy Bottom commonly occurs adjacent to Wetland complex, Riparian complex and one of the Loamy ecological sites.

Representative Soil Features:

This ecological site components are dominantly Cumulic and Vitrandic taxonomic subgroups of Haploxerolls great groups of the Mollisols taxonomic order. Soils are dominantly very deep. Average available water capacity of about 8 inches (20.3 cm) in the 0 to 40 inches (0-100 cm) depth range.

Soil parent material is dominantly mixed alluvium derived from loess possibly mixed with minor amounts of ash in

the upper part of the soil.

The associated soils are Caldwell, Mondavi and similar soils.

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

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

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

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

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

Subsurface fragments > 3 inches (% Volume):
Minimum: 0
Maximum: 5
Average: 2

Subsurface fragments ≤ 3 inches (% Volume):
Minimum: 0
Maximum: 15
Average: 2

Drainage Class: Range from somewhat poorly drained to moderately well drained.
Water table depth: 20 to greater than 50 inches

Flooding:
Frequency: None to Occasional

Ponding:
Frequency: None

Saturated Hydraulic Conductivity Class:
0 to 10 inches: Moderately high
10 to 40 inches: Moderately high

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

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

Sodium Absorption Ratio:
Minimum: 0
Maximum: 0

Calcium Carbonate Equivalent (percent):

Minimum: 0
Maximum: 0

Soil Reaction (pH) (1:1 Water):
0 - 10 inches: 5.6 to 8.4
10 - 40 inches: 5.6 to 9.0

Available Water Capacity (inches, 0 – 40 inches depth):
Minimum: 5.7
Maximum: 8.9
Average: 8

Vegetation dynamics

Ecological Dynamics:

Loamy Bottom produces about 3000-5000 pounds/acre of biomass annually.

Loamy Bottom has several variations with basin wildrye as the constant:
1. Basin wildrye – three-tip sagebrush, basin big sagebrush (Channeled Scabland)
2. Basin wildrye with no shrub in the loess hills area (a little rabbitbrush)
3. Basin wildrye – rose/snowberry (Palouse Hills)

Regarding saline-alkali soils Daubenmire wrote, “It seems impossible to find areas where one can be confident that the vegetation has not been somewhat altered by domesticated animals.” The same is also true of loamy bottoms, riparian areas and wetlands. These areas have been heavily grazed, and drained, filled or straightened to enable farming.

Basin wildrye, also called Great Basin wildrye, is at the core of the Loamy Bottom ecological site and warrants a degree of understanding. Basin wildrye is a cool season bunchgrass but is considered weakly rhizomatous. It has coarse, robust stems and leaves, grows to 5 to 7 feet tall and sometimes exceeds 3 feet in diameter, and thus, is one of the highest producing species. Basin wildrye is commonly found on loamy bottoms, mildly to moderately saline-sodic soils and on the tops of loamy mounds. It tolerates alkaline soils and seasonal flooding but not anaerobic conditions.

The stability and resiliency of the reference communities on Loamy Bottom sites is directly linked to the health and vigor of basin wildrye. Given the opportunity (good vigor and favorable moisture), basin wildrye can establish ownership and expand across the Loamy Bottom ecological site. Basin wildrye expands via two processes: (1) Tillering from basal buds for new shoots, and (2) new seedlings from germinating seed.

The natural disturbance regime for sagebrush-bunchgrass communities is periodic lightning-caused fires. The fire return intervals (FRI) listed in research for sagebrush steppe communities is quite variable. Ponderosa pine communities have the shortest FRI of about 10-20 years (Miller). The FRI increases as one moves to wetter forested sites or to drier shrub steppe communities. Given the uncertainties and opinions of reviewers, a mean of 75 years and a range of 50-100 was chosen for Wyoming sagebrush communities (Rapid Assessment Model). The FRI for Loamy Bottom is the same as upland sites. This would place the historic FRI for grassland steppe around 30-50 years.

The shrubs on Loamy Bottom – threetip sagebrush, rabbitbrush, rose and snowberry – all sprout following fire. Because basin wildrye produces a large amount of biomass, fire can burn and smolder in the crown of the plant for considerable time. This leaves basin wildrye plants much diminished. It can take a few years for basin wildrye to fully recover from the effects of fire.

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. As grazing pressure increases the plant community unravels in stages:
1. More preferred grasses decline.
2. Basin wildrye plants produce fewer shoots as crowns become smaller. Unpalatable forbs increase.

3. As the decline continues invasive species such as knapweed, perennial pepperweed and annual grasses colonize the site
4. With further decline the site can become a shrub-invasive weed community

Managing grasslands to improve the vigor and health of native bunchgrasses begins with an understanding of grass physiology. New growth for existing bunchgrasses begins each year from basal buds. Basin wildrye plants can expand via tillering, or new plants through natural reseeding. Regrowth from spring grazing comes mostly from photosynthesis.

In the spring each year it is important to monitor and maintain an adequate top growth: (1) to optimize regrowth following spring grazing, (2) so plants have enough energy to replace basal buds annually, and (3) to protect the elevated growing points of basin wildrye.

During seed formation, the growing points of basin wildrye become elevated 4-6 inches and are vulnerable to damage or removal. Repeated grazing during late spring 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).

Basin wildrye 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

In Washington, basin wildrye-sagebrush communities provide habitat for a variety of upland wildlife species.

Supporting Information:

Associated Sites:
Loamy Bottom is associated with other ecological sites in bottoms and basin areas of MLRA 9, including Wetland Complex, Riparian Complex, Loamy bunchgrass,
Loamy dwarf shrub, Shallow Stony, and Cool Loamy.

Similar Sites:
MLRAs 6, 7 & 8 have a similar Loamy Bottom ecological site.

Inventory Data References (narrative):
Data to populate Reference Community came from several sources: (1) NRCS ecological sites from 2004, (2) Soil Conservation Service range sites from 1980s and 1990s, (3) Daubenmire's habitat types, and (4) ecological systems from Natural Heritage Program

Major Land Resource Area

MLRA 009X
Palouse and Nez Perce Prairies

Subclasses

- R009XY930WA–Loamy Bottom

Stage

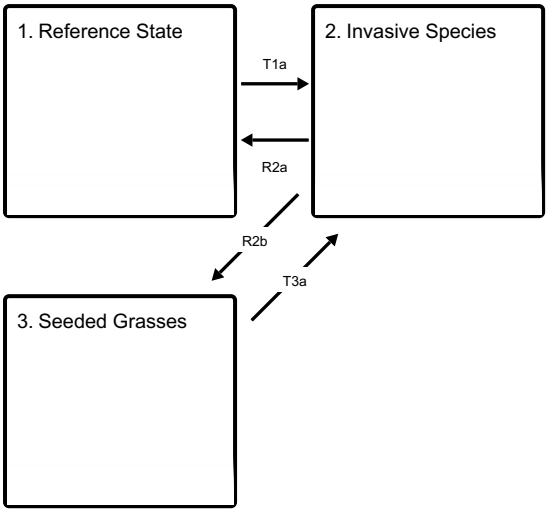
Provisional

Contributors

Kevin Guinn, C. Smith, R. Fleenor, K. Paup-Lefferts

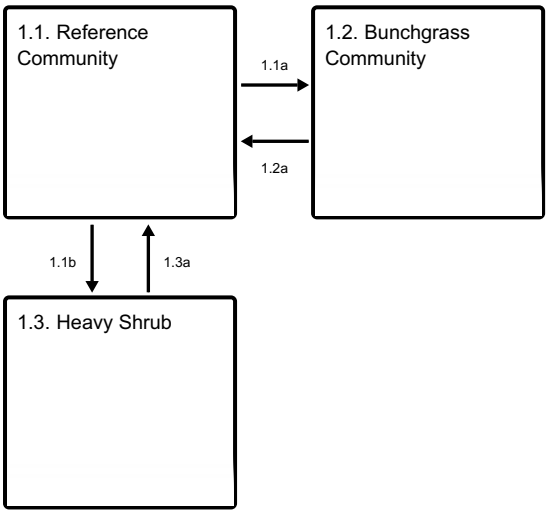
State and transition model

Ecosystem states



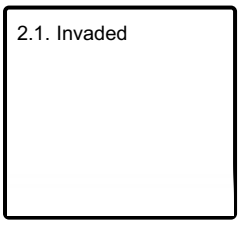
T1a - grazing pressure
R2a - restoration
R2b - restoration
T3a - grazing pressure

State 1 submodel, plant communities



1.1a - Moderate-severity fire, or several years of above average precipitation
1.1b - grazing pressure
1.2a - Natural regeneration of shrubs - period of no fire.
1.3a - moderate-severity fire

State 2 submodel, plant communities



State 3 submodel, plant communities

3.1a - grazing pressure

3.2a - shrub control, weed control and reseeding

State 1
Reference State

State 1 Narrative: State 1 represents grassland steppe with none to minor amounts of invasive or exotic weed species. All the functional, structural groups have one or more native species. Reference State Community Phases: 1.1 Reference Basin wildrye – Basin &/or Wyoming big sagebrush 1.2 Bunchgrass Basin wildrye 1.3 Heavy Sage Basin &/or Wyoming big sagebrush – Basin Wildrye Dominate Reference State Species: Basin wildrye, Wyoming and/or basin big sagebrush At-risk Communities: • All communities in the reference state are at risk of invasion by exotic species. Annual or biennial weeds and annual grass seeds blow onto most sites annually • Community Phase 1.3, the heavy shrub community, has the highest risk of moving to State 2 because it has low cover of basin wildrye and high cover of shrubs • Any Loamy Bottom community with high shrub cover and low cover of basin wildrye will also have invasive weeds, and thus, no longer be in the Reference State • To seed or not to seed is the question after a fire. Community 1.3 and State 2 should be seeded to basin wildrye to minimize weed infestation. Any site with low cover of basin wildrye and any site with low to moderate cover of weeds should be seeded after a fire.

Community 1.1
Reference Community

Reference Community 1.1 for Loamy Bottom in MLRA 9

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	
			Sprouting Shrubs – Minor (3-7% canopy)	15%	900 lbs.
			ARTR4 three-tip sagebrush		
			CHRYS rabbitbrush		
			ROSA rose		
			SYAL snowberry		
			RIBES current		
Dominant Tall Bunchgrass	65%	4000 lbs.	**Mid-Size Bunchgrasses – Minor**	10%	600 lbs.
LECI4 basin wildrye			ACNE9 Nelson's needlegrass		
			POCU3 Cusick's bluegrass		
			PSSP6 bluebunch wheatgrass		
			ELGL blue wildrye		
			FEID Idaho fescue		
Short Grass – Minor	less than 5%	200 lbs.	**Grass-Like – Trace**		
POSE Sandberg bluegrass			CAREX sedge		Trace
Native Forbs – Minor				10%	600 lbs.
BASA3 arrowleaf balsamroot			POGR9 cinquefoil		
LUPIN lupine			CALOC Mariposa lily		
CREPI hawksbeard			ERIGE2 erigeron		
PHLO2 longleaf phlox			ASTRA milkvetch / locoweed		
PHHO spiny phlox			LOMAT lomatium / biscuitroot		
ERIOG buckwheat			CASTI2 paintbrush		
COLLO collomia			LIRU4 stoneseed		
ACMI2 yarrow			PLPA2 woolly plantain		
ANDI2 low pussytoes			HYCA4 waterleaf		

Estimated Production (pounds / acre)	Below	Normal	Above
	3500	5000	6000

Basin wildrye – Basin &/or Wyoming big sagebrush 65% basin wildrye 10% mid-size bunchgrasses 15% sprouting shrubs 10% native forbs Depending on location within MLRA 9, Reference Community 1.1 is dominated by basin wildrye with some big sagebrush (Channeled Scabland region) or basin wildrye with some rose and snowberry (Palouse Hills region) or just basin wildrye (other regions in MLRA 9).

Community 1.2
Bunchgrass Community

Basin wildrye 80% basin wildrye 10% mid-size bunchgrasses 5% sprouting shrubs 5% native forbs Community 1.2 is even more strongly bunchgrass dominated.

Community 1.3
Heavy Shrub

Basin &/or Wyoming big sagebrush – Basin Wildrye 15% basin wildrye 10% mid-size bunchgrasses 50% sprouting shrubs 15% native forbs Community 1.3 is dominated by shrubs (big sagebrush, rabbitbrush, rose or snowberry). Native forbs and other shrubs are prevalent and there are minor amounts of weeds (broadleaf or annual grasses). There is enough basin wildrye remaining for Community 1.3 to shift back to the other communities in the reference state as basin wildrye can be aggressive on favorable sites such as Loamy Bottom.

Pathway 1.1a
Community 1.1 to 1.2

1.1a Result: Shift from Reference Community 1.1 to bunchgrass community 1.2. Shrub cover is all but eliminated, while basin wildrye has a moderate increase in cover. Primary Trigger: Moderate-severity fire consumes above-ground plant biomass and shrubs are set back or killed. Basin wildrye has a lot of biomass and the fire burns into the crowns, but some portion of the crowns remain intact. So, basin wildrye survives and increases its vigor the next few years. For other 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 need two growing seasons rest before grazing resumes or, the pastures can be lightly grazed during the 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. Secondary Trigger: Several years of above average precipitation. High seasonal water table kills most of the sagebrush, allowing basin wildrye to assert almost total cover dominance. This is a rare occurrence, but it did happen in the mid-1980s. Ecological process: Fire kills basin big sagebrush and it does not have any sprouting ability. Threetip sagebrush and rabbitbrush are set back but will sprout following fire to stay in the community. The reduction in shrubs releases resources and increases light for grasses and forbs. Basin wildrye, bluebunch wheatgrass and other bunchgrasses have good vigor post-fire and expand via tillering and new seedlings.

Pathway 1.1b
Community 1.1 to 1.3

1.1b Result: shift from reference community 1.1 to heavy sagebrush community 1.3. Primary Trigger: grazing pressure (heavy grazing intensity, season long grazing of frequent lats spring grazing to basin wildrye and other palatable species Ecological Process: consistent defoliation pressure to basin wildrye and other palatable species results in poor vigor, shrinking crowns and plant mortality. Resources are released and niche space available. Shrubs make a big increase via growth by surviving shrubs and new shrub seedlings. The increase in shrub canopy also contributes to the decline in bunchgrasses.

Pathway 1.2a
Community 1.2 to 1.1

1.2a Result: Shift from bunchgrass community 1.2 to reference community 1.1. Shrubs increase while basin wildrye declines. Primary Trigger: Natural regeneration of shrubs results in a small decline in basin wildrye with corresponding increase in shrubs. This requires a period of no fire. Secondary Trigger: Several years of average or below normal precipitation leading to a significant drop in the lateral water flow and drying out the soil profile, which leads to fine root die-off of basin wildrye. Competitive advantage shifts to shrubs. Good management is required to

keep the basin wildrye loss to a minimum as shrubs re-enters the community Ecological process: Community 1.2 was fire caused. During a period of no fire sprouting shrubs grow and new shrub seedlings establish. Increased shading causes a decline in bunchgrasses.

Pathway 1.3a
Community 1.3 to 1.1

1.3a Result: Significant shift from heavy sagebrush community 1.3 to reference community 1.1. Primary Trigger: moderate-severity fire coupled with good vigor in basin wildrye. Ecological Process: fire sets back threetip sage and rabbitbrush while basin big sagebrush is killed. Because basin wildrye has a lot of biomass the fire does burn into the crown, but some portion of most basin wildrye crowns remain intact. Basin wildrye can be aggressive and move into spots formerly occupied by shrubs and in a few years assume a position of dominance. Basin wildrye expands via tillering and new seedlings.

State 2
Invasive Species

State 2 Narrative: State 2 represents invasive species communities that have 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 2: Can have several variations: 1. Invasive annual or biennial weeds (mustard, prickly lettuce, perennial pepperweed) 1. Invasive annual grasses (field brome, ventenata, medusahead) 2. Shrubs (basin big sagebrush, threetip sage, or rabbitbrush) with invasive weeds or annual grasses Dominate State 2 Species: Invasive weeds: mustard, prickly lettuce, perennial pepperweed, knapweeds Invasive annual grasses: field brome, cheatgrass, medusahead, ventenata Sagebrush, rabbitbrush, snowberry or rose

Community 2.1
Invaded

3 variations: invasive annual/biennial weeds, invasive annual grasses, or shrubs with invasive weeds and/or annual grasses.

State 3
Seeded Grasses

State 3 Narrative: State 3 represents a site that has been seeded to desirable grasses such as basin wildrye or intermediate wheatgrass. Community Phases for State 3: 3.1 Seeded Grasses 3.2 Shrub / Invasive Weeds – Seeded Grasses

Community 3.1
Seeded Grass

Community 3.1 remains stable with 0.8 plant / sq. ft. or greater of mid-sized bunchgrasses or with a full stand of basin wildrye. 85% seeded grasses

Community 3.2
Shrub / Invasive Weeds – Seeded Grasses

50% shrub/weeds 40% seeded grasses

Pathway 3.1a
Community 3.1 to 3.2

3.1a Result: shift from seeded grass community 3.1 to community 3.2 dominated by shrubs &/or invasive weeds Primary Trigger: grazing pressure (heavy grazing intensity, season long grazing or frequent late spring grazing) to seeded grasses. Ecological process: consistent defoliation pressure to seeded grasses results in poor vigor, shrinking crowns and plant mortality. Released resources and available niche space provide opportunity for shrubs to dominate, or for invasive species to colonize the site and expand to a position of dominance.

Pathway 3.2a
Community 3.2 to 3.1

3.2a Result: shift from shrub/weed dominated community 3.2 back to community 3.1 dominated by seeded grasses. Primary Trigger: human intervention to kill shrubs, reduce invasive weed population and to re-seed or inter-seed desirable grass species if necessary. If the community has a good population of seeded grasses with good vigor, shrub control may be the only treatment needed. When the remnant grass population is not adequate, seeding will also be necessary. Ecological process: shrubs and weeds are killed, and seedbed prepared for seeding operation. Herbicide application, tillage and seeding operation must be timely. Seed placement should ensure seed-soil contact at 1/8”-1/4” depth. Post-seeding management should ensure that desirable grass seedlings become established and broadleaf weeds are controlled. Stands with a good population of remnant desirable grasses, may achieve desired results without seeding.

Transition T1a
State 1 to 2

T1a Result: Shift from Reference State (native grassland with no invasive species) to State 2 which is dominated by invasive weeds or annual grasses. The transition from State 1 to State 2 occurs as Community 1.3 declines until it crosses the biological threshold. This transition occurs once the cover of basin wildrye drops significantly and invasive species are co-dominant to dominant. Primary Trigger: grazing pressure (heavy grazing intensity, season-long grazing, or frequent late spring grazing) to basin wildrye. Ecological process: with consistent defoliation pressure basin wildrye and other palatable species exhibit poor vigor, shrinking crowns and plant mortality. This releases resources and niche space for invasive species. Weed seeds from invasive species blow onto the site or are carried in with runoff water. On most sites weed seeds are waiting for an opportunity to colonize the site. In a series of retrogressions basin wildrye cover continues to decline while invasive species increase accordingly until invasive species are dominant. Indicators: Decreasing cover of basin wildrye and increasing cover of invasive species. Increasing canopy gaps between basin wildrye plants.

Restoration pathway R2a
State 2 to 1

R2a Result: Shift from invasive species in State 2 back to Reference State. This restoration transition does not occur without a significant commitment of time & resource inputs to restore ecological processes, native bunchgrasses, sagebrush and native forb species. TWO OPTIONS: Option#1: Step 1 seed to introduced grasses; Step 2 seed to native species Step 1 shifting from State 2 to State 3: It will take two years or longer to kill annual species and to exhaust the seedbank of invasive weed seed. Site will then need to be seeded to introduced 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, improved pore spaces and increased soil moisture within the soil profile. The site would also need several years of no significant fires and proper grazing management as well. See narrative for R1 recovery above. Step 2 shifting from State 3 to State 1: This assumes that the shift from State 2 to State 3 has been successful. Introduced grasses and any remaining weeds must be killed while maintaining soil structure to ensure a proper seedbed (cloddy, a little rough and trashy to provide safe sites for the seed). A pulverized dust mulch must be avoided at all costs. The seeding of native species could occur in two steps: (1) first year, use a seed mix to duplicate the Reference Community – mostly basin wildrye with other native bunchgrasses so that broadleaf weeds may be controlled, and (2) second year re-introduce sagebrush and native forbs. Plugs may be used for sagebrush and native forbs rather than seed. Post-seeding the site would also need several years with no significant fires and proper grazing management as well to ensure plant establishment and vigor. Option #2: seed directly to native species Take two years or more to kill weeds and to exhaust the weed seedbank while maintaining soil structure. As in Option 1 above, the seeding of native species could occur in two steps: (1) first year, use a seed mix to duplicate the Reference Community – mostly basin wildrye with other native bunchgrasses so that broadleaf weeds may be controlled, and (2) second year re-introduce sagebrush and native forbs. Plugs may be used for sagebrush and native forbs rather than seed. Post-seeding the site would also need several years with no significant fires and proper grazing management as well to ensure plant establishment and vigor.

Restoration pathway R2b

State 2 to 3

R2b Transition from State 2 (a community dominated by invasive annual species) to State 3, which can be to basin wildrye or to introduced grasses such as intermediate wheatgrass. 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 can require 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 1/8-1/4 inch is desired). Proper grazing management is essential to maintain the stand post-seeding. Intermediate wheatgrass is highly adapted to the Loamy Bottom 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.

Transition T3a
State 3 to 2

T3a Result: Shift from State 3 (seeded grasses) to State 2 which dominated by invasive weeds or annual grasses. Primary Trigger: grazing pressure (heavy grazing intensity, season long grazing or frequent late spring grazing) to seeded grasses. Ecological Process: with consistent defoliation pressure seeded grasses exhibit poor vigor, shrinking crowns and plant mortality. This releases resources and niche space for invasive species to colonize the site. The competitive advantage goes to the exotic species which are opportunistic and take most of the site's resources. In a series of retrogressions seeded grasses continue to decline while invasive species increase accordingly until invasive species are dominant. Indicators: shrinking crowns and mortality of desirable species, increasing gaps between seeded grasses, and increasing cover of invasive annual species. 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