

# Ecological site DX034A02X162 Shallow Loamy Pinedale Plateau (SwLy PP)

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### **General information**

**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.

### **MLRA** notes

Major Land Resource Area (MLRA): 034A-Cool Central Desertic Basins and Plateaus

Major Land Resource Area (MLRA) 34A, Cool Central Desertic Basins and Plateaus, consists of approximately 21 million acres in Wyoming, Colorado and Utah, it consists of 10 Land Resource Units (LRU). These units are divisions of the MLRA based on geology, landscape, common soils, water resources and plant community potentials. The elevation ranges from approximately 5600 feet (1700 m) along the Green River in UT and CO to approximately 9500 feet (2900 m) near Jeffrey City, WY. Annual precipitation ranges from 7 to 16 inches (177 to 406 mm), with the driest areas in the Green River and Great Divide Basins and the wettest areas in northern Carbon County, Southeast Fremont County and Albany County. There is a seasonal weather pattern that trends west to east, with more winter precipitation in the west and more spring/summer in the east, illustrated by diminishing amounts of Big Sagebrush in the eastern part of the MLRA.

## LRU notes

The Pinedale Plateau LRU is in the upper Green River Drainage from Pinedale, Wyoming at the north working southward to Farson, Wyoming and easterly to South Pass, Wyoming. It is situated between the Wyoming Range and Wind River Range largely in Sublette County with some areas in Lincoln County, northern Sweetwater County, and a small portion of Fremont County. The total area of this LRU is approximately 1,210,000 acres. It shares a boundary with MLRA 46-Northern Rocky Mountain Foothills (proposed for the foothills of western Wyoming). This LRU is dominated by the New Fork Tongue of the Wasatch formation, a large artesian aguifer that is estimated to hold large amounts of water with relatively quick recharge (Martin, 1997). It is also home to the Lance Formation, a cretaceous strata that is part of the Mesaverde Group, which holds large amounts of hydrocarbons, giving way to one of the largest on shore natural gas fields (Jonah Field) (Bowker et al 2000). The soils in the Pinedale Plateau are dominated by older Alfisols with thick argillic and calcic horizons and younger deep alluvial soils along drainage ways and in river bottoms. Salts are not a major influence in the Pinedale Plateau compared to the adjacent Green River Basin LRU but do occur, including sodium, calcium carbonate, and other soluble salts. Soils are tied closely to their parent geology but are more developed and older so typically do not have bedrock contact within six feet. This LRU has an aridic ustic soil moisture regime and frigid (bordering on cryic) soil temperature regime. The precipitation pattern is bimodal with a slight spikes in the spring and fall. Winter temperatures are cold allowing snow to accumulated and stay until spring. This lends perfectly to cool season grasses and forbs to flourish, also allowing Big Sagebrush to establish and dominate the landscape. The mean annual soil temperatures are between 36 to 40 degree Fahrenheit (2.2 to 4.4 degree Celsius) and average precipitation is between 9 and 12 inches (230-305 mm) annually. Elevations of this LRU range between 6500 and 7500 feet (1980-2280 m).

### **Classification relationships**

Relationship to Other Established Classification Systems National Vegetation Classification System (NVC): 3 Semi-Desert 3.B.1 Cool Semi-Desert Scrub & Grassland 3.B.1.Ne Western North American Cool Semi-Desert Scrub & Grassland Division
M169 Great Basin & Intermountain Tall Sagebrush Shrubland & Steppe Macrogroup
G303 Intermountain Dry Tall Sage Steppe and Shrubland Group
A3182 Wyoming big sagebrush Mesic Steppe and Shrubland Alliance
CEGL001009 Artemisia tridentata ssp. wyomingensis/Pseudoroegnaria spicata Shrubland Association

Ecoregions (EPA): Level I: 10 North American Deserts Level II: 10.1 Cold Deserts Level III: 10.1.4 Wyoming Basin

# **Ecological site concept**

• This site not does receive any additional water.

• These soils:

o are not saline or saline-sodic

o are shallow (10-20 inches deep)

o may be skeletal within 20 inches (50 cm) of the soil surface (greater than 35 percent rock fragments by volume) o are not strongly or violently effervescent in the surface mineral layer (within top 10 inches; 25 cm)

o have surface textures that usually range from fine sandy loam to light clay loam in surface mineral layer (4 inches; 10 cm)

• have slopes that range from 15-45 percent

• clay content is not greater than 35 percent in mineral soil surface layer (6 inches; 15 cm) Climate:

aridic ustic moisture regime (ustic bordering on aridic)

frigid (bordering on cryic) temperature regime

# Associated sites

DX034A02X122	Loamy Pinedale Plateau (Ly PP)			
	Soils are moderately deep to very deep (greater than 20 inches).			

# Similar sites

R034AY262WY	Shallow Loamy Foothills and Basins West (SwLy)			
	Previous version of this site, but applied to a larger geographic area.			

#### Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) Artemisia tridentata ssp. wyomingensis
Herbaceous	(1) Pseudoroegneria spicata

### Legacy ID

R034AC162WY

### **Physiographic features**

The Shallow Loamy Pinedale Plateau (SwLy-PP) ecological site occurs in intermontane basin landscapes on hill and hillslope landforms (see following definitions). The slopes typically range from 15 to 45 percent, but can occur from 0 to greater than 50 percent. This site occurs on all aspects.

### Landscape Definitions:

intermontane basin—A generic term for wide structural depressions between mountain ranges that are partly filled with alluvium and called "valleys" in the vernacular.

### Landform Definitions:

hills—A landscape dominated by hills and associated valleys. The landform term is singular (hill). hillslope -- A generic term for the steeper part of a hill between its summit and the drainage line, valley flat, or depression floor at the base of the hill.

Landforms	<ul><li>(1) Intermontane basin &gt; Hill</li><li>(2) Hillslope</li></ul>
Runoff class	Negligible to very high
Flooding frequency	None
Ponding frequency	None
Elevation	6,500–7,500 ft
Slope	15–45%
Aspect	Aspect is not a significant factor

#### Table 2. Representative physiographic features

## **Climatic features**

Annual precipitation ranges from 9 to 12 inches per year. Wide fluctuations may occur in yearly precipitation and result in more below average years than those with above average precipitation. Temperatures show a wide range between summer and winter and between daily maximums and minimums. This is predominantly due to the high elevation and dry air, which permits rapid incoming and outgoing radiation. Cold air outbreaks in winter move rapidly from northwest to southeast and account for extreme minimum temperatures. Much of the precipitation accumulation (45 percent) comes in the winter in the form of snow (October to April). The wettest month is May (1.69 inches). The dominant plants (sagebrush and cool season grasses) are well adapted to these conditions. Daytime winds are generally stronger than nighttime and occasional strong storms may bring brief periods of high winds with gusts to more than 50 miles per hour. The growing season is short (less than 60 day) and cool (critical growth period): primary growth typically occurs between May and June.

Growth of native cool-season plants begins about mid-April and continues to approximately early July. Some greenup of cool-season plants usually occurs in September with adequate fall moisture.

All data is based on the 30-year average from 1981-2010.

Frost-free period (characteristic range)	30-70 days
Freeze-free period (characteristic range)	50-80 days
Precipitation total (characteristic range)	9-12 in
Frost-free period (actual range)	15-70 days
Freeze-free period (actual range)	45-90 days
Precipitation total (actual range)	9-13 in
Frost-free period (average)	36 days
Freeze-free period (average)	64 days
Precipitation total (average)	11 in

#### Table 3. Representative climatic features



Figure 1. Monthly precipitation range



Figure 2. Monthly minimum temperature range



Figure 3. Monthly maximum temperature range



Figure 4. Monthly average minimum and maximum temperature



Figure 5. Annual precipitation pattern



Figure 6. Annual average temperature pattern

### **Climate stations used**

- (1) PINEDALE [USC00487260], Pinedale, WY
- (2) BOULDER REARING STN [USC00480951], Boulder, WY
- (3) CORA [USC00482054], Cora, WY

### Influencing water features

There are no influencing water features in the Shallow Loamy Pinedale Plateau ecological site.

### Wetland description

N/A

### Soil features

The soils of this site are shallow and formed in slope alluvium and colluvium derived from interbedded sedimentary rock and conglomerate. Surface and subsurface textures are fine sandy loam to light clay loam. Rock fragments are typically channery or flaggy (angular) and may be present at the surface with outcropping bedrock, increasing in volume with depth to lithic or paralithic contact. These soils are well-drained and have moderate to moderately rapid permeability. The soil moisture regime is ardic ustic and the soil temperature regime is frigid.

Major Soil Series correlated to this site include: Broback, Craighigh, and Hoofer Representative soil taxonomy: Loamy-skeletal, mixed, superactive, calcareous, frigid, shallow Aridic Ustorthents Loamy-skeletal, mixed, superactive, frigid Aridic Haplustalfs Loamy, mixed, superactive, frigid, shallow Aridic Haplustalfs

#### Table 4. Representative soil features

Parent material	(1) Slope alluvium-sandstone and sha	
	(2) Residuum–sandstone and shale	

Surface texture	<ul><li>(1) Very parachannery loam</li><li>(2) Sandy clay loam</li><li>(3) Very gravelly sandy loam</li></ul>
Family particle size	(1) Loamy-skeletal
Drainage class	Well drained
Permeability class	Moderately slow to moderate
Depth to restrictive layer	10–20 in
Soil depth	10–20 in
Surface fragment cover <=3"	5–20%
Surface fragment cover >3"	5–15%
Available water capacity (0-20in)	1.9–3.9 in
Calcium carbonate equivalent (0-20in)	0–15%
Electrical conductivity (0-10in)	0–4 mmhos/cm
Sodium adsorption ratio (0-10in)	0–10
Soil reaction (1:1 water) (0-10in)	7.6–8.4
Subsurface fragment volume <=3" (15-40in)	0–50%
Subsurface fragment volume >3" (15-30in)	0–40%

# **Ecological dynamics**

A State-and-Transition Model (STM)diagram is depicted below. Thorough descriptions of each state, transition, plant community phase, and pathway are found after the model in this document. This diagram is based on available experimental research, field observations, professional consensus, and interpretations. While based on the best available information, the STM will change over time as knowledge of ecological processes increases.

Plant community composition within the same ecological site has a natural range of variability across the LRU due to the naturally occurring variability in weather, soils, and aspect. Not all managers will choose the Reference Plant Community as the management goal. Other plant communities may be desired to meet land management objectives. This is valid as long as the rangeland health attributes assessment departures are none to slight or slight to moderate from the Reference State. The biological processes on this site are complex; therefore, representative values are presented in a land management context. The species lists are representative and are not botanical descriptions of all species occurring, or potentially occurring, on this site. They are not intended to cover every situation or the full range of conditions, species, and responses for the site.

Both percent species composition by weight and percent cover are used in this ESD. Most observers find it easier to visualize or estimate percent cover for woody species (trees and shrubs). Foliar cover is used to define plant community phases and states in the State-and-Transition Model. Cover drives the transitions between communities and states because of the influence of shade and interception of rainfall.

Species composition by dry weight remains an important descriptor of the herbaceous community and of site productivity as a whole and includes both herbaceous and woody species. Calculating similarity index requires data on species composition by dry weight.

Although there is considerable qualitative experience supporting the pathways and transitions within the State-and-Transition Model, no quantitative information exists that specifically identifies threshold parameters between reference states and degraded states in this ecological site. For information on STMs, see the following citations: Bestelmeyer et. al. 2003, Bestelmeyer et. al. 2004, Bestelmeyer and Brown 2005, and Stringham et. al. 2003.

A resource concern risk assessment and dominant resource concerns are provided for each Land Use, State, and/or Plant Community Phase based on NRCS resource concern and planning criteria used to determine resource treatment levels during the conservation planning process. A resource concern is the resource condition that does not meet the minimum accepted levels established by planning criteria as shown in Section III of the NRCS Field Office Technical Guide (https://efotg.sc.egov.usda.gov/#/).

• Low risk means a low probability for the category of resource concerns and additional assessment is typically not necessary.

• Medium risk means that the category of resource concerns could occur, and additional assessment is recommended if the identified resource is a client concern and/or objective.

• High risk means that a resource concern in that category is likely to occur.

The resource categories are: S (soil), W (water), A (air), P (plant), A (animal), E (energy), and H (human). The dominant resource concerns further refine the resource category to a specific resource concern within that category.

### State and transition model

#### Ecosystem states



- T1-2 Herbivory (continuous or season-long, low to moderate stocking)
- T1-3 Soil-disturbance (e.g. hoof action, rodents, water erosion) and high intensity fire or chemical and mechanical treatment
- **T1-4** Extreme soil-disturbance (e.g. oil and gas development, road construction, heavy use areas)
- T2-3 Soil-disturbance (e.g. hoof action, rodents, water erosion) or catastrophic wildfire or chemical and mechanical treatment
- T2-4 Extreme soil-disturbance (e.g. oil and gas development, road construction, heavy use areas)
- T3-4 Extreme soil-disturbance (e.g. oil and gas development, road construction, heavy use areas)

#### State 1 submodel, plant communities



- P1-2 Sage-killing event (drought, herbivory, prolonged soil saturation, freeze-kill, snow mold, infrequent fire)
- P2-1 Natural Succession

#### State 2 submodel, plant communities

2.1. Big Sagebrush/Short- stature Grass Plant Community	P1-2	2.2. Short-stature Grass/Big Sagebrush Plant Community
	P2-1	

P1-2 - Sage-killing event (herbivory, drought, prolonged soil saturation, freeze-kill, snow mold)

P2-1 - Natural Succession

#### State 3 submodel, plant communities

3.1.
Rabbitbrush/Rhizomat
ous Grass Plant
Community

#### State 4 submodel, plant communities



P1-2 - Extreme soil disturbance (oil and gas development, road construction, gravel pit, heavy use areas)

P2-1 - Reclamation (contouring, deep ripping, re-seeding, prescribed grazing)

### State 1 Reference State



The Reference State consists of two plant communities: the Big Sagebrush/Bunchgrass Plant Community and the Bunchgrass/Big Sagebrush Plant Community. Each plant community differs in percent composition and foliar cover of bunchgrasses and Wyoming big sagebrush (*Artemisia tridentata* ssp. wyomingensis) as the dominant shrub. Forbs are a minor component. Two important processes occur in the reference state and result in plant community changes: 1) sagebrush-killing disturbances such as herbivory, drought, prolonged soil saturation, freeze-kill, snow mold, and to a lesser extent, fire; and 2) time without those disturbances, generally referred to as "natural succession." Fire is thought to have been infrequent due to low fine fuel loads, but when it occurred it was small acreage and stand replacing (Innes 2019). Fire Return Intervals are difficult to estimate due to little direct evidence

of fire from pre-settlement times, but what information does exist suggests over 200 years for low fuel sites in the Wyoming Basin (Innes 2019).

**Characteristics and indicators.** The shift between plant community phases is dependent upon sagebrush-killing disturbances, and without them sagebrush will increase even with proper grazing management. Improper grazing management may accelerate the rate of increase for the shrub component. Management actions or treatments are not typically prescribed or used to mimic the natural disturbance regime due to fragile nature of the soils and lower productivity potential on this site. Treatments that do exist many times have goals for increased leader growth on shrubs for big game winter range. Prescribed fire is not used due to land uses, ownership patterns and lack of fine fuels (Clause and Randall, 2014).

**Resilience management.** This site has moderate to moderately high resilience due to its aridic ustic (ustic bordering on aridic) soil moisture regime and frigid bordering on cryic temperature regime (Chambers et.al. 2014). Precipitation is typically low, but more effective with cooler temperatures and present when needed during the critical growth period (May through June). The site can usually recover after disturbance but is susceptible to delays in recovery during extreme climatic events such as drought. The site has moderately high resistance to invasion by annual grasses because of climate limitations (dry and cold). The site may be susceptible to invasion after extreme disturbance during warmer climatic periods or on southeast aspects and concave microtopography. At the LRU scale, this site is less resilient than Sandy, Loamy, or Clayey sites, and it is less resistant to invasion by annual invasive grasses when on south-facing aspects. Lower resilience and resistance is caused by slope, aspect, rock fragments, and reduced infiltration, making this site more susceptible to dry and drought conditions and harder for new perennial plants to become established.

### **Dominant plant species**

- Wyoming big sagebrush (Artemisia tridentata ssp. wyomingensis), shrub
- bluebunch wheatgrass (Pseudoroegneria spicata), grass
- needle and thread (Hesperostipa comata), grass

#### **Dominant resource concerns**

- Terrestrial habitat for wildlife and invertebrates
- Inadequate livestock water quantity, quality, and distribution

# Community 1.1 Big Sagebrush/Bunchgrass Plant Community



This plant community is well adapted to Cool Central Desertic Basins and Plateaus climatic conditions. The diversity in plant species allows for drought tolerance, and natural plant mortality is very low. Perennial plants that dominate this site have strong, healthy root systems that allow production to increase significantly with favorable moisture conditions. Abundant plant litter is available for soil building and moisture retention. Plant litter is properly distributed with very little movement off-site. This plant community provides for soil stability and a properly functioning hydrologic cycle. The Big Sagebrush/Bunchgrass Community can occur across the entire ecological site or can occur in a mosaic with the Bunchgrass/Big Sagebrush Community. This community can occur over time without these disturbances and accelerated with added herbivory pressure. Wyoming big sagebrush is dominant with foliar

cover ranging from 15 to 25 percent. At this sagebrush canopy level in this precipitation zone, there is some competition between the shrub overstory and the herbaceous understory. (Winward, 2007) A Big Sagebrush/Bunchgrass Community with a degraded understory is an "at-risk" community. There are generally few canopy gaps that can be moderate in size (three to six feet). Rock cover on the soil surface is common and often armors the site against soil erosion. Many plant interspaces have canopy or litter cover. Production of grasses is lower than in the Bunchgrass/Big Sagebrush Community. Total annual production ranges from 300 to 700 pounds per acre with a Representative Value (RV) of 500 pounds per acre.

# Community 1.2 Bunchgrass/Big Sagebrush Plant Community



The Bunchgrass/Big Sagebrush Community can occur across the entire ecological site on a given landscape but more likely occurs in a mosaic pattern associated with the disturbance cycle at any given location. Mid-stature bunchgrasses dominate and sagebrush is sub-dominant with foliar cover ranging from 5 to 15 percent. At this sagebrush canopy level in this precipitation zone, there is little, if any, competition between the shrub over-story and the herbaceous understory. In fact, there is evidence to suggest that the under-story receives more benefit from the sage over-story than negative effects. (Winward, 2007). There are generally few canopy gaps and most are generally small (one to two feet) with some moderate (two to three feet). Rock cover on the soil surface is common. Most shrub inter-spaces have canopy or litter cover that armors the site against soil erosion. Production of grasses is higher than in the Big Sagebrush/Bunchgrass Community.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	195	325	455
Shrub/Vine	75	125	175
Forb	30	50	70
Total	300	500	700



Figure 8. Plant community growth curve (percent production by month WY0301, 34AC, Upland Sites. All Upland Sites.

# Pathway P1-2 Community 1.1 to 1.2



Plant Community



Plant Community

Sagebrush killing event via climatic events such as drought, prolonged soil saturation, freeze-kill, snow mold, and herbivory with infrequent fire.

**Context dependence.** A successful pathway is contingent upon a grazing regime that allows for periodic critical growth period rest (May through June). The historic herbivory regime was light and episodic, sometimes including spring/fall migration patterns by mid-size ungulates who "ride the green wave" from winter to summer ranges (Aikens et.al. 2017).

#### **Conservation practices**

Prescribed Grazing

## Pathway P2-1 Community 1.2 to 1.1





Bunchgrass/Big Sagebrush Plant Community

Big Sagebrush/Bunchgrass Plant Community

Natural succession (time without sagebrush killing event).

**Context dependence.** The time period for this pathway is dependent upon weather events such as drought and above normal precipitation years. Drought results in a slower pathway while favorable precipitation can result in a faster pathway. A grazing regime that mimics the historic regime (light intensity, episodic grazing events) will not alter the pathway, but a continuous grazing regime at low to moderate intensity can accelerate the pathway and puts the plant community at-risk of transitioning to the Grazing Resistant State if maintained over long periods of time.

### State 2 Grazing Resistant State





Figure 9. Interbedded sandstone and shale bedrock outcrop

The Grazing Resistant State consists of two plant communities: the Big Sagebrush/Short-stature Grass Plant Community and the Short-stature Grass/Big Sagebrush Plant Community. There has been a shift in under-story herbaceous species dominance from mid-stature cool-season bunchgrasses to short-stature, shallow rooted bunchgrasses and rhizomatous grasses and grass-likes. Gap interspace and bare ground increase, while herbaceous foliar cover decrease.

**Characteristics and indicators.** There are fewer mid-size bunchgrasses and they are typically found under the shrub canopy where they are protected from herbivory. The shrub canopy interspaces are occupied by grazing tolerant grasses as well as patches of bare ground that are sometimes connected. Canopy gaps and bare ground increase, while herbaceous foliar cover decreases. Drier site conditions result in lower productivity and less herbaceous production potential. Decreased infiltration is caused by increased bare ground patch size and lack of litter that acts as mulch in retaining soil moisture and retarding runoff. In many cases, the transition to the Grazing Resistant State may have occurred many decades ago during an era of higher stocking rates and continuous grazing during the growing season. However, continual grazing during the critical growth period (roughly May-June) at proper stocking rates will facilitate the transition to this state or maintain it as a stable state.

**Resilience management.** Site resilience is lower than the Reference State. Site hydrology has been modified due to moisture being utilized by shallower rooting species. Therefore, the site is drier earlier in the season, lower in diversity, and unable to recover as quickly after a disturbance such as drought. This state is more drought-prone, and therefore sees wider productivity swings during dry versus wet years. Site resistance to invasion by annual grasses is similar to the reference state, although there are more niches for undesirable annual forbs such as desert alyssum or annual invasive grasses such as cheatgrass to become established during favorable (hot/dry) conditions on southeastern aspects and concave micro-topography.

### **Dominant plant species**

- Wyoming big sagebrush (Artemisia tridentata ssp. wyomingensis), shrub
- Sandberg bluegrass (Poa secunda), grass
- thickspike wheatgrass (Elymus lanceolatus ssp. lanceolatus), grass
- needleleaf sedge (Carex duriuscula), grass

#### **Dominant resource concerns**

- Sheet and rill erosion
- Classic gully erosion
- Plant productivity and health
- Plant structure and composition
- Terrestrial habitat for wildlife and invertebrates
- Feed and forage imbalance
- Inadequate livestock water quantity, quality, and distribution

# Community 2.1 Big Sagebrush/Short-stature Grass Plant Community



This plant community is characterized as Wyoming big sagebrush dominated with a diminished under-story. The understory has lost many of the mid-stature cool-season bunchgrasses, and they have been replaced with short-stature bunchgrasses such as Sandberg bluegrass, rhizomatous wheatgrasses and grass-likes, and mat-forming forbs. Shrub foliar cover is often greater than 15 percent and typically comprising over have of total annual production. Areas that catch and retain snow are more likely to have higher shrub cover. Herbaceous production and foliar cover has decreased. A small amount of annual invasive grasses such as cheatgrass could occur on south aspects, mostly less than five percent foliar cover. There is often a slight increase in sprouting shrubs (less than 10 percent composition by weight). This plant community is at-risk of transitioning to the Disturbed State with additional disturbance such as heavy grazing, sagebrush treatment, or ground-disturbing activity. Productivity is highly variable and fluctuates drastically in response to drought and wet cycles. Total annual production is lower than in Reference State, leading to lower soil organic matter content and therefore lower soil stability than in the Reference State. Total annual production ranges from 200 to 600 pounds per acre with a Representative Value (RV) of 400 pounds per acre. Biotic integrity is affected by the change in functional/structural group dominance.

# Community 2.2 Short-stature Grass/Big Sagebrush Plant Community

This plant community is characterized by a dominance of short-stature grasses such as Sandberg bluegrass, rhizomatous grasses and grass-likes, and mat-forming forbs. A sagebrush killing event has happened recently, and Wyoming big sagebrush foliar cover is typically less than 15 percent. A small amount of annual invasive grasses such as cheatgrass could occur on south aspects, mostly less than five percent foliar cover. There is often a slight increase in sprouting shrubs (less than 10 percent composition by weight).Total annual production ranges from 200 to 600 pounds per arcre with a Representative Value (RV) of 400 pounds per acre. Biotic integrity is affected by the change in functional/structural group dominance. This plant community is at-risk of transitioning to the Disturbed State with additional disturbance such as heavy grazing, sagebrush treatment, or ground-disturbing activity.

# Pathway P1-2 Community 2.1 to 2.2

Sagebrush killing event, mainly natural climatic events such as herbivory, drought, prolonged soil saturation, freezekill, or snow mold. Fire is not typically a driver in this state due to the lack of fine fuels in the understory.

**Context dependence.** This pathway relies upon close to normal precipitation and temperature as well as a grazing regime that is low to moderate intensity. If extreme conditions/disturbances such as hot temperatures, drought, or high intensity grazing occur, there is risk of a transition to the Disturbed State depending upon severity and cumulative disturbance.

### **Conservation practices**

Brush Management

Pathway P2-1

# Community 2.2 to 2.1

Natural succession (time without sagebrush killing event).

**Context dependence.** The time period for pathway is dependent upon weather events such as drought and above normal precipitation years. Drought conditions result in a slower pathway while favorable precipitation can result in a faster pathway. A grazing regime that mimics the historic regime (light intensity, episodic grazing events) will not alter the pathway, but a continuous grazing regime at low to moderate to intensity can accelerate the pathway. Prolonged high intensity grazing without adequate recovery puts the plant community at risk of transitioning to the Disturbed State.

# State 3 Disturbed State

The Disturbed State is a result of soil-disturbing activities outside of the normal disturbance regime expected for this site. Examples are high intensity hoof action, anthropogenic activity, rodent activity, or prolonged soil saturation, which includes occasional irrigation. It may also occur after brush management (sagebrush treatment) preceded or followed by grazing that include high-intensity grazing use without appropriate recovery periods. Brush management treatment methods are typically chemical (including 2,4-D or tebuthiuron) due to soil limitations to mechanical treatment. However, mechanical treatments do occur when large rock fragments are not present on the soil surface. Herbivory (including browse and/or insects) can contribute to disturbances affecting this state. High intensity fire could be a factor in maintaining this plant community by stimulating sprouting shrubs (rabbitbrush) and killing sagebrush. The Disturbed State consists of one plant community, the Rabbitbrush/Rhizomatous Grass Plant Community. Soil erosion is accelerated because of increased bare ground. This state is maintained by recurrent disturbance and by soil erosion.

**Characteristics and indicators.** There is a shift toward sprouting shrub and rhizomatous grass dominance. Both green and rubber rabbitbrush may be present. Annual weeds such as desert alyssum, flixweed, and lambsquarter, are often present in small amounts (less than five percent composition by dry weight). Invasive annual grasses such as cheatgrass may occur in small amounts on southern aspects.

**Resilience management.** Site resilience is lower than the Reference State or Grazing Resistant State. Site hydrology has been modified due to moisture being utilized by shallower rooting species. Therefore, the site is drier earlier in the season and unable to recover as quickly after a disturbance. However, existing sprouting shrub canopy and remnant perennial vegetation provide some amount of resiliency. Site resistance to invasion by annual grasses is lower due to niches in the understory for establishment as well as the added factor of disturbance. Episodic and limited moisture is more suited to annual life forms during drought.

### **Dominant plant species**

- yellow rabbitbrush (Chrysothamnus viscidiflorus), shrub
- rubber rabbitbrush (Ericameria nauseosa), shrub
- thickspike wheatgrass (Elymus lanceolatus ssp. lanceolatus), grass

### **Dominant resource concerns**

- Sheet and rill erosion
- Classic gully erosion
- Plant productivity and health
- Plant structure and composition
- Terrestrial habitat for wildlife and invertebrates
- Feed and forage imbalance
- Inadequate livestock water quantity, quality, and distribution

## Community 3.1 Rabbitbrush/Rhizomatous Grass Plant Community

This plant community is the result of a recent soil-disturbing activity. Rhizomatous wheatgrasses are the dominant perennial grass, and annual forbs are often present. Annual grasses such as cheatgrass could be present on south

aspects. With sagebrush removed, green or rubber rabbitbrush is the dominant shrub, often exceeding 30 percent of the annual production. Subdominant understory species include bottlebrush squirreltail, Sandberg bluegrass, and unpalatable annual and perennial forbs. In the absence of annuals, there can be a substantial amount of bare ground. Total annual production ranges from 200 to 600 pounds per acre with a Representative Value (RV) of 400 pounds per acre. The soil is not adequately protected, and erosion is expected without management to allow for adequate litter and residual. The biotic integrity is reduced due to low annual production, relative dominance and unexpected structural/functional groups, and potentially invasive species if present. The watershed is functioning-at-risk.

# State 4 Highly Disturbed State

The Disturbed State is a result of extreme soil-disturbing activities outside of the normal disturbance regime expected for this site. Primary examples include road construction, oil and gas exploration, as well as livestock and recreation heavy use areas.

**Characteristics and indicators.** Primary indicators of this state are extreme soil disturbance associate with anthropogenic activities. Depending on the time since disturbance, recent climatic events, and reclamation efforts, the plant community could be dominated by annual weeds or it could be reclaimed to a variety of introduced or native species.

**Resilience management.** Site resilience is lower than the Reference State, but potentially higher than the Grazing Resistant or Disturbed States. Site hydrology modifications exist, but may be temporary if proper reclamation occurs. Site resistance to invasion by annual forbs is lower due to an increase in soil disturbance allowing niches in the understory for establishment. Common annuals to invade this site include kochia, Russian thistle, and halogeton. Cheatgrass may be present if introduced with seeding efforts, but does not dominate the site or influence site dynamics.

### **Dominant resource concerns**

- Sheet and rill erosion
- Classic gully erosion
- Plant productivity and health
- Plant structure and composition
- Plant pest pressure
- Terrestrial habitat for wildlife and invertebrates
- Feed and forage imbalance
- Inadequate livestock water quantity, quality, and distribution

# Community 4.1 Reclaimed Plant Community

This plant community is highly variable based on weather conditions during restoration activities, the management practices used, the seed mix, and how soil was stockpiled during the disturbance. Total annual production ranges from 300 to 700 pounds per acre with a Representative Value (RV) of 500 pounds per acre. The soil is is typically adequately protected, but erosion can occur during high runoff events. The biotic integrity is dependent on the seed mix used to reclaim the site. There is high variability in watershed function depending on reclamation success.

# Community 4.2 Annual Plant Community

As part of succession, all sites that are severely disturbed will go through this plant community as part of their restoration. Weather is the largest determining factor in how long a site will be in this plant community phase, but is approximately two to five years on sites that use Best Management Practices for site restoration (http://www.uwyo.edu/wrrc/). The site has low potential for recovery. Seeding is needed to restore functional structural groups. Productivity in this plant community phase is highly variable based on current year's weather. Total annual production ranges from 100 to 300 pounds per acre with a Representative Value (RV) of 200 pounds per acre.

# Pathway P1-2 Community 4.1 to 4.2

Extreme soil-disturbance from anthropogenic activity such as oil and gas development, road construction, and heavy use areas for livestock production or recreation.

**Context dependence.** Subsurface rock fragments are often brought to the surface during disturbance, complicating reclamation efforts. This pathway could also occur from one severe disturbance or multiple consecutive disturbances (e.g. livestock or recreational heavy use areas) and extreme conditions such as hot temperatures, extreme drought, or high intensity grazing.

# Pathway P2-1 Community 4.2 to 4.1

Reclamation efforts include re-seeding. In cases where heavy equipment caused the disturbance, contouring, or deep ripping may be necessary to provide a suitable site for re-seeding. Care must be taken to not bring subsurface rock to the surface and to stockpile and replace surface layers separately from subsurface. Prescribed grazing and restricting vehicle traffic on the site is necessary to facilitate successful seeding of perennial species.

**Context dependence.** Drought conditions and herbivory pressure may hinder restoration efforts, and multiple seeding efforts may be necessary if failure is caused by drought. Mulch can be effective for soil moisture retention and erosion control on slopes greater than eight percent.

### **Conservation practices**

Critical Area Planting
Mulching
Prescribed Grazing

# Transition T1-2 State 1 to 2



Reference State



Grazing Resistant State

Herbivory pressure in excess of normal Reference State conditions. A typical scenario is continuous spring or season-long grazing with low stocking intensity.

**Constraints to recovery.** Recovery is inhibited by continued herbivory pressure, reduced seedbank, and drought conditions. Annual grasses may occur in small amounts when on southeast aspects and concave microtopography.

**Context dependence.** This transition typically occur over a long period of time with no sudden event to trigger the transition.

# Transition T1-3 State 1 to 3

Soil-disturbance outside of the normal disturbance regime expected for this site. Examples include high intensity fire, high intensity hoof action, anthropogenic activity (e.g. mechanical and/or chemical treatments), recreational activities, rodent activity, or prolonged soil saturation, which includes occasional irrigation.

**Constraints to recovery.** Recovery is inhibited by consecutive disturbances over a relatively short time period and prolonged drought conditions. There is a risk of annual invasion on southeastern aspects and concave micro-topography.

Context dependence. This transition typically occurs after multiple consecutive disturbances.

# Transition T1-4 State 1 to 4

Extreme soil-disturbance from anthropogenic activity such as oil and gas development, road construction, and heavy use areas for livestock production or recreation.

**Constraints to recovery.** Recovery is inhibited by soil depth, herbivory pressure, and prolonged drought conditions.

**Context dependence.** Soils are fragile, and this pathway could occur from one severe disturbance or multiple consecutive disturbances (e.g. livestock or recreation heavy use areas) and/or extreme conditions such as hot temperatures, extreme drought, or high intensity grazing without adequate recovery periods.

# Transition T2-3 State 2 to 3

Soil-disturbance outside of the normal disturbance regime expected for this site. Examples include catastrophic wildfire, high intensity hoof action, anthropogenic activity (e.g. mechanical and chemical treatments), recreational activity, rodent activity, or prolonged soil saturation, which includes occasional irrigation.

**Constraints to recovery.** Recovery is inhibited by consecutive disturbances over a relatively short time period, herbivory pressure, and drought conditions. There is a risk of annual grass invasion on southeastern aspects and concave micro-topography.

Context dependence. This transition typically occurs after multiple consecutive disturbances.

# Transition T2-4 State 2 to 4

Extreme soil-disturbance from anthropogenic activity such as oil and gas development, road construction, and heavy use areas for livestock production or recreation.

**Constraints to recovery.** Recovery is inhibited by soil depth, herbivory pressure, and prolonged drought conditions.

**Context dependence.** This transition is typically sudden after a mechanical disturbance, but can also occur with multiple consecutive disturbances (e.g. livestock or recreation heavy use areas) and can be exacerbated by hot temperatures and/or extreme drought.

## Transition T3-4 State 3 to 4

Extreme soil-disturbance from anthropogenic activity such as oil and gas development, road construction, and heavy use areas for livestock production or recreation.

**Constraints to recovery.** Recovery is inhibited by soil depth, herbivory pressure, and prolonged drought conditions.

**Context dependence.** This transition is typically sudden after a mechanical disturbance, but can also occur with multiple consecutive disturbances (e.g. livestock or recreation heavy use areas) and can be exacerbated by hot temperatures and extreme drought.

# Additional community tables

 Table 6. Community 1.2 plant community composition

Г

Grassike         1         Perennial Mid-Size Cool Season Burcharsses         120-200         1           Ibubehnch wheatgrass         PSSP6 <i>Pseudoroegneria spicata</i> 50-200         10-40           Indian ricegrass         ACHY         Achratherum hymenoides         25-100         5-20           prairle Junegrass         KOMA         Koeleria macranthe         0-60         0-10           Sandberg bluegrass         POSE         Pos secunda         5-50         1-10           muttongrass         POSE <i>Pos secunda</i> 5-50         1-10           signdar wheatgrass         ELEL <i>Elymus chynoides</i> 5-50         1-10           signdar wheatgrass         ELLAL <i>Elymus chynoides</i> 5-50         1-10           signdar wheatgrass         PAL <i>Elymus chynoides</i> 5-50         1-10           signdar wheatgrass         PALAL <i>Elymus chynoides</i> 5-50         5-10           Mic Grasses/Grassilites         20-50         0-51         5-10         1-10         1-10         1-10         1-10         1-10         1-10         1-10         1-10         1-10         1-10         1-10         1-10         1-10         1-10         1-10         1-10 </th <th>Group</th> <th>Common Name</th> <th>Symbol</th> <th>Scientific Name</th> <th>Allitual Production (Lb/Acre)</th> <th>ruliai Guvei (%)</th>	Group	Common Name	Symbol	Scientific Name	Allitual Production (Lb/Acre)	ruliai Guvei (%)
1         Perennial Mid-Size Cool Season Bunchgrasses         120-200           blubuchurch whatgrass         PSSP6         Pasudorognena spicata         50-200         10-40           Indian ricegrass         ACHY         Achnatherum hymenoides         25-100         5-20           needle and thread         HECO26         Hesperssipa comata         25-100         5-20           prairie Junegrass         KOMA         Koelena macranthe         0-50         0-10           sandberg bluegrass         POSE         Pa secunda         5-50         1-10           muttongrass         POFE         Pao secunda         5-50         1-10           squirreltail         ELES         Elymus trachycaulus         0-50         1-10           squirreltail         ELES         Elymus trachycaulus         0-50         1-10           slender wheatgrass         ELRL         Elymus trachycaulus         0-50         1-10           western wheatgrass         PASM         Pascopyrum smithii         25-50         5-10           Misc Grasses/Grassilke         CAMO         Calamagrastis montanensis         0-25         0-5           needlelaf sedge         CAMO         Calamagrastis montanensis         0-25         0-5           gandberg bluegras	Grass	/Grasslike				
bluebunch wheatgrass         PSSP6         Pseudoroegneria sploata         50–200         10–40           Indian ricegrass         ACHY         Achmatherum hymenoides         25–100         5–20           neadle and thread         HECO26         Hasparostipa comata         25–100         5–20           prairial Junegrass         POSE         Poa secunda         5–50         1–10           muttongrass         POSE         Poa secunda         5–50         1–10           squirrelial         ELELS         Elymus elymoides         5–50         1–10           squirrelial         ELELS         Elymus elymoides         5–50         1–10           slender wheatgrass         ELLA         Elymus trachycoulus         0–60         0–010           slender wheatgrass         ELLA         Elymus trachycoulus         0–50         5–10           mickospito whoatgrass         PASM         Pascopyrum smithii         25–50         5–10           meetier wheatgrass         CAMO         Calamagrostis montanensis         0–25         0–5           needleaf sedge         CAMO         Calamagrostis montanensis         0–25         0–5           threactleaf sedge         CAMO         Calex fill/olia         0–25         0–5	1	Perennial Mid-Size Cool	Season Bu	Inchgrasses	120–200	
Indian ricegrass         ACHY         Achnatherum hymonoides         25-100         5-20           neadle and thread         HECO26         Hesperstifica comata         25-100         5-20           prairie Jungrass         KOMA         Koleria macrantha         0-50         0-10           Sandberg bluegrass         POSE         Poa secunda         5-50         1-10           Letterman's needlegrass         ACLE9         Achnatherum lettermanii         5-50         1-10           squinettail         ELEL5         Elymus elymoides         5-50         1-10           squinettail         ELEL5         Elymus elymoides         5-50         1-10           slendor wheatgrass         ELLAL         Elymus lancoolatus ssp. lancoolatus         25-50         5-10           western wheatgrass         PASM         Pascymur smithii         25-50         5-10           western wheatgrass         CAMO         Calaragrostis montanensis         0-25         0-5           inteadleaf sedge         CAMO         Calaragrostis montanensis         0-25         0-5           Grass. perennial         2CP         Grass. perennial         0-25         0-5           Kombeat         ERIOS         Eriogonum         5-25         1-5 <tr< td=""><td></td><td>bluebunch wheatgrass</td><td>PSSP6</td><td>Pseudoroegneria spicata</td><td>50–200</td><td>10–40</td></tr<>		bluebunch wheatgrass	PSSP6	Pseudoroegneria spicata	50–200	10–40
neadle and thread         HECO26         Hasperostipa comata         25-100         5-20           prairie Junegrass         KOMA         Koeleria macrantha         0-50         0-10           Sandberg bluagrass         POSE         Poa sacunda         5-50         1-10           muttograss         POFE         Poa fendleriana         5-50         1-10           squirrettail         ELELS         Elymus elymoides         5-50         1-10           squirrettail         ELETA         Elymus trachycaulus         0-50         0-10           2         Rhizomatous Grasses         20-50         1         20-50         1           western wheatgrass         ELIAL         Elymus lanceolatus sog, lanceolatus         22-50         5-10           3         Misc Grasses/Grasslikes         20-50         1         2         6           plains reedgrass         CAMO         Calamagrostis montanensis         0-25         0-5           3         Misc Grasses/Grasslikes         20-50         1         5           1         Grass, perennial         COP         6         5           3         Misc Grasslow and		Indian ricegrass	ACHY	Achnatherum hymenoides	25–100	5–20
prairie Junegrass         KOMA         Koeloria macrantha         0-50         0-10           Sandberg bluegrass         POSE         Poa secunda         5-50         1-10           muttongrass         POFE         Poa fendleriana         5-50         1-10           Lettermar's needlegrass         ACLE9         Achnatherum lettermanii         5-50         1-10           squirreltail         ELEL5         Elymus elymoides         5-50         1-10           stender wheatgrass         ELTR7         Elymus trachycaulus         0-50         0-10           2         Rhizomatous Grasses         20-50         5-10         0         0         0           western wheatgrass         PASM         Pascopyrum smithii         25-50         5-10         0 <t< td=""><td></td><td>needle and thread</td><td>HECO26</td><td>Hesperostipa comata</td><td>25–100</td><td>5–20</td></t<>		needle and thread	HECO26	Hesperostipa comata	25–100	5–20
Sandberg bluegrass         POSE         Poa secunda         5-50         1-10           muttongrass         POFE         Poa fendleriana         5-50         1-10           Letterman's needlegrass         ACLE9         Achnatherum lettermanii         5-50         1-10           squirreltal         ELE15         Elymus elymote's         5-50         1-10           slender wheatgrass         ELTR         Elymus lanceolatus ssp. lanceolatus         25-50         5-10           western wheatgrass         PLLAL         Elymus lanceolatus ssp. lanceolatus         25-50         5-10           western wheatgrass         CAMO         Calamagrostis montanensis         0-25         0-5           needleleaf sedge         CAMO         Calamagrostis montanensis         0-25         0-5           sandberg bluegrass         POSE         Poa secunda         0-25         0-5           standberg bluegrass         POSE         Poa secunda         0-25         0-5           Grass, perennial         2OP         Grass, perennial         0-25         0-5           Standberg bluegrass         POSE         Poa secunda         5-25         1-5           Upine         LUPIN         Lupinus         0-25         0-5           s		prairie Junegrass	KOMA	Koeleria macrantha	0–50	0–10
muttongrass         POFE         Poa fendleriana         5-50         1-10           Letterman's needlegrass         ACLE9         Achnatherum lettermanii         5-50         1-10           squirreltail         ELEL5         Eymus elymoides         5-50         1-10           slender wheatgrass         ELTR         Elymus trachycaulus         0-50         0-10           2         Rhizomatous Grasses         ZELA         Elymus lanceolatus sep, lanceolatus         22.50         5-10           westem wheatgrass         PASM         Pascopyrum smithii         25-50         5-10           1         Misc Grasse/Grassilkos         0-25         0-5         10           plains reedgrass         CAMO         Calamagrostis montanensis         0-25         0-5           needlelaaf sedge         CADI         Carex duriuscula         0-25         0-5           Grass, perennial         2GP         Grass, perennial         0-25         0-5           Forb		Sandberg bluegrass	POSE	Poa secunda	5–50	1–10
Letterman's needlegrass         ACLE9         Achnatherum lettermanii         5-50         1-10           squirrettail         ELEL5         Elymus elymoides         5-50         1-10           slender wheatgrass         ELTR7         Elymus trachycaulus         0-50         0-10           2         Rhizomatous Grasses         20-50         5-10           thickspike wheatgrass         ELLAL         Elymus lanceolatus ssp. lanceolatus         22-50         5-10           western wheatgrass         PASM         Pascopyrum smithii         25-50         5-10           a leadleaf sedge         CADU6         Carex duriuscula         0-25         0-5           needleleaf sedge         CADU6         Carex duriuscula         0-25         0-5           Grass, perennial         2GP         Grass, perennial         0-25         0-5           Grass, perennial         2GP         Grass, perennial         0-25         0-5           Forb		muttongrass	POFE	Poa fendleriana	5–50	1–10
squirreitail     ELE15     Elymus elymoides     5-50     1-10       slender wheatgrass     ELTR7     Elymus trachycaulus     0-50     0-10       2     Rhizomatous Grasses     20-50     20-50     0       thickspike wheatgrass     PASM     Pascopyrum smithii     25-50     5-10       3     Misc Grasses/Grasslikes     20-50     0     0       plains reedgrass     CAMO     Calamagrostis montanensis     0-25     0-5       needleleaf sedge     CADU6     Carex duriuscula     0-25     0-5       Sandberg bluegrass     POSE     Poa secunda     5-25     1-5       Grass, perennial     2GP     Grass, perennial     0-25     0-5       Forb     20-45     1-5     1-5       Iupine     LUPIN     Lupinus     0-25     0-5       aster     SYMPH4     Symphyotrichum     0-25     0-5       spiny phlox     PHIO     Phlox hoodii     5-25     1-5       logleaf phlox     PHIO     Phlox Inogifolia     0-15     0-3       fitxideaf plainsmustard     SCLU     Schoencorambe linifolia     0-15     0-3       scarlet globermallow     SPCO     Sphaeralcea coccinea     0-15     0-3       goldenweed     ERICE     Eri		Letterman's needlegrass	ACLE9	Achnatherum lettermanii	5–50	1–10
slender wheatgrass       ELTR7       Elymus trachycaulus       050       010         2       Rhizomatous Grasses       20-50       5       0         thickspike wheatgrass       PASM       Pascopyrum smithii       25-50       5-10         western wheatgrass       PASM       Pascopyrum smithii       25-50       5-10         3       Misc Grassel/Grasslikes       20-50       0       0         plains reedgrass       CAMO       Calamagrostis montanensis       025       05         needleleaf sedge       CADU6       Carex duriuscula       025       05         Sandberg blegrass       POSE       Poa secunda       025       05         Grass, perennial       2GP       Grass, perennial       025       05         Forb       20-45       15       15       15         Upine       LUPIN       Lupinus       025       05         aster       SYMPH4       Symphyotrichum       025       05         spiny phlox       PHHO       Phlox longifolia       015       03         Ingleaf phlox       PHIO2       Phlox longifolia       015       03         scarlet globemallow       SPCO       Sphaeralcea co		squirreltail	ELEL5	Elymus elymoides	5–50	1–10
2         Rhizomatous Grasses         20-50           thickspike wheatgrass         ELLAL         Elymus lanceolatus ssp. lanceolatus         25-50         5-10           western wheatgrass         PASM         Pascopyrum smithii         25-50         5-10           3         Misc Grasses/Grasslikes         20-50             20         plains reedgrass         CAMO         Calamagrostis montanensis         0-25         0-5           needlelaaf sedge         CAFL         Carex duriuscula         0-25         0-5           Sandberg bluegrass         POSE         Poa secunda         5-25         1-5           Grass, perennial         2GP         Grass, perennial         0-25         0-5           Forb          20-45           1-5           4         Perennial Forbs         20-45           5-25         1-5           buckwheat         ERIOG         Eriogonum         5-25         1-5          5-25         1-5           lupine         LUPIN         Lupinus         0-25         0-5           5-26         1-5          1-5          3          1-5		slender wheatgrass	ELTR7	Elymus trachycaulus	0–50	0–10
thickspike wheatgrass         ELLAL         Elymus tanceolatus ssp. tanceolatus         25-50         5-10           western wheatgrass         PASM         Pascopyrum smithii         25-50         5-10           3         Misc Grasses/Grasslikes         20-50             plains reedgrass         CAMO         Calamagrostis montanensis         0-25         0-5           needleleaf sedge         CADU6         Carex duriuscula         0-25         0-5           standberg bluegrass         POSE         Poa secunda         5-25         1-5           Grass, perennial         2GP         Grass, perennial         0-25         0-5           Forb          20-45           1-5           Iupine         LUPIN         Lupinus         0-25         0-5           aster         SYMPH4         Symphyotrichum         0-25         0-5           spiny phlox         PHHO         Phlox hoodii         5-25         1-5           longleaf phlox         PHLO2         Phlox longifolia         0-15         0-3           ragwort         SERC         Senecio         0-15         0-3           sternless mock         STAC         Stendus coucinea         0-1	2	Rhizomatous Grasses	-	•	20–50	
western wheatgrass         PASM         Pascopyrum smithii         25-50         5-10           3         Misc Grasses/Grasslikes         20-60         20-60         20-55         20-55		thickspike wheatgrass	ELLAL	Elymus lanceolatus ssp. lanceolatus	25–50	5–10
3         Misc Grasses/Grasslikes         20–50           plains reedgrass         CAMO         Calamagrostis montanensis         0–25         0–5           needleleaf sedge         CADU6         Carex duriuscula         0–25         0–5           threadleaf sedge         CAFI         Carex duriuscula         0–25         0–5           Sandberg bluegrass         POSE         Poa secunda         5–25         1–5           Grass, perennial         2GP         Grass, perennial         0–25         0–5           Forb          Perennial Forbs         20–45            4         Perennial Forbs         20–45             buckwheat         ERIOG         Eriogonum         5–25         1–5           lupine         LUPIN         Lupinus         0–25         0–5           aster         SYMPH4         Symphyotrichum         0–25         0–5           iongleaf phlox         PHLO2         Phlox hoodii         5–25         1–5           iongleaf phlox         PHLO2         Phlox langifolia         0–15         0–3           faxleaf plainsmustard         SCLI         Schoenocrambe linifolia         0–15         0–3           scarlet globemal		western wheatgrass	PASM	Pascopyrum smithii	25–50	5–10
plains reedgrass         CAMO         Calamagrostis montanensis         0-25         0-5           needleleaf sedge         CADU6         Carex duriuscula         0-25         0-5           threadleaf sedge         CAFI         Carex duriuscula         0-25         0-5           Sandberg bluegrass         POSE         Poa secunda         5-25         1-5           Grass, perennial         2GP         Grass, perennial         0-25         0-5           Forb         20-45         20-45         20-45           buckwheat         ERIOG         Eriogonum         5-25         1-5           aster         SYMPH4         Symphyotrichum         0-25         0-5           spiny phlox         PHHO         Phlox hoodii         5-25         1-5           longleaf phlox         PHLO2         Phlox tongifolia         0-15         0-3           faxleaf plainsmustard         SCLI         Schoenocrambe linifolia         0-15         0-3           sternless mock         STAC         Stenotus acaults         0-15         0-3           goldenweed         STAC         Stenotus acaults         0-15         0-3           feabane         ERIGE2         Erigeron         0-15         0-3 <td>3</td> <td>Misc Grasses/Grasslikes</td> <td>5 5</td> <td>· · · · · · · · · · · · · · · · · · ·</td> <td>20–50</td> <td></td>	3	Misc Grasses/Grasslikes	5 5	· · · · · · · · · · · · · · · · · · ·	20–50	
needleleaf sedge         CADU6         Carex duriuscula         0-25         0-5           threadleaf sedge         CAFI         Carex filifolia         0-25         0-5           Sandberg bluegrass         POSE         Poa secunda         5-25         1-5           Grass, perennial         2GP         Grass, perennial         0-25         0-5           Forb         20-45         20-45           4         Perennial Forbs         20-45         1-5           buckwheat         ERIOG         Eriogonum         5-25         1-5           lupine         LUPIN         Lupinus         0-25         0-5           aster         SYMPH4         Symphyotrichum         0-25         0-5           spiny phlox         PHHO         Phlox hoodii         5-25         1-5           longleaf phlox         PHLO2         Phlox longifolia         0-15         0-3           ragwort         SENEC         Senecio         0-15         0-3           scarlet globemallow         SPCO         Sphaeralcea coccinea         0-15         0-3           goldenweed         STAC         Stenotus acaulis         0-15         0-3           fleabane         ERIGE2         Erigeron		plains reedgrass	CAMO	Calamagrostis montanensis	0–25	0–5
threadleaf sedge       CAFI       Carex filifolia       0-25       0-5         Sandberg bluegrass       POSE       Poa secunda       5-25       1-5         Grass, perennial       2GP       Grass, perennial       0-25       0-5         Forb		needleleaf sedge	CADU6	Carex duriuscula	0–25	0–5
Sandberg bluegrass       POSE       Poa secunda       5-25       1-5         Grass, perennial       2GP       Grass, perennial       0-25       0-5         Forb       20-45         4       Perennial Forbs       20-45         buckwheat       ERIOG       Eriogonum       5-25       1-5         lupine       LUPIN       Lupinus       0-25       0-5         aster       SYMPH4       Symphyotrichum       0-25       0-5         spiny phlox       PHHO       Phlox hoodii       5-25       1-5         longleaf phlox       PHL02       Phlox longifolia       0-15       0-3         flaxleaf plainsmustard       SCLI       Schoenocrambe linifolia       0-15       0-3         goldenweed       STAC       Stenotus acaulis       0-15       0-3         goldenweed       STAC       Stenotus acaulis       0-15       0-3         hoary tansyaster       MACA2       Machaeranthera canescens       0-15       0-3         hoary tansyaster       MACA2       Machaeranthera canescens       0-15       0-3         bluebells       MERTE       Mertensia       0-15       0-3         bluebells       MERTE       Mertensia		threadleaf sedge	CAFI	Carex filifolia	0–25	0–5
Grass, perennial2GPGrass, perennial0–250–5Forb4Perennial Forbs20–45buckwheatERIOGEriogonum5–251–5lupineLUPINLupinus0–250–5asterSYMPH4Symphyotrichum0–250–5spiny phloxPHHOPhlox hoodii5–251–5longleaf phloxPHLO2Phlox longifolia0–150–3flaxleaf plainsmustardSCL1Schoenocrambe linifolia0–150–3scarlet globemallowSPCOSphaeralcea coccinea0–150–3stemless mock goldenweedSTACStenotus acaulis0–150–3fleabaneERIGE2Erigeron0–150–3hoary tansyasterMACA2Machaeranthera canescens0–150–3bluebellsMERTEMertensia0–150–3hairy false goldenasterHEVI4Heterotheca villosa0–150–3milkvetchASTRAAstragalus0–150–3milkvetchASTRAAstragalus0–150–3hairy false goldenasterHEVI4Heterotheca villosa0–150–3milkvetchASTRAAstragalus0–150–3milkvetchASTRAAstragalus0–150–3hairy false goldenasterHEVI4Heterotheca villosa0–150–3milkvetchASTRAAstragalus0–150–3hairy false goldenasterHEVI4Heterotheca villosa0–1		Sandberg bluegrass	POSE	Poa secunda	5–25	1–5
Forb       20-45         4       Perennial Forbs       20-45         buckwheat       ERIOG       Eriogonum       5-25       1-5         lupine       LUPIN       Lupinus       0-25       0-5         aster       SYMPH4       Symphyotrichum       0-25       0-5         spiny phlox       PHHO       Phix hoodii       5-25       1-5         longleaf phlox       PHLO2       Phix longifolia       0-15       0-3         flaxleaf plainsmustard       SCL1       Schoenocrambe linifolia       0-15       0-3         ragwort       SENEC       Senecio       0-15       0-3         scarlet globemallow       SPCO       Sphaeralcea coccinea       0-15       0-3         stemless mock goldenweed       STAC       Stenotus acaulis       0-15       0-3         fleabane       ERIGE2       Erigeron       0-15       0-3         rayless tansyaster       MACA2       Machaeranthera canescens       0-15       0-3         bluebells       MERTE       Metensia       0-15       0-3         bluebells       MERTE       Metensia       0-15       0-3         milkvetch       ASTRA       Astragalus       0-15       0-3		Grass, perennial	2GP	Grass, perennial	0–25	0–5
4       Perennial Forbs       20-45         buckwheat       ERIOG       Eriogonum       5-25       1-5         lupine       LUPIN       Lupinus       0-25       0-5         aster       SYMPH4       Symphyotrichum       0-25       0-5         spiny phlox       PHHO       Phlox hoodii       5-25       1-5         longleaf phlox       PHLO2       Phlox longifolia       0-15       0-3         flaxleaf plainsmustard       SCLI       Schoenocrambe linifolia       0-15       0-3         ragwort       SENEC       Senecio       0-15       0-3         scarlet globemallow       SPCO       Sphaeralcea coccinea       0-15       0-3         goldenweed       STAC       Stenotus acaulis       0-15       0-3         fleabane       ERIGE2       Erigeron       0-15       0-3         indexpuster       MACA2       Machaeranthera canescens       0-15       0-3         bluebells       MERTE       Mertensia       0-15       0-3         bluebells       MERTE       Mertensia       0-15       0-3         hairy false goldenaster       HEVI4       Heterotheca villosa       0-15       0-3         mikvetch	Forb	L	<u> </u>	l	L	
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rayless tansyasterMAGR2Machaeranthera grindelioides0–150–3bluebellsMERTEMertensia0–150–3beardtonguePENSTPenstemon0–150–3hairy false goldenasterHEVI4Heterotheca villosa0–150–3milkvetchASTRAAstragalus0–150–3Wyoming besseyaBEWYBesseya wyomingensis0–150–3pussytoesANTENAntennaria5–151–3tapertip hawksbeardCRAC2Crepis acuminata0–150–3western varrowACMIOAchillea millefolium var. occidentalis0–150–3		hoary tansyaster	MACA2	Machaeranthera canescens	0–15	0–3
bluebellsMERTEMertensia0–150–3beardtonguePENSTPenstemon0–150–3hairy false goldenasterHEVI4Heterotheca villosa0–150–3milkvetchASTRAAstragalus0–150–3Wyoming besseyaBEWYBesseya wyomingensis0–150–3pussytoesANTENAntennaria5–151–3tapertip hawksbeardCRAC2Crepis acuminata0–150–3western varrowACMIQAchillea millefolium var. occidentalis0–150–3		rayless tansyaster	MAGR2	Machaeranthera grindelioides	0–15	0–3
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hairy false goldenasterHEVI4Heterotheca villosa0–150–3milkvetchASTRAAstragalus0–150–3Wyoming besseyaBEWYBesseya wyomingensis0–150–3pussytoesANTENAntennaria5–151–3tapertip hawksbeardCRAC2Crepis acuminata0–150–3western varrowACMIQAchillea millefolium var. occidentalis0–150–3		beardtongue	PENST	Penstemon	0–15	0–3
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Wyoming besseya       BEWY       Besseya wyomingensis       0–15       0–3         pussytoes       ANTEN       Antennaria       5–15       1–3         tapertip hawksbeard       CRAC2       Crepis acuminata       0–15       0–3         western varrow       ACMIQ       Achillea millefolium var. occidentalis       0–15       0–3		milkvetch	ASTRA	Astragalus	0–15	0–3
pussytoes       ANTEN       Antennaria       5–15       1–3         tapertip hawksbeard       CRAC2       Crepis acuminata       0–15       0–3         western varrow       ACMIQ       Achillea millefolium var. occidentalis       0–15       0–3		Wvoming besseya	BEWY	Besseva wvomingensis	0–15	0–3
tapertip hawksbeard       CRAC2       Crepis acuminata       0–15       0–3         western varrow       ACMIO       Achillea millefolium var. occidentalis       0–15       0–3		pussvtoes	ANTEN	Antennaria	5–15	1–3
western varrow ACMIO Achillea millefolium var. occidentalis 0–15 0–3	<u> </u>	tapertip hawksbeard	CRAC2	Crepis acuminata	0–15	0–3
	<u> </u>	western varrow	ACMIO	Achillea millefolium var. occidentalis	0–15	0–3

	agoseris	AGOSE	Agoseris	0–15	0–3
	onion	ALLIU	Allium	0–5	0–1
	cryptantha	CRYPT	Cryptantha	0–5	0–1
	larkspur	DELPH	Delphinium	0–5	0–1
	rockcress	ARABI2	Arabis	0–5	0–1
	sandwort	ARENA	Arenaria	0–5	0–1
	Indian paintbrush	CASTI2	Castilleja	0–5	0–1
	pale bastard toadflax	COUMP	Comandra umbellata ssp. pallida	0–5	0–1
	ipomopsis	IPOMO2	Ipomopsis	0–5	0–1
	desertparsley	LOMAT	Lomatium	0–5	0–1
	western wallflower	ERAS2	Erysimum asperum	0–5	0–1
	stonecrop	SEDUM	Sedum	0–5	0–1
	sagebrush buttercup	RAGL	Ranunculus glaberrimus	0–5	0–1
	hollyleaf clover	TRGY	Trifolium gymnocarpon	0–5	0–1
	clover	TRIFO	Trifolium	0–5	0–1
	violet	VIOLA	Viola	0–5	0–1
	deathcamas	ZIGAD	Zigadenus	0–5	0–1
	Forb, perennial	2FP	Forb, perennial	0–5	0–1
5	Annual Forbs			0–5	
	rockjasmine	ANDRO3	Androsace	0–5	0–1
	bushy bird's beak	CORA5	Cordylanthus ramosus	0–5	0–1
	cryptantha	CRYPT	Cryptantha	0–5	0–1
	smallflower gymnosteris	GYPA2	Gymnosteris parvula	0–5	0–1
	flatspine stickseed	LAOC3	Lappula occidentalis	0–5	0–1
	bushy blazingstar	MEDI	Mentzelia dispersa	0–5	0–1
	broomrape	OROBA	Orobanche	0–5	0–1
	wirelettuce	STEPH	Stephanomeria	0–5	0–1
	Forb, annual	2FA	Forb, annual	0–5	0–1
Shrub	/Vine				
6	Sagebrush			40–100	
	mountain big sagebrush	ARTRV	Artemisia tridentata ssp. vaseyana	0–100	0–15
	Wyoming big sagebrush	ARTRW8	Artemisia tridentata ssp. wyomingensis	25–100	5–15
	little sagebrush	ARARL	Artemisia arbuscula ssp. longiloba	0–25	0–5
	prairie sagewort	ARFR4	Artemisia frigida	0–25	0–5
	black sagebrush	ARNO4	Artemisia nova	0–25	0–5
7	Misc Shrubs			10–25	
	shadscale saltbush	ATCO	Atriplex confertifolia	0–25	0–5
	Gardner's saltbush	ATGA	Atriplex gardneri	0–25	0–5
	yellow rabbitbrush	CHVI8	Chrysothamnus viscidiflorus	5–25	1–5
	rubber rabbitbrush	ERNA10	Ericameria nauseosa	0–25	0–5
	winterfat	KRLA2	Krascheninnikovia lanata	0–25	0–5
	granite prickly phlox	LIPU11	Linanthus pungens	0–25	0–5
	plains pricklypear	OPPO	Opuntia polyacantha	0–25	0–5

bud sagebrush	PIDE4	Picrothamnus desertorum	0–25	0–5
greasewood	SAVE4	Sarcobatus vermiculatus	0–25	0–5
spineless horsebrush	TECA2	Tetradymia canescens	0–25	0–5
shortspine horsebrush	TESP2	Tetradymia spinosa	0–25	0–5
Shrub (>.5m)	2SHRUB	Shrub (>.5m)	0–25	0–5

# **Animal community**

Livestock:

The following table lists suggested stocking rates for cattle under continuous season-long grazing under normal growing conditions with a harvest efficiency (HE) of 25 percent. These are conservative estimates that should be used only as guidelines in the initial stages of the conservation planning process. Often, the current plant composition does not entirely match any particular plant community (as described in this ecological site description). A field visit is required to document actual plant composition and production. More precise carrying capacity estimates, considering forage preference and accessibility (slope, distance to water, etc.), should be calculated using field data, particularly when grazers other than cattle are involved. Under more intensive grazing management, improved harvest efficiencies (up to 35 percent) can result in an increased carrying capacity, but recovery time for upland sites is much longer. If distribution problems occur, stocking rates should be reduced or facilitating conservation practices (i.e., cross-fencing, water development) implemented to maintain plant health and vigor.

Initial Suggested Stocking Rate:

Plant Community Production (lbs./ac.) (AUMs/ac.)\* Ac./AUM

- 1.1 Big Sagebrush/Bunchgrass 300-500-700 0.05 20
- 1.2 Bunchgrass/Big Sagebrush 300-500-700 0.08 13
- 2.1 Big Sagebrush/Short-stature Grass 200-400-600 0.04 25
- 2.2 Short-stature Grass/Big Sagebrush 200-400-600 0.05 20
- 3.1 Rabbitbrush/Rhizomatous Grass 200-400-600 0.05 20
- 4.1 Reclaimed 300-500-700 0.10 10

## 4.2 Annual 100-200-300 0.03 33

\* Continuous, season-long grazing by cattle under average growing conditions.

Calculation for stocking rates are as follows: Using RV values for production, take forage palatable to grazing cattle and multiply by 0.25 HE and divide by 912.5 pounds per AUM air-dry weight (ADW) to arrive at the initial suggested stocking rate in AUMs per acre.

Grazing by domestic livestock is one of the major income-producing industries in the area. Rangeland in this area may provide year-long forage for cattle, sheep, or horses. During the dormant period, the forage for livestock must be supplemented with protein because the quality does not meet minimum livestock requirements.

Distance to water, shrub density, and slope can affect grazing capacity within a management unit. Accessibility adjustments should be made for the planning area as necessary. For example, 30 percent of a management unit may have 25 percent slopes and distances of greater than one mile from water, resulting in a 50 percent reduction in grazing access; therefore, the adjustment is calculated for 30 percent of the unit (i.e. 50 percent reduction on 30 percent of the management unit). Fencing, slope length, management, access, terrain, kind and class of livestock, and breeds are all factors that can increase or decrease the percent of grazing access within a management unit. Adjustments should be made that incorporate these factors when calculating the carrying capacity of a management unit.

Wildlife:

### Reference State:

1.1 Big Sagebrush/Bunchgrass: This community phase provides optimal transitional and summer habitat for sagegrouse, mule deer, pronghorn, and elk. A diverse suite of herbaceous species also provide important micronutrient requirements for big game species throughout the year. These areas also provide high quality bird nesting habitat where sagebrush canopy and residual bunchgrasses hide nests and young from predators. This very common community is used widely as migration and stopover habitat by big game. Spring green-up of grass is a critical

### nutritional component of this community for migrating big game.

1.2 Bunchgrass/Big Sagebrush: This community phase tends to have higher herbaceous plant diversity that may attract more diverse wildlife use. The plant community provides suitable forage and cover for sagebrush obligate species. The more open canopy promotes higher diversity and quantity of forbs that are important for early sage-grouse brood-rearing habitat. It also provides high quality habitat for mule deer, elk and pronghorn as they transition between winter and summer ranges. This very common community is used widely as migration and stopover habitat by big game. Spring green-up of grass and forb diversity is a critical nutritional component of this community for migrating big game.

### Grazing Resistant State:

2.1 Big Sagebrush/Short-stature Grass: This community phase is variable in its value to wildlife. The value of the sagebrush community is similar to the reference state but the value of the grass community decreases. In periods of high plant vigor, the herbaceous understory provides cover for nesting birds and small mammals. In periods of drought and low plant vigor, the herbaceous understory is short and not dense enough to provide adequate cover and habitat value declines. Diversity is low, and mat-forming forbs often occupy the space and nutrients needed for more desirable forbs.

2.2 Short-stature Grass/Big sagebrush: This community phase is variable in its value to wildlife. Value is low for species dependent on sagebrush unless in close proximity to areas with sagebrush cover. In periods of high plant vigor, herbaceous species provide cover for some birds and small mammals. In periods of drought and low plant vigor, the herbaceous community is often too short and not dense enough to provide adequate cover and habitat. Plant and animal diversity is low.

### Disturbed State:

3.1 Rabbitbrush/Rhizomatous Grass: This community phase is highly variable in its value to wildlife. It typically is less diverse, has lower forage value and has limited structure that wildlife need for cover. This state is vulnerable to repeated disturbance which can result in a complete loss of value for wildlife. In addition, sites in this state are more susceptible to invasion of non-native species, further degrading the value for wildlife.

### Highly Disturbed State

4.1 Reclaimed: This community phase is highly variable in its value to wildlife. Reclamation success, size and configuration of the reclaimed area, the species planted, and the time it takes for plants to establish will determine the value of the site for wildlife. A fully reclaimed site containing a diversity of herbaceous and woody native plants can eventually provide the same wildlife habitat benefits as the reference state. In most cases, grasses and forbs establish early in the reclamation process, whereas shrubs take significantly longer to establish. Wildlife species dependent on herbaceous plant communities for forage (such as elk) will benefit from reclamation sooner than those species dependent on a mixed shrub/grass community. Suitable habitat for wildlife species that require tall, dense sagebrush (sage-grouse, pronghorn, mule deer, and sagebrush obligate songbirds) is likely possible within a decade, providing appropriate shrub species were planted. It is possible to achieve successful, diverse reclamation on linear disturbances (i.e. pipelines) without seeding shrubs, but it will take longer than a decade for seed from shrubs adjacent to the area to established on-site.

4.2 Annual Plant Community: This plant community exhibits a low level of plant species diversity, and thus, is less apt to meet the seasonal needs of most wildlife who frequent this community. Small mammals and songbirds will still utilize this phase, although not to the capacity as the above states.

# Hydrological functions

Water is the principal factor limiting forage production on this site. This site is dominated by soils in hydrologic group D. Infiltration is low when soils are wet due to shallow depth to bedrock or impervious subsurface layer. Runoff potential for this site varies from high to moderate depending on soil depth, bedrock type (impervious vs. permeable) and ground cover (refer to Part 630, NRCS National Engineering Handbook for detailed hydrology information).

Rills and gullies are not typically be present. Water flow patterns should be barely distinguishable if at all present. Pedestals are only slightly present in association with bunchgrasses. Litter typically falls in place, and signs of movement are not common. Chemical and physical crusts are rare to non-existent. Biological crusts are present, but only cover one to two percent of the soil surface.

## **Recreational uses**

This site provides hunting opportunities for upland game species. The wide variety of plants which bloom in the spring have an aesthetic value that appeals to recreationists.

## Wood products

No appreciable wood products are present on the site.

### Other products

None

### Inventory data references

Information has been derived from NRCS clipping data and other inventory data. Field observations from range trained personnel were also used. Those involved in developing this site include: Bryan Christensen, Range Management Specialist, NRCS and Karen Clause, Range Management Specialist, NRCS. Other sources used as references include: USDA NRCS Water and Climate Center, USDA NRCS National Range and Pasture Handbook, and USDA NRCS Soil Surveys from various counties.

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### Approval

Kirt Walstad, 9/28/2023

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### Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	
Contact for lead author	
Date	05/04/2024
Approved by	Kirt Walstad
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

#### Indicators

- 1. Number and extent of rills:
- 2. Presence of water flow patterns:
- 3. Number and height of erosional pedestals or terracettes:
- 4. Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):
- 5. Number of gullies and erosion associated with gullies:
- 6. Extent of wind scoured, blowouts and/or depositional areas:
- 7. Amount of litter movement (describe size and distance expected to travel):
- 8. Soil surface (top few mm) resistance to erosion (stability values are averages most sites will show a range of values):
- 9. Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):
- 10. Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:
- 11. Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):
- 12. Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):

Dominant:

Sub-dominant:

Other:

Additional:

- 13. Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):
- 14. Average percent litter cover (%) and depth ( in):
- 15. Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annualproduction):
- 16. Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:
- 17. Perennial plant reproductive capability: