

Ecological site DX032X01B121 Limy Skeletal (LiSk) Big Horn Basin Rim

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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): 032X–Northern Intermountain Desertic Basins

032X – Northern Intermountain Desertic Basins – This MLRA is comprised of two major Basins, the Big Horn and Wind River. These two basins are distinctly different and are split by LRU's to allow individual ESD descriptions. These warm basins are surrounded by uplifts and rimmed by mountains, creating a unique set of plant responses and communities. Unique characteristics of the geology and geomorphology single these two basins out.

Further information regarding MLRAs, refer to: United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. Available electronically at: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_053624#handbook.

LRU notes

Land Resource Unit (LRU):

32X02B (WY): This LRU is the Big Horn Basin within MLRA 32. This LRU is lower in elevation, slightly warmer and receives slightly less overall precipitation than the Wind River Basin (LRU 02). This LRU was originally divided into two LRU's - LRU A which was the core and LRU B which was the rim. With the most current standards, this LRU is divided into two Subsets. This subset is Subset B, referred to as the Rim, is a transitional band between the basin floor and the lower foothills. The subset encircles Subset A which was originally LRU A. As the LRU shifts towards the south and tracks east, changes in geology and relation to the mountain position, creates a minor shift in soil chemistry influencing the variety of ecological sites and plant interactions. The extent of soils currently correlated to this ecological site does not fit within the digitized boundary. Many of the noted soils are provisional and will be reviewed and corrected in mapping update projects. Other map units are correlated as small inclusions within other MLRA's/LRU's based on elevation, landform, and biological references.

Moisture Regime: Ustic Aridic – Prior to 2012, many of the soils within this group were correlated as Frigid Ustic Aridic or as Mesic Typic Aridic, with few mapped within this cross over zone. As progressive soil survey mapping continues, these “crossover” or transitional areas are being identified and corrected.

Temperature Regime: Mesic

Dominant Cover: Rangeland, with Saltbush flats the dominant vegetative cover for this LRU/ESD.

Representative Value (RV) Effective Precipitation: 10-14 inches (254 – 355 mm)

RV Frost-Free Days: 105-125 days

A differentiating break in vegetation or response for this ecological site has not been identified between Big Horn Basin LRU subsets, and has only been identified in the upper regions of Subset A and throughout Subset B, so at this time the site is being placed in Subset B and will be written as a 7-12” site, as it spans the extent within Subset A thru B. If significant evidence is gathered to warrant a break into the two separate ecological sites it will then be

revised.

Classification relationships

Relationship to Other Established Classification Systems:

National Vegetation Classification System (NVC):

3 Xeromorphic Woodland, Scrub & Herb Vegetation Class

3.B Cool Semi-Desert Scrub & Grassland Subclass

3.B.1 Cool Semi-Desert Scrub & Grassland formation

3.B.1.NE Western North American Cool Semi-Desert Scrub & Grassland Division

M169 Great Basin & Intermountain Tall Sagebrush Shrubland & Steppe Macrogroup

G302 Artemisia Tridentata - Artemisia tripartita - Purshia tridentata Big Sagebrush Steppe Group

CEGL001535 - Artemisia tridentata ssp. wyomingensis/Pseudoroegneria spicata Herbaceous Vegetation or

CEGL001009 - Artemisia tridentata ssp. wyomingensis/Pseudoroegneria spicata Shrubland

Ecoregions (EPA):

Level I: 10 North American Deserts

Level II: 10.1 Cold Deserts

Level III: 10.1.18 Wyoming Basin

Level IV: 10.1.18.g Big Horn Salt Desert Shrub Basin

Ecological site concept

- Site receives no additional water.
- Slope is less than 30 percent
- Soils are:
 - o Moderately deep to very deep (20-78 plus inches (50-200+ cm)
 - o less than 5 percent stone and boulder cover and greater than 35 percent cobble and gravel cover
 - o Skeletal (greater than or equal to 35 percent rock fragments) within 20 inches (50 cm) of mineral soil surface
 - o Violently effervescent starting within 4 inches (10 cm) of the mineral soil surface; calcium carbonates increases with depth
 - o Clay content is less than 35 percent in top 4 inches (10 cm) of mineral soil surface; Textures range from fine sandy loam to clay loam in top 4 inches (10 cm) of mineral soil surface
 - o All subsurface horizons in the particle size control section have a weighted average of greater than 18 percent but less than or equal to 35 percent clay. (The particle size control section is the segment of the profile from either the start of an argillic horizon for 50 cm's or from 25-100 cm).
 - o Non-saline, sodic, or saline-sodic

Associated sites

DX032X01B175	Skeletal (Sk) Big Horn Basin Rim Skeletal ecological site will occur in concave areas or areas with a deeper deposit of non-carbonitic alluvial materials. Where limy skeletal will occur on more convex or areas with a greater deposit of calcic materials.
DX032X01B122	Loamy (Ly) Big Horn Basin Rim Loamy ecological site will occur in similar locations as the skeletal site, in areas where fewer rocks were deposited and may be associated with Limy Upland ecological site.

Similar sites

DX032X01B120	Limy Upland (LiU) Big Horn Basin Rim Site has fewer rock fragments throughout the soil profile, a shift in grasses species, and greater management responses.
DX032X01B123	Loamy Calcareous (LyCa) Big Horn Basin Rim Site has carbonates starting lower in the profile, greater production and a shift in plant species between the two sites.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) <i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> (2) <i>Krascheninnikovia lanata</i>
Herbaceous	(1) <i>Pseudoroegneria spicata</i> (2) <i>Hesperostipa comata</i>

Legacy ID

R032XB121WY

Physiographic features

This site occurs on nearly level to gently rolling land and on slopes generally less than 30 percent. Within the Big Horn Basin, this site is found to exist predominately on the gently sloping summits of erosional remnants or fan remnants that flow from the foothills into the basin proper. These landforms cross several climatic zones and are influenced by multiple geomorphic processes, for example: alluvial fans crossed/eroded by streams/stream terraces, covered by landslides, or breached by uplifts/escarpments. On a smaller scale, this site occurs in a patch-work dynamic at the base or across the basin floor (remnants) as wind and water move and shift sediments, derived from carbonate rich parent material, across the landscape (alluvium).

Table 2. Representative physiographic features

Landforms	(1) Intermontane basin > Alluvial fan (2) Intermontane basin > Fan remnant (3) Intermontane basin > Pediment (4) Intermontane basin > Strath terrace
Runoff class	Low to high
Elevation	1,158–1,890 m
Slope	0–30%
Aspect	Aspect is not a significant factor

Climatic features

Mean Annual Precipitation ranges from 5 to 14 inches; however, when modeled, represents 7 to 12 inches of relative effective annual precipitation (178 – 305 mm). The normal precipitation pattern shows peaks in May and June and a secondary peak in September. This amounts to about 50 percent of the mean annual precipitation. Much of the moisture that falls in the latter part of the summer months is lost by evaporation and much of the moisture that falls during the winter time is lost by sublimation. Average snowfall is about 20 inches annually. Wide fluctuations may occur in yearly precipitation and result in more dry years than those with more than normal precipitation.

Temperatures show a wide range between summer and winter and between daily maximums and minimums, due to the high elevation and dry air, which permits rapid incoming and outgoing radiation. Cold air outbreaks from Canada in winter move rapidly from northwest to southeast and account for extreme minimum temperatures. Chinook winds may occur in winter and bring rapid rises in temperature.

Extreme storms may occur during the winter, but most severely affect ranch operations during the late winter and spring months. High winds are generally blocked from the basin by high mountains but can occur in conjunction with an occasional thunderstorm. Growth of native cool-season plants begins about April 1st and continues to about July 1st. Cool weather and moisture in September may produce some green-up of cool season plants that will continue to late October.

For detailed information visit the Natural Resources Conservation Service National Water and Climate Center at <http://www.wcc.nrcs.usda.gov/>. Clark 3NE, Cody, Cody 12SE, Heart Mtn, and Powell Fld Stn are the representative

weather stations within LRU 01, Subset B. The following graphs and charts are a collective sample representing the averaged normals and 30-year annual rainfall data for the selected weather stations from 1981 to 2010.

Table 3. Representative climatic features

Frost-free period (characteristic range)	88-113 days
Freeze-free period (characteristic range)	118-137 days
Precipitation total (characteristic range)	178-254 mm
Frost-free period (actual range)	82-118 days
Freeze-free period (actual range)	112-140 days
Precipitation total (actual range)	178-305 mm
Frost-free period (average)	101 days
Freeze-free period (average)	127 days
Precipitation total (average)	203 mm

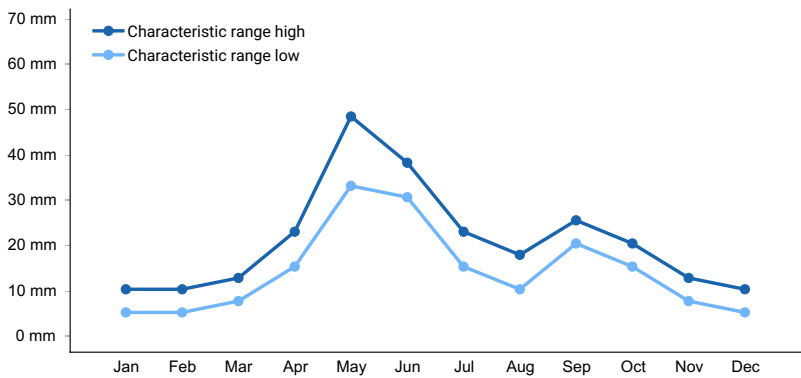


Figure 1. Monthly precipitation range

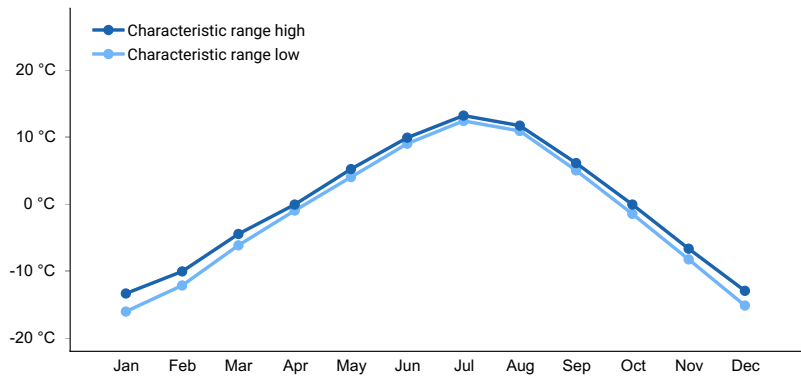


Figure 2. Monthly minimum temperature range

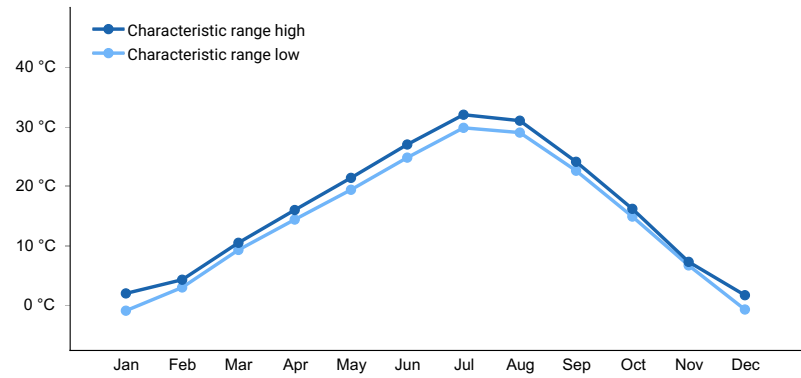


Figure 3. Monthly maximum temperature range

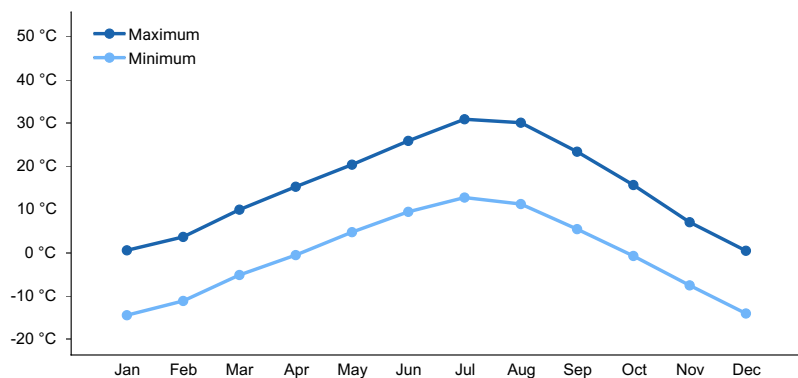


Figure 4. Monthly average minimum and maximum temperature

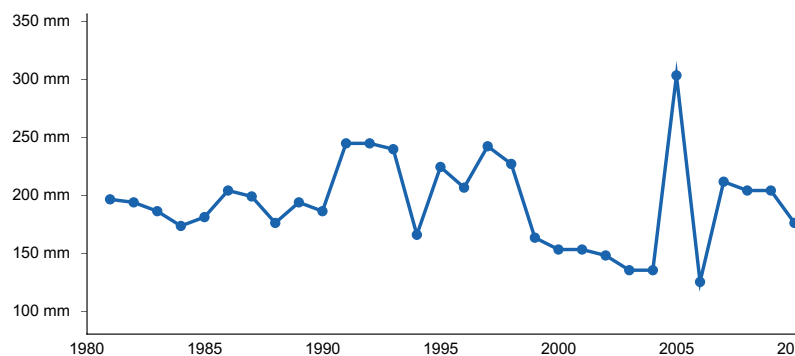


Figure 5. Annual precipitation pattern

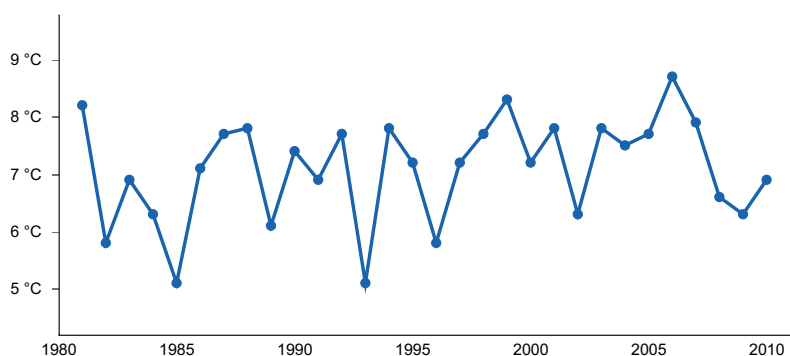


Figure 6. Annual average temperature pattern

Climate stations used

- (1) CLARK 3NE [USC00481775], Powell, WY
- (2) CODY 12SE [USC00481850], Meeteetse, WY
- (3) LOVELL [USC00485770], Lovell, WY
- (4) SHELL 1NE [USC00488124], Shell, WY
- (5) EMBLEM [USC00483031], Burlington, WY
- (6) TENSLEEP 16SSE [USC00488858], Ten Sleep, WY
- (7) BASIN [USC00480540], Basin, WY
- (8) GREYBULL [USC00484080], Greybull, WY
- (9) WORLAND [USW00024062], Worland, WY

Influencing water features

The characteristics of these upland soils have no influence from ground water (water table below 60 inches or 150 cm) and have minimal influence from surface water and overland flow. There may be isolated features that are affected by snowpack that persists longer than surrounding areas due to position on the landform (shaded or protected pockets), but overflow is not a suitable fit. No streams are classified within this ecological site.

Soil features

The soils of this site are moderately deep to very deep (greater than 20" to bedrock), moderately well to well drained, and moderately slow to moderate permeability. The soil characteristic having the most influence on the plant community is available moisture (affected by the calcium carbonates throughout the soil profile) and the potential to develop soluble salt near the surface. More data is needed to quantify these characteristics specifically for this site.

Major Soil Series correlated to this site include: Claprych, Larim, Clapper-like, Andergeorge-like, Clapper, Cascajo, Cascajo-like, and Milldraw.



Figure 7. Hand excavated soils pit for the Limy Skeletal ecological site within the Big Horn Basin.

Table 4. Representative soil features

Parent material	(1) Alluvium–igneous, metamorphic and sedimentary rock (2) Slope alluvium–calcareous conglomerate (3) Residuum–limestone and dolomite
Surface texture	(1) Very cobbly, very gravelly, extremely gravelly sandy clay loam (2) Clay loam (3) Loam
Family particle size	(1) Loamy-skeletal (2) Clayey-skeletal
Drainage class	Moderately well drained to well drained
Permeability class	Very slow to moderate
Soil depth	51 cm
Surface fragment cover <=3"	15–60%
Surface fragment cover >3"	0–35%
Available water capacity (Depth not specified)	7.87–16 cm
Calcium carbonate equivalent (0-152.4cm)	15–30%
Electrical conductivity (Depth not specified)	0–4 mmhos/cm
Sodium adsorption ratio (Depth not specified)	0–13
Soil reaction (1:1 water) (Depth not specified)	7.8–8.4

Subsurface fragment volume <=3" (Depth not specified)	15–60%
Subsurface fragment volume >3" (Depth not specified)	0–60%

Ecological dynamics

The Limy Skeletal ecological site within the Big Horn Basin Rim was originally correlated as a coarse upland range site. During the review of the coarse upland range site, several communities presented with more rock fragments throughout the profile than expected and there were areas that were found to have calcareous characteristics throughout the profile. Historically, classification of the soils in the Big Horn Basin did not recognize the calcareous tendencies. Although this site is similar to the Coarse Upland range site, the community potential and system resilience are altered by the chemistry within the soil. The dominance of bluebunch wheatgrass, increased bare ground or lichen cover and reduced production express the “shallow” acting characteristic of the site. Wyoming big sagebrush, although present on this site, is generally restricted in vigor and production compared to the Coarse Upland range site. Minimal research can be found for this particular ecological site.

Potential vegetation on this site, as with the Loamy site, is dominated by mid cool-season perennial grasses. Other significant vegetation includes winterfat, Wyoming big sagebrush, black sagebrush, and a variety of forbs. The expected potential composition for this site is 75 percent grasses, 10 percent forbs, and 15 percent woody plants. The composition and production will vary due to historic use and fluctuating precipitation.

As this site deteriorates species such as blue grama, threadleaf sedge, Sandberg bluegrass, and Wyoming big sagebrush will increase. Plains prickly pear and weedy annuals will invade. Cool-season grasses such as bluebunch wheatgrass, needle and thread, and Indian ricegrass will decrease in frequency and production.

Due to the amount and pattern of the precipitation, in combination with soil limitations, the Wyoming big sagebrush component has a lower vigor and overall structure than similar ecological sites within the same area. Sagebrush may not be resilient once it has been removed or severely reduced if a vigorous stand of grass exists and is maintained. Blue grama and threadleaf sedge may become the dominant vegetation if the area is subjected to frequent and severe (continuous season-long) periods of grazing, especially year-long grazing; resulting in a dense sod cover of blue grama and threadleaf sedge.

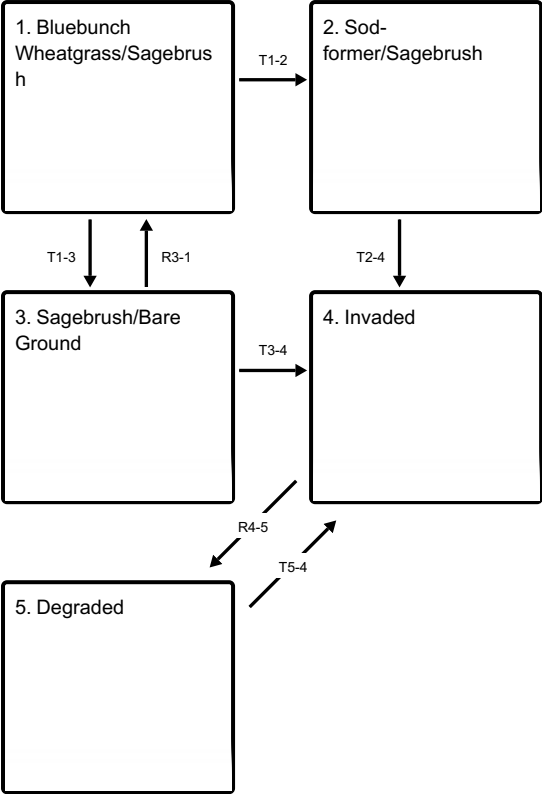
The reference plant community (description follows the plant community diagram) has been determined by study of relic rangeland sites, or areas protected from excessive disturbance. Trends in plant communities going from heavily grazed areas to lightly grazed areas, seasonal use pastures, and historical accounts have also been used.

The following is a State and Transition Model (STM) Diagram for this ecological site. An STM has five fundamental components: states, transitions, restoration pathways, community phases and community pathways. The state, designated by the bold box, is a single community phase or suite of community phases. The reference state is recognized as State 1. It describes the ecological potential and natural range of variability resulting from the natural disturbance regime of the site. The designation of alternative states (State 2, etc) in STMs denotes changes in ecosystem properties that cross a certain threshold.

Transitions are represented by the arrows between states moving from a higher state to a lower state (State 1 - State 2) and are denoted in the legend as a “T” (T1-2). They describe the variables or events that contribute directly to loss of state resilience and result in shifts between states. Restoration pathways are represented by the arrows between states returning back from a lower state to a higher state (State 2 - State1 or better illustrated by State 1

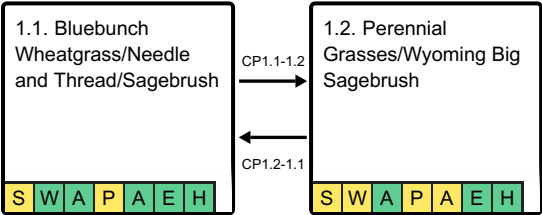
State and transition model

Ecosystem states



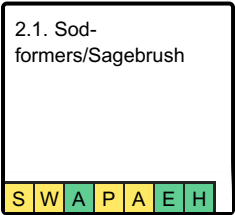
- T1-2** - Frequent and severe grazing (yearlong grazing) or compaction from surface traffic, will weaken the mid-stature grasses and allow blue grama and threadleaf sedge to increase.
- T1-3** - Frequent and severe grazing as well as prolonged drought weakens the herbaceous cover reducing the community to a sagebrush dominated canopy.
- T2-4** - Drought with or without hoof impact or mechanical soil impact to displace the sod opens the niche for invasive species to establish.
- R3-1** - Brush management with seeding and long-term prescribed grazing with rest will allow this community to improve.
- T3-4** - Disturbance to the soil surface provides the opportunity for invasive species to find their niche in a community.
- R4-5** - Integrated weed management, seeding and grazing management will establish a community similar to Reference.
- T5-4** - Any disturbance to or failure in reclaiming the community leaves this State at risk to invasion.

State 1 submodel, plant communities

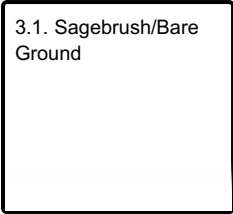


- CP1.1-1.2** - Moderate, continuous season-long grazing, especially with drought, will reduce the key grasses moving this community to the Perennial Grasses/Sagebrush Community Phase.
- CP1.2-1.1** - Prescribed grazing with deferment over time will allow the key bunchgrasses to increase in the community.

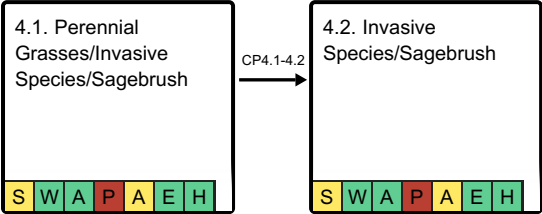
State 2 submodel, plant communities



State 3 submodel, plant communities

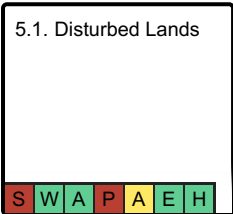


State 4 submodel, plant communities



CP4.1-4.2 - Continuous season-long grazing, drought, or mechanical disturbances are a few of the impacts that weaken and remove the native community and allow invasive species to become dominant on a site.

State 5 submodel, plant communities



State 1
Bluebunch Wheatgrass/Sagebrush

The Bluebunch Wheatgrass/Sagebrush State (State 1) is the reference community for the Limy Skeletal ecological site. The prominent cover of bluebunch wheatgrass and other mid-stature cool-season bunchgrasses with perennial forbs and a mix of Wyoming big sagebrush, black sagebrush and winterfat make for a productive and stable site.

Characteristics and indicators. Bluebunch wheatgrass is the dominant herbaceous species on this site with Wyoming big sagebrush as the dominant woody cover. Black sagebrush is common on this ecological site, but there is a specific zones within the Rim subset that black sagebrush is more dominant (tied directly to the dolomite and limestone related areas). Lichen provide a significant soil cover in combination with other cryptogamic crusts.

Resilience management. The hardiness of the vegetation that thrive within the harsh conditions of the soil characteristics of the Limy Skeletal ecological site create a plant community resistant to change. But once disturbed, the herbaceous component of this site is difficult to restore, reducing the resiliency of the community.

Community 1.1
Bluebunch Wheatgrass/Needle and Thread/Sagebrush



Figure 8. Bluebunch wheatgrass and needle and thread are dominant on this Limy Skeletal Site.

This plant community is the interpretive plant community for the Limy Skeletal ecological site and is considered to be the Reference Plant Community. This state evolved with grazing by large herbivores and infrequent periodic fires. This plant community can be found on areas that are properly managed with grazing and on areas receiving occasional short periods of rest. The potential vegetation is about 75% grasses or grass-like plants, 10% forbs, and 15% woody plants. This state is dominated by cool season mid-grasses. The major grasses include bluebunch wheatgrass, needle and thread, Indian ricegrass, and rhizomatous wheatgrasses (Western and Thickspike). Other grasses occurring in this state include bottlebrush squirreltail, prairie junegrass, and Sandberg bluegrass. Wyoming big sagebrush and black sagebrush are an important element of this state, occurring in a mosaic pattern, and making up 5 to 15% of the annual production. Winterfat is common in the community as are a variety of forbs. The total annual production (air-dry weight) of this state is about 325 lbs./acre, but it can range from about 150 lbs./acre in unfavorable years to about 450 lbs./acre in above average years.

Resilience management. This plant community is extremely stable and well adapted to the Northern Intermountain Desertic Basins climatic conditions. The diversity in plant species is high across this community which allows for a high drought tolerance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity).

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- black sagebrush (*Artemisia nova*), shrub
- winterfat (*Krascheninnikovia lanata*), shrub
- bluebunch wheatgrass (*Pseudoroegneria spicata*), grass
- needle and thread (*Hesperostipa comata*), grass
- Indian ricegrass (*Achnatherum hymenoides*), grass
- tapertip hawksbeard (*Crepis acuminata*), other herbaceous
- spiny phlox (*Phlox hoodii*), other herbaceous
- scarlet globemallow (*Sphaeralcea coccinea*), other herbaceous

Dominant resource concerns

- Sheet and rill erosion
- Wind erosion
- Plant productivity and health
- Plant structure and composition

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	135	224	280
Shrub/Vine	28	84	168
Forb	6	28	56
Total	169	336	504

Table 6. Soil surface cover

Tree basal cover	0%
Shrub/vine/liana basal cover	0%
Grass/grasslike basal cover	0%
Forb basal cover	0%
Non-vascular plants	0%
Biological crusts	5-20%
Litter	10-20%
Surface fragments >0.25" and <=3"	5-45%
Surface fragments >3"	0-15%
Bedrock	0%
Water	0%
Bare ground	10-35%

Table 7. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	—	5-10%	5-25%	0-5%
>0.15 <= 0.3	—	0-5%	0-40%	0-5%
>0.3 <= 0.6	—	0-5%	0-10%	0-2%
>0.6 <= 1.4	—	—	—	—
>1.4 <= 4	—	—	—	—
>4 <= 12	—	—	—	—
>12 <= 24	—	—	—	—
>24 <= 37	—	—	—	—
>37	—	—	—	—

Community 1.2

Perennial Grasses/Wyoming Big Sagebrush



Figure 10. Broom snakeweed and Sandberg bluegrass have replaced needle and thread, and the bluebunch wheatgrass has decreased in this community.

Historically, this plant community evolved under grazing and a low fire frequency. Currently, it is found under moderate, season-long grazing by livestock and will be exacerbated by prolonged drought conditions. This plant community is still dominated by cool-season grasses, while short warm-season grasses and miscellaneous forbs account for the balance of the understory. Sagebrush (Wyoming big sagebrush and black sagebrush) is the larger part of the overall production and accounts for the majority of the upper canopy. The bluebunch wheatgrass is still abundant in the community, with needle and thread although they are decreasing. Rhizomatous wheatgrasses, bottlebrush squirreltail, Sandberg bluegrass are increasing. Forbs commonly found in this plant community include scarlet globemallow, fringed sagewort, and spiny phlox. Wyoming big sagebrush and black sagebrush can make up to 25 percent of the annual production. The upper canopy of sagebrush and lower canopy of grasses and forbs provide a diverse plant community. When compared to the Reference Community 1.1, the change in sagebrush accompanied by the increase of blue grama, threadleaf sedge, and plains prickly pear cactus are indicators of a transition. Indian ricegrass will only occur in trace amounts under the sagebrush canopy or within the patches of prickly pear. In addition, the amount of winterfat may or may not have changed depending on the season and species of use. The total annual production (air-dry weight) of this state is about 250 pounds per acre, but it can range from about 150 lbs./acre in unfavorable years to about 400 lbs./acre in above average years.

Resilience management. Rangeland Health Implications/Indicators: The herbaceous component is mostly intact and plant vigor and replacement capabilities are sufficient. Water flow patterns and litter movement may be occurring but only on steeper slopes. Incidence of pedestalling is minimal. Soils are mostly stable and the surface shows minimum soil loss. The watershed is functioning and the biotic community is intact. This plant community is resilient, but is subject to change. The herbaceous species present are well adapted to grazing; however, species composition can be altered through long-term year-long or continuous season-long grazing or natural and man-made disturbances.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), shrub
- black sagebrush (*Artemisia nova*), shrub
- winterfat (*Krascheninnikovia lanata*), shrub
- rubber rabbitbrush (*Ericameria nauseosa*), shrub
- bluebunch wheatgrass (*Pseudoroegneria spicata*), grass
- squirreltail (*Elymus elymoides*), grass
- western wheatgrass (*Pascopyrum smithii*), grass
- Sandberg bluegrass (*Poa secunda*), grass
- spiny phlox (*Phlox hoodii*), other herbaceous
- broom snakeweed (*Gutierrezia sarothrae*), other herbaceous
- scarlet globemallow (*Sphaeralcea coccinea*), other herbaceous
- woolly plantain (*Plantago patagonica*), other herbaceous

Dominant resource concerns

- Sheet and rill erosion

- Compaction
- Aggregate instability
- Plant productivity and health
- Plant structure and composition
- Feed and forage imbalance

Table 8. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	106	168	224
Shrub/Vine	56	84	168
Forb	6	28	56
Total	168	280	448

Table 9. Soil surface cover

Tree basal cover	0%
Shrub/vine/liana basal cover	0%
Grass/grasslike basal cover	0%
Forb basal cover	0%
Non-vascular plants	0%
Biological crusts	5-20%
Litter	10-25%
Surface fragments >0.25" and <=3"	5-45%
Surface fragments >3"	0-15%
Bedrock	0%
Water	0%
Bare ground	10-40%

Table 10. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	—	0-15%	10-20%	0-10%
>0.15 <= 0.3	—	0-5%	0-5%	0-2%
>0.3 <= 0.6	—	0-5%	0-2%	0-2%
>0.6 <= 1.4	—	—	—	—
>1.4 <= 4	—	—	—	—
>4 <= 12	—	—	—	—
>12 <= 24	—	—	—	—
>24 <= 37	—	—	—	—
>37	—	—	—	—

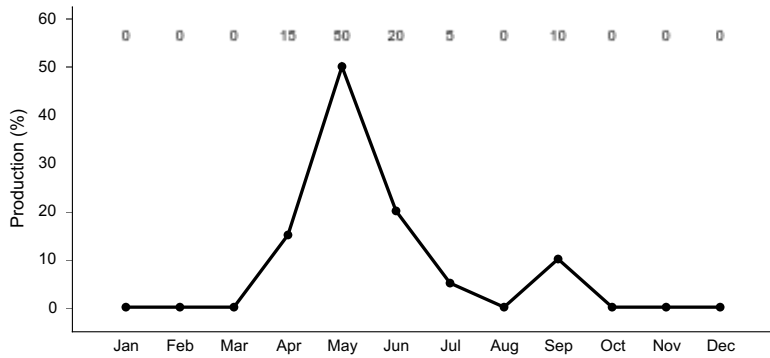
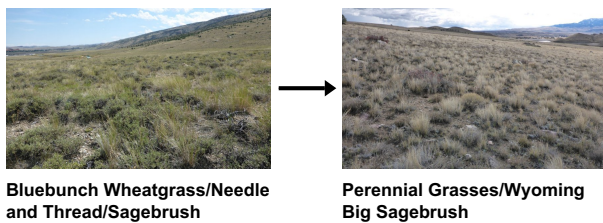


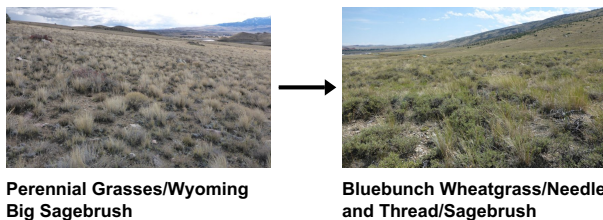
Figure 12. Plant community growth curve (percent production by month). WY0501, 5-9BH Upland sites. Monthly percentages of total annual growth for all upland sites with dominantly C3 Cool season plants..

Pathway CP1.1-1.2 Community 1.1 to 1.2



Moderate, continuous season-long grazing will convert the plant community to the Perennial Grass/Sagebrush Community Phase. Prolonged drought will exacerbate this transition. The continuous use reduces the key mid-stature bunchgrasses such as bluebunch wheatgrass, needle and thread, and Indian ricegrass; allowing the short-stature bunchgrasses and sod-formers to increase in the community.

Pathway CP1.2-1.1 Community 1.2 to 1.1



Prescribed grazing or possibly long-term prescribed grazing, will allow recovery to the Reference Community Phase. Rotational grazing with deferment is implemented as part of the prescribed method of use. Prescribed fire or brush management may encourage rejuvenation of sagebrush and will remove old standing growth of bluebunch wheatgrass and other bunchgrasses. Consideration of the risk of invasive species needs to be taken before using prescribed fire on this community.

Conservation practices

Brush Management
Prescribed Burning
Critical Area Planting
Prescribed Grazing
Grazing Land Mechanical Treatment
Range Planting
Heavy Use Area Protection
Upland Wildlife Habitat Management

Grazing management to improve wildlife habitat
Patch-burning to enhance wildlife habitat

State 2

Sod-former/Sagebrush

The Sod-former/Sagebrush ecological site is a low-stature community that has shifted from the cool-season bunchgrasses to warm-season tillering grasses (blue grama) with intermixed grass-like species (threadleaf sedge).

Characteristics and indicators. Wyoming big sagebrush and black sagebrush are still the prominent woody cover for this site, however there may be a notable composition of winterfat. Season of use and species of grazing ungulate will be a factor affecting this cover. The sagebrush cover is still dwarfed or droughty in appearance and generally has been reduced in vigor by the shift in hydrology of this community. Most other mid and short-stature cool-season bunchgrasses are limited to within the canopy of the sagebrush or within the protective ring of cactus clumps.

Resilience management. The dense root map of blue grama and threadleaf sedge make this community extremely resistant to change, and resilient to disturbance. Although the establishment of blue grama and threadleaf sedge is a slow process, it will recover with time. Removal of grazing or disturbance does not provide a shift in the herbaceous cover within this community. The overall health and vigor of both the herbaceous as well as woody cover will improve with the removal of the grazing pressure or disturbance from the community. Blue grama's wide-spread increase in many ecological sites within the Big Horn Basin is hypothesized to be a response to shifts in timing of precipitation and seasonal warm-up patterns over the last 100 years.

Community 2.1

Sod-formers/Sagebrush



Figure 13. Threadleaf sedge community on the Limy Skeletal ecological site.

This plant community is the result of frequent and severe (year-long or continuous season-long) grazing, which has adversely affected the perennial grasses as well as impacted the shrub component. Other factors that can affect this community include drought, shift in climate, wildlife browsing and alternative uses. A dense sod of blue grama with patches of threadleaf sedge dominates this state. Prickly pear cactus will increase in the community, and can limit livestock's ability to access grazable forage. Sagebrush has been reduced or in some cases removed, while rubber rabbitbrush may persist in the community. Wyoming big sagebrush has been noted to decrease first in a community while black sagebrush appears to be more resilient on the landscape. When compared to the Reference Communities, blue grama and threadleaf sedge have increased. Prickly pear cactus has invaded. All cool-season mid-grasses, forbs, and most shrubs have been greatly reduced. Production has significantly decreased. The total annual production (air-dry weight) of this state is about ___ pounds per acre, but it can range from about ___ lbs./acre in unfavorable years to about ___ lbs./acre in above average years.

Resilience management. Rangeland Health Implications/Indicators: This community is at risk of transition to a completely sod-bound community as explained above, as the sod is extremely resistant to change and continued

frequent and severe grazing or the removal of grazing does not seem to affect the plant composition or structure of the sod-formers, but it will eventually remove the shrub component from the plant community. The biotic integrity of this state is not functional and plant diversity is extremely low. The plant vigor is significantly weakened and replacement capabilities are limited due to the reduced number of cool-season grasses. This sod-bound plant community is very resistant to water infiltration. While this sod protects the site itself, off-site areas are affected by excessive runoff that can cause rills and gully erosion. Water flow patterns are obvious in areas of bare ground and pedestalling is apparent along the sod edges. Rill channels are noticeable in the interspaces and down slope. The watershed may or may not be functioning, as runoff may affect adjoining sites.

Dominant plant species

- rubber rabbitbrush (*Ericameria nauseosa*), shrub
- black sagebrush (*Artemisia nova*), shrub
- Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), shrub
- blue grama (*Bouteloua gracilis*), grass
- threadleaf sedge (*Carex filifolia*), grass
- bluebunch wheatgrass (*Pseudoroegneria spicata*), grass
- plains pricklypear (*Opuntia polyacantha*), other herbaceous
- scarlet globemallow (*Sphaeralcea coccinea*), other herbaceous
- spiny phlox (*Phlox hoodii*), other herbaceous
- broom snakeweed (*Gutierrezia sarothrae*), other herbaceous

Dominant resource concerns

- Sheet and rill erosion
- Ephemeral gully erosion
- Naturally available moisture use
- Plant productivity and health
- Plant structure and composition
- Feed and forage imbalance

State 3

Sagebrush/Bare Ground



Figure 14. Historic use and drought has removed the herbaceous lower canopy, leaving sagebrush as the only cover.

The loss of most of the herbaceous understory in the community leaves a barren and generally decadent (in appearance) stand of Wyoming big sagebrush and black sagebrush. Lichen and cryptogamic crust cover may or may not be in tact, health of this living soil cover is dependent on the type of disturbance and period of recovery following the disturbances that has lapsed.

Characteristics and indicators. The dominance of sagebrush cover, with a mix of there short shrubs, with the lack of most herbaceous cover is the characteristics of the Sagebrush/*Bare Ground* State. Remnant populations of perennial grasses will occur in the canopy of sagebrush or within the protective niche within cactus clumps.

Resilience management. The lack of native propagates and the limitations of this calcic soil restrict the ability of most native species to recover, lowering the resiliency of this State. This ecological state is at risk of transitioning to an invaded state due to the lack of soil cover and competitive native species.

Community 3.1 Sagebrush/Bare Ground



Figure 15. Historic use and drought have removed the lower canopy leaving sagebrush as the only cover in this community.

This plant community is the result of frequent and severe grazing and drought. Sagebrush dominates this plant community, with an absence of most perennial grasses. Forbs may be present, especially lower growing annual forbs. Wyoming big sagebrush and black sagebrush are the major vegetative cover. The dominant grasses are bottlebrush squirreltail, Sandberg bluegrass, and blue grama. Cactus often invades. The interspaces between plants have expanded leaving the amount of bare ground more prevalent. As compared with the Reference State, the annual production declines, with the loss of herbaceous production. Shrub production may fluctuate slightly; however, the historic presumption of shrub increasing significantly has not been documented. Overall sagebrush cover maintains or may increase slightly, but age and density of the canopy cover will vary over time. The open interspaces leave this site vulnerable to weedy annual species such as cheatgrass to occupy the site if a seed source is available. If invasive species gain a foothold, they push the state across a threshold into the Invaded State. The total annual production (air-dry weight) of this state is about ___ pounds per acre, but it can range from about ___ lbs./acre in unfavorable years to about ___ lbs./acre in above average years.

Resilience management. Rangeland Health Implications/Indicators: This plant community is resistant to change as the stand becomes more decadent. These areas hold a lower fire threat because of the lack of fine fuels and the increase of bare ground between sagebrush plants. Plant diversity is moderate to poor. The plant vigor is diminished and replacement capabilities are limited due to the reduced number of cool-season grasses. Plant litter is noticeably less when compared to reference communities. Soil erosion is accelerated because of increased bare ground. Water flow patterns and pedestalling are obvious. Infiltration is reduced and runoff is increased. Rill channels may be noticeable in the interspaces and gullies may be establishing where rills have concentrated down slope.

State 4 Invaded

The Invaded State has a range of variability that is distinguished by its population of invasive or introduced (non-native) species that has successfully established and become significant within the composition of the community. A significant component of this community initially is comprised of the native species that comprise the reference communities.

Characteristics and indicators. The composition by weight of ten percent or more of an invasive species is the factor tipping a community over the threshold into the Invaded State. The community can be relatively intact, having a representative composition of native species similar to the Reference State, but with a significant composition (minimum of five percent) cover of an invasive species or mix of invasive species. Cheatgrass is the most significant

threat at this time; however, there are other aggressive non-native species that pose a concern on this ecological site. These species include field cottonrose, mustards, Russian thistle, and Kochia.

Resilience management. The competitive edge of most invasive species makes this site resistant to change and resilient following disturbance. Cheatgrass has been seen to respond with a positive potential following disturbances (fire, mechanical).

Community 4.1

Perennial Grasses/Invasive Species/Sagebrush

The Perennial Grasses/Invasive Species/Sagebrush phase has maintained a representative sample of the perennial grasses and forbs that are typical of the site with the accompanying sagebrush composition (Wyoming big sagebrush and black sagebrush). The invasive species are present and hold a significant (10 percent or greater) composition of the landscape, and are prominent on the site (referring to a more wide scale composition, not one isolated patch in an isolated portion of the landscape). Production of the desired perennial species of this site is generally reduced but the total production is maintained or elevated due to the production potential of many of the annual or invasive species.

Resilience management. Rangeland Health Implications/Indicators: This plant community is resistant to change. These areas may be more prone to fire as fine fuels are more available and the bare ground between the sagebrush plants is decreased. Plant diversity is moderate to poor. The plant vigor is diminished and replacement capabilities are limited due to the reduced number of cool-season grasses. Plant litter is noticeably more when compared to reference communities due to the potential biomass produced by the invasive species (species dependent). Soil erosion is variable depending on the species of invasion and the litter accumulation thus associated, this variability also applies to water flow patterns and pedestalling. Infiltration is reduced and runoff is increased due to loss of perennial vegetation and root density.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- black sagebrush (*Artemisia nova*), shrub
- winterfat (*Krascheninnikovia lanata*), shrub
- bluebunch wheatgrass (*Pseudoroegneria spicata*), grass
- needle and thread (*Hesperostipa comata*), grass
- cheatgrass (*Bromus tectorum*), grass
- squirreltail (*Elymus elymoides*), grass
- scarlet globemallow (*Sphaeralcea coccinea*), other herbaceous
- woolly plantain (*Plantago patagonica*), other herbaceous
- flatspine stickseed (*Lappula occidentalis*), other herbaceous

Dominant resource concerns

- Sheet and rill erosion
- Compaction
- Aggregate instability
- Plant structure and composition
- Plant pest pressure

Community 4.2

Invasive Species/Sagebrush

This community phase is the at-risk community. As the native populations of perennial grasses and forbs become weakened, the site becomes invader driven, and irreversible. If environmental or management stressors or disturbances occur to remove the shrub component, the site crosses a threshold to State 6, Annual Grasses/Invaders. The sagebrush is able to compete and maintain a strong community under a heavy infestation level unless fire or disturbance of any nature weakens the plant. The canopy of the sagebrush serves as a protective niche for native grass species allowing them to persist. But the herbaceous native community is low in resistance and even lower in resilience. The invasive community is a highly resistant and resilient community.

Resilience management. Rangeland Health Implications/Indicators: This plant community is resistant to change as the stand becomes more decadent. These areas may be more prone to fire as fine fuels are more available and the bare ground between the sagebrush plants is decreased. Plant diversity is poor. The plant vigor is diminished and replacement capabilities are limited due to the reduced number of cool-season grasses. Plant litter is noticeably more when compared to reference communities due to the potential biomass produced by the invasive species (species dependent). Soil erosion is variable depending on the species of invasion and the litter accumulation thus associated. The variability of the water flow and pedestalling as well as infiltration and runoff is determined again by the species that establishes on this site.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- black sagebrush (*Artemisia nova*), shrub
- rubber rabbitbrush (*Ericameria nauseosa*), shrub
- winterfat (*Krascheninnikovia lanata*), shrub
- cheatgrass (*Bromus tectorum*), grass
- Sandberg bluegrass (*Poa secunda*), grass
- squirreltail (*Elymus elymoides*), grass
- scarlet globemallow (*Sphaeralcea coccinea*), other herbaceous
- woolly plantain (*Plantago patagonica*), other herbaceous
- flatspine stickseed (*Lappula occidentalis*), other herbaceous

Dominant resource concerns

- Sheet and rill erosion
- Compaction
- Aggregate instability
- Plant productivity and health
- Plant structure and composition
- Plant pest pressure
- Wildfire hazard from biomass accumulation
- Feed and forage imbalance

Pathway CP4.1-4.2 Community 4.1 to 4.2

Frequent or Severe Grazing, Drought, Disturbances (mechanical) and Wildfire – Drought, wildfire, or other climatic stresses on the system can continue to stress the native species reducing their ability to maintain their footprint in the plant community. This continued stress or the complication with mechanical disturbances or, frequent or severe grazing or pressure from wildlife and livestock can reduce the natives to an nonviable or unsustainable population and allow the invasive species to dominate the site, specifically cheatgrass (downy brome).

State 5 Degraded

The Degraded State could be drafted as a stand-alone box within the state and transition model diagram. No matter what state a site originally is ranked in, once the site is mechanically disturbed, or suffers a catastrophic or significant natural disaster that alters the soil properties (erosional, depositional, hydrological or chemical), the site potential is altered. Mechanical disturbances and reclamation practices using non-native species could qualify some stages of this state to be considered as a land use shift. The end result in either case is the shift in potential and response in management so that it is no longer similar to the reference community. The potential shifts are highly variable, so a dynamic state was captured to detail the altered communities that exist on the landscape.

Characteristics and indicators. The soil disturbance and mechanical or physical removal of the vegetative canopy is the key characteristic of the Disturbed State. The initial indicators are the primary successional species that establish following a disturbance including kochia, six weeks fescue, and sunflowers. These initial colonizers will then be followed by any seeded species, or other species from within the locations seed bank.

Resilience management. This State is highly variable and in a state of flux as the successional processes occur. The continued disturbance of these areas is a potential threat. This State is at high risk of transitioning to the Invaded State.

Community 5.1 Disturbed Lands

The title Disturbed Lands is encompassing two broad classifications of these land types. Go-back fields are referring to sites that were once cultivated or have had minor surface disturbance, and have since been left to natural processes. Homestead and abandoned farming sites can be identified on the landscape (through photo-tone shifts in aerial photographs) and are generally a mix of natives that have moved into disturbed sites or a co-mingling of introduced species and natives. These sites are difficult to reclaim, generally due to the introduced species that persist on the landscape. And once reclaimed, do not tend to respond to the natural disturbance regimes in the same manner that a native, mechanically undisturbed site would respond. The Limy Skeletal ecological site was not typically farmed specifically, but was influenced by homesteading or irrigation processes. The extent of this type is limited on the landscape. In a similar process, mined lands or lands affected by energy development including gravel or mineral excavation pits, transmission corridors, transportation corridors and oil and gas development sites provide a host of successional processes. Many times, these locations are re-exposed to disturbance frequently by mechanical means leaving annual weeds and primary successional species as the dominate canopy. Older, established sites or abandoned locations, have established communities similar to those expected on go-back fields and may be stable in nature. The growth curve of this plant community will vary depending on the species that are selected for seeding. For a more accurate portrait of the growth curve for the seeded community, the species used and the climatic tendencies of the region must be considered.

Resilience management. Rangeland Health Implications/Indicators: The plant community is variable and depending on the age of the stand and the stage of successional tendencies that the location is in will determine how stable (resilient/resistant) the community is. Plant diversity is generally strong, but is usually lacking in the structural groups that are desired on the site. Soil erosion is variable depending on the disturbance regime that is occurring on the site and again on the specific community that has established on a specific location. The variability of the water flow and pedestalling as well as infiltration and runoff is determined again by the species that establishes on this site.

Dominant plant species

- rubber rabbitbrush (*Ericameria nauseosa*), shrub
- winterfat (*Krascheninnikovia lanata*), shrub
- Sandberg bluegrass (*Poa secunda*), grass
- squirreltail (*Elymus elymoides*), grass
- sixweeks fescue (*Vulpia octoflora*), grass
- burningbush (*Bassia scoparia*), other herbaceous
- tansymustard (*Descurainia*), other herbaceous
- scarlet globemallow (*Sphaeralcea coccinea*), other herbaceous

Dominant resource concerns

- Sheet and rill erosion
- Wind erosion
- Compaction
- Aggregate instability
- Plant productivity and health
- Plant structure and composition
- Plant pest pressure
- Terrestrial habitat for wildlife and invertebrates
- Feed and forage imbalance

Transition T1-2 State 1 to 2

Frequent and severe (year-long or continuous season-long) grazing or compaction from surface traffic, will convert the plant community to a Sod-former Plant Community. The impact to of frequent or repeated hits during grazing, hoof impact, and lack of rest for recovery weakens and removes the key grass species in the community. As the mid-stature grasses decline, blue grama is able to increase and alter the hydrology of the site.

Constraints to recovery. The dense root mat formed by blue grama and threadleaf sedge alters the hydrology, effectively removing moisture from the site, limiting the available resources for other native species. The dense sod also limits the available soil space for seedling establishment. Interspaces between sod patches are prone to erosion and runoff (limited infiltration of moisture).

Transition T1-3

State 1 to 3

Frequent and severe grazing plus no fire on soils with limited soluble salts, will convert the plant community to the Sagebrush/*Bare Ground* Plant Community. This is especially evident on areas with historically higher precipitation and the sagebrush stand is not adversely impacted by drought or heavy browsing. Grazing impacts to the herbaceous cover repeatedly removes it from the community leaving a sagebrush dominated community. Drought, insect damage, and other natural disturbances can assist in this transition.

Constraints to recovery. The lack of a seed bank and the harsh environment of the soils limits seedling establishment and survival. The unpredictable and variable spring precipitation also limits success of recovery for the Limy Skeletal ecological site.

Transition T2-4

State 2 to 4

Drought, Frequent or severe grazing, Disturbance – Drought as the only factor or drought with grazing intensity together can work to weaken or kill Wyoming big sagebrush on the landscape, and once it has declined or been removed from an area it is not known if or how long it will take for it to come back without cultural methods, which do not carry a reliable success rate. Threadleaf sedge have been seen to die back or die out with prolonged drought opening the canopy and the community's vulnerability to invasive species. Disturbance by mechanical means or human activities that break the root masses or disturb the soil surface open this closed community to potential invasive species, especially when there is a readily available seed source for those invasive species.

Constraints to recovery. The dense sod of threadleaf sedge will continue to impact the hydrology and competition for limited resources in this community limiting the potential for recovery. The lack of other key herbaceous species also is a constraint on this site. The inability, at this time, to eradicate cheatgrass does not allow for a complete recovery of an invaded community.

Restoration pathway R3-1

State 3 to 1

Brush management with prescribed grazing or rest allows for this community to improve. Trials completed in the local area have demonstrated the ability for these Limy Skeletal ecological sites to recover herbaceous cover following a sagebrush mowing treatment. The recovery is dependent on the remnant population the is present, the current weather patterns, and timing.

Conservation practices

Brush Management
Prescribed Burning
Critical Area Planting
Mulching
Prescribed Grazing
Grazing Land Mechanical Treatment

Range Planting
Heavy Use Area Protection
Integrated Pest Management (IPM)

Transition T3-4

State 3 to 4

Drought, soil disturbances, or high-intensity grazing with a seed source present can open the soil surface and weaken the sod allowing invasive species to establish. Although not common, fire can provide the niche for cheatgrass to establish on this site.

Constraints to recovery. Once invasive species, especially cheatgrass, establish, it is costly and difficult (if even possible) to remove. The lack of the key grass species also limits recover of this site.

Restoration pathway R4-5

State 4 to 5

Integrated Pest Management, with Seeding the site to a native mixture - Success is not known to have occurred, and is rated to be low and highly variable for the rate of control of most species. Cheatgrass is one of the most invasive species for many of these sites, although there are other challenges. With intensive weed control and inputs this community can resemble an at-risk community within the reference state, but it is not possible to reach the reference community condition once annuals have established on a site.

Conservation practices

Critical Area Planting
Prescribed Grazing
Grazing Land Mechanical Treatment
Range Planting
Heavy Use Area Protection
Integrated Pest Management (IPM)
Upland Wildlife Habitat Management

Transition T5-4

State 5 to 4

Frequent or Severe Grazing, Disturbance with a seed Source, or Drought - Any disturbance that occurs or stress that is placed on the herbaceous cover, weakens the canopy and allows for invasive species to establish if a seed source is present. This State is at high risk of transitioning to an Invaded State. The challenge of successful seedings on a calcareous soil opens the community to invasion.

Constraints to recovery. The challenge of eradicating or reducing invasive species such as cheatgrass prevents recovery of most invaded communities without significant inputs for weed control, seeding with long-term grazing management.

Additional community tables

Table 11. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	Mid-stature Cool-season Bunchgrasses			56–168	
	bluebunch wheatgrass	PSSP6	<i>Pseudoroegneria spicata</i>	56–140	10–25
	needle and thread	HECO26	<i>Hesperostipa comata</i>	28–84	5–15
	Indian ricegrass	ACHY	<i>Achnatherum hymenoides</i>	0–28	0–5
2	Rhizomatous Cool-season Grasses			0–56	
	western wheatgrass	PASM	<i>Pascopyrum smithii</i>	0–56	0–10
	thickspike wheatgrass	ELLAL	<i>Elymus lanceolatus ssp. lanceolatus</i>	0–28	0–5
3	Short-stature Cool-season Bunchgrasses			0–56	
	squirreltail	ELEL5	<i>Elymus elymoides</i>	0–28	0–5
	Sandberg bluegrass	POSE	<i>Poa secunda</i>	0–28	0–5
	muttongrass	POFE	<i>Poa fendleriana</i>	0–28	0–5
	prairie Junegrass	KOMA	<i>Koeleria macrantha</i>	0–28	0–5
4	Miscellaneous Grasses			0–28	
	Grass, perennial	2GP	<i>Grass, perennial</i>	0–28	0–5
	blue grama	BOGR2	<i>Bouteloua gracilis</i>	0–28	0–5
	threadleaf sedge	CAFI	<i>Carex filifolia</i>	0–28	0–5
Forb					
5	Perennial Forbs			6–56	
	prairie sagewort	ARFR4	<i>Artemisia frigida</i>	0–22	0–5
	tapertip hawksbeard	CRAC2	<i>Crepis acuminata</i>	0–22	0–5
	spiny phlox	PHHO	<i>Phlox hoodii</i>	0–22	0–5
	scarlet globemallow	SPCO	<i>Sphaeralcea coccinea</i>	0–22	0–5
	Forb, perennial	2FP	<i>Forb, perennial</i>	0–22	0–5
	milkvetch	ASTRA	<i>Astragalus</i>	0–22	0–5
Shrub/Vine					
6	Dominant Shrubs			28–112	
	Wyoming big sagebrush	ARTRW8	<i>Artemisia tridentata ssp. wyomingensis</i>	28–84	5–15
	black sagebrush	ARNO4	<i>Artemisia nova</i>	0–84	0–15
	winterfat	KRLA2	<i>Krascheninnikovia lanata</i>	0–56	0–10
7	Miscellaneous Shrubs			0–56	
	rubber rabbitbrush	ERNA10	<i>Ericameria nauseosa</i>	0–28	0–5
	shadscale saltbush	ATCO	<i>Atriplex confertifolia</i>	0–28	0–5
	Shrub (>.5m)	2SHRUB	<i>Shrub (>.5m)</i>	0–28	0–5

Table 12. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	Mid-stature Cool-season Bunchgrasses			28–84	
	bluebunch wheatgrass	PSSP6	<i>Pseudoroegneria spicata</i>	28–84	5–25
	needle and thread	HECO26	<i>Hesperostipa comata</i>	0–28	0–5
2	Rhizomatous Cool-season Grasses			0–56	
	western wheatgrass	PASM	<i>Pascopyrum smithii</i>	0–56	0–10
	thickspike wheatgrass	ELLAL	<i>Elymus lanceolatus ssp. lanceolatus</i>	0–28	0–5
3	Short-stature Cool-season Grasses			28–84	
	squirreltail	ELEL5	<i>Elymus elymoides</i>	6–56	2–10
	Sandberg bluegrass	POSE	<i>Poa secunda</i>	6–56	2–10
	muttongrass	POFE	<i>Poa fendleriana</i>	0–28	0–5
	prairie Junegrass	KOMA	<i>Koeleria macrantha</i>	0–28	0–5
4	Miscellaneous Grasses			0–28	
	blue grama	BOGR2	<i>Bouteloua gracilis</i>	0–28	0–5
	threadleaf sedge	CAFI	<i>Carex filifolia</i>	0–28	0–5
	Grass, perennial	2GP	<i>Grass, perennial</i>	0–28	0–5
Forb					
5	Perennial Forbs			6–56	
	scarlet globemallow	SPCO	<i>Sphaeralcea coccinea</i>	0–28	0–5
	spiny phlox	PHHO	<i>Phlox hoodii</i>	0–28	0–5
	broom snakeweed	GUSA2	<i>Gutierrezia sarothrae</i>	0–28	0–5
	prairie sagewort	ARFR4	<i>Artemisia frigida</i>	0–28	0–5
	plains pricklypear	OPPO	<i>Opuntia polyacantha</i>	6–28	2–5
	Forb, perennial	2FP	<i>Forb, perennial</i>	0–28	0–5
6	Annual Forbs			0–17	
	woolly plantain	PLPA2	<i>Plantago patagonica</i>	0–6	0–2
	flatspine stickseed	LAOC3	<i>Lappula occidentalis</i>	0–6	0–2
	western tansymustard	DEPI	<i>Descurainia pinnata</i>	0–6	0–2
	Forb, annual	2FA	<i>Forb, annual</i>	0–6	0–2
Shrub/Vine					
7	Dominant Shrubs			28–112	
	Wyoming big sagebrush	ARTRW8	<i>Artemisia tridentata ssp. wyomingensis</i>	28–112	5–25
	black sagebrush	ARNO4	<i>Artemisia nova</i>	0–84	0–20
8	Miscellaneous Shrubs			0–56	
	rubber rabbitbrush	ERNA10	<i>Ericameria nauseosa</i>	0–56	0–5
	Shrub (>.5m)	2SHRUB	<i>Shrub (>.5m)</i>	0–56	0–5
	winterfat	KRLA2	<i>Krascheninnikovia lanata</i>	0–28	0–5

Animal community

Animal Community – Wildlife Interpretations:

1.1 - Bluebunch Wheatgrass/Needle and thread/Sagebrush (Reference Community): The predominance of grasses in this plant community favors grazers and mixed-feeders, such as bison, elk, and antelope. Suitable thermal and escape cover for deer may be limited due to the low quantities of woody plants. However, topographical variations could provide some escape cover. When found adjacent to sagebrush dominated states, this plant community may provide brood rearing/foraging areas for sage grouse, as well as lek sites. Other birds that would frequent this plant community include western meadowlarks, horned larks, and golden eagles. Many grassland obligate small mammals would occur here.

1.2 - Perennial Grasses/Sagebrush Plant Community: The combination of an overstory of sagebrush and an understory of grasses and forbs provide a very diverse plant community for wildlife. The crowns of sagebrush tend to break up hard crusted snow on winter ranges, so mule deer and antelope may use this state for foraging and cover year-round, as would cottontail and jack rabbits. It provides important winter, nesting, brood-rearing, and foraging habitat for sage grouse. Brewer's sparrows' nest in big sagebrush plants and hosts of other nesting birds utilize stands in the 20-30% cover range.

2.1 - Blue Grama/Threadleaf Sedge/Sagebrush Plant Community: This community provides limited foraging for antelope and other grazers. They may be used as a foraging site by sage grouse where reference state community phases are limited. Generally, these are not target plant communities for wildlife habitat management.

3.1 - Sagebrush/*Bare Ground* Plant Community: This plant community can provide important winter foraging for elk, mule deer and antelope, as sagebrush can approach 15% protein and 40-60% digestibility during that time. This community provides excellent escape and thermal cover for large ungulates, as well as nesting habitat for sage grouse.

4.1 - Perennial Grasses/Invasive Species/Sagebrush Plant Community and 4.2 - Invasive Species/Sagebrush Plant Community: The retained combination of sagebrush and the added diversity with the invasive grasses and/or forbs provide an extended plant community for wildlife. The similarities to Community Phase 1.2 (Rhizomatous Wheatgrasses/Perennial Grasses/Sod formers/Wyoming Big Sagebrush) are to some extent enhanced for some species with the added forage provided by the invasive species. But as the invasive species increase, decreasing the desirable species, the wildlife species benefits are decreased as well.

5.1 - Disturbed Lands Plant Community and 5.2 - Restored/Reclaimed Lands Plant Community: The variability of this site prevents a detailed review of wildlife benefits. However, many of the introduced grasses, forbs and shrubs can provide adequate cover, feed and nesting sites for those wildlife species that would have selected the site prior to disturbance. Limitations and enhancements need to be considered by specific locations.

Animal Community – Grazing Interpretations:

The following table lists suggested stocking rates for cattle under continuous season-long grazing under normal growing conditions. 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). Because of this, a field visit is recommended, in all cases, to document plant composition and production. More precise carrying capacity estimates should eventually be calculated using this information along with animal preference data, particularly when grazers other than cattle are involved. Under more intensive grazing management, improved harvest efficiencies can result in an increased carrying capacity. If distribution problems occur, stocking rates must be reduced to maintain plant health and vigor.

The Carrying capacity is calculated as the production for a normal year X .25 efficiency factor / 912.5 #/AUM to calculate the AUM's/Acre.

Plant Community Production Carrying Capacity*

Plant Community Description/Title: Lbs./Acre AUM/Acre Acres/AUM

1.1 Bluebunch Wheatgrass/Needleandthread/Sagebrush 150-450 0.09 11.2

1.2 Perennial Grasses/Sagebrush 150-400 0.07 14.6

2.1 Blue Grama/Threadleaf Sedge/Sagebrush

3.1 Sagebrush/*Bare Ground*

4.1 Perennial Grasses/Invasive Species/Sagebrush and 4.2 Invasive Species/Wyoming Big Sagebrush

5.1 Disturbed Lands ** **

* - Carry Capacity is figured for continuous, season-long grazing by cattle under average growing conditions. ** - Sufficient data for invaded and reclaimed communities has not been collected or evaluated, at this time, so no projection of a stocking rate recommendation or production range will be established at this time.

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

Distance to water, shrub density, and slope can affect carrying capacity (grazing capacity) within a management unit. Adjustments should be made for the area that is considered necessary for reduction of animal numbers. For example, 30% of a management unit may have 25% slopes and distances of greater than one mile from water; therefore, the adjustment is only calculated for 30% of the unit (i.e. 50% reduction on 30% 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 graze-able acres within a management unit. Adjustments should be made that incorporate these factors when calculating stocking rates.

Hydrological functions

Water is the principal factor limiting forage production on this site. This site is dominated by soils in hydrologic group B and C, with localized areas in hydrologic group D. Infiltration ranges from moderately slow to moderate. Runoff potential for this site varies from low to moderate depending on soil hydrologic group and ground cover. In many cases, areas with greater than 75% ground cover have the greatest potential for high infiltration and lower runoff. An example of an exception would be where short-grasses form a strong sod and dominate the site. Areas where ground cover is less than 50% have the greatest potential to have reduced infiltration and higher runoff (refer to Part 630, NRCS National Engineering Handbook for detailed hydrology information).

Rills and gullies should 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. Cryptogamic crusts are present, but only cover 1-2% of the soil surface.

Recreational uses

This site provides hunting opportunities for upland game species. The wide varieties of plants which bloom from spring until fall have an aesthetic value that appeals to visitors. Outside of plants, the extent offers a variety of Culture Resources to view on the landscape based on the location of many of these sites on higher ground on the benches and fans which also provides a rich source of geology for exploration. The extent of this ecological site is found within wild horse use areas; Pryor Mountain and McCullough Peaks. Wild horse/Wildlife Excursions are found as recreational venues for BLM lands and State lands within the Big Horn Basin. This ecological site, however, can prove to have limitations when associated with roadways and trails in relation to erosion potential and functionality. The soils will be sticky or slick when wet and are erosive.

Wood products

No appreciable wood products are present on the site.

Other products

Herbs: Several of the forb species within the communities of the Loamy Calcareous Ecological site have medicinal characteristics and have been used by the Native Americans in this area and more recently by the naturopathic profession.

Ornamental Species: The forbs commonly found as well as the shrub component of these communities have been used in landscaping and xeriscaping.

Inventory data references

Information presented in the site description was derived from NRCS inventory data. Field observations from range trained personnel were also used. Those involved in developing the site include: Blaise Allen, Area Range Management Specialist, NRCS; and Marji Patz, Ecological Site Specialist, NRCS. Other sources used as references include USDA NRCS Water and Climate Center, USDA NRCS National Range and Pasture Handbook, USDI and USDA Interpreting Indicators of Rangeland Health Version 3, and USDA NRCS Soil Surveys from various counties.

Quality control and quality assurance completed by: Dan Mattke, Area Resource Soil Scientist, NRCS; Daniel Wood, MLRA Soil Survey Leader, NRCS; John Hartung, Wyoming State Rangeland Management Specialist, NRCS; Jeff Goats, Wyoming State Soil Scientist, NRCS; Scott Woodall, Regional Quality Assurance Ecological Site Specialist, NRCS.

For specific data inquiries, contact the Powell, Wyoming Soil Survey Office (USDA-NRCS).

Inventory Data References:

Ocular field estimations observed by trained personnel were completed at each site. Then sites were selected where a 100 foot tape was stretched and the following sample procedures were completed by inventory staff. For full sampling protocol and guidelines with forms please refer to the Wyoming ESI Operating Procedures, compiled in 2012 for the Powell and Rock Springs Soil Survey Office, USDA-NRCS.

- Double Sampling Production Data (9.6 hoop used to estimate 10 points, clipped a minimum of 3 of these estimated points, with two 21 foot X 21 foot square extended shrub plots).
- Line Point Intercept (over story and understory captured with soil cover). Height of herbaceous and woody cover is collected every three feet along established transect.)
- Continuous Line Intercept (Woody Canopy Cover, with minimum gap of 0.2 of a foot for all woody species and succulents. Intercept height collected at each measurement.),
- Gap Intercept (Basal Gap measured with a minimum gap requirement of 0.7 foot.),
- Sample Point (10 – 1 meter square point photographs taken at set distances on transect. Read using the sample point computer program established by the High Plains Agricultural Research Center, WY).
- Soil Stability (Slake Test – surface and subsurface samples collected and processed according to the soil stability guidelines provided by the Jornada Research Center, NM.)

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Approval

Scott Woodall, 9/16/2020

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)	Marji Patz
Contact for lead author	marji.patz@usda.gov; 307-271-3130
Date	03/29/2020
Approved by	Scott Woodall
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rare to non-existent, but will have an increase of incurrence on steeper slopes of 10-30%.

2. **Presence of water flow patterns:** Barely observable but may be occurring on steeper slopes (10-30%)

3. **Number and height of erosional pedestals or terracettes:** Essentially non-existent, or rare if occurring.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground is 25 to 45% occurring in small patch-like areas throughout site.

5. **Number of gullies and erosion associated with gullies:** Active gullies should not be present.

6. **Extent of wind scoured, blowouts and/or depositional areas:** Rare to non-existent.

7. **Amount of litter movement (describe size and distance expected to travel):** Little to no plant litter movement occurring. Litter remains in place and is not moved by erosional forces.

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Plant cover and litter is at 50 to 75% of soil surface and maintains soil surface integrity. Soil stability class is anticipated to be 3.0 or greater on average. Ranging from 1 in interspaces and up to 6 under plant canopy.

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil data is limited for this site. A-horizons vary in depth from 1 to 12 inches with OM of 1-2%.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Plant community consists of, on average, 75% grasses, 10% forbs, and 15% shrubs. This, with an evenly distributed canopy and litter, with deep healthy rooted native grasses enhancing infiltration, limits the runoff potential to little or no effect on this site.

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** No compaction layer or soil surface crusting should be present.

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: Mid-stature cool season bunchgrasses

Sub-dominant: perennial shrubs = cool season rhizomatous grasses

Other: perennial forbs > short stature bunchgrass and grass-likes

Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Minimal decadence noted, typically associated with shrub canopy. Through drought conditions will see some decadence with Bluebunch Wheatgrass.
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14. **Average percent litter cover (%) and depth (in):** Litter ranges from 5 to 15% of total canopy with total litter including beneath the plant canopy can reach up to 50%. Herbaceous litter depth typically ranges from 3-10 mm, with woody litter varying between 4-6 cm.
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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** Total normal or average production is estimated at 400 lbs. with a low of 150 lbs. and ranging to 550 lbs.
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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:** Blue grama, Sandberg bluegrass, threadleaf sedge, fringed sagewort, prickly pear cactus, broom snakeweed and rubber rabbitbrush; alyssum, blue mustard, annual false wheatgrass, as well as other annuals, and then exotics and species found on the noxious weed list including but not limited to: cheatgrass, Russian thistle, kochia, and bull thistle.
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17. **Perennial plant reproductive capability:** All species are capable of reproducing.
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