USDA Natural Resources Conservation Service

Ecological site DX032X01B120
Limy Upland (LiU) Big Horn Basin Rim

Last updated: 3/12/2025
Accessed: 05/13/2025

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):

32X01B (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

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 does not receive any additional water.
• Slope is less than 20 percent.
• Soils are:
o not saline or saline-sodic.
o moderately deep, deep, or very deep
o with less than 3 percent stone and boulder cover and less than 20 percent cobble and gravel cover.
o not skeletal within 20 inches of the mineral soil surface.
o are strongly or violently effervescent starting in surface mineral 4” (10 cm).
o textures usually range from very fine sandy loam to clay loam in surface mineral 4”.
o Clay content is less than 32 percent in surface mineral 4 inches of mineral soil.
o Average particle size class is less than 35 percent clays.

The concept of this site is based on the presence of secondary or possibly primary carbonates that exist throughout the entire profile of a soil (strong to violent effervescent starting in the upper 4 inches (10 cm) of the profile), but that does not have a calcic diagnostic horizon (a pronounced accumulation of carbonates usually identified as a white horizon that is harder or slightly cemented). A similar separation from this site is the loamy calcareous site, which lacks the effervescence in the beginning of the profile but has developed a calcic horizon; it has many of the same characteristics and responses as the limy. These two sites may become one site over time, but currently are being reviewed as two distinctively different sites. These sites previously were correlated as a Loamy Ecological Site and the site concept was built to absorb the variations in vegetation. But with further review, it is seen that they predominately have a bluebunch plant community and with mismanagement or corrected management, respond in a different manor or more specifically with a different potential than what we see with the Loamy ecological site. As more soils are reviewed, a break point for CCE’s (calcium carbonate equivalent) will be established (soils that are limy are above XX CCE’s).

Associated sites

DX032X01B109	**Cobbly Upland (CoU) Big Horn Basin Rim** Cobbly Upland will be found intermixed with the above mentioned ecological sites as well as Limy Upland in the alluvial deposits on relict stream terraces, strath terraces, and similar landforms.
DX032X01B121	**Limy Skeletal (LiSk) Big Horn Basin Rim** Limy skeletal will be located in gravel or cobble alluvial deposits (relict or strath terraces), bands of limy skeletal and limy upland can be found, especially on fans originating from the dolomite/limestone formations in the Bighorn and Rattlesnake mountain ranges.
DX032X01B123	**Loamy Calcareous (LyCa) Big Horn Basin Rim** Loamy Calcareous is found in lower or more concave positions where the calcium carbonates have shifted lower in the profile. In some instances, the carbonates have been flushed lower, or deposition has occurred to bury the carbonates deeper in the profile.

Similar sites

DX032X01B122	**Loamy (Ly) Big Horn Basin Rim** Loamy and Limy Upland have similar soil characteristics with one major difference, that is the significant presence of calcium carbonate in the soils. Loamy has no or minimal carbonates (CCE of less than 14) and Limy Upland will have a CCE 15 or greater starting within 4 inches (10 cm) of the soil surface.
DX032X01B162	**Shallow Loamy (SwLy) Big Horn Basin Rim** Shallow Loamy will have a similar plant community dominated by bluebunch wheatgrass, however, Shallow Loamy generally does not have the carbonates in the soil and is a shallower soil (less than 20 inches to bedrock or paralithic contact). The potential forbs and sagebrush health also varies between these sites. (SwLy has healther sage, and more forbs; LiU has short droughty sagebrush and a small diversity of forbs and other grasses.)

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Artemisia tridentata subsp. wyomingensis* (2) *Krascheninnikovia lanata*
Herbaceous	(1) *Pseudoroegneria spicata* (2) *Hesperostipa comata*

Legacy ID

R032XB120WY

Physiographic features

This site occurs on nearly level to gently rolling land and on slopes less than 20 percent. The Limy Upland ecologica site is found on the gently sloping summits of erosional remnants or fan remnants that flow from the foothills into the basin proper, but are found on several landforms. This site occurs in a patch-work dynamic because of the alluvial processes that formed this basin, with sediments derived from carbonate rich parent material, across the landscape (alluvium).

Table 2. Representative physiographic features

Landforms	(1) Intermontane basin > Fan remnant (2) Intermontane basin > Stream terrace (3) Intermontane basin > Erosion remnant
Runoff class	Low to very high
Elevation	1,280–1,890 m
Slope	0–20%
Aspect	Aspect is not a significant factor

Climatic features

Annual precipitation and modeled relative effective annual precipitation ranges from 10 to 14 inches (254–355 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 is lost by evaporation, and much of the moisture that falls during the winter is lost by sublimation. Average snowfall totals 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 late winter and spring. 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 1 and continues to about July 1. 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. 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)	91-97 days
Freeze-free period (characteristic range)	113-123 days
Precipitation total (characteristic range)	178-229 mm
Frost-free period (actual range)	89-108 days
Freeze-free period (actual range)	111-125 days
Precipitation total (actual range)	178-254 mm
Frost-free period (average)	95 days
Freeze-free period (average)	118 days
Precipitation total (average)	229 mm

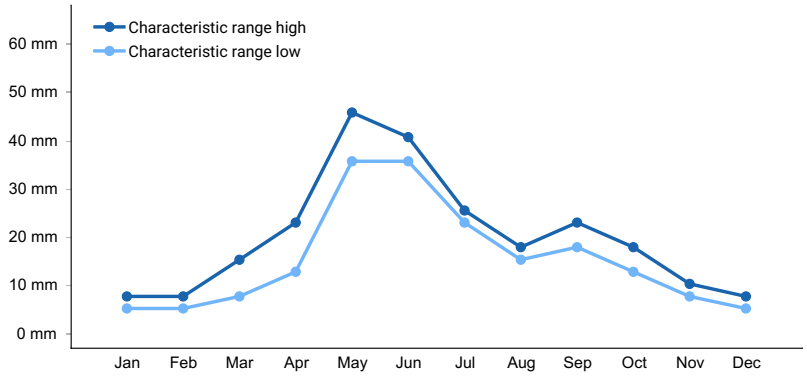


Figure 1. Monthly precipitation range

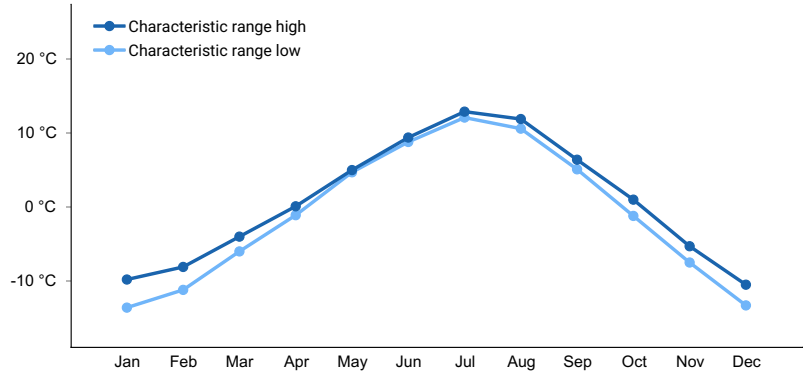


Figure 2. Monthly minimum temperature range

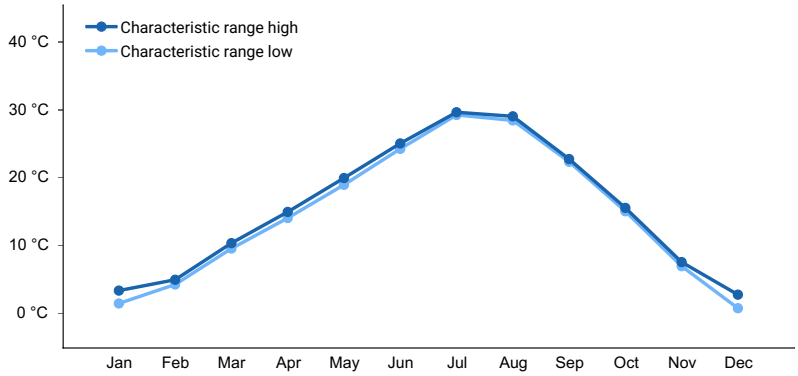


Figure 3. Monthly maximum temperature range

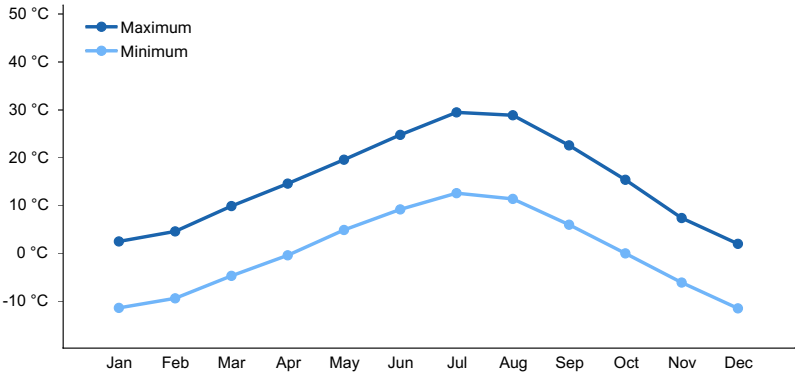


Figure 4. Monthly average minimum and maximum temperature

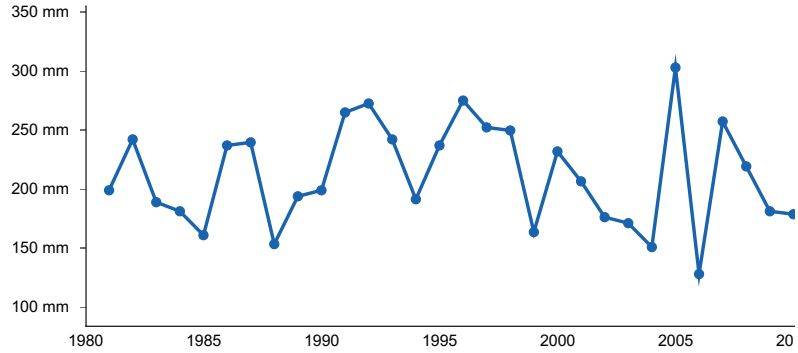


Figure 5. Annual precipitation pattern

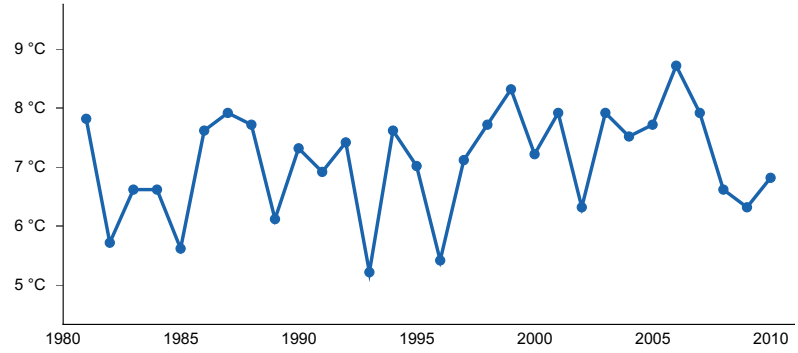


Figure 6. Annual average temperature pattern

Climate stations used

- (1) CLARK 3NE [USC00481775], Powell, WY
- (2) CODY 12SE [USC00481850], Meeteetse, WY
- (3) CODY [USC00481840], Cody, WY

- (4) HEART MTN [USC00484411], Powell, WY
- (5) POWELL FLD STN [USC00487388], Powell, WY

Influencing water features

The characteristics of these upland soils have no influence from ground water (water table below 60 inches (150 cm)) and have minimal influence from surface water or 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). No streams are classified within the Limy Upland 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 and slow infiltration/percolation through the soil due to high levels of calcium carbonate in the soil profile. The potential to develop soluble salt near the surface is also a concern in this profile. More data is needed to quantify these characteristics specifically for this site.

Major Soil Series correlated to this site include: Pultney-like, Rim Rock Basin, Chugcity

Figure 7. Hand excavated soils pit in the Limy Upland ecological site.

Table 4. Representative soil features

Parent material	(1) Slope alluvium–limestone and dolomite (2) Residuum–interbedded sedimentary rock (3) Alluvium–igneous, metamorphic and sedimentary rock
Surface texture	(1) Gravelly, cobbly sandy clay loam (2) Fine sandy loam (3) Loam (4) Silty clay loam
Family particle size	(1) Fine-loamy
Drainage class	Moderately well drained to well drained
Permeability class	Moderately slow to moderate
Soil depth	51–508 cm
Surface fragment cover <=3"	0–20%
Surface fragment cover >3"	0–15%
Calcium carbonate equivalent (Depth not specified)	10–25%
Electrical conductivity (Depth not specified)	0–6 mmhos/cm

Sodium adsorption ratio (0-101.6cm)	0–13
Soil reaction (1:1 water) (0-101.6cm)	7.4–8.6
Subsurface fragment volume <=3" (Depth not specified)	0–15%
Subsurface fragment volume >3" (Depth not specified)	0–10%

Ecological dynamics

The Limy Upland ecological site was originally correlated as either a loamy or shallow loamy range site. During the review of the Loamy range site, each representative reference community site visited was found to have calcareous characteristics. Historically, classification of the soils in the Big Horn Basin did not recognize the calcareous tendencies. Although this site is very similar to the Loamy and Shallow Loamy range sites, the community potential and system resilience are altered by the chemistry within the soil. Initial correlations of these soils and communities were made to Loamy when production was prominent, or to Shallow loamy due to the dominance of Bluebunch wheatgrass and reduced production expressing a “shallow” acting characteristic. Wyoming big sagebrush, although present on this site, is generally restricted in vigor and production compared to a true Loamy ecological site. No research specific to the Limy Upland ecological site has been located.

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

As this site deteriorates species such as blue grama, Sandberg bluegrass, and rubber rabbitbrush will increase. Plains prickly pear and weedy annuals will invade. Cool-season grasses such as bluebunch wheatgrass, rhizomatous wheatgrasses, 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 loamy 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/or threadleaf sedge become the dominant vegetation under frequent and severe periods of grazing, especially continuous year-long grazing; resulting in a dense sod cover of blue grama and threadleaf sedge.

Within the inherent variability across the landscape, a small population of salt tolerant species is accepted on the Limy Upland ecological sites. Re-evaluation of soil characteristics has led to the removal of the salt tolerant state within this ecological site dynamic. Shadscale is a common shrub within the Limy Upland ecological site. A dominance of salt tolerant shrubs compared to sagebrush warrants a review of the soil characteristics and possibly require a re-correlation of the soils and ecological site.

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.

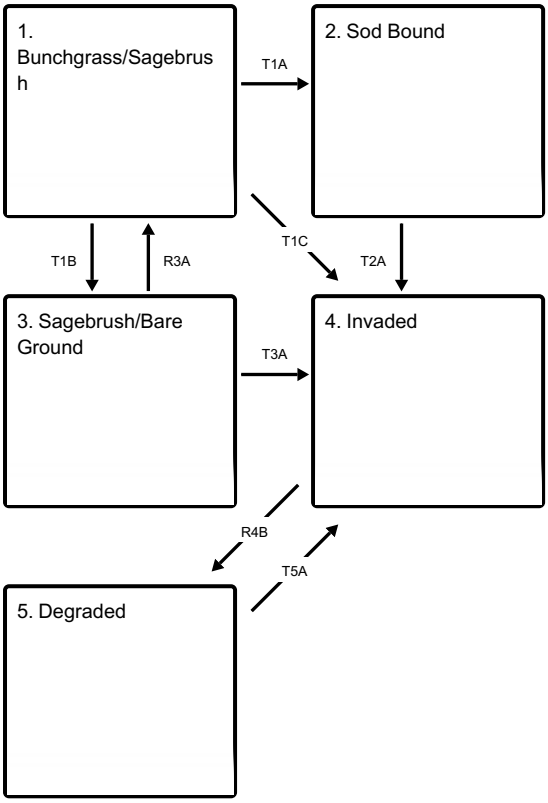
The following is a State and Transition Model (STM) Diagram for this ecological site. An STM has five fundamental components: states, transitions, restoration pathways, community phases and community pathways. The state, designated by the bold box, is a single community phase or suite of community phases. 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



T1A - Severe and frequent grazing (continuous season-long or year-long) with drought encourages the sod-forming species to establish and then out-compete the more desirable mid-stature cool-season bunchgrasses.

T1B - Grazing impacts to the herbaceous cover weakens and eventually removes the grasses from the community leaving a mixed shrub community.

T1C - Disturbances such as season-long continuous grazing, drought, or fire with a seed source present provides invasive species the opportunity to establish in the Reference State.

T2A - Drought or surface impact will provide the niche for invasive species to establish and transition the sod-former community to an Invaded State.

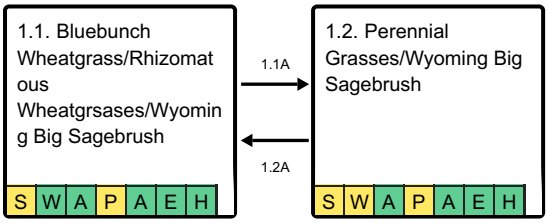
R3A - Long-term grazing management with incorporation of rest to allow recovery with assistance with seeding of desirable species are needed to restore this community.

T3A - Drought and canopy disturbance with seed sources present encourages the transition to the Invaded State.

R4B - Integrated pest management, long-term grazing management with seeding is required to reclaim or restore to a non-invaded state.

T5A - The lack of management or seeding failure allow the re-invasion of this site.

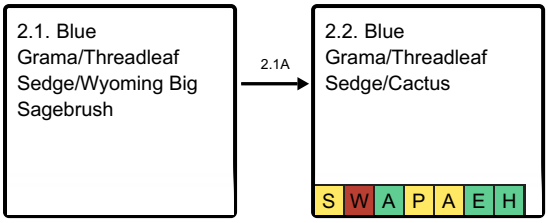
State 1 submodel, plant communities



1.1A - Frequent and severe grazing and drought will drive this community to a short-stature grass dominated community.

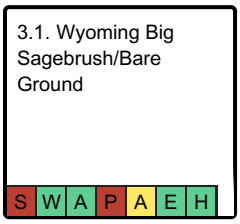
1.2A - Prescribed grazing with rest allows recovery of the desired herbaceous cover returning this community to reference, with time.

State 2 submodel, plant communities

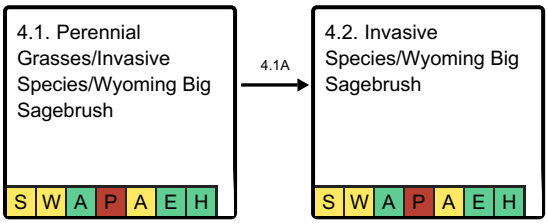


2.1A - Drought and frequent and severe grazing will remove sagebrush and encourage cactus to become dominant in the community.

State 3 submodel, plant communities

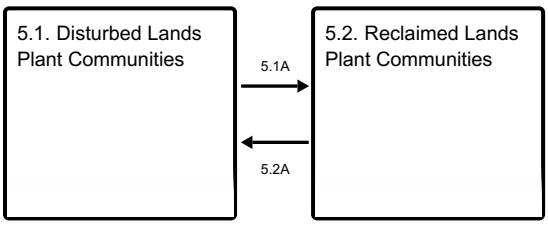


State 4 submodel, plant communities



4.1A - Drought, frequent and severe use, or fire can remove the desired natives and leave an invader dominated community.

State 5 submodel, plant communities



5.1A - Seeding, integrated pest management, and prescribed grazing with time can assist a degraded site to a reclaimed community.

5.2A - Lack of management, seeding failure or further disturbance will revert this site to a degraded community phase.

State 1
Bunchgrass/Sagebrush

The Reference State holds a healthy mix of bluebunch wheatgrass, rhizomatous wheatgrasses, as well as Indian ricegrass, needle and thread, and to a minor extent sod-formers such as blue grama and threadleaf sedge. The high calcium carbonates in the soils reduces the differences between coarser textured soils to finer textured soils. A minor shift between Indian ricegrass, blue grama and threadleaf sedge to needle and thread, western wheatgrass, and bottlebrush squirreltail does occur between sandier textures to clay loam textures. The lack of significant distinction limits the ability to separate the two communities into individual ecological sites, so the range of plant composition will capture this characteristic within the plant community tables.

Characteristics and indicators. The reference state is characterized by the dominance of bluebunch wheatgrass, at 50% or less composition by weight, with Wyoming big sagebrush at 10% or less composition by weight. The droughty nature of these soils reduces the plant cover and maintains a higher level of bare ground than a soil with no chemistry. Lichen is a common soil cover that is found to indicate elevated levels of carbonates in the soil.

Resilience management. Although bluebunch wheatgrass and sagebrush are resilient species, they are at-risk when subjected to continuous season-long or year-long grazing. Once they are removed from a community they can be difficult to recover.

Community 1.1
Bluebunch Wheatgrass/Rhizomatous Wheatgrsases/Wyoming Big Sagebrush

Figure 8. Bluebunch dominated community on a Limy Upland ecological site.

This plant community is the interpretive plant community for this site and is considered to be the Reference Plant Community. This state evolved with grazing by large herbivores. The fire role on this site is reduced by the lack of dense cover to carry a fire; although not a major role, there is still a risk for fire in this community following a year with high productivity. This plant community can be found on areas that are properly managed with grazing with areas receiving occasional short periods of rest. The potential vegetation is about 75% grasses or grass-like plants, 15% forbs, and 10% woody plants. This state is dominated by cool season mid-grasses. The major grasses include bluebunch wheatgrass, rhizomatous wheatgrasses (Western and Thickspike), needle and thread, and Indian ricegrass. Other grasses occurring in this state include bottlebrush squirreltail, prairie junegrass, and Sandberg bluegrass. Wyoming big sagebrush is a conspicuous element of this state, occurring in a mosaic pattern, and making up 5 to 10% of the annual production. Winterfat is a common component found on this site. A variety of forbs also occurs in this state and plant diversity is high (see Plant Composition Table). The total annual production (air-dry weight) of this state is about 300 lbs./acre, but it can range from about 125 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 allows for 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
- western wheatgrass (*Pascopyrum smithii*), grass
- milkvetch (*Astragalus*), other herbaceous
- spiny phlox (*Phlox hoodii*), other herbaceous
- tapertip hawksbeard (*Crepis acuminata*), other herbaceous

Dominant resource concerns

- Sheet and rill erosion
- Ephemeral gully erosion
- Compaction

- Aggregate instability
- 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	112	224	308
Shrub/Vine	22	101	168
Forb	6	11	28
Total	**140**	**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	0-15%
Litter	10-25%
Surface fragments >0.25" and <=3"	0-20%
Surface fragments >3"	0-15%
Bedrock	0%
Water	0%
Bare ground	20-40%

Table 7. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	5-10%	5-15%	0-5%
>0.15 <= 0.3	–	0-15%	5-50%	0-2%
>0.3 <= 0.6	–	0-2%	0-5%	0-2%
>0.6 <= 1.4	–	–	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

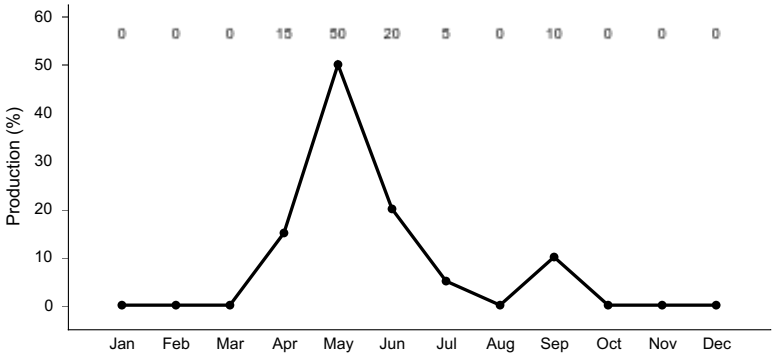


Figure 10. Plant community growth curve (percent production by month). WY0501, 5-9BH Upland sites. Monthly percentages of total annual growth for all upland sites with dominantly C3 Cool season plants..

Community 1.2
Perennial Grasses/Wyoming Big Sagebrush

Figure 11. Bluebunch wheatgrass, threadleaf sedge, and Sandberg bluegrass are prominent 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. Wyoming big sagebrush is now a conspicuous part of the overall production and accounts for the majority of the over story. The dominant grass is bluebunch wheatgrass, with Sandberg bluegrass, bottlebrush squirreltail, blue grama, and threadleaf sedge increasing on the site. Forbs commonly found in this plant community include scarlet globemallow, fringed sagewort, and spiny phlox. Wyoming big sagebrush can make up to 25% of the annual production. The over story of sagebrush and understory of grasses and forbs provide a diverse plant community. Plains prickly pear cactus will be present, but occurs in small isolated patches. Indian ricegrass and rhizomatous wheatgrass has decreased and may occur in only trace amounts under the sagebrush canopy or within cactus clumps. Winterfat is common, but different seasons and species of use will reduce its vigor. The total annual production (air-dry weight) of this state is about 200 pounds per acre, but it can range from about 125 lbs./acre in unfavorable years to about 400 lbs./acre in above average years.

Resilience management. Rangeland Health Implications/Indicators: 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 improper management and disturbance causing decadence and decrease in vigor of the vegetative cover. 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.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub

- black sagebrush (*Artemisia nova*), shrub
- winterfat (*Krascheninnikovia lanata*), shrub
- Sandberg bluegrass (*Poa secunda*), grass
- bluebunch wheatgrass (*Pseudoroegneria spicata*), grass
- squirreltail (*Elymus elymoides*), grass
- scarlet globemallow (*Sphaeralcea coccinea*), other herbaceous
- plains pricklypear (*Opuntia polyacantha*), other herbaceous
- woolly plantain (*Plantago patagonica*), other herbaceous
- tapertip hawksbeard (*Crepis acuminata*), other herbaceous

Dominant resource concerns

- Sheet and rill erosion
- Compaction
- Aggregate instability
- Plant productivity and health
- Plant structure and composition

Table 8. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	78	129	252
Shrub/Vine	56	112	168
Forb	6	11	28
Total	**140**	**252**	**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	0-10%
Litter	10-25%
Surface fragments >0.25" and <=3"	0-20%
Surface fragments >3"	0-15%
Bedrock	0%
Water	0%
Bare ground	20-50%

Table 10. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	5-10%	5-20%	1-10%
>0.15 <= 0.3	–	0-10%	0-10%	0-5%
>0.3 <= 0.6	–	0-2%	0-2%	0-2%
>0.6 <= 1.4	–	–	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

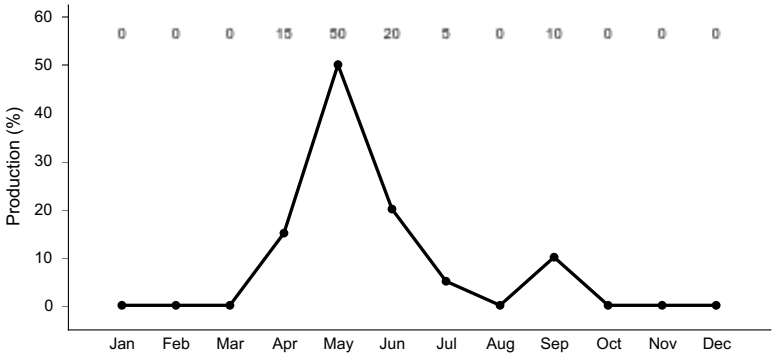
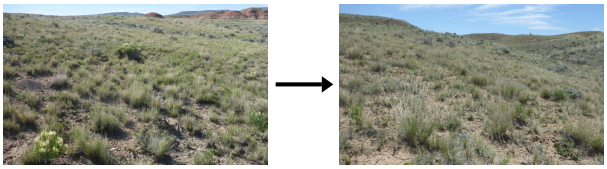


Figure 13. Plant community growth curve (percent production by month). WY0501, 5-9BH Upland sites. Monthly percentages of total annual growth for all upland sites with dominantly C3 Cool season plants..

Pathway 1.1A
Community 1.1 to 1.2



Bluebunch Wheatgrass/Rhizomatous Wheatgrsases/Wyoming Big Sagebrush

Perennial Grasses/Wyoming Big Sagebrush

Moderate, continuous season-long grazing will convert the plant community to the Perennial Grass/Wyoming Big Sagebrush Plant Community. Prolonged drought will exacerbate this transition. The stressers reduce the bunchgrasses such as Bluebunch Wheatgrass, Needleandthread, Indian ricegrass; allowing the solitary growth and sod-formers to increase in dominance in the community.

Pathway 1.2A
Community 1.2 to 1.1

Perennial Grasses/Wyoming Big Sagebrush

Bluebunch Wheatgrass/Rhizomatous Wheatgrsases/Wyoming Big Sagebrush

Prescribed grazing or possibly long-term prescribed grazing, will allow recovery of this plant community to the

Reference community. The probability of this occurring is high especially if rotational grazing along with short deferred grazing is implemented as part of prescribed method of use.

Conservation practices

Brush Management
Prescribed Burning
Grazing Land Mechanical Treatment
Integrated Pest Management (IPM)
Prescribed Grazing
Invasive Plant Species Control

State 2
Sod Bound

Blue grama and threadleaf sedge are sod-forming species that exist as a component of the perennial vegetation naturally (in reference communities) in the ecological site. The general tendency of these species is to increase under grazing pressure, becoming dominant. The species that gains dominance appears to be dependent on which species is more prevalent in the community before the negative pressures are applied.

Characteristics and indicators. This state is characterized by the dominance of these sod-formers and the lack of a most other cool-season bunchgrasses is distinct on the landscape. The lack of sagebrush and increasing cactus cover is also characteristic of the Sod-Former State (State 2).

Resilience management. Sod-forming species, blue-grama and threadleaf sedge alike, are hardy and resilient. Once they have established a dense root-mat they are extremely difficult to remove from a site without significant inputs. They also alter the natural hydrologic process of a community limiting the potential for other species to recover.

Community 2.1
Blue Grama/Threadleaf Sedge/Wyoming Big Sagebrush

This plant community is the result of frequent and severe year-long grazing, which has adversely affected the perennial grasses as well as impacted the shrub component. Other factors that can affect the shrubs include drought, heavy browsing, and other surface disturbances. A dense sod of blue grama with patches of threadleaf sedge dominates this state. Wyoming big sagebrush has been reduced to small patches, and rubber rabbitbrush is present. When compared to the Reference State (State 1), blue grama and threadleaf sedge, have increased. Prickly pear cactus has invaded. Cool-season mid-grasses, forbs, and most shrubs have been greatly reduced. Production has been 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 losing the shrub component from the plant community. The biotic integrity 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 immediate area, 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 inter-spaces and down slope. The watershed may or may not be functioning, as runoff may affect adjoining sites.

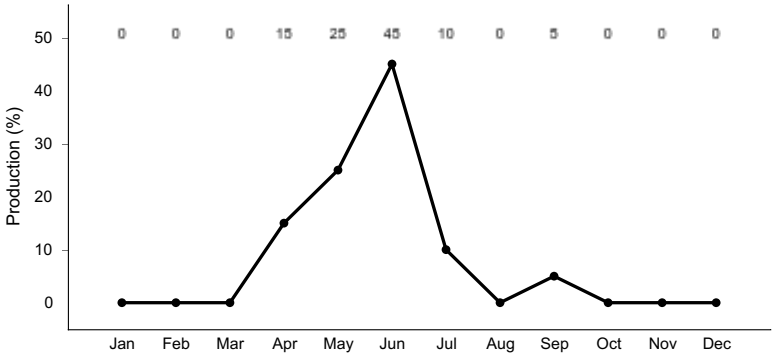


Figure 14. Plant community growth curve (percent production by month). WY0504, 5-9 BH Upland Sites Warm Season Dominate. Monthly percentages of total annual growth based on a predominately C4 warm season plant community with shrubs and some C3 plants. Generally sod-forming community..

Community 2.2
Blue Grama/Threadleaf Sedge/Cactus

Drought or continued pressure removes the remaining shrubs, leaving a sod of blue grama with patches of threadleaf sedge and cactus as the main ground cover. Prickly pear cactus can become dense enough to reduce the ability for livestock to graze the limited forage. Wyoming big sagebrush has been generally removed from the site with only isolated occurrences. Rubber rabbitbrush is significantly reduced, but will persist in the community. Compared to the Reference Community 1.1, Community 2.2 has increased in blue grama and threadleaf sedge, cactus has invaded, and cool-season grasses, forbs, and shrubs have been greatly reduced or removed. Production has been 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 sod bound community 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 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 the bare ground areas and pedestalling is apparent along the sod edges. Rill channels are noticeable in the inter-spaces 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
- blue grama (*Bouteloua gracilis*), grass
- threadleaf sedge (*Carex filifolia*), grass
- plains pricklypear (*Opuntia polyacantha*), 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
- Terrestrial habitat for wildlife and invertebrates
- Feed and forage imbalance
- Inadequate livestock shelter

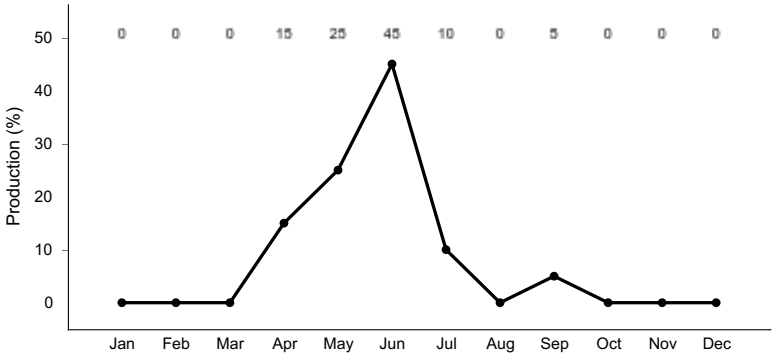


Figure 15. Plant community growth curve (percent production by month). WY0504, 5-9 BH Upland Sites Warm Season Dominate. Monthly percentages of total annual growth based on a predominately C4 warm season plant community with shrubs and some C3 plants. Generally sod-forming community..

Pathway 2.1A
Community 2.1 to 2.2

Frequent or Severe Grazing, Drought/Insect Damage, Fire/Wildfire – The Wyoming big sagebrush component of this community is the at risk species. Sagebrush will decrease under drought, and if grazing pressures persist through season or year-long patterns, becoming decadent and then dying. The sod-dominated community reduces the ability for sagebrush to propagate, also leading to a recession of the already limited sagebrush component. Although rare in occurrence, due to lack of fine fuels and canopy cover, fire will remove the shrub canopy as well. Cactus increases, and in some cases, rubber rabbitbrush will increase as sagebrush recedes. Recent drought periods (past ten years) have had an impact on the health and vigor of blue grama and threadleaf sedge. The dense root structure of the sod-forming plants is reduced allowing other species to establish.

State 3
Sagebrush/Bare Ground

If continued pressure or disturbance occurs on the vulnerable community within the reference state (State 1), it can be forced into the Sagebrush/*Bare Ground* State. Over time, drought or grazing pressures on this state will reduce the herbaceous plant cover to occurrences under the canopy of Wyoming Big sagebrush or similar shrub species (rabbitbrush) and within the protection of prickly pear cactus.

Characteristics and indicators. A sagebrush canopy with limited understory cover is the major characteristic of this community. There is a misnomer that claimed an increase in brush cover, however, the lack of understory will give the perception of increased shrub cover.

Resilience management. The soil conditions are limiting for plant establishment, and the climatic variables within this area are also challenging. Once the understory is reduced, it will take time and resources to improve the site. The existing understory species will have an influence on the recovery potential of a community. A Wyoming big sagebrush community with a scare understory of bottlebrush squirreltail was located. There were trace amounts of bluebunch wheatgrass, Sandberg bluegrass, and annual forbs. Production was low and Wyoming big sagebrush was at approximately 25% canopy. Bureau of Land Management (BLM), completed a variety of treatments over three years. The trials showed that the timing and climate during the trial determined which species would thrive. The mowing treatments during this trial occurred at optimal germination conditions for bottlebrush squirreltail. So the mowing treatment acted as a seed dispersal process allowing the plant species to flourish.

Community 3.1
Wyoming Big Sagebrush/Bare Ground

This plant community is the result of drought and frequent and severe grazing. Sagebrush dominates this plant community, and the preferred cool season grasses have been greatly reduced. The cool-season grass remnants commonly found in the understory of the sagebrush or within cactus clumps are bluebunch wheatgrass, bottlebrush squirreltail, Sandberg bluegrass, and needle and thread. The interspaces between plants have expanded leaving the amount of bare ground more prevalent. 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 an invaded or annual grass 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 may actually be more resistant to fire as less fine fuels are available and the bare ground between the sagebrush plants is increased. Continued frequent and severe grazing or the removal of grazing does not seem to affect the composition or structure of the plant community. 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.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- bluebunch wheatgrass (*Pseudoroegneria spicata*), grass
- squirreltail (*Elymus elymoides*), grass
- Sandberg bluegrass (*Poa secunda*), grass
- plains pricklypear (*Opuntia polyacantha*), other herbaceous
- spiny phlox (*Phlox hoodii*), other herbaceous
- woolly plantain (*Plantago patagonica*), 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
- Feed and forage imbalance

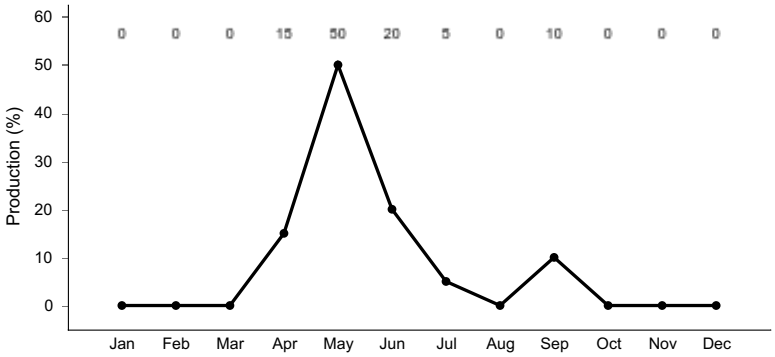


Figure 16. Plant community growth curve (percent production by month). WY0501, 5-9BH Upland sites. Monthly percentages of total annual growth for all upland sites with dominantly C3 Cool season plants..

State 4
Invaded

Invasive plant species are a permanent concern with rangelands and management. Each year new species are discovered and will alter this section as they are. Currently within the Big Horn Basin there are several varieties of thistles, knapweeds, milkweeds, mustards and others that create a management issue for livestock and ecology. In areas where there has been a disturbance, natural or man-made, these species can gain a place in the landscape and are difficult to impossible to eradicate. Because of this it becomes a battle to maintain control with annual or prolonged management of the weed species, and preventing further shifts or changes to the native composition.

Community 4.1
Perennial Grasses/Invasive Species/Wyoming Big Sagebrush

The Perennial Grasses/Invasive Species/Wyoming big sagebrush phase has maintained a representative sample of the perennial grasses and forbs that are typical of the site with the accompanying Wyoming big sagebrush composition. The invasive species are present and hold a significant (10% 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
- bluebunch wheatgrass (*Pseudoroegneria spicata*), grass
- Sandberg bluegrass (*Poa secunda*), grass
- blue grama (*Bouteloua gracilis*), grass
- cheatgrass (*Bromus tectorum*), grass
- plains pricklypear (*Opuntia polyacantha*), other herbaceous
- woolly plantain (*Plantago patagonica*), other herbaceous
- mustard (*Brassica*), other herbaceous

Dominant resource concerns

- Compaction
- Aggregate instability
- Naturally available moisture use
- Plant productivity and health
- Plant structure and composition
- Plant pest pressure
- Feed and forage imbalance

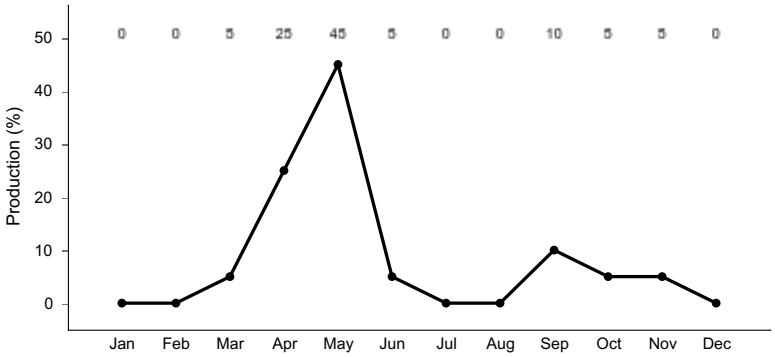


Figure 17. Plant community growth curve (percent production by month). WY0505, 5-9 BH Upland Sites, Annual Grasses Dominate. Monthly percentages of total annual growth, based on plant communities being affected by annual grasses (cheatgrass) or similar weedy species..

Community 4.2

Invasive Species/Wyoming Big Sagebrush

Wyoming big sagebrush is able to maintain a community under a heavy infestation level unless fire or disturbance of any nature weakens the plant. The canopy of the sagebrush serves as a protected niche in the system that can hold native grass species and help them to persist. But the system is low in resistance and even lower in resilience.

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
- cheatgrass (*Bromus tectorum*), grass
- woolly plantain (*Plantago patagonica*), other herbaceous
- mustard (*Brassica*), other herbaceous
- plains pricklypear (*Opuntia polyacantha*), other herbaceous

Dominant resource concerns

- Compaction
- Aggregate instability
- Naturally available moisture use
- Plant productivity and health
- Plant structure and composition
- Plant pest pressure
- Wildfire hazard from biomass accumulation
- Feed and forage imbalance

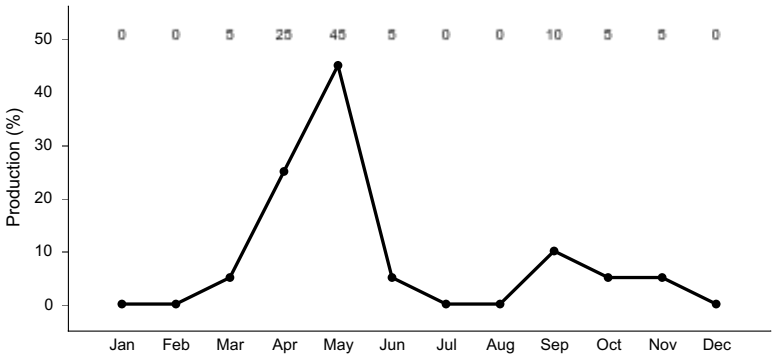


Figure 18. Plant community growth curve (percent production by month). WY0505, 5-9 BH Upland Sites, Annual Grasses Dominate. Monthly percentages of total annual growth, based on plant communities being affected by annual grasses (cheatgrass) or similar weedy species..

Pathway 4.1A
Community 4.1 to 4.2

Frequent or Severe Grazing, Drought, Disturbances (mechancial) 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.

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. To consider this as an alternate ecological site would not be unreasonable. In some cases (site by site consideration), a re-correlation of a location may be the best solution. But in many cases, the site has not been altered out of the current site, but the potential has shifted enough that it is no longer truly comparable to the reference community. So a dynamic state was captured to detail the altered communities that exist on the landscape.

Community 5.1
Disturbed Lands Plant Communities

The title Disturbed Lands is encompassing three 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. In a similar process, mined lands or lands affected by energy development including transmission corridors, transportation corridors and 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 last type of Disturbed lands is the “introduced grass plantings”. Although this could be considered reclaimed or restored, there are sites that were seeded to introduced or improved species, such as crested wheatgrass, smooth brome, or tall wheatgrass in a monoculture. These communities will transition or mature as the stand density declines with lack of management or inputs, the canopy opens and allows natives, if present, to begin to establish. Although each planting is highly variable on the exact composition that will be present, they appear to be stable and can be productive sites. 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.

Community 5.2
Reclaimed Lands Plant Communities

Reclamation practices have shifted greatly over the last several decades. Crested wheatgrass was a species used frequently for reclamation throughout Wyoming and many of these communities persist today. Although there are areas where native species from neighboring sites are starting to slowly extend into the crested wheatgrass stands, many times, these stands remain as a monoculture until a disturbance occurs to open the canopy slightly to provide a more tolerable niche. Bozosky Russian wildrye and varieties of rhizomatous and bunch-wheatgrasses have also been used in mixes to help compensate for the chemistry of these soils. Although the success of vegetative seedings are low in this LRU, due to the low precipitation and timing of precipitation events, there are limited areas along pipeline corridors, well sites or pad sites, and along transportation corridors where re-seeded sites have succeeded. As mentioned in the community phase above, as these seedings mature and the stands open, they can be characteristically similar to other disturbed sites. Where under the more current, and understood definition of reclaimed or restored, sites are planted to as close to a natural occurring plant community as possible. This excludes the use of non-native species and allows for a more similar ecological response than what is expected with

non-native species. Again, these seedings will not replicate the reference community in response to management due to the change in soil dynamics with mechanical disturbance, seedbed preparation and seeding, but they can be very similar. The growth curve of this plant community will vary depending on the species that are selected as the reclamation seed mix. 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: Seeding mixtures will determine the plant community resistant to change and resilience to threat of invasive species and to erosion. Many of the stands established during seeding are diversity poor, but are better than the monocultures that were planned historically. Many seeded sites may be prone to fire as they mature as many of the cultivated seeds produce more biomass (possibly more litter) and thus may create more fine fuels to fuel a fire. Soil erosion is variable depending on the establishment of the seeding, how it is seeded, and mechanical procedures put in place. 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.

Pathway 5.1A
Community 5.1 to 5.2

Seeding, Brush Management, Integrated Pest Management, Prescribed grazing management – With the proper mechanical improvements and the follow-up through establishment and then maintenance, a disturbed site can be improved and managed. However, climatic limitations and soil chemistry limit the success of seeding treatments. Depending on the site location, invasive species are a risk to most sites within the Basin and create a low success potential for this process.

Conservation practices

Critical Area Planting
Grazing Land Mechanical Treatment
Range Planting
Heavy Use Area Protection
Integrated Pest Management (IPM)
Native Plant Community Restoration and Management
Prescribed Grazing
Invasive Plant Species Control
Herbaceous Weed Control

Pathway 5.2A
Community 5.2 to 5.1

No use, No Fire, Long Term Prescribed Grazing, Frequent or Severe Grazing. In general, if a site is not maintained with the conditions of which the species are adapted under, a decline in vigor will occur and then a shift in composition will occur. Since the site is altered from reference state in soils due to plowing, mining, or other similar disturbances, the plant community will not follow the same expected shifts of a native community and this will refer back to a community more reflective of a disturbed plant composition.

Transition T1A
State 1 to 2

Frequent and severe grazing (yearlong grazing) will convert the plant community to the Sod-Former/Sagebrush State. Drought or the shift in precipitation timing and spring warm up has also encouraged the shift to short-statured sod-forming grasses.

Constraints to recovery. The dense root system of blue grama and threadleaf sedge are difficult to reduce to allow other native species to establish on a site. The alternation of hydrologic properties of these sod-former further

creates a dry and hostile environment for most mid-stature cool-season grasses.

Transition T1B
State 1 to 3

Frequent and severe grazing will convert the plant community to the Big Sagebrush/*Bare Ground* Plant Community. This conversion is found on areas where the sagebrush stand is not adversely impacted by drought or heavy browsing, but the herbaceous species have been weakened or removed from the system.

Constraints to recovery. The limited or lack of seed sources for the desired mid-stature cool-season bunchgrasses and the natural soil conditions that provide a harsh environment for seed germination restrict the ability for this community to recover.

Transition T1C
State 1 to 4

Frequent and severe grazing, fire, drought, or disturbance with introduction of a seed source will allow this plant community and any of the states to shift to the Invaded State. There is a high risk of crossing the threshold into the Invaded State, especially with the continued increase of invaders in high traffic areas and the persistence of drought which opens the plant community to aggressive species like cheatgrass.

Constraints to recovery. The difficulty in reducing and inability to eradicate cheatgrass is the main constraint to recovery. The limiting characteristics of the soils also restricts establishment of desirable species.

Transition T2A
State 2 to 4

Blue grama and 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 provide the potential niche for invasive species to establish, especially when there is a readily available seed source for those invasive species.

Constraints to recovery. The limited ability to eradicate invasive species such as cheatgrass limits the ability for this community to recover.

Restoration pathway R3A
State 3 to 1

The use of herbivory during the dormant season with the introduction of native seed sources to encourage the re-establishment of grasses to this community is one means of assisting with recovery of the Sagebrush/*Bare Ground* State. Rest and long-term grazing management are needed to allow the recovery of native species.

Conservation practices

Critical Area Planting
Prescribed Grazing
Grazing Land Mechanical Treatment
Range Planting
Upland Wildlife Habitat Management
Prescribed Grazing
Grazing Management Plan

Transition T3A
State 3 to 4

A combination of long-term drought or a canopy disturbance will convert the sagebrush/bare ground plant community to the Invaded State, if an invader species seed source is present.

Constraints to recovery. The challenge of eradicating or reducing and maintaining an invaded plant community while encourage native species has not been successfully accomplished, especially on these droughty soils.

Restoration pathway R4B
State 4 to 5

Integrated pest management with an intensive ground treatment to remove/eradicate the invasive species is the first process in restoring this community. The removal of the invasive species is then followed by seeding with long-term grazing management and weed management to restore or reclaim an invaded community to a native community. Success is extremely limited and is only known to have been completed on small scale areas.

Conservation practices

Cover Crop
Critical Area Planting
Prescribed Grazing
Grazing Land Mechanical Treatment
Range Planting
Upland Wildlife Habitat Management
Early Successional Habitat Development/Management
Invasive Plant Species Control

Transition T5A
State 5 to 4

The lack of weed management, further ground disturbance or seeding failure allow the invasive species to re-establish transitioning a reclaimed site back to an invaded state.

Constraints to recovery. The limited capabilities to control invasive species is the main constraint to recovery. However, the limiting characteristics of the soil also inhibit the establishment of native species that could help reduce the threat of invasive species.

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**			135–252	
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	56–224	20–50
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	6–56	1–10
	needle and thread	HECO26	*Hesperostipa comata*	6–56	1–10
2	**Rhizomatous Wheatgrasses**			6–28	
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	6–22	1–5
	western wheatgrass	PASM	*Pascopyrum smithii*	6–22	1–5
3	**Short-stature Cool-season Bunchgrasses**			0–56	
	squirreltail	ELEL5	*Elymus elymoides*	0–22	0–5
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–22	0–5
	Sandberg bluegrass	POSE	*Poa secunda*	0–22	0–5
4	**Miscellaneous Grasses/Grass-likes**			0–28	
	Grass, perennial	2GP	*Grass, perennial*	0–22	0–5
	blue grama	BOGR2	*Bouteloua gracilis*	0–22	0–5
	threadleaf sedge	CAFI	*Carex filifolia*	0–22	0–5
Forb					
5	**Perennial Forbs**			0–28	
	milkvetch	ASTRA	*Astragalus*	0–22	0–5
	bastard toadflax	COUM	*Comandra umbellata*	0–22	0–5
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	0–22	0–5
	fleabane	ERIGE2	*Erigeron*	0–22	0–5
	desertparsley	LOMAT	*Lomatium*	0–22	0–5
	spiny phlox	PHHO	*Phlox hoodii*	0–22	0–5
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–22	0–5
	Forb, perennial	2FP	*Forb, perennial*	0–22	0–5
Shrub/Vine					
6	**Dominant Shrubs**			28–112	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	22–84	5–10
	black sagebrush	ARNO4	*Artemisia nova*	0–56	0–10
	winterfat	KRLA2	*Krascheninnikovia lanata*	6–22	1–5
7	**Miscellaneous Shrubs**			0–56	
	prairie sagewort	ARFR4	*Artemisia frigida*	0–22	0–5
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–22	0–5
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–22	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**			56–140	
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	56–140	10–50
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–22	0–5
	needle and thread	HECO26	*Hesperostipa comata*	0–22	0–5
2	**Rhizomatous Wheatgrasses**			0–28	
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–22	0–5
	western wheatgrass	PASM	*Pascopyrum smithii*	0–22	0–5
3	**Short-stature Cool-season Bunchgrasses**			6–84	
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–56	0–10
	squirreltail	ELEL5	*Elymus elymoides*	0–22	0–5
	Sandberg bluegrass	POSE	*Poa secunda*	6–22	0–5
4	**Miscellaneous Grasses/Grass-likes**			0–22	
	Grass, perennial	2GP	*Grass, perennial*	0–22	0–5
	blue grama	BOGR2	*Bouteloua gracilis*	0–22	0–5
	threadleaf sedge	CAFI	*Carex filifolia*	0–22	0–5
Forb					
5	**Perennial Forbs**			0–28	
	milkvetch	ASTRA	*Astragalus*	0–17	0–5
	bastard toadflax	COUM	*Comandra umbellata*	0–17	0–5
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	0–17	0–5
	fleabane	ERIGE2	*Erigeron*	0–17	0–5
	desertparsley	LOMAT	*Lomatium*	0–17	0–5
	spiny phlox	PHHO	*Phlox hoodii*	0–17	0–5
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–17	0–5
	Forb, perennial	2FP	*Forb, perennial*	0–17	0–5
6	**Annual Forbs**			0–11	
	woolly plantain	PLPA2	*Plantago patagonica*	0–6	0–2
	Forb, annual	2FA	*Forb, annual*	0–6	0–2
	madwort	ALYSS	*Alyssum*	0–6	0–2
	flatspine stickseed	LAOC3	*Lappula occidentalis*	0–6	0–2
Shrub/Vine					
7	**Dominant Shrubs**			22–112	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	22–84	5–25
	black sagebrush	ARNO4	*Artemisia nova*	0–28	0–5
	winterfat	KRLA2	*Krascheninnikovia lanata*	1–11	0–5
8	**Miscellaneous Shrubs**			0–56	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–28	0–5
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–28	0–5
	prairie sagewort	ARFR4	*Artemisia frigida*	0–11	0–5

Animal community

Animal Community – Wildlife Interpretations:

1.1 - Bluebunch Wheatgrass/Rhizomatous Wheatgrasses/Needleandthread/Wyoming Big 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 - Bluebunch Wheatgrass/Sandberg Bluegrass/Wyoming Big 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/Wyoming Big 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 - Wyoming Big 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/Wyoming Big 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.

4.2 - Invasive Species/Wyoming Big Sagebrush Plant Community: Limited nesting and cover is provided by the persistent overstory cover of the Wyoming big sagebrush.

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
1.1 Bluebunch Wheatgrass/Rhizomatous Wheatgrasses/Needleandthread/Wyoming Big Sagebrush 125-450 0.08
1.2 Bluebunch Wheatgrass/Sandberg Bluegrass/Wyoming Big Sagebrush 125-400 0.05
2.1 Blue Grama/Threadleaf Sedge/Wyoming Big Sagebrush ** **
3.1 Wyoming Big Sagebrush/*Bare Ground* ** **
4.1 Perennial Grasses/Invasive Species/Wyoming Big Sagebrush ** **
4.2 Invasive Species/Wyoming Big Sagebrush ** **
5.1 Disturbed Lands and 5.2 Restored/Reclaimed 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 be 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. 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 more erosive than the Loamy range sites and so consideration needs to be given when crossing these areas with trails and roadways.

Wood products

No appreciable wood products are present on the site.

Other products

Herbs: Several of the forb species within the communities of the Limy Upland 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 is derived from NRCS inventory data. Field observations from range-trained personnel also were used. 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 IV, and USDA NRCS Soil Surveys from various counties.

Those involved in the development of the new concept for the Limy Upland ecological site include Blaise Allen, Multi-County Rangeland Management Specialist, NRCS; and Marji Patz, Ecological Site Specialist, NRCS.

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

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-feet 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 three of these estimated points, with two 21-foot X 21-foot square extended shrub plots).
• Line Point Intercept (overstory 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 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 (Ten 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

Kirt Walstad, 3/12/2025

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.

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Date	03/25/2020
Approved by	Kirt Walstad
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 occurrence on steeper slopes of 10-20%.

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2. **Presence of water flow patterns:** Barely observable, but will see a limited extent of flow patterns occurring within the vegetation interspaces on steeper slopes (10-20%)

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

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground is 15 to 30% occurring in small patch-like areas throughout site. Interspaces between plant bases has a significant cover of lichen present, accounting for the decrease of bare ground with a decrease in plant cover compared to similar ecological sites.

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5. **Number of gullies and erosion associated with gullies:** Active gullies should not be present. The presence of increased gully activity is a strong indication of a degraded state within this ecological site.

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

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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.

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Plant cover, lichen and litter is at 70% or greater 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 5 under plant canopy.

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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 8 inches with OM of 1-2%.

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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, 15% forbs, and 10% 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.

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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.

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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:

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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 20% 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 littler 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 250 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 are natives that will increase with pressure on this site. A variety of native and non-native annuals such as alyssum, blue mustard, and exotic species found on the noxious weed list including but not limited to: cheatgrass, spotted knapweed, and bull thistle will persist on this site.

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17. **Perennial plant reproductive capability:** All species are capable of reproducing.
