USDA Natural Resources Conservation Service

Ecological site DX032X01B154
Shale (Sh) Big Horn Basin Rim

Last updated: 9/05/2019
Accessed: 05/18/2024

General information

Approved. An approved ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model, enough information to identify the ecological site, and full documentation for all ecosystem states contained in the state and transition model.

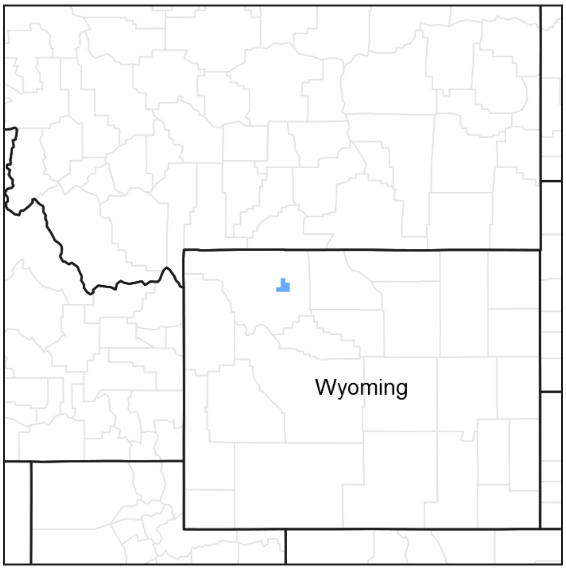


Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

MLRA notes

Major Land Resource Area (MLRA): 032X–Northern Intermountain Desertic Basins

Major land resource area (MLRA):

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 land resource units (LRUs) to allow individual ecological site descriptions (ESD s). 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 further individualize these two basins.

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 032X. 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
3.B.1. NE.5 Great Basin Saltbush Scrub Macrogroup
3.B.1. NE.5.a Intermountain Dwarf Saltbush – Sagebrush Scrub
A1110 Gardner's Saltbush Low Scrub
CEGL001438 Atriplex gardneri Dwarf-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.b Big Horn Basin
10.1.18.d Foothill Shrublands and Low Mountains
10.1.18.g Big Horn Salt Desert Shrub Basin

Ecological site concept

• This site receives no additional water.
• The slope is less than 65 percent.

• Soils in the Shale ecological site:
- are saline, sodic, saline-sodic, or gypsic
- are very shallow (depth to restrictive layer is less than 10 inches or 25 cm)
- have less than 30 percent cover of surface fragments (gravels, cobbles, and stones)
- have textures that usually range from silt loam to clay
- have less than 35 percent clay content in the mineral soil profile (0-10 inches)
- have an average particle size class of more than 25 percent but less than 65 percent clay

The Shale ecological site concept is based on soils that are very shallow: depth to a paralithic or lithic (bedrock) contact is 10 inches (25 cm). The underlying bedrock or residuum is of shale or other salt-laden sedimentary bedrock.

This Shale ecological site is very similar to and is generally associated with the Saline Upland Clayey ecological site. Cody Shale and bentonite escarpments are common geology associated with this site. Shale is less than 10 inches to shale parent material (bedrock) and saline upland is greater than 10 inches. The Saline Upland Clayey ecological site typically is found over shale or interbedded sedimentary bedrock, typically on lower and gentler slopes, and in many cases will have a very similar plant community. The production potential and erosion hazard are the two interpretive characteristics that differ between these two sites.

Associated sites

R032XY304WY	**Clayey (Cy) 10-14" East Precipitation Zone** The Clayey ecological site may have responses to disturbance, management and climatic changes similar to a saline upland site, however they lack the chemistry burden, and may not have the strong soil structure or “fluffy” tendencies as the soils dry out. Location on the landscapes are similar, but Clayey sites tend to occur in flatter places or in areas with a more concave shape allowing water to infiltrate and move through the profile better, moving salts lower in the profile.
R032XY340WY	**Saline Lowland Drained (SLDr) 10-14" East Precipitation Zone** The Saline Lowland, Drained site will have similar plants, with the presence or stronger accent of greasewood. Many times the salts will not be visible in the profile, but SAR and EC are present. Generally located on terraces or benches above a downcut or severely incised stream channel.
R032XY338WY	**Saline Lowland (SL) 10-14" East Precipitation Zone** The Saline Lowland site is greasewood-dominated, and occurs on a terrace or step below Saline Upland sites (along draws or in drainageways). They have an associated wat er table, and will generally have a higher percentage of ground cover and productivity.

Similar sites

DX032X01B141	**Saline Upland Loamy (SUL) Big Horn Basin Rim** The Saline Upland Loamy site is within the Big Horn Basin and is the loamy fraction of the general Saline Upland site. This site contains 18 to 35 percent clay within the particle-size control section and classifies typically as a fine-loamy textural class. The site has a similar composition to the original Saline Upla nd site, with a narrower concept and corrected range of production.
DX032X01B143	**Saline Upland Clayey (SUC) Big Horn Basin Rim** The Saline Upland Clayey site is within the Big Horn Basin and is the clayey fraction of the general Saline Upland site. This site contains greater than 35 percent clays within the particle-size control section and is greater than 10 inches deep to a restrictive layer. The site can look identical to the shale site, especially in a degraded state; however, the site does have the potential for greater herbaceous cover. May occur in association with a Shale site.
R032XY344WY	**Saline Upland (SU) 10-14" East Precipitation Zone** The Saline Upland site was all-encompassing for the Big Horn Basin Saline Upland sites, within the 10-14" east precipitation zone in Wyoming. This site can be very similar is characteristics and appearance but tends to have higher potential production and stability. May occur in association with a Shale ecological site.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Atriplex gardneri* (2) *Artemisia pedatifida*
Herbaceous	(1) *Achnatherum hymenoides* (2) *Elymus elymoides*

Legacy ID

R032XB154WY

Physiographic features

The Shale ecological site generally occurs on slopes ranging from nearly level to 60 percent. These soils occur where marine shales (e.g. Cody Shale and Gypsum Springs) outcrop or along eroded fans formed from interbedded sandstone and shale. They may also occupy erosional features of the foothills and lower mountain ranges with lower precipitation. The interbedded and dissected geomorphic features within the Big Horn Basin has a range of saline-driven communities. The dominant landforms associated with this site are escarpments and erosional remnants.

Many of these landforms are complex soils, with intermixed chemistry and ranging from shallow to very deep. This will create pockets of calcareous or saline or sodic soils as well as areas that are not influenced by chemistry. Transitioning across the landform positions, soils shift with the deposition of salt-laden materials or with the overflow of chemical-laden runoff. With these transitions, the break between one ecological site and another (and the representative plant community for each) is often a broad and nondescript band between the two sites. This can make it difficult, when on the landscape, to identify clearly which site is dominant for a specific point along that transitional gradient.

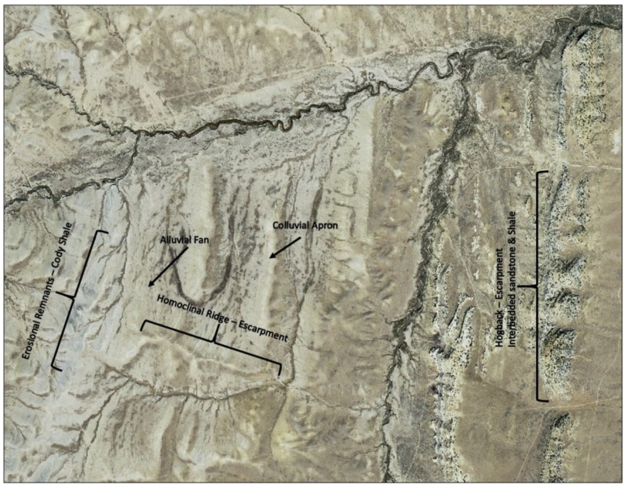


Figure 2. Physiographic Image - Aerial View of landforms and associated sites for Shale.

Table 2. Representative physiographic features

Landforms	(1) Intermontane basin > Erosion remnant (2) Intermontane basin > Escarpment (3) Intermontane basin > Pediment (4) Intermontane basin > Hillslope
Runoff class	Low to very high
Elevation	1,463–1,966 m
Slope	0–60%
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 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 D. 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)	87-97 days
Freeze-free period (characteristic range)	113-123 days
Precipitation total (characteristic range)	203-279 mm
Frost-free period (actual range)	83-108 days
Freeze-free period (actual range)	111-125 days
Precipitation total (actual range)	178-279 mm
Frost-free period (average)	93 days
Freeze-free period (average)	118 days
Precipitation total (average)	229 mm

Climate stations used

- (1) HEART MTN [USC00484411], Powell, WY
- (2) POWELL FLD STN [USC00487388], Powell, WY
- (3) CODY [USC00481840], Cody, WY
- (4) CODY 12SE [USC00481850], Meeteetse, WY
- (5) SHELL 1NE [USC00488124], Shell, 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. No streams are classified within this ecological site. The lack of water table above 60 inches (150 cm) during any part of the growing season is a key factor for the Saline Upland sites. As the landscape transitions into the bottomlands (lowlands) or drainageways, gaining overland flow and ground water influence changes the site to a saline lowland or saline subirrigated ecological site. In areas where there was historically a water table, but the stream or source has dow ncut or has been depleted, a site labeled Saline Lowland, Drained was created to cover a mixed or relict plant community.

Soil features

The soils of this site are very shallow (less than 10 inches to bedrock) well-drained soils formed from residuum. These soils have rapid to slow permeability and can be of any texture; however, range generally in the sandy clay loam, silt loam to clay. This Shale ecological site usually occurs on steep slopes with many outcrops of shale bedrock but can be found on more gentle slopes on eroded landforms. These clay shales are usually saline or alkaline in various degrees, and normally produce sparse stands of halophytes and saline-tolerant grasses. The soil characteristics with the most influence on the plant community are the very shallow soils, which drastically reduces the amount of available moisture and potential quantities of soluble salts.

Major soil series correlated to this site include Hilight, Midway, Shingle, and Rallod. This list of soil series is subject to change upon completion and correlation of the initial soil surveys WY629, WY603, and WY617; as well as revisions to completed soil surveys WY043 and MT611.

Figure 9. Soils Profile Image - Shale Soil that is very shallow to paralithic contact.

Table 4. Representative soil features

Parent material	(1) Residuum–shale (2) Slope alluvium–sedimentary rock
Surface texture	(1) Clay loam (2) Clay (3) Silty clay loam (4) Sandy clay loam
Family particle size	(1) Clayey
Drainage class	Well drained
Permeability class	Slow to moderate
Soil depth	3–25 cm
Surface fragment cover <=3"	0–10%
Surface fragment cover >3"	0–10%
Available water capacity (0-101.6cm)	1.52–5.08 cm
Calcium carbonate equivalent (0-101.6cm)	0–5%
Electrical conductivity (0-101.6cm)	2–16 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–40
Soil reaction (1:1 water) (0-101.6cm)	6.6–9
Subsurface fragment volume <=3" (Depth not specified)	5–20%
Subsurface fragment volume >3" (Depth not specified)	0–5%

Ecological dynamics

Potential vegetation on this site is dominated by salt-tolerant plants and drought-resistant mid-stature cool-season perennial grasses. The expected potential composition for this site is 30 percent grasses, 10 percent forbs and 60 percent woody plants. The composition and production will vary naturally due to variability of soluble salts and fluctuating precipitation. Historic use has played a subtler role in the variability of these sites.

As this site shifts in chemistry or as the site deteriorates, species such as birdfoot sagebrush and woodyaster will increase. Weedy annuals will invade. Cool-season grasses such as Indian ricegrass, bottlebrush squirreltail, and rhizomatous wheatgrasses will decrease in frequency and production.

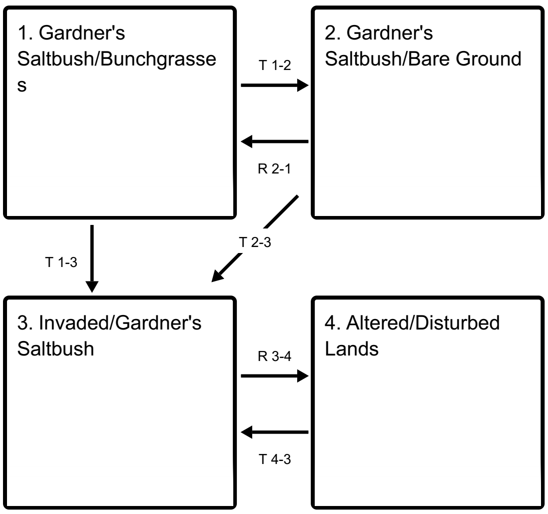
Historically, fire frequency has been included as a driving factor for this site. Because of the naturally occurring bare ground, lack of herbaceous cover, and corresponding lack of fine fuels, fire is not a threat. Fires are non-existent to extremely rare and incidental.

The following State-and-Transition Model (STM) Diagram has five fundamental components: states, transitions, restoration pathways, community phases, and community pathways. The state, designated by the bold box, is considered to be a set of parameters with thresholds defined by ecological processes. A State can be 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 dynamic ecological processes that occur on 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



T 1-2 - Natural variability, frequent and severe grazing, severe ground disturbance, drought, or a combination of these factors eliminates or prevents perennial grass establishment and supports Gardner's saltbush.

T 1-3 - Frequent and severe grazing, ground disturbance, or drought with a seed source present provides weedy species the opportunity to invade this community.

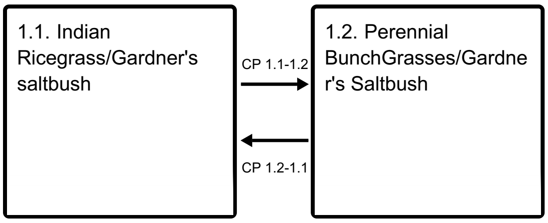
R 2-1 - Long-term prescribed grazing allows existing populations to gain vigor and encourages seedlings if seed source is available and climatic conditions are favorable. This site may require mechanical or cultural inputs to allow minor improvements in a foreseeable time frame.

T 2-3 - Drought, frequent or severe grazing, non-use, or ground disturbance with seed source present exposes this barren community to invasion by weedy species.

R 3-4 - Integrated pest management with grazing lands mechanical treatment, or rangeland seeding with prescribed grazing will be required inputs to alter the soils and hydrology of this site to allow a desirable plant cover to establish and control the invasive species (species dependent.)

T 4-3 - Drought, lack of maintenance, or further ground disturbance with seed source present exposes this disturbed community to (re-)invasion by weedy species.

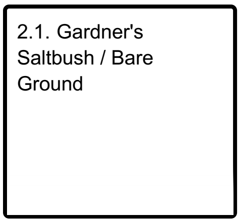
State 1 submodel, plant communities



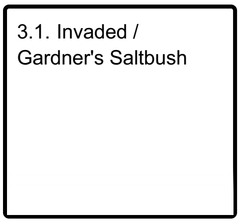
CP 1.1-1.2 - The combination of frequent and severe grazing and drought or the natural variability in amount and timing of precipitation influence the abundance and dominance of Indian ricegrass compared to bottlebrush squirreltail and Sandberg bluegrass.

CP 1.2-1.1 - Given time to rest and recover and respond to favorable conditions, or once the pressure is released (climatic patterns return to normal), composition will shift back to an Indian ricegrass site.

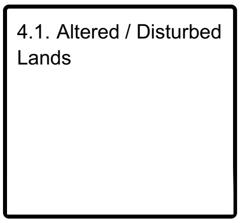
State 2 submodel, plant communities



State 3 submodel, plant communities



State 4 submodel, plant communities



State 1
Gardner's Saltbush/Bunchgrasses

The Shale ecological site is a complex concept that includes a wide range of soil chemistry that creates a salt-tolerant community, much like Saline Upland ecological sites. However, the plant community is low in diversity because of this complexity. Field sampling cannot capture the full dynamic of the chemistry and the current lack of soil laboratory data prevents clear separation of specific characteristics. Composition and production for this, the Reference State, and for State 2 have been designed to incorporate the range of possibilities. Soils within the Shale Big Horn Basin Rim site have a wide range of alkali, saline, sodic and gypsum influences, and are characterized by Gardner's saltbush-dominated plant communities. These communities may also have birdfoot sagebrush, Pursh seepweed, and greasewood in some locations.

Characteristics and indicators. Gardner's Saltbush, and other salt-tolerant dwarf shrubs, contributes 60 percent of this community. The grass, comprising 30 percent of the plant community, is predominately bottlebrush squirreltail; however, Indian ricegrass, rhizomatous wheatgrasses, and alkali sacaton are common. Needle and thread and threadleaf sedge are incidental in this state. The forb component is minor with only 10 percent of the production from a few select forbs. A variety of biscuitroot/desertparsley (Lomatium), wild onion, and woodyaster are found in this state. As this site degrades, flatspine stickseed will increase.

Resilience management. The chemistry and soil tendencies of this ecological site reduces the general resilience of this site. The hardiness of the species on this site make it resistant to change.

Dominant plant species

- Gardner's saltbush (*Atriplex gardneri*), shrub
- Indian ricegrass (*Achnatherum hymenoides*), grass
- squirreltail (*Elymus elymoides*), grass
- western wheatgrass (*Pascopyrum smithii*), grass
- Sandberg bluegrass (*Poa secunda*), grass

Community 1.1
Indian Ricegrass/Gardner's saltbush

Figure 10. Community 1.1 – Reference Site with Gardner's saltbush and Indian ricegrass.

The Reference Plant Community for the Shale ecological site is a token of the erosive and droughty saline and alkaline soils. This plant community can be found on a wide range of management scenarios but is most prevalent in areas receiving periods of rest with moderate to light use. Potential vegetation consists of about 30 percent grasses or grass-like plants, 1 0 percent forbs, and 60 percent woody plants. Gardner's saltbush is the dominant vegetation in the community. Other salt-tolerant shrubs frequently found are birdfoot sagebrush, Pursh seepweed , and in some instances, greasewood. Greasewood is most commonly found at the toe or lower portions of the slope where water may permeate along the shale surface, seeping out along the lower margins of the shale beds. The major grasses are Indian ricegrass and bottlebrush squirreltail, but rhizomatous wheatgrasses, Sandberg bluegrass, and alkali sacaton are common. Other grasses that occur in this state include Sandberg bluegrass, needle and thread, and (rarely) threadleaf sedge. A variety of forbs may also occur in this state (see Plant Composition Table). Overall, the site tends to be poor in species diversity, but an evenly distributed community. The total annual production (air-dry weight) of this state is about 175 pounds per acre, but it can range from about 80 lbs./acre in unfavorable years to about 300 lbs./acre in above average years.

Resilience management. Rangeland Health Implications/Indicators: This state is at-risk, but well adapted to the variable climatic conditions within the Big Horn Basin. The species adapted to this site are drought-tolerant and can adapt to or transition as the site persists through natural drought conditions. This is a sustainable plant community but is difficult to reestablish when degraded. Site and soil stability, watershed function, and biologic integrity are unique to this site and function at the best possible levels. Higher extents of bare ground and the erosional tendencies of salt-laden soils leave this site naturally vulnerable to sheet and wind erosion.

Dominant plant species

- Gardner's saltbush (*Atriplex gardneri*), shrub
- Indian ricegrass (*Achnatherum hymenoides*), grass
- squirreltail (*Elymus elymoides*), grass

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	56	90	168
Grass/Grasslike	28	84	140
Forb	6	22	28
Total	**90**	**196**	**336**

Table 6. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	25-50%
Grass/grasslike foliar cover	10-30%
Forb foliar cover	0-10%
Non-vascular plants	0%
Biological crusts	0-5%
Litter	5-10%
Surface fragments >0.25" and <=3"	0-10%
Surface fragments >3"	0-10%
Bedrock	0%
Water	0%
Bare ground	35-65%

Table 7. 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	0-5%
Litter	5-10%
Surface fragments >0.25" and <=3"	0-10%
Surface fragments >3"	0-10%
Bedrock	0%
Water	0%
Bare ground	30-65%

Table 8. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	20-50%	10-20%	0-5%
>0.15 <= 0.3	–	0-20%	0-10%	0-5%
>0.3 <= 0.6	–	0-10%	0-5%	–
>0.6 <= 1.4	–	–	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Figure 12. Plant community growth curve (percent production by month). WY0701, 10-14E upland sites.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
			5	25	40	10	5	10	5		

Community 1.2
Perennial BunchGrasses/Gardner's Saltbush

As the Reference Community begins to fail, Sandberg bluegrass becomes a stable bunchgrass with Gardner’s saltbush. This plant community can is still found on a wide range of management scenarios but is most prevalent in areas under continuous, season-long grazing practices. Potential vegetation consists of about 25 percent grasses or grass-like plants, 10 percent forbs, and 65 percent woody plants. Gardner’s saltbush maintains as the dominant vegetation in the community. Birdfoot sagebrush generally is more prevalent as well on these sites, however, it is not understood if it is a relation to use or natural variability in the soils. Pursh seepweed is still commonly found in the community and, as in Reference Community 1.1, greasewood is still not uncommon. Rhizomatous wheatgrasses and Sandberg bluegrass increase in composition as Indian ricegrass begins to fade from the community. Bottlebrush squirreltail will maintain across into this community, and alkali sacaton is still frequently located in this plant community. The total annual production (air-dry weight) of this state is about 150 pounds per acre, but it can range from about 75 lbs./acre in unfavorable years to about 250 lbs./acre in above average years.

Resilience management. Rangeland Health Implications/Indicators: This state is stable in comparison to the Reference Community but is still at risk of degrading. The lower stature bunchgrasses are best adapted to the variable climatic conditions within the Big Horn Basin. The species adapted to this site are drought-tolerant and can adapt to or transition with the variable precipitation events. This is a sustainable plant. Site and soil stability, watershed function, and biologic integrity are unique to this site and function is minimally to not affected with this shift in the plant community. Higher extents of bare ground and the erosional tendencies of salt-laden soils leaves this site naturally vulnerable to sheet and wind erosion.

Dominant plant species

- Gardner's saltbush (*Atriplex gardneri*), shrub
- squirreltail (*Elymus elymoides*), grass
- western wheatgrass (*Pascopyrum smithii*), grass
- Sandberg bluegrass (*Poa secunda*), grass

Table 9. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	56	90	168
Grass/Grasslike	22	62	84
Forb	6	17	28
Total	**84**	**169**	**280**

Table 10. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	25-50%
Grass/grasslike foliar cover	10-30%
Forb foliar cover	0-10%
Non-vascular plants	0%
Biological crusts	0-5%
Litter	5-10%
Surface fragments >0.25" and <=3"	0-10%
Surface fragments >3"	0-10%
Bedrock	0%
Water	0%
Bare ground	35-65%

Table 11. 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	5-10%
Litter	0-5%
Surface fragments >0.25" and <=3"	0-10%
Surface fragments >3"	0-10%
Bedrock	0%
Water	0%
Bare ground	35-65%

Table 12. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	20-50%	10-20%	0-5%
>0.15 <= 0.3	–	0-20%	0-5%	0-5%
>0.3 <= 0.6	–	0-10%	0-5%	–
>0.6 <= 1.4	–	–	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Figure 14. Plant community growth curve (percent production by month). WY0701, 10-14E upland sites.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
			5	25	40	10	5	10	5		

Pathway CP 1.1-1.2
Community 1.1 to 1.2

Frequent and severe grazing or drought - The combination of frequent and severe grazing and drought weakens Indian ricegrass, while Sandberg bluegrass may increase or maintain its production. Chemistry or erosional patterns may also contribute to this natural swing or shift between Community 1.1 and 1.2.

Context dependence. Difficulties in identifying the mechanism that is causing a particular plant shift in this State's community phases relate to the complexity of the chemistry within the soil profile, the variability in slope (grade and shape), as well as annual variation in vegetative cover from year to year.

Pathway CP 1.2-1.1
Community 1.2 to 1.1

Prescribed grazing over time with rest—The ability for Indian ricegrass to establish is limited by the availability if a seed source and the limitations of the soils for seedling germination. But given time and in favorable conditions this can occur. Many times, in the case of drought, once the pressure is released (climatic patterns return to normal), the natural fluctuations in precipitation driven production will shift back and Indian ricegrass will be expressed as dominant on the site.

Context dependence. The complexity of the chemistry within the soil profile, the variability in slope (grade and shape), as well as annual variation in vegetative cover from year to year can make it difficult to identify the mechanism that is causing a particular plant shift in this State's community phases.

Conservation practices

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

Planned Grazing System
Prescribed Grazing
Grazing Management Plan
Monitor key grazing areas to improve grazing management
Monitoring and Evaluation
Prescriptive grazing management system for grazed lands

State 2
Gardner's Saltbush/Bare Ground

Although Gardner's saltbush/bare ground community is the most common community identified across the Big Horn Basin, there is a rationale to be considered on timing of the year of inventory, the soil-specific conditions, and climatic factors for the year. Complexity of chemistry may be one factor for the lack of grasses and forbs in this state, but drought and management can also contribute to the shift. Determination of the drivers for specific shifts to this community are not conclusive and require additional investigation. It is recognized, however, that continuous grazing pressure and drought conditions, the productivity and sustainability of most perennial grasses diminish, creating a shrub-dominated state. In the absence of invasive species, this state will persist on the landscape.

Characteristics and indicators. Gardner's saltbush stands as a near-monoculture on this site. Forbs and a few other woody species will persist on this site; however, all perennial grasses have been removed from this community.

Resilience management. In the absence of invasive species, this state will persist on the landscape. Very long-term prescribed grazing and grazing land mechanical treatment (with possible seeding) may be practices that can be used to bring this state near or similar to Reference. Remnant populations of native perennial grasses are rare driving the need for inter-seeding to reestablish herbaceous species to this community. No research was located for large areas of revegetation, but limited success has occurred with seeding trials completed by the Bureau of Land Management (BLM) and the University of Wyoming.

Dominant plant species

- Gardner's saltbush (*Atriplex gardneri*), shrub
- Pursh seepweed (*Suaeda calceoliformis*), shrub

Community 2.1
Gardner's Saltbush / Bare Ground

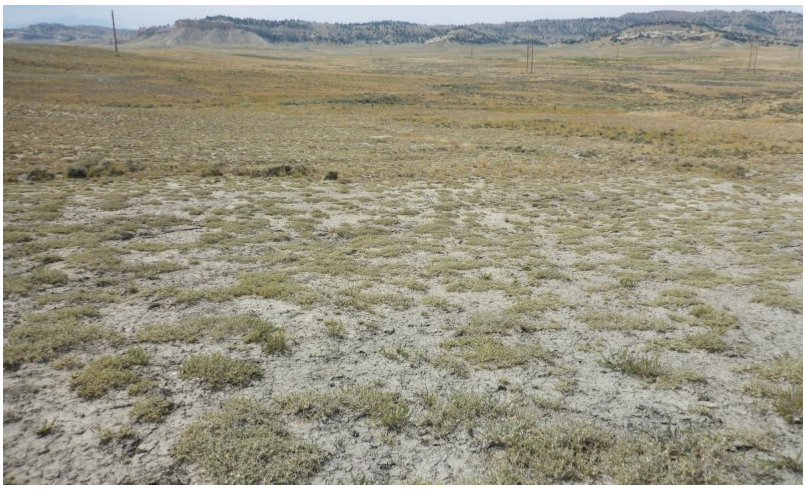


Figure 15. Saltbush dominated community with minimal herbaceous coverage in woody canopy gaps.

This plant community can occur where sites are subjected to continuous, season-long (year-long) grazing and with certain soil chemistry. Gardner's saltbush dominates this site, comprising almost 100 percent of the plant community. The interspaces between plants had no shift or only minimal change, but the loss of herbaceous plants left the soils even more vulnerable to the erosive elements. Elimination of all grasses reduced the plant production, but woody and forb composition did not change when compared to the Reference communities (1.1 and 1.2). The overall change to this community is not substantial in size, but significant in implication. The following production range does not capture the extreme variability in leaf and leader production, rather it is based on an average. The total annual production (air-dry weight) of this state averages 100 pounds per acre, but it can range from 35 lbs./acre in unfavorable years to 175 lbs./acre in above average years.

Resilience management. Rangeland Health Implications/Indicators: This plant community is resistant to change. Fire plays no role in this community; however, historically it was stated to be a factor. The lack of fine fuels, large patchwork of bare ground and erosional tendencies reduce the risk of fire and inhibit the ability for improvement. Grazing, or lack thereof, has not been found to affect the plant composition or structure of the plant community. Plant diversity is extremely low. The plant vigor and replacement capabilities are dependent upon the soil properties and climatic variabilities. Plant litter is similar but tends to be less when compared to the Reference plant communities (1.1 and 1.2) in response to loss of herbaceous cover. Noxious weeds such as cheatgrass (downy brome) and halogeton can invade the large openings, forcing the transition to the Invaded State. Soil erosion is accelerated because of loss of herbaceous cover, and the associated fibrous root system stability. Shifts in bare ground are minimal but do attribute to the erosional changes. Water flow patterns are obvious, and pedestalling may be visible with woody structure. Infiltration is reduced and runoff is increased. Rill channels are distinct in the interspaces; gullies are common where rills have concentrated downslope, especially in areas of new disturbance. These sites are prone to gulling when there is an intense precipitation event or fast melt off following a significant dry period, especially in sodic soils that have become “fluffy” during dry periods. Sodium causes a flocculation of the soils (a detachment of soil particles), that when dried typically become very hard. In some instances, the surface will become billowed and loose. When either is wetted, particles are easily dispersed or moved (erosive).

Dominant plant species

- Gardner's saltbush (*Atriplex gardneri*), shrub

Table 13. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	34	101	168
Forb	6	11	28
Grass/Grasslike	–	–	–
Total	**40**	**112**	**196**

Table 14. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	25-50%
Grass/grasslike foliar cover	0%
Forb foliar cover	0-5%
Non-vascular plants	0%
Biological crusts	0-5%
Litter	0-5%
Surface fragments >0.25" and <=3"	0-10%
Surface fragments >3"	0-10%
Bedrock	0%
Water	0%
Bare ground	45-70%

Table 15. 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	0-5%
Litter	0-5%
Surface fragments >0.25" and <=3"	0-10%
Surface fragments >3"	0-10%
Bedrock	0%
Water	0%
Bare ground	45-70%

Table 16. Canopy structure (% cover)

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

Figure 17. Plant community growth curve (percent production by month). WY0701, 10-14E upland sites.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
			5	25	40	10	5	10	5		

State 3
Invaded/Gardner's Saltbush

Areas of weed-free shale communities that are surrounded by weed-dominated communities of associated sites create the appearance of being resistant to invasion by many undesirable species threatening the rangelands today. Shale soils are still vulnerable to a selection of species that still present issues as these lands are disturbed by development, continued drought, and shifts in use patterns. Many of these sites are at-risk from local threats such as mustards, Russian thistle, and clasping pepperweed; as well as the national threats of halogeton, cheatgrass (downy brome), and a variety of thistles. The persistence, resistance, and resilience of the specific risk is species-dependent.

Characteristics and indicators. This site will maintain a saltbush dominated community that may resemble Community phases 1.1, 1.2, or 2.1 but with a significant presence (5 percent or greater) of an invasive weed.

Resilience management. The persistence, resistance and resilience of specific is species dependent.

Dominant plant species

- Gardner's saltbush (*Atriplex gardneri*), shrub
- squirreltail (*Elymus elymoides*), grass
- Sandberg bluegrass (*Poa secunda*), grass

Community 3.1
Invaded / Gardner's Saltbush

Figure 18. Native and Invasive weed species in a Shale ecological site.

The Invaded/Gardner’s Saltbush plant community is a mirror of either State 1 or State 2, maintaining representative sample of the native perennial grasses and forbs with the accompanying Gardner’s Saltbush composition. The presence of invasive species in a significant (5 percent or greater) composition of the community is the key indicator the threshold is crossed. This composition is based on a wider-scale composition, not isolated patches on the landscape. Production of the desired perennial species of this site generally is reduced but the total production is maintained or elevated due to the production potential of many of the annual or invasive species. Production of this community phase will vary depending upon the invasive species. Site-specific evaluation will need to be completed to determine productivity and the growth curve that is best suited.

Resilience management. Rangeland Health Implications/Indicators: This plant community is resistant to change. Plant diversity is moderate to poor. The plant vigor is diminished and replacement capabilities are limited due to the reduced composition 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 upon the species of invasion and the associated litter accumulation. This variability also applies to water flow patterns and pedestalling. Infiltration and runoff effects may vary with species. Increased biomass of cheatgrass and even potentially halogeton may improve these factors; however, no data has been found to support either at this time.

Dominant plant species

- Gardner's saltbush (*Atriplex gardneri*), shrub

State 4
Altered/Disturbed Lands

Recreation (all-terrain vehicles, known as ATVs), roads, trails, and mining and energy development are the land uses that have had a majority of an impact on this site. Soils that are correlated as Shale rank low on capability classes and tend to be labeled as non-useable or non-productive, and either no attempt was made to reclaim areas or reseeding attempts have failed. As this land recovers and is restored or reclaimed, or if further disturbances occur, the site potential and stability is greatly affected.

Characteristics and indicators. Lands that fall within this State have had major soil disturbance, human - animal - or natural, that has altered the surface, contact with the paralithic or lithic layer, or has removed the saltbush community from the site. Increased erosion, loss of the saltbush cover, evidence of mechnaical manipulation of the site, and early successional plants dominating the community (non-invasive weeds) are key indicators of this State.

Resilience management. The natural succession of disturbed sites are driven by soil chemistry and hindered by the erosive tendencies of the soils. The limitation to resiliency in this State is the inability for the soils to recover or return to an undisturbed condition once mechanically altered.

Community 4.1
Altered / Disturbed Lands

Terms such as "sacrifice areas," "badlands," and "wastelands" are common for this site. Although attempts are made to improve these areas, success is limited. Degraded or disturbed lands are locations that have been impacted by human settlement and land use development. Big Horn Basin offers a diverse geology that provides mining opportunities for bentonite, limestone, gravels, and oil. Well pads, pits, and spoil areas accompanying the haul roads and access points leaves a notable footprint on the landscape. The Basin was settled initially by and for farming, with an extensive hand-dug irrigation network to carry water to many otherwise wastelands. However, scarcity of water (drought impacts), economics of farming, and soil health awareness has caused many to abandon farming for other land uses. Shale sites generally were not farmed but were impacted by the activity on surrounding soils. Rangeland improvement trials were completed in the late 1940s and early 1 960s by the Bureau of Land Management in conjunction with University of Wyoming. Trials include d water spreader dikes, contour furrowing, and range seeding. These barren landscapes were contour furrowed or seeded predominantly with crested wheatgrass (Agropyron Cristatum) and Russian wildrye (*Psathyrostachys juncea*). The objective was to create increased water-holding capacity, improving vigor and production of Nuttall's (Gardner's) Saltbush, and enhance seed establishment. Locations that have been reviewed show a range of success with crested wheatgrass seedings. Furrows and spreader dikes are visible but are holding significant sediment loads. Productivity varies greatly between disturbance types, age and successional stage of recovery, and seeding mixes. Due to the lack of current and comparative production data, no production estimate is provided. The growth curve will depend upon the species seeded, or the succession completed, so no growth curve will be given.

Resilience management. Hydrologic changes with mechanical soil disturbance, in conjunction with introduced species, alters the functionality of the disturbed lands away from Reference. The response of these soils is not expected to recover to the pre-disturbance function in a lifetime. Therefore, these communities will not respond the same as an unaltered, native community. Similarly, with lands that were farmed and irrigated and then left to return to a natural state, the vegetation is not able to respond the same as a Reference community. As a point of detail, altered sites may have an increased potential depending upon the extent, type, and conditions of the disturbance. Persistence of introduced or improved species and character growth traits assist in identifying this community. Although not invasive, their aggressive nature helps them to thrive in harsh conditions. Crested wheatgrass, Russian wildrye, rhizomatous wheatgrasses, Indian ricegrass, and big bluegrass are a few cultivar species that have been planted and have persisted on the landscape, altering the community. Mechanical seedbed preparation alone, without consideration of the original disturbance, is an alteration to the soil function and will alter hydrology to an extent (practice-specific). In associated sites, a reclaimed community is included. For this ecological site, the shallow nature of the soils to a restrictive layer limits the ability to reclaim to a natural state. Successful restoration or reclamation to a native community has not been identified. Improvements and reclamation to a functional landscape have been attempted to limited success and are discussed above. For this reason, no reclaimed/restored community will be described for this Saline Upland ecological site.

Transition T 1-2
State 1 to 2

Natural variability, frequent and severe grazing, severe ground disturbance, or Drought—The combination of frequent and severe grazing and drought reduces the key bunchgrasses of this community. With no recovery time or rest, the herbaceous species may become very sparse and grasses specifically will be removed from the community leaving a saltbush-dominated site. Extended long periods of drought alone or severe ground disturbance reduces or inhibits resiliency of this community, including Gardner's saltbush. Combinations of soil chemistry may also be a natural factor for the lack of grasses in the system. Soils that are high in both sodium and gypsum commonly are less accommodating to grasses.

Constraints to recovery. The soil chemistry, fine-earth textures, and depth to shale create a hostile environment for seedling establishment. The added tendency of forming soil crusts, which become extremely hard or "fluffy," and the lack of seed source make it very difficult for this community to recover under natural circumstances.stances.

Context dependence. Recovery is not a factor for those communities that are results of a variability or complexity in the soil chemistry driving the lack of herbaceous cover. this natural variability is an influence of the natural soil profile and would be considered the reference potential of that location.

Transition T 1-3
State 1 to 3

Frequent and severe grazing, ground disturbance, or drought with a seed source prese nt—The combination of frequent and severe grazing and drought reduces the key bunchgrasses of this community and provides invasive species the opportunity to establish once the seed source is present. Hoof impact, an intensive storm event, or other single disturbance can be enough to create the niche needed for invasive species seedling establishment.

Constraints to recovery. Weed control technology limits the ability for these sites to recover. Access to sites, chemical limits with the high chemistry in the soil, and the lack of eradication methods for most major invasive weeds are the recover constraints for this community.

Restoration pathway R 2-1
State 2 to 1

Prescribed grazing (long-term), (possibly with seeding)—By reducing use and allowing native grasses to recover with prescribed grazing, the potential to recover is dependent upon a seed source and climate. However, the time required may not be feasible. Native seed mixtures that have been proven to tolerate saline, sodic, or saline/sodic soils are not necessarily the key species for the Reference communities. Once a site is seeded (drilled or broadcast seeding), the response to management and climatic conditions may be altered, and the site will not function as a native (undisturbed) site, and would correlate as a reclaimed site.

Transition T 2-3
State 2 to 3

Non-use, ground disturbance (with seed source present), drought, frequent or severe grazing—Once a community has transitioned to a saltbush-dominated community, productivity and functionality of the site are at risk. If further disturbance (livestock, human, or environmental disturbance) occurs, or a seed source is introduced into this at-risk community, annuals and other less desirable species gain the opportunity to establish.

Constraints to recovery. The ease of access due to slope and lack of desirable roads, as well as soil inhibitions with herbicides can make treating or controlling weeds difficult. The need to stabilize the soils (reduce erosion) along with weed control can make the economics of treating this community challenging. The specific species of invasive weeds that are established on a location, the size of the community that is being treated, and the specific soil chemistry will all alter how a location will respond to the invasion and the treatment.

Restoration pathway R 3-4
State 3 to 4

Integrated pest management, grazing land mechanical treatment, or rangeland seeding with prescribed grazing—Once invasive species such as cheatgrass, halogeton , or thistles are established, complete eradication generally is not a feasible option, limiting the ability to restore the community to a higher state. An invaded site, however, can be restored to a functional plant community through intensive or integrated pest management. Grazing land mechanical treatments to reduce existing invasive populations and to introduce forage species that are desirable, adapted to the soils, and able to compete with the invasive species will possibly improve the grazing suitability of this community. Establishment will be slow and the variety of available seed sources for saline, sodic, alkaline, or gypsic soil conditions is limited; however, small-scale projects have been achieved with marginal success.

Conservation practices

Critical Area Planting
Mulching
Prescribed Grazing

Grazing Land Mechanical Treatment
Range Planting
Heavy Use Area Protection
Integrated Pest Management (IPM)
Upland Wildlife Habitat Management
Planned Grazing System
Native Plant Community Restoration and Management
Prescribed Grazing
Invasive Plant Species Control
Grazing Management Plan
Improve the plant diversity and structure of non-cropped areas for wildlife food and habitat
Monitor key grazing areas to improve grazing management
Intensive Management of Rotational Grazing
Biological suppression and other non-chemical techniques to manage herbaceous weeds invasive species
High level Integrated Pest Management to reduce pesticide environmental risk
Monitoring and Evaluation
Herbaceous Weed Control
Prescriptive grazing management system for grazed lands

Transition T 4-3
State 4 to 3

Non-use, disturbance, severe and frequent grazing, or drought with a seed source present—Soils become loose because of non-use or when the decrease in key species due to severe and frequent grazing, drought, or disturbance opens the canopy and provides opportunity for invasive species to establish. Continued pressure, added disturbances, or introduction of undesirable species will weaken and trigger a shift from the Degraded State to an Invaded State.

Constraints to recovery. The inability to eradicate or suppress many invasive species is the major constraint to recovery.

Additional community tables

Table 17. 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**			22–56	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	22–56	5–20
	needle and thread	HECO26	*Hesperostipa comata*	0–11	0–5
2	**Short-stature, Cool-season Bunchgrasses**			11–34	
	squirreltail	ELEL5	*Elymus elymoides*	11–34	5–15
	Sandberg bluegrass	POSE	*Poa secunda*	0–11	0–5
3	**Rhizomatous, Cool-season Grasses**			0–22	
	western wheatgrass	PASM	*Pascopyrum smithii*	0–11	0–5
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–11	0–5
4	**Miscellaneous Grasses and Grass-likes**			22–45	
	Grass, perennial	2GP	*Grass, perennial*	0–11	0–5
	threadleaf sedge	CAFI	*Carex filifolia*	0–11	0–5
	Grass-like (not a true grass)	2GL	*Grass-like (not a true grass)*	0–11	0–5
8	**Mat-forming (Tillering), Warm-season Grasses**			0–11	
	alkali sacaton	SPAI	*Sporobolus airoides*	0–11	0–5
	blue grama	BOGR2	*Bouteloua gracilis*	0–6	0–5
Forb					
5	**Perennial Forbs**			6–28	
Shrub/Vine					
6	**Dominant Shrubs**			56–168	
	Gardner's saltbush	ATGA	*Atriplex gardneri*	56–168	20–40
7	**Miscellaneous Shrubs**			0–22	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–11	0–5
	birdfoot sagebrush	ARPE6	*Artemisia pedatifida*	0–11	0–5
	shadscale saltbush	ATCO	*Atriplex confertifolia*	0–11	0–5
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–11	0–5
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–11	0–5

Table 18. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Short-stature, Cool-season Bunchgrasses**			11–56	
	squirreltail	ELEL5	*Elymus elymoides*	6–56	5–25
	Sandberg bluegrass	POSE	*Poa secunda*	0–11	0–5
2	**Rhizomatous, Cool-season Grasses**			6–22	
	western wheatgrass	PASM	*Pascopyrum smithii*	6–22	0–10
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–11	0–10
3	**Mid-stature, Cool-season Bunchgrasses**			0–11	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–11	0–5

	needle and thread	HECO26	*Hesperostipa comata*	0–11	0–5
4	**Mat-forming (Tillering), Warm-season Grasses**			0–11	
	alkali sacaton	SPAI	*Sporobolus airoides*	0–11	0–5
	blue grama	BOGR2	*Bouteloua gracilis*	0–6	0–5
5	**Miscellaneous Grasses and Grass-likes**			0–11	
	Grass, perennial	2GP	*Grass, perennial*	0–11	0–5
	threadleaf sedge	CAFI	*Carex filifolia*	0–6	0–5
	Grass-like (not a true grass)	2GL	*Grass-like (not a true grass)*	0–6	0–5
	Grass, annual	2GA	*Grass, annual*	0–6	0–5
	annual wheatgrass	ERTR13	*Eremopyrum triticeum*	0–6	0–5
Forb					
6	**Perennial Forbs**			0–28	
	Forb, perennial	2FP	*Forb, perennial*	0–6	0–5
	textile onion	ALTE	*Allium textile*	0–6	0–5
	milkvetch	ASTRA	*Astragalus*	0–6	0–5
	tufted evening primrose	OECA10	*Oenothera caespitosa*	0–6	0–5
	tansyaster	MACHA	*Machaeranthera*	0–6	0–5
	desertparsley	LOMAT	*Lomatium*	0–6	0–5
	leafy wildparsley	MUDI	*Musineon divaricatum*	0–6	0–5
	princesplume	STANL	*Stanleya*	0–6	0–5
	smooth woodyaster	XYGL	*Xylorhiza glabriuscula*	0–6	0–5
7	**Annual Forbs**			0–6	
	madwort	ALYSS	*Alyssum*	0–6	0–5
	Wilcox's woollystar	ERWI	*Eriastrum wilcoxii*	0–6	0–5
	Forb, annual	2FA	*Forb, annual*	0–6	0–5
Shrub/Vine					
8	**Dominant Shrubs**			56–168	
	Gardner's saltbush	ATGA	*Atriplex gardneri*	34–168	20–50
9	**Miscellaneous Shrubs**			0–34	
	greasewood	SAVE4	*Sarcobatus vermiculatus*	0–22	0–5
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–11	0–5
	birdfoot sagebrush	ARPE6	*Artemisia pedatifida*	0–11	0–5
	shadscale saltbush	ATCO	*Atriplex confertifolia*	0–11	0–5
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–11	0–5

Table 19. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Forb					
1	**Perennial Forbs**			0–28	
	princesplume	STANL	*Stanleya*	0–11	0–5
	smooth woodyaster	XYGL	*Xylorhiza glabriuscula*	0–11	0–5
	milkvetch	ASTRA	*Astragalus*	0–11	0–5
	desertparsley	LOMAT	*Lomatium*	0–6	0–5
	tansyaster	MACHA	*Machaeranthera*	0–6	0–5
	leafy wildparsley	MUDI	*Musineon divaricatum*	0–6	0–5
	tufted evening primrose	OECA10	*Oenothera caespitosa*	0–6	0–5
	textile onion	ALTE	*Allium textile*	0–6	0–5
	Forb, perennial	2FP	*Forb, perennial*	0–6	0–5
2	**Annual Forbs**			0–6	
	madwort	ALYSS	*Alyssum*	0–6	0–5
	Wilcox's woollystar	ERWI	*Eriastrum wilcoxii*	0–6	0–5
	Forb, annual	2FA	*Forb, annual*	0–6	0–5
Shrub/Vine					
3	**Dominant Shrubs**			34–168	
	Gardner's saltbush	ATGA	*Atriplex gardneri*	34–168	20–50
	Pursh seepweed	SUCA2	*Suaeda calceoliformis*	0–22	0–20
4	**Miscellaneous Shrubs**			0–34	
	greasewood	SAVE4	*Sarcobatus vermiculatus*	0–22	0–5
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–11	0–5
	birdfoot sagebrush	ARPE6	*Artemisia pedatifida*	0–11	0–5
	shadscale saltbush	ATCO	*Atriplex confertifolia*	0–11	0–5
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–11	0–5

Animal community

Animal Community – Wildlife Interpretations:

1.1 – Indian Ricegrass/Gardner’s Saltbush: Perennial Bunchgrasses/Gardner’s Saltbush: This plant community exhibits a low level of plant species diversity. It may have forage value for antelope and deer, but in most cases is not a desirable plant community due to the lack of cover and selectivity by the wildlife. It is not, for most cases, a desirable plant community to select for in wildlife habitat management. Due to the open and exposed nature of this community, it may be a location for sage grouse leks, if there is edge effect provided by a sagebrush site surrounding the saltbush community.

1.2 – Perennial Bunchgrasses/Gardner’s Saltbush: This plant community exhibits a low level of plant species diversity. It may have forage value for antelope and deer, but in most cases is not a desirable plant community due to the lack of cover and selectivity by the wildlife. It is not, for most cases, a desirable plant community to select for in wildlife habitat management. Due to the open and exposed nature of this community, it may be a location for sage grouse leks, if there is edge effect provided by a sagebrush site surrounding the saltbush community.

2.1 – Gardner’s Saltbush/*Bare Ground*: This plant community exhibits a low level of plant species diversity. It may have forage value for antelope and deer, but in most cases is not a desirable plant community due to the lack of cover and selectivity by the wildlife. It is not, for most cases, a desirable plant community to select for in wildlife habitat management. Due to the open and exposed nature of this community, it may be a location for sage grouse leks, if there is edge effect provided by a sagebrush site surrounding the saltbush community.

3.1 – Invaded/Gardner’s Saltbush: This plant community exhibits a low level of plant species diversity. It is not a desirable plant community to select as a wildlife habitat management objective. However, seeds produced by many of the invasive species serve as a forage source for sage grouse and other birds as well as grassland obligate small mammals.

4.1 – Altered (Disturbed and Restored/Reclaimed): This is not a desirable plant community to select as a wildlife habitat management objective. After establishment, this community exhibits a low level of plant species diversity. However, seeds produced by seeded species may serve as a forage source for sage grouse and other birds as well as grassland obligate small mammals. Depending upon the stage of succession, or selected seed mixture, locations may vary widely on value for wildlife habitat management.

Animal Community – Grazing Interpretations:

The following table lists suggested stocking rates for cattle under continuous, season-long grazing with 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.

Plant Community Production Carrying Capacity*
The carrying capacity is calculated as the production (normal year) X .25 efficiency factor / 912.5 lbs. /AUM (Animal Unit Month, the amount of forage required by one mature cow of approximately 1,000 pounds weight, with or without a calf, for 1 month) to calculate the AUMs/Acre.

Plant Community Description/Title Lbs./Acre AUM/Acre* Acres/AUM*
Below Ave. Normal Above Ave.
1.1 Reference: Indian Ricegrass/Gardner’s Saltbush 80 175 300 0.05 20.0
1.2 Perennial Bunchgrasses / Gardner’s Saltbush 75 150 250 0.04 25.0
2.1 Gardner’s Saltbush / *Bare Ground* 35 100 175 0.03 33.0
3.1 Natives / Invasives / Saltbush ** ** ** ** **
4.1 Disturbed/Degraded ** ** ** ** **

* - Carrying capacity is figured for continuous, season-long grazing by cattle under average growing conditions.
** - Sufficient data for invaded and reclaimed communities has not yet been collected or evaluated, 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 must be supplemented with protein because the forage 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 percent of a management unit may have 25 percent slopes and distances of greater than one mile from water; therefore, the adjustment is only calculated for 30 percent of the unit (i.e. 50 percent reduction on 30 percent of the management unit).

Fencing, slope length, management, access, terrain, kind and class of livestock, and breeds are all factors that can increase or decrease the percent of grazeable 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 D. Infiltration ranges from slow to moderate. Runoff potential for this site varies from moderate to very high depending upon soil hydrologic group and ground cover. In many cases, areas with greater than 75 percent 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 percent 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 typically should not be present. Water flow patterns may be present but should be barely distinguishable. Pedestals are only slightly present in association with bunchgrasses such as bluebunch wheatgrass. 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 percent of the soil surface.

Recreational uses

This site provides limited hunting opportunities for upland game species. Because of the raw nature of these sites, cultural artifacts can be viewed in the area of these sites especially along the drainageways that dissect the area. The locations generally are close or include a diverse geology that offers a chance to explore the unique and varied geology of the area. This ecological site, however, proves to be very limited in association 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 other associated ecological sites. These soils must be taken into consideration when crossing the area with trails or roadways. The site generally is rough as well, and provides no soft cover for camping or resting.

Wood products

No appreciable wood products are present on the site.

Other products

This site is limited with minimal vegetative cover to provide other products.

Inventory data references

Information presented in the original site description was derived from NRCS inventory data. Field observations from range-trained personnel also were used . Those involved in developing the original site include Chris Krassin, Range Management Specialist, NRCS and Everet Bainter, Range Management Specialist. 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.

Those involved in the development of the new concept for Saline Upland Ecological site include Ray Gullion, Area Range Management Specialist; Jim Haverkamp, Area Range Management Specialist, NRCS; Mandi Hirsch, Range Management Specialist, Popo Agie Conservation District; Jim Wolf, Resource Manager, USDI-BLM; John Likins, Range Management Specialist, Retired USDI-BLM; Jeremy Artery, Rangeland Management Specialist, USDI-BLM; Leah Yandow, Wildlife Biologist, USDI-BLM; Daniel Wood, MLRA Soil Survey Leader, NRCS; Jane Karinen, Soil Data Quality Specialist, NRCS; and Marji Patz, Ecological Site Specialist, NRCS.

Quality control and quality assurance completed by John Hartung, State Rangeland Management Specialist, NRCS; Brian Jensen, State Wildlife Biologist, NRCS; and Scott Woodall, Regional Quality Assurance Ecological Site Specialist, 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 two of these estimated points, with two 21 ft. X 21 ft. 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

Scott Woodall, 9/05/2019

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	11/30/2018
Approved by	Marji Patz
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rills will be continuous and prominent on this site but are stable and will have more inter-rills with few deep rills on the landscape. Rills should be most prevalent on slopes greater than 20% .

2. **Presence of water flow patterns:** Water flow paths will be obvious, regular and continuous with debris dams occurring only on lesser slopes.

3. **Number and height of erosional pedestals or terracettes:** Erosional pedestals present with terracettes present at debris dams. Infrequent and less than 1 inch in height; most commonly associated with perennial bunchgrasses.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground can range from 40-65%.

5. **Number of gullies and erosion associated with gullies:** Active gullies should not be present. Active gullies may be present on steeper slopes (>20%).

6. **Extent of wind scoured, blowouts and/or depositional areas:** Minimal to nonexistent.

7. **Amount of litter movement (describe size and distance expected to travel):** Plant litter movement is expected.

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil Stability Index ratings range from 1 (interspaces) to 3 (under plant canopy), but average values should be 3.0 or greater. Salts influence the stability of this soil.

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Refer to soil series description and map unit for specific information. The soil surface structure is platy to vesicular, with a prismatic subsurface structure. Depth will vary from 1 to 10 inches (2-25 cm). The dry surface colors generally are in the 10YR to 7.5YR range with a hue of 5 and a chroma of 2. Organic matter in the surface ranges from 0.5 to 1.0 %.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** The plant community consists of 50-75% shrubs, 5% forbs and 20-45% grasses.

Evenly distributed plant canopy (35-55%) and litter help slow runoff. Lack of cover and tendency to crust, runoff is common. Basal cover is typically less than 5% and does very little to affect runoff. Raindrop impact and runoff are common 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 would be expected but soil surface is typically crusted and hard to very hard when dry.

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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: perennial shrubs >>

    Sub-dominant: Cool season, mid-stature grasses >

    Other: Forbs = Short-stature grasses/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):** Some plant mortality and decadence (10 to 15%) is expected on this site. Perennial bunchgrass shows higher mortality with drought stress, dwarf shrubs (saltbush) will show minimal mortality.

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14. **Average percent litter cover (%) and depth (in):** Litter ranges from 5-10% of total canopy measurement with total litter (including beneath the plant canopy) from 5-20% expected. Herbaceous litter depth typically ranges from 1 - 3 mm. Woody litter can be 2-5 mm. Litter cover is in contact with soil surface with little evidence of biological activity.

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** English: 80 - 300 lbs/ac (175 lbs/ac average); Metric: 90 - 336 kg/ha (196 kg/ha average).

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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:** Pursh Seepweed, birdfoot sagebrush, flatspine stickseed, and woodyaster are native species that increase with stress; invasive species such as, but not limited to: halogeton, cheatgrass (downy brome), and Russian thistle are also found on this site. Other common noxious weeds can be found on the Noxious Weed List for Wyoming and specific counties.

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17. **Perennial plant reproductive capability:** All species have a limited capability of reproducing.
