USDA Natural Resources
Conservation Service

Ecological site DX032X01A154
Shale (Sh) Big Horn Basin Core

Last updated: 4/09/2020
Accessed: 05/06/2024

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.

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 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 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):

32X01A (WY): This LRU is the Big Horn Basin within MLRA 32. This LRU is lower in elevation, slightly warmer and receives slightly less overall precipitaiton 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 A, referred to as the Core, which is warm, dry eroded basin floor. As the LRU shifts outer edges, aspect and relation to the major bodies of water and taller landforms create minor shifts 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. Older ESD's will refer to LRU A. LRU A and LRU 01 in MLRA 32X are synonymous.

Moisture Regime: Typic Aridic, prior to 2012, there are map units that cross over to ustic aridic or ustic aridic was correlated into this core area. As progressive mapping continues and when the ability to do update projects, these overlapping map units will be corrected.

Temperature Regime: Mesic
Dominant Cover: Rangeland, with Saltbush flats the dominant vegetative cover for this LRU/ESD.
Representative Value (RV) Effective Precipitation: 5-9 inches (127 – 229 mm)
RV Frost-Free Days: 110-150 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 Scurb
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 (and)
10.1.18.g Big Horn Salt Desert Shrub Basin

Ecological site concept

• Site receives no additional water.
• Slope is < 60%
• Soils are:
- saline, sodic, or saline-sodic, gypsic
- Very Shallow (depth to restrictive layer is < 10″ (25 cm).
- With < 30% cover of surface fragments (gravels, cobbles, stones)
- Textures usually range from silt loam to clay
- Clay content is ≥ 35% in mineral soil profile (0-10”).
- With an average particle size class ≥ 35% but < 60% clay

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

The Shale ecological site is very similar and is generally associated with the saline upland clayey ecological site. Shale is less than 10 inches to shale (bedrock) and saline upland is greater than 10 inches. Saline Upland Clayey is generally found over shale bedrock, typically on lower or gentler slopes, and in many cases will have a very similar plant community. The production potential and erosion hazard are the two main distinctive characteristics between these two sites.

Associated sites

DX032X01A158	**Shallow Clayey (SwCy) Big Horn Basin Core** Shallow Clayey ecological site may have simlar soil properties but will be slightly deeper in nature with the lack of salt indications. Sagebrush and bunchgrasses such as bluebunch wheatgrass are prevelent on this site.
R032XY104WY	**Clayey (Cy) 5-9” Big Horn Basin 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 tend to occur in flatter or areas with a more concave shape allowing water to infiltrate and move through the profile better, moving salts lower in the profile.

DX032X01W138	**Saline Lowland (SL) Big Horn Basin Wet** The Saline Lowland site is greasewood dominated, and occurs on a terrace or step below saline upland sites (along drainages or in drainage-ways). They have an associated water-table, and will generally have a higher ground cover and productivity.
R032XY144WY	**Saline Upland (SU) 5-9” Big Horn Basin Precipitation Zone** Saline Upland sites are very similar but have a higher potential production and highe species diveristy than is common for a Shale ecological site. Typically, shale sites will be found side by side with saline upland sites as the soils transition from an eroded landform to an apron or depositional landform.

Similar sites

R032XY354WY	**Shale (Sh) 10-14" East Precipitation Zone** Shale 10-14” Foothills and Basins East P.Z., 032XY354WY, has higher production.
DX032X01A143	**Saline Upland Clayey (SUC) Big Horn Basin Core** Saline Upland, Clayey will appear very similar to this site if in a degraded state. Production potential and species diversity overall is higher for the Saline Upland, Clayey Site .
DX032X01A176	**Very Shallow (VS) Big Horn Basin Core** Very Shallow ecological site are found on soils without the salt influence and can be over a mix of sedimentary bedrock. Pincushion forbs and bunchgrasses are dominant on this site.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Atriplex gardneri*
Herbaceous	(1) *Elymus elymoides*

Legacy ID

R032XA154WY

Physiographic features

These sites generally occur on slopes ranging from nearly level to 60%. These soils occur where marine shales 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 precipitations. The inter-bedded and dissected geomorphic features within the Big Horn Basin has a range of saline-driven communities. The dominant landform associated with this site is fan aprons (including alluvial fans and fan remnants).

Many of these landforms are erosional remnants and have soils ranging from shallow to very deep. The variability of soils across the landform is influenced by the geology and its inherent chemistry. This will create pockets of calcareous or saline/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 chemistry 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 non-descript 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.

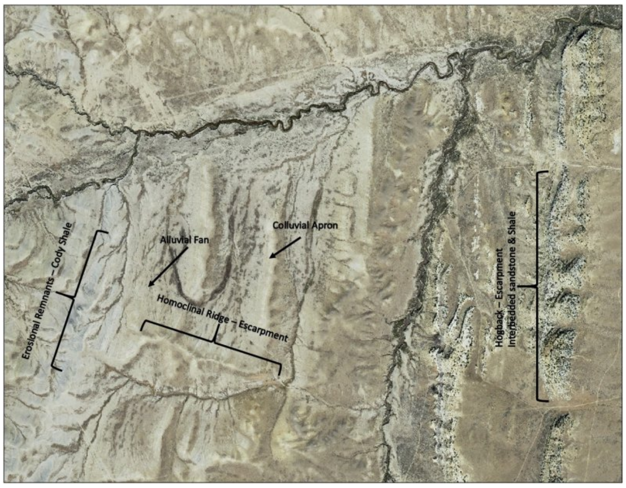


Figure 1. Physiographic features for the Shale Big Horn Basin Core ecological site.

Table 2. Representative physiographic features

Landforms	(1) Intermontane basin > Eroded fan remnant sideslope (2) Intermontane basin > Ridge (3) Intermontane basin > Escarpment (4) Intermontane basin > Pediment
Runoff class	Low to very high
Elevation	1,128–1,829 m
Slope	0–60%
Aspect	Aspect is not a significant factor

Climatic features

Annual precipitation ranges from 5-9 inches per year. The normal precipitation pattern shows peaks in May and June and a secondary peak in September. This amounts to about 50% 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 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 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.

The following information is from the “Emblem” climate station:
Minimum Maximum 5 yrs. out of 10 between
Frost-free period (days): 98 171 May 13 – September 19
Freeze-free period (days): 120 184 May 1 – October 5
Mean Annual Precipitation (inches): 3.22 10.97
Mean annual precipitation: 7.42 inches
Mean annual air temperature: 45.01 F (31.2 F Avg. Min. to 58.7 F Avg. Max.)

For detailed information visit the Natural Resources Conservation Service National Water and Climate Center at http://www.wcc.nrcs.usda.gov/ website. Other climate station(s) representative of this precipitation zone include: Basin, Deaver, Lovell and Worland.

Table 3. Representative climatic features

Frost-free period (characteristic range)	106-116 days
Freeze-free period (characteristic range)	130-143 days
Precipitation total (characteristic range)	178-203 mm
Frost-free period (actual range)	98-119 days
Freeze-free period (actual range)	128-149 days
Precipitation total (actual range)	152-203 mm
Frost-free period (average)	111 days
Freeze-free period (average)	137 days
Precipitation total (average)	178 mm

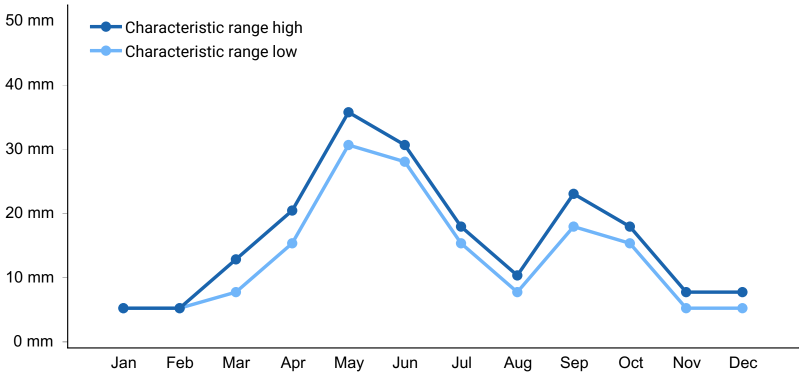


Figure 2. Monthly precipitation range

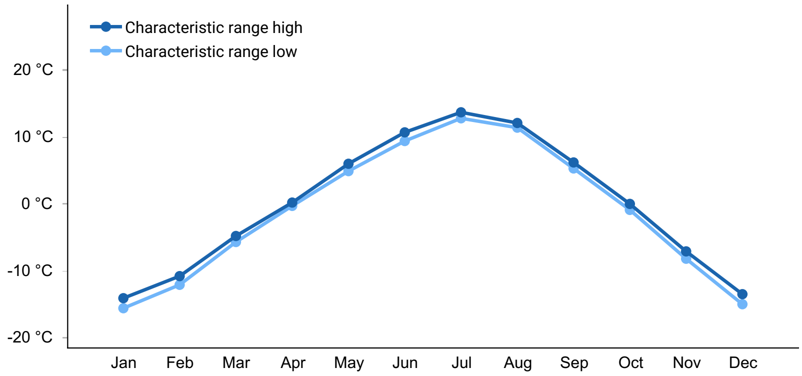


Figure 3. Monthly minimum temperature range

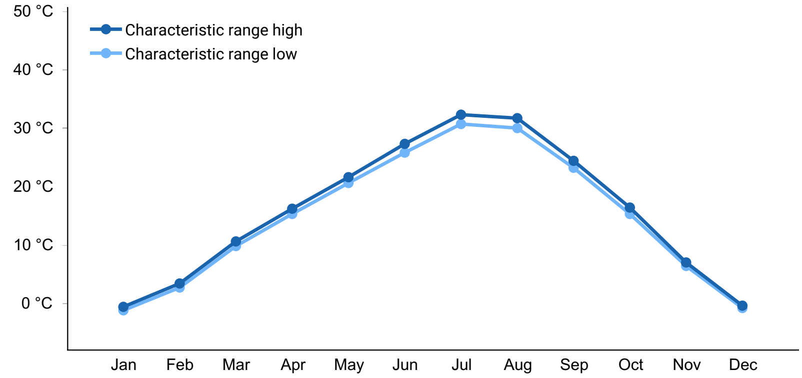


Figure 4. Monthly maximum temperature range

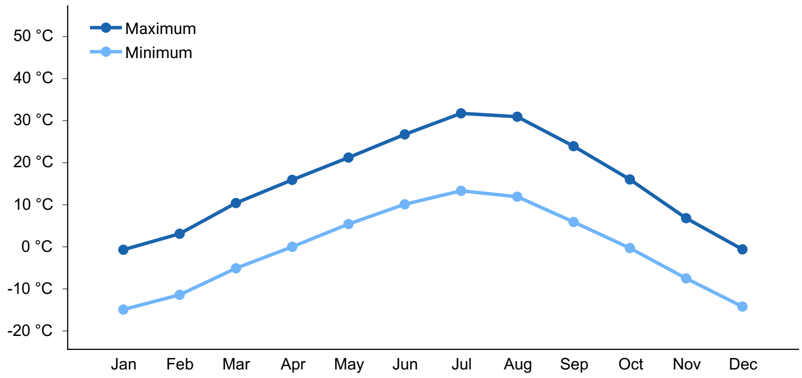


Figure 5. Monthly average minimum and maximum temperature

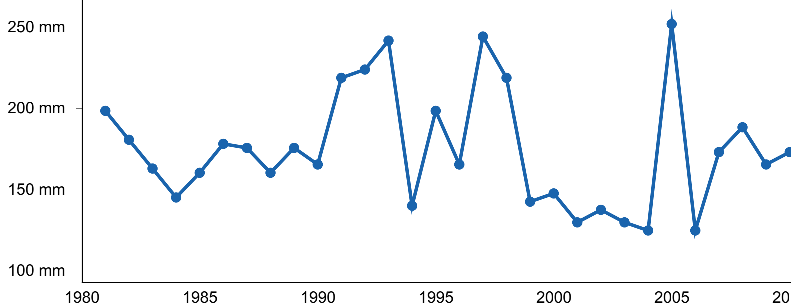


Figure 6. Annual precipitation pattern

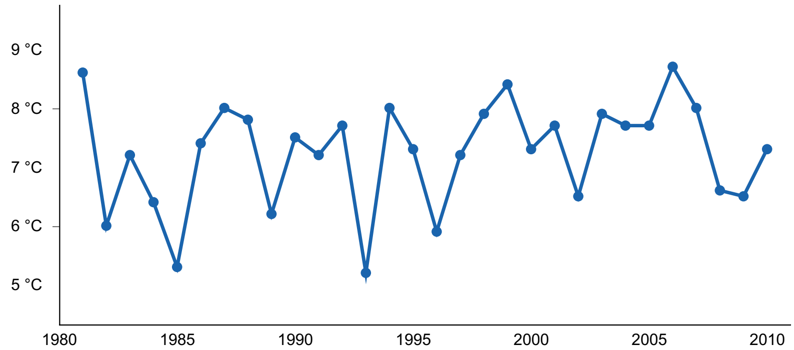


Figure 7. Annual average temperature pattern

Climate stations used

- (1) LOVELL [USC00485770], Lovell, WY
- (2) GREYBULL [USC00484080], Greybull, WY
- (3) EMBLEM [USC00483031], Burlington, WY
- (4) DEAVER [USC00482415], Deaver, WY
- (5) WORLAND [USW00024062], Worland, WY
- (6) BASIN [USC00480540], Basin, WY
- (7) WORLAND [USC00489770], Worland, WY
- (8) GREYBULL S BIG HORN AP [USW00024048], Greybull, 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/overland flow. No streams are classified within this ecological site. The lack of water table above 60 in (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 drainages, 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 down cut 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 site usually occurs on steep slopes with many outcrops of shale bedrock. 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 having 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: Birdsley-like, Bributte, Chipeta, Chipeta-like, and Persayo. 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 8. Soil Profile of a Shale Site.

Table 4. Representative soil features

Parent material	(1) Residuum–shale
Surface texture	(1) Clay loam (2) Clay (3) Silt loam (4) Sandy clay loam
Family particle size	(1) Clayey
Drainage class	Well drained
Permeability class	Slow to moderate
Depth to restrictive layer	3–25 cm
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% grasses, 10% forbs and 60% 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.

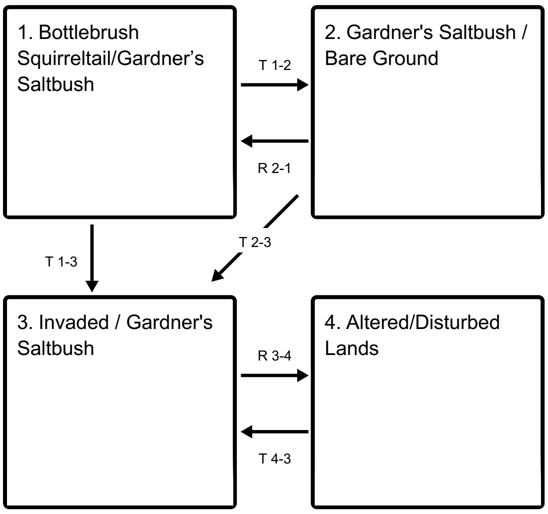
Historically, fire frequency has been included as a driving factor for this site. Because of the naturally occurring bare ground, lack of herbaceous cover, and corresponding lack of fine fuels, fire is not a threat. Fires are non-existent to extremely rare and incidental.

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 occurring 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/prevents perennial grass establishment and supports Gardner's saltbush.

T 1-3 - Frequent and Severe Grazing, Ground Disturbance, and/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

1.1. Bottlebrush Squirreltail/Gardner’s Saltbush Community Phase

State 2 submodel, plant communities

2.1. Gardner's Saltbush / Bare Ground Community Phase

State 3 submodel, plant communities

3.1. Invaded / Gardner's Saltbush Community Phase

State 4 submodel, plant communities

4.1. Altered / Disturbed Lands Community Phase

State 1
Bottlebrush Squirreltail/Gardner’s Saltbush

Shale, much like the saline upland ecological sitse, is a dynamic and complex concept that includes a wide range of soil chemistry, that work together to create a salt-tolerant community. 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 State and State 2 have been designed to incorporate the range of possibilities.

Characteristics and indicators. Soils within the 5-9" precipitation zone, and with a wide range of alkali, saline, sodic and/or gypsum influences, are characterized by Gardner's saltbush dominated plant communities. These communities may also have bud sagebrush, birdfoot sagebrush, pursh seepweed, and in some locations greasewood; these woody species together will comprise approximately 60% of the production on the site. The grass, comprising 30% of the plant community, is predominately bottlebrush squirreltail; however, Indian ricegrass, rhizomatous wheatgrasses, and alkali sacaton are common. Needleandthread and blue grama are incidental in this state. The forb component is minor with only 10% of the production from a few select forbs. A variety of biscuitroot/desert parsleys (Lomatiums), wild onion, and woodyaster are found in this state. As this site degrades, flatspine stickseed will increase

Resilience management. The site is naturally prone to erosion and drought, and so the species adapted to this site are hardy and resilient. However, this community is fragile, and is susceptible to rapid degradation with focused use. This site is generally not located in areas that are readily utilized by livestock or for general daily activity.

Dominant plant species

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

Community 1.1
Bottlebrush Squirreltail/Gardner’s Saltbush Community Phase

This is the Reference Plant Community for the Shale ecological site. The community evolved with erosivity and droughty saline and/or alkaline soils. This plant community can be found on areas that are properly managed with grazing and on areas receiving periods of rest. Potential vegetation is about 30% grasses or grass-like plants, 10% forbs, and 60% woody plants. Gardner’s saltbush dominates this state. Other salt tolerant shrubs include bud sagebrush, pursh seepweed, and birdfoot sagebrush. In some instances, greasewood has been found to persist on these sites, especially at the toe or lower portions of the slope where water may seep through and accumulate along the shale surface. The major grass is bottlebrush squirreltail, but Indian ricegrass, rhizomatous wheatgrasses, and alkali sacaton are common. Other grasses occurring in this state include Sandberg bluegrass, needleandthread, and rarely blue grama. A variety of forbs may also occur in this state (see Plant Composition Table). Overall, the site tends to be species (diversity) poor but an evenly distributed community. The total annual production (air-dry weight) of this state is about 130 pounds per acre, but it can range from about 80 lbs./acre in unfavorable years to about 265 lbs./acre in above average years.

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

Dominant plant species

- Gardner's saltbush (*Atriplex gardneri*), shrub
- 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	78	140
Grass/Grasslike	28	56	129
Forb	6	11	28
Total	**90**	**145**	**297**

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%
Litter	5-20%
Surface fragments >0.25" and <=3"	0-10%
Surface fragments >3"	0-10%
Bedrock	0%
Water	0%
Bare ground	35-60%

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%
Litter	5-20%
Surface fragments >0.25" and <=3"	0-10%
Surface fragments >3"	0-10%
Bedrock	0%
Water	0%
Bare ground	35-65%

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%	0-5%	–
>0.3 <= 0.6	–	–	0-5%	–
>0.6 <= 1.4	–	–	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

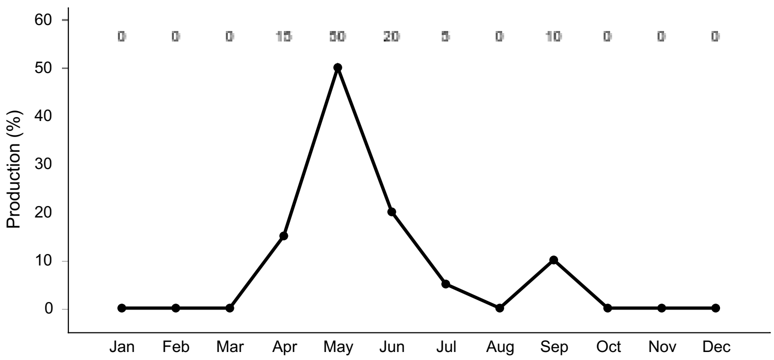


Figure 10. Plant community growth curve (percent production by month). WY0501, 5-9BH Upland sites. Monthly percentages of total annual growth for all upland sites with dominantly C3 Cool season plants..

State 2
Gardner's Saltbush / Bare Ground

A saltbush dominant site with bare ground is the most prominent native community for the Shale ecological site. It is not listed as reference because there is potential for native grasses to be present on this site. Complexity of chemistry may be one factor for the lack of grasses and forbs in this state, but management can also contribute to the shift. The determination if this state is produced by soil texture, management, or climatic conditions may not be conclusive, and require additional investigation.

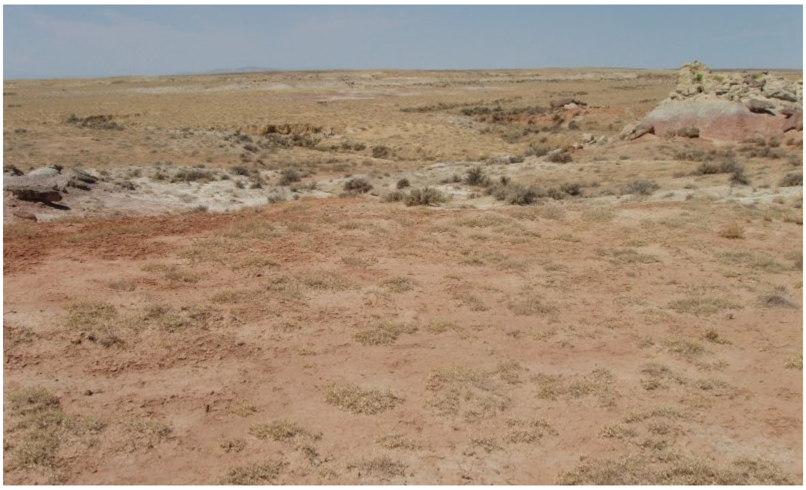
Characteristics and indicators. The indicator marking the shift to State 2, is the lack or loss of perennial grasses. The dominant structure of this site is Gardner's Saltbush, with a possible composition of birdfoot sagebrush and native forbs such as flatspine stickseed, purple tansyaster, prickly pear cactus and woodyaster.

Resilience management. It is recognized that with continued grazing pressure and drought conditions, the productivity and sustainability of most perennial grasses will decrease leaving a shrub dominated state. In the absence of invasive species, this state can persist on the landscape. Very long-term prescribed grazing and grazing land mechanical treatment (with seeding possibly) may be practices that can be used to bring this state near or similar to reference. Remnant populations of native perennial grasses will persist in pockets within the Gardner's Saltbush, but in some instances, seeding may be required to help re-establish herbaceous species to these sites. No research was located for large areas of re-vegetation, but limited success has occurred with seeding trials completed by BLM and University of Wyoming.

Dominant plant species

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

Community 2.1
Gardner's Saltbush / Bare Ground Community Phase



This plant community can occur where sites are subjected to continuous year-long grazing and where soils are highly sodic. Gardner’s saltbush dominates this site, comprising almost 100% of the plant community. The interspaces between plants may have expanded slightly, but the loss of herbaceous plants has left the soil surface more exposed to erosive elements. Cool season grasses have been eliminated. When compared to the Reference State (1), plant production may be reduced due to the loss of herbaceous cover. The change is not substantial in size, but significant in implication. Given, the variability in leaf and leader production depending on a wide spectrum of variables, the following production range does not capture the extremes, but is based on an average. The total annual production (air-dry weight) of this state averages 75 pounds per acre, but it can range from 25 lbs./acre in unfavorable years to 105 lbs./acre in above average years.

Resilience management. Rangeland Health Implications/Indicators: This plant community is resistant to change. These areas are resistant to fire because no or minimal standing fine fuels are available and the bare ground between plants is significant (>35%). Grazing, or lack thereof, does not seem to affect the plant composition or structure of the plant community. Plant diversity is extremely low. The plant vigor and replacement capabilities are dependent on the 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 Russian knapweed and halogeton can invade the large openings, forcing the transition to the invaded state. Soil erosion is accelerated because of increased bare ground. 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 down slope, 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 with no compaction or compression, will become soft or loose. If compressed or compacted when dried can become very hard. When either is wetted, will be easily dispersed or moved (erosive).

Dominant plant species

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

Table 9. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	28	84	112
Forb	–	–	6
Grass/Grasslike	–	–	–
Total	**28**	**84**	**118**

Table 10. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	20-50%

Grass/grasslike foliar cover	0%
Forb foliar cover	0-5%
Non-vascular plants	0%
Biological crusts	0%
Litter	0-5%
Surface fragments >0.25" and <=3"	0-10%
Surface fragments >3"	0-10%
Bedrock	0%
Water	0%
Bare ground	50-75%

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	0%
Litter	0-5%
Surface fragments >0.25" and <=3"	0-10%
Surface fragments >3"	0-10%
Bedrock	0%
Water	0%
Bare ground	50-75%

Table 12. Canopy structure (% cover)

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

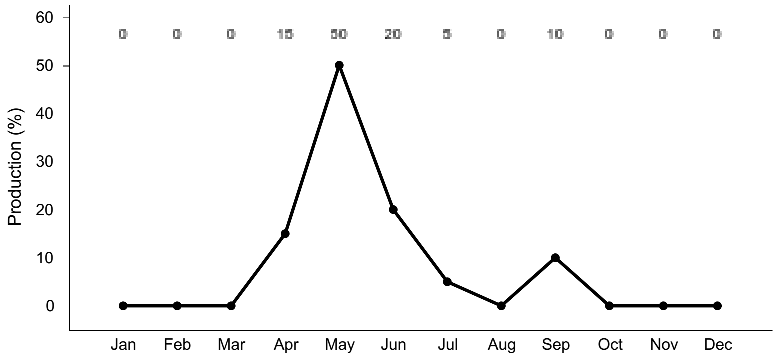


Figure 12. Plant community growth curve (percent production by month). WY0501, 5-9BH Upland sites. Monthly percentages of total annual growth for all upland sites with dominantly C3 Cool season plants..

State 3
Invaded / Gardner's Saltbush

The Shale site has the presence of being resistant to invasion by many undesirable species threatening the rangelands today. However, there are a few 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 specific communities within this state will be discussed further below.

Characteristics and indicators. The Invaded/Gardner's Saltbush site will vary between a mirror image of State 1 or State 2 with an invasive species such as cheatgrass or halogeton present as a significant component of the community (>5% composition).

Resilience management. The persistence, resistance and resilience of specific communities within this state are dependent on the factor that introduced the invader species, and what invader species establishes on the site.

Dominant plant species

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

Community 3.1
Invaded / Gardner's Saltbush Community Phase

The Invaded Saltbush Community has maintained a representative sample of the native perennial grasses and forbs with the accompanying Gardner’s Saltbush composition. The invasive species are present and hold a significant (5% or greater) composition of the landscape and are prominent on the site (referring to a wider scale composition, not isolated patches on 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. Production of this community phase will vary depending on 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 on 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, 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

Mining/energy development and roads are the land uses that have had an impact on this site. Much of the land correlated as Shale is deemed unfit or non-productive, and either no attempt was made to reclaim areas or reseeding attempts have failed. As this land recovers, is restored or reclaimed, or further disturbances occur, the site potential and stability is greatly affected. Specific references will be discussed below.

Characteristics and indicators. Outside of obvious land movement scars and remnants of disturbance activities, the lack of all woody vegetation, presence of seeded (introduced/native) species, or the presence of Russian thistle, halogeton, and other primary succession or invasive species are the key indicators that a community is altered or disturbed. Many times, erosion control techniques, drill rows, or contouring is obvious for a significant time following the treatments.

Resilience management. Erosion control and weed control are the two factors that determine the ability for this site to maintain an improvement (range seeding). If left to recover naturally, or with no improvements, erosion will be the greatest concern affecting the resiliency of this ecological site.

Community 4.1
Altered / Disturbed Lands Community Phase

Degraded or disturbed lands are locations that have been impacted by human settlement and land use development. Big Horn Basin was farmed during settlement periods; however, scarcity of water and drought impacts, caused many to abandon farming for other land uses. In more current times, advancement of irrigation techniques extended farm fields or created edges/corners that are difficult to farm and have low productivity especially in the salt-affected areas. Terms such as sacrifice areas, badlands, and wastelands are common for this site. Although attempts are made to improve these areas, success is limited. 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 so is not included in this site description. Improvements and reclamation to a functional landscape have been attempted to limited success and are discussed below.

Resilience management. Rangeland improvement trials were completed in the late 1940’s and early 1960’s by the Bureau of Land Management in conjunction with University of Wyoming. Trials included, water spreader dikes, contour furrowing and range seeding. These barren landscapes were contour furrowed and/or seeded with pre-dominantly 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. However, the furrows were still visible to the eye and the spreader dikes, (although visible) were holding significant sediment loads. Mechanical alternations to the hydrology, in conjunction with introduced species, shifts these disturbed lands away from the reference functionality group for the foreseeable future. The argument is made that these communities will not respond the same as an unaltered, native community. Similarly, with lands that were farmed/irrigated and then left to return to a natural state of vegetation will never respond the same as a reference community. Persistence of an introduced, non-native species is a very indicative trait that will assist in identifying this community. These non-native species are not invasive, although they may be persistent and aggressive. Crested wheatgrass, Russian wildrye, rhizomatous wheatgrasses, Indian ricegrass, and big bluegrass are a few cultivar species that have been planted that have persisted on the landscape, altering the community. The act of seedbed preparation alone, without consideration of the original disturbance, can be seen as an alteration to the soil function. Productivity of these sites varies greatly dependent on the disturbance, age and successional stage of recovery, and if or what species were seeded. Due to the lack of current and comparative production data, no production estimate is provided. The growth curve will depend on the species seeded, or the succession completed. So no growth curve will be given.

Transition T 1-2
State 1 to 2

Natural Variability, Frequent and Severe Grazing, Severe Ground Disturbance, and/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 to begin with. Soils that are high in both sodium and gypsum are commonly less accommodating to grasses.

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

Transition T 1-3
State 1 to 3

Frequent and Severe Grazing, Ground Disturbance, and/or Drought with a seed source present - 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. Ease of access, constraints of herbicides due to slope and soil chemistry, and the specific species of invasion are the major limitations to recovery for this site. The lack of native/desirable seed source and the hostile germination environment of these very shallow, heavy textured, salt-laden soils are also major players in the potential of 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 on a seed source and climate. However, the time required may not be feasible. The natural availability of native seed is minor in this environment, and the seedling viability/establishment is limited due to soil properties. 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 altered/disturbed state.

Context dependence. Previous mention of the natural variability in the chemistry of this ecological site lends to a natural occurrence of the Garner's saltbush / *Bare Ground* state. In the context of recovery, when the community is naturally occurring due to the limitations of the chemistry in the soil, the only option for improving the site would be to mechanically seed and amend the soil. This has been attempted with varying degrees of success. But once it has been mechanically altered, the site would revert to State 4 - Altered/ Disturbed Lands.

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
Early Successional Habitat Development/Management
Planned Grazing System
Native Plant Community Restoration and Management
Prescribed Grazing
Invasive Plant Species Control
Intensive Management of Rotational Grazing
Prescriptive grazing management system for grazed lands

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.

Context dependence. 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/or 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 is generally 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/gypsic soil conditions is limited; however, small scale projects have been achieved with marginal success.

Context dependence. The location-specific soil properties, the available seed sources, the invader species involved, and the accessibility of the site are all factors that will determine the best approach for this community.

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
Early Successional Habitat Development/Management
Planned Grazing System
Native Plant Community Restoration and Management
Prescribed Grazing
Invasive Plant Species Control
Grazing Management Plan
Grazing management to improve wildlife habitat
Prescriptive grazing management system for grazed lands

Transition T 4-3
State 4 to 3

Non-Use, Disturbance, Severe and Frequent Grazing, Drought with a seed source present – Loose soils as a result of non-use and/or chemistry within the soil provides a seedbed for introduced seeds to germinate. 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 altered / disturbed state to an Invaded state.

Constraints to recovery. The very shallow, fine-textured, salt-laden nature of these soils inhibit or creates a hostile environment for seedling establishment. Access can make weed treatment/prevention difficult, as well as chemical binding issues with soil chemistry can be a concern.

Additional community tables

Table 13. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Short-stature, Cool-season Bunchgrasses**			17–56	
	squirreltail	ELEL5	*Elymus elymoides*	26–50	5–20
	Sandberg bluegrass	POSE	*Poa secunda*	0–6	0–2
2	**Rhizomatous, Cool-season Grasses**			11–34	
	western wheatgrass	PASM	*Pascopyrum smithii*	0–34	0–10
3	**Mid-stature, Cool-season Bunchgrasses**			0–22	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–22	0–5
	needle and thread	HECO26	*Hesperostipa comata*	0–6	0–2
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	0–6	0–2
4	**Mat-forming (Tillering), Warm-season Grasses**			0–11	
	alkali sacaton	SPAI	*Sporobolus airoides*	0–6	0–2
	blue grama	BOGR2	*Bouteloua gracilis*	0–6	0–2
5	**Miscellaneous Grasses and Grass-likes**			0–6	
	Grass, perennial	2GP	*Grass, perennial*	0–6	0–5
Forb					
6	**Perennial Forbs**			0–28	
	smooth woodyaster	XYGL	*Xylorhiza glabriuscula*	0–11	0–5
	textile onion	ALTE	*Allium textile*	0–6	0–5
	desertparsley	LOMAT	*Lomatium*	0–6	0–5
	leafy wildparsley	MUDI	*Musineon divaricatum*	0–6	0–5
	Forb, perennial	2FP	*Forb, perennial*	0–6	0–5
	milkvetch	ASTRA	*Astragalus*	0–6	0–5
	princesplume	STANL	*Stanleya*	0–6	0–5
Shrub/Vine					
7	**Dominant Shrubs**			56–112	
	Gardner's saltbush	ATGA	*Atriplex gardneri*	56–112	20–50
8	**Miscellaneous Shrubs**			0–28	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–11	0–5
	bud sagebrush	PIDE4	*Picrothamnus desertorum*	0–11	0–5
	birdfoot sagebrush	ARPE6	*Artemisia pedatifida*	0–11	0–5
	greasewood	SAVE4	*Sarcobatus vermiculatus*	0–11	0–5
	shadscale saltbush	ATCO	*Atriplex confertifolia*	0–11	0–5

Table 14. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Forb					
1	**Perennial Forbs**			0–6	
	Forb, perennial	2FP	*Forb, perennial*	0–6	0–5
	milkvetch	ASTRA	*Astragalus*	0–6	0–5
	leafy wildparsley	MUDI	*Musineon divaricatum*	0–6	0–5
	smooth woodyaster	XYGL	*Xylorhiza glabriuscula*	0–6	0–5
	tansyaster	MACHA	*Machaeranthera*	0–6	0–5
	textile onion	ALTE	*Allium textile*	0–6	0–5
	princesplume	STANL	*Stanleya*	0–6	0–5
	desertparsley	LOMAT	*Lomatium*	0–6	0–5
2	**Annual Forbs**			0–6	
	Forb, annual	2FA	*Forb, annual*	0–6	0–2
	flatspine stickseed	LAOC3	*Lappula occidentalis*	0–6	0–2
	Wilcox's woollystar	ERWI	*Eriastrum wilcoxii*	0–6	0–2
Shrub/Vine					
3	**Dominant Shrubs**			28–84	
	Gardner's saltbush	ATGA	*Atriplex gardneri*	28–84	20–45
4	**Miscellaneous Shrubs**			0–28	
	greasewood	SAVE4	*Sarcobatus vermiculatus*	0–11	0–5
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–6	0–5
	bud sagebrush	PIDE4	*Picrothamnus desertorum*	0–6	0–5
	birdfoot sagebrush	ARPE6	*Artemisia pedatifida*	0–6	0–5
	shadscale saltbush	ATCO	*Atriplex confertifolia*	0–6	0–5

Animal community

Animal Community – Wildlife Interpretations:

1.1 - Saltbush/Bunchgrasses: The predominance of woody plants in this plant community provides winter grazing for mixed feeders, such as elk, and antelope. Suitable thermal and escape cover for these animals are limited due to the low quantities of tall woody plants. When found adjacent to sagebrush-dominated states, this plant community may provide lek sites for sage grouse. Other birds that would frequent this plant community include western meadowlarks, horned larks, and golden eagles. Some grassland obligate small mammals would occur here.

2.1 - 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 – Invasives/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. Knapweeds provide good cover for small mammals and birds as well.

4.1 – Altered (Disturbed and Restored/Reclaimed): Depending on 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 # /AUM to calculate the AUM's/Acre.
Plant Community Description/Title Lbs./Acre AUM/Acre* Acres/AUM*
Below Ave. Normal Above Ave.
1.1 Reference: Saltbush / Bunchgrasses 80 130 265 0.04 25.0
2.1 Saltbush / *Bare Ground* 25 75 105 0.02 50.0
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 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 D. Infiltration ranges from slow to moderate. Runoff potential for this site varies from moderate to very high 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 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% 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 drainages that dissect the area. And the locations are generally 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. Need to take these soils into consideration when crossing the area with trails or roadways. The site is generally 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 were also 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.

Information presented here has been derived from NRCS inventory data, Field observations from range trained personnel, and the existing range site descriptions. Those involved in developing the Saline Upland range site include: Chris Krassin, Range Management Specialist, NRCS and Everet Bainter, Range Management Specialist.

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; 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 foot tape was stretched and the following sample procedures were completed by inventory staff. For full sampling protocol and guidelines with forms please refer to the Wyoming ESI Operating Procedures, compiled in 2012 for the Powell and Rock Springs Soil Survey Office, USDA-NRCS.
• Double Sampling Production Data (9.6 hoop used to estimate 10 points, clipped a minimum of 3 of these estimated points, with two 21 foot X 21 foot square extended shrub plots).
• Line Point Intercept (over story and understory captured with soil cover). Height of herbaceous and woody cover is collected every three feet along established transect.)
• Continuous Line Intercept (Woody Canopy Cover, with minimum gap of 0.2 of a foot for all woody species and succulents. Intercept height collected at each measurement.),
• Gap Intercept (Basal Gap measured with a minimum gap requirement of 0.7 foot.),
• Sample Point (10 – 1 meter square point photographs taken at set distances on transect. Read using the sample point computer program established by the High Plains Agricultural Research Center, WY).
• Soil Stability (Slake Test – surface and subsurface samples collected and processed according to the soil stability guidelines provided by the Jornada Research Center, NM.)

Other references

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Approval

Scott Woodall, 4/09/2020

Rangeland health reference sheet

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

Author(s)/participant(s)	Marji Patz, Ray Gullion
Contact for lead author	marji.patz@wy.usda.gov
Date	11/28/2018
Approved by	Scott Woodall
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 15%.

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 45-65%.

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:** None.

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 are generally 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 effect runoff. Raindrop impact and runoff are common on this site.

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** No compaction layer would be expected but soil surface is typically crusted and hard to very hard when dry.

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: Short stature grasses/grasslikes = Forbs

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: 85 - 250 lbs/ac (150 lbs/ac average); Metric: 95 - 280 kg/ha (168 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:** 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.
