

Ecological site DX032X01B172

Stony Upland (StU)

Big Horn Basin Rim

Last updated: 3/05/2025

Accessed: 08/03/2026

General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

MLRA notes

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

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

LRU notes

Land Resource Unit (LRU): 32X01B (WY): This LRU is the Big Horn Basin within MLRA 32. This LRU is lower in elevation, slightly warmer and receives slightly less overall precipitation than the Wind River Basin (LRU 02). This LRU was originally divided into two LRU's - LRU A which was the core and LRU B which was the rim. With the most current standards, this LRU is divided into two Subsets. This subset is Subset B, referred to as the Rim, is a transitional band between the basin floor and the lower foothills. The subset encircles Subset A which was originally LRU A. As the LRU shifts towards the south and tracks east, changes in geology and relation to the mountain position, creates a minor shift in soil chemistry influencing the variety of ecological sites and plant interactions. The extent of soils currently correlated to this ecological site does not fit within the digitized boundary. Many of the noted soils are provisional and will be reviewed and corrected in mapping update projects. Other map units are correlated as small inclusions within other MLRA's/LRU's based on elevation, landform, and biological references. Moisture Regime: Ustic Aridic – Prior to 2012, many of the soils within this group were correlated as Frigid Ustic Aridic or as Mesic Typic Aridic, with few mapped within this cross over zone. As progressive soil survey mapping continues, these “crossover” or transitional areas are being identified and corrected. Temperature Regime: Mesic Dominant Cover: Rangeland, with Saltbush flats the dominant vegetative cover for this LRU/ESD. Representative Value (RV) Effective Precipitation: 10-14 inches (254 – 355 mm) RV Frost-Free Days: 105-125 days

Classification relationships

Relationship to Other Established Classification Systems: National Vegetation Classification System (NVC): 3 Xeromorphic Woodland, Scrub & Herb Vegetation Class 3.B Cool Semi-Desert Scrub & Grassland Subclass 3.B.1 Cool Semi-Desert Scrub & Grassland formation 3.B.1.NE Western North American Cool Semi-Desert Scrub & Grassland Division M169 Great Basin & Intermountain Tall Sagebrush Shrubland & Steppe Macro group G302 Artemisia tridentata - Artemisia tripartita - Purshia tridentata Big Sagebrush Steppe Group A3182 Artemisia tridentata ssp. wyomingensis Mesic Steppe & Shrubland Alliance CEGLO01051 - Artemisia tridentata ssp. wyomingensis/Hesperostipa comata 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.d Foothill Shrublands and Low Mountains (and) 10.1.18.g Big Horn Salt Desert Shrub Basin

Ecological site concept

- Site receives no additional water.
- Slope is 30%
- Soils are:
 - o Textures range from fine sandy loam to clay loam in top 4" (10 cm) of mineral soil surface
 - o Clay content is ?18% in top 4" (10 cm) of mineral soil surface
 - o All subsurface horizons in the particle size control section have a weighted average of ?18% but 35% clay. (The particle size control section is the segment of the profile from either the start of an argillic horizon for 50 cm's or from 25-100 cm's).
 - o Moderately deep to very deep (20-80+ in. (50-200+ cm)
 - o Greater than 5% stone and boulder cover (generally 5-15%) with cobble and gravel cover
 - o Skeletal (?35% rock fragments) starting within 8-20" (20-50

cm) of mineral soil surface (may have up to but not exceeding 35% rock fragments above 8") o Non-saline, sodic, or saline-sodic

Associated sites

DX032X01B121	Limy Skeletal (LiSk) Big Horn Basin Rim
DX032X01B175	Skeletal (Sk) Big Horn Basin Rim
DX032X01B122	Loamy (Ly) Big Horn Basin Rim
DX032X01A162	Shallow Loamy (SwLy) Big Horn Basin Core

Similar sites

DX032X01B175	Skeletal (Sk) Big Horn Basin Rim
DX032X01B109	Cobbly Upland (CoU) Big Horn Basin Rim

Table 1. Dominant plant species

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

Legacy ID

R032XB172WY

Physiographic features

This site occurs on undulating rolling landforms, generally on steeper sideslopes or alluvial fans.

Table 2. Representative physiographic features

Landforms	(1) Intermontane basin > Eroded fan remnant (2) Intermontane basin > Alluvial fan (3) Intermontane basin > Outwash fan
-----------	--

Runoff class	Negligible to high
Elevation	1,490 – 1,590 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 is lost by evaporation, and much of the moisture that falls during the winter is lost by sublimation. Average snowfall totals about 20 inches annually. Wide fluctuations may occur in yearly precipitation and result in more dry years than those with more than normal precipitation.

Temperatures show a wide range between summer and winter and between daily maximums and minimums, due to the high elevation and dry air, which permits rapid incoming and outgoing radiation. Cold air outbreaks from Canada in winter move rapidly from northwest to southeast and account for extreme minimum temperatures. Chinook winds may occur in winter and bring rapid rises in temperature. Extreme storms may occur during the winter, but most severely affect ranch operations during late winter and spring. High winds are generally blocked from the basin by high mountains, but can occur in conjunction with an occasional thunderstorm. Growth of native cool-season plants begins about April 1 and continues to about July 1. Cool weather and moisture in September may produce some green-up of cool-season plants that will continue to late October. For detailed information visit the Natural Resources Conservation Service National Water and Climate Center at <http://www.wcc.nrcs.usda.gov/>. Clark 3NE, Cody, Cody 12SE, Heart Mtn, and Powell Fld Stn are the representative weather stations 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)	90-100 days
Freeze-free period (characteristic range)	110-120 days
Precipitation total (characteristic range)	230-280 mm
Frost-free period (actual range)	80-110 days
Freeze-free period (actual range)	110-130 days
Precipitation total (actual range)	180-310 mm
Frost-free period (average)	90 days
Freeze-free period (average)	120 days
Precipitation total (average)	250 mm

- (1) HEART MTN [USC00484411], Powell, WY
- (2) CODY [USC00481840], Cody, WY
- (3) CODY 12SE [USC00481850], Meeteetse, WY
- (4) THERMOPOLIS 9NE [USC00488884], Thermopolis, WY
- (5) POWELL FLD STN [USC00487388], Powell, WY
- (6) 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 or overland flow. There may be isolated features that are affected by snowpack that persists longer than surrounding areas due to position on the landform (shaded or protected pockets), but overflow is not a suitable fit. No streams are classified within this ecological site.

Soil features

The soils of this site are deep to moderately deep (greater than 20" to bedrock), moderately well to somewhat excessively well-drained & moderately slow to moderately rapid permeable. This site consists of a strong cap of soils with few rock fragments (less than 35%) with a skeletal fraction with bouldery to cobbly coarse fragments lower in the soil profile. The soil surface can be covered extensively with these coarse fragments, with at least 5% stones and boulders. The increased fragment cover impacts the plant cover, and plant density is reduced. The soil characteristics having most influential to the plant community are volume of coarse fragments in the profile that reduces the available moisture and the extensive cover of these coarse fragments, which can reduce the plant density.

Major Soil Series correlated to this site includes: Romberg

Table 4. Representative soil features

Parent material	(1) Colluvium – interbedded sedimentary rock (2) Glaciomarine deposits – igneous and metamorphic rock (3) Slide deposits – igneous, metamorphic and sedimentary rock
Surface texture	(1) Extremely bouldery, extremely stony, very stony loam (2) Silt loam (3) Clay loam (4) Sandy clay loam
Family particle size	(1) Fine-loamy (2) Loamy-skeletal (3) Fine-loamy over sandy or sandy-skeletal
Drainage class	Well drained to somewhat excessively drained
Permeability class	Moderately slow to moderately rapid
Soil depth	50 cm

Surface fragment cover <=3"	0 – 50 %
Surface fragment cover >3"	10 – 40 %
Available water capacity (Depth not specified)	7.11 – 15.24 cm
Calcium carbonate equivalent (Depth not specified)	0 – 10 %
Electrical conductivity (Depth not specified)	Not specified
Sodium adsorption ratio (Depth not specified)	0 – 10
Soil reaction (1:1 water) (Depth not specified)	6.8 – 8.4
Subsurface fragment volume <=3" (0-20.3cm)	0 – 20 %
Subsurface fragment volume >3" (0-20.3cm)	0 – 10 %

Ecological dynamics

The Stony Upland ecological site within the Absaroka Lower Foothills was originally correlated as a coarse upland range site. During the review of the coarse upland range site, communities were identified with a significant stone and boulder surface cover that had a fine-loamy surface soil (top 8 to 10 inches of the soil profile with less than 35 percent rock fragments) with a skeletal subsurface soil that was comprised of cobbles and stones. Although similar to the Coarse Upland range site, the community potential and system resilience are altered by the contrasting textural classes. The dominance of bluebunch wheatgrass, increased surface fragment cover and reduced production express the “shallow” acting characteristic of the site. Wyoming big sagebrush is generally restricted in cover due to limited available rooting soil surface. Minimal research can be found for this particular ecological site.

Potential vegetation on the Stony Upland ecological site, as with the Loamy ecological site, is dominated by mid-stature cool-season perennial grasses. Other significant vegetation includes Wyoming big sagebrush, fringed sagewort and a variety of forbs. Purple prairie clover is unique to this site, as well as yucca. The expected potential composition is 75 percent grasses, 10 percent forbs, and 15 percent woody plants. The composition and production will vary due to historic use and fluctuating precipitation.

As the Stony Upland ecological site deteriorates species such as threadleaf sedge, Sandberg bluegrass, and broom snakeweed will increase. Plains pricklypear and weedy annuals will invade. Cool-season grasses such as bluebunch wheatgrass, needle and thread, and

Indian ricegrass will decrease in frequency and production.

Sagebrush may not be resilient once it has been removed or severely reduced if a vigorous stand of grass exists and is maintained. Threadleaf sedge may become the dominant vegetation if the area is subjected to frequent and severe (continuous season-long) periods of grazing, especially year-long grazing; resulting in a dense sod cover of threadleaf sedge.

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

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

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

State and transition model

Additional community tables

Table 5. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
Grass/Grasslike					
1	Mid-stature Cool-season Bunchgrasses			84-280	
	bluebunch wheatgrass	PSSP6	<i>Pseudoroegneria spicata</i>	56-224	10-30
	needle and thread	HECO26	<i>Hesperostipa comata</i>	6-56	1-10
	Indian ricegrass	ACHY	<i>Achnatherum hymenoides</i>	0-28	0-5
2	Rhizomatous Cool-season Grasses			28-84	
	western wheatgrass	PASM	<i>Pascopyrum smithii</i>	6-56	1-10
	thickspike wheatgrass	ELLAL	<i>Elymus lanceolatus ssp. lanceolatus</i>	0-28	0-5
3	Short-stature Cool-season Bunchgrasses			0-28	
	squirreltail	ELEL5	<i>Elymus elymoides</i>	0-28	0-5
	prairie Junegrass	KOMA	<i>Koeleria macrantha</i>	0-28	0-5
	Sandberg bluegrass	POSE	<i>Poa secunda</i>	0-28	0-5
4	Miscellaneous Grasses			0-28	
	threadleaf sedge	CAFI	<i>Carex filifolia</i>	0-28	0-5
	blue grama	BOGR2	<i>Bouteloua gracilis</i>	0-28	0-5
	Grass, perennial	2GP	<i>Grass, perennial</i>	0-28	0-5
Forb					
5	Perennial Forbs			11-56	
	milkvetch	ASTRA	<i>Astragalus</i>	0-28	0-5
	purple prairie clover	DAPU5	<i>Dalea purpurea</i>	6-28	1-5
	beardtongue	PENST	<i>Penstemon</i>	0-28	0-5
	spiny phlox	PHHO	<i>Phlox hoodii</i>	0-28	0-5
	scarlet globemallow	SPCO	<i>Sphaeralcea coccinea</i>	0-28	0-5
	dotted blazing star	LIPU	<i>Liatris punctata</i>	0-28	0-5
	Forb, perennial	2FP	<i>Forb, perennial</i>	0-28	0-5
Shrub/Vine					
6	Dominant Shrubs			28-112	

	Wyoming big sagebrush	ARTRW8	<i>Artemisia tridentata ssp. wyomingensis</i>	28-112	5-15
	prairie sagewort	ARFR4	<i>Artemisia frigida</i>	0-28	0-5
7	Miscellaneous Shrubs			0-56	
	rubber rabbitbrush	ERNA10	<i>Ericameria nauseosa</i>	0-56	0-10
	winterfat	KRLA2	<i>Krascheninnikovia lanata</i>	0-28	0-5
	Shrub (>.5m)	2SHRUB	<i>Shrub (>.5m)</i>	0-28	0-5

Table 6. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
-------	-------------	--------	-----------------	----------------------	------------------

Table 7. Community 3.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
-------	-------------	--------	-----------------	----------------------	------------------

Table 8. Community 4.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
-------	-------------	--------	-----------------	----------------------	------------------

Table 9. Community 5.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
-------	-------------	--------	-----------------	----------------------	------------------

Animal community

Animal Community – Wildlife Interpretations: 1.1 - Bluebunch Wheatgrass/Sagebrush (Reference Community): The predominance of grasses in this plant community favors grazers and mixed-feeders, such as bison, elk, and antelope. Suitable thermal and escape cover for deer may be limited due to the low quantities of woody plants. However, topographical variations could provide some escape cover. When found adjacent to sagebrush dominated states, this plant community may provide brood rearing/foraging areas for sage grouse, as well as lek sites. Other birds that would frequent this plant community include western meadowlarks, horned larks, and golden eagles. Many grassland obligate small mammals would occur here. 2.1 - Threadleaf Sedge/Sagebrush Plant Community: This community provides limited foraging for antelope and other grazers. They may be used as a foraging site by sage grouse where reference state community phases are limited. Generally, these are not target plant communities for wildlife habitat management. 3.1 - Bluebunch Wheatgrass/ Pin cushion Forbs Community: the predominance of grasses in this plant community favors grazers and mixed-feeders, however, the lack of vigor limits available forage to utilize. 4._ - Invaded State: The retained combination of sagebrush and the added diversity with the invasive grasses and/or forbs provide an extended plant community for wildlife. The similarities to Community Phase 1.1 are to some extent enhanced for some species with the added forage provided by the invasive species. But as the invasive species increase, decreasing the desirable species, the wildlife species benefits are decreased as well. 5.1 - Disturbed Lands: The variability of this site prevents a detailed review of wildlife benefits. However, many of the introduced grasses, forbs and shrubs can provide adequate cover, feed and nesting sites for those wildlife species that would have selected the site prior to disturbance. Limitations and enhancements need to be considered by specific locations. Animal Community – Grazing Interpretations: The following table lists suggested stocking rates for cattle under continuous season-long grazing under normal growing conditions. These are conservative estimates that should be used only as guidelines in the initial stages of the conservation planning process. Often, the current plant composition does not entirely match any particular plant community (as described in this ecological site description). Because of this, a field visit is recommended, in all cases, to document plant composition and production. More precise carrying capacity estimates should eventually be calculated using this information along with animal preference data, particularly when grazers other than cattle are involved. Under more intensive grazing management, improved harvest efficiencies can result in an increased carrying capacity. If distribution problems occur, stocking rates must be reduced to maintain plant health and vigor. The Carrying capacity is calculated as the production for a normal year X .25 efficiency factor / 912.5 #/AUM to calculate the AUM's/Acre and Acres/AUM. Plant Community Production Carrying Capacity* Plant Community Description/Title: Lbs./Acre AUM/Acre Acres/AUM 1.1 Bluebunch Wheatgrass/Sagebrush 200 - 350 - 500 0.07 AUM/ac 14 ac/AUM 1.2 Perennial Grasses/Sagebrush ** ** 2.1 Threadleaf Sedge/Sagebrush ** ** 3.1 Bluebunch Wheatgrass/Pin Cushion Forbs ** ** 4._ Invaded ** ** 5.1 Disturbed Lands ** ** - Carry Capacity is figured for continuous, season-long grazing by cattle under average growing conditions. ** - Sufficient data for invaded and reclaimed communities has not be collected or evaluated, at this time, so no projection of a stocking rate recommendation or production range will be established at this time. Grazing by domestic livestock is one of the major income-producing industries in the area. Rangeland in this area may provide yearlong forage for cattle, sheep, or horses. During the dormant period, the forage for livestock use needs to be supplemented with protein because the quality does not meet minimum livestock requirements. Distance to water, shrub density, and slope can affect carrying capacity (grazing capacity) within a management unit. Adjustments should be made for the area that is considered necessary for reduction of animal numbers. For example, 30% of a management unit may have 25% slopes and distances of greater than one mile from water; therefore, the adjustment is only calculated for 30% of the unit (i.e. 50% reduction on 30% of the management unit). Fencing, slope length, management, access, terrain, kind and class of livestock, and breeds are all factors that can increase or decrease the percent of graze-able acres within a management unit. Adjustments should be made that incorporate these factors when calculating stocking rates.

Hydrological functions

Water is the principal factor limiting forage production on this site. This site is dominated by soils in hydrologic group B and C, with localized areas in hydrologic group D. Infiltration ranges from moderately slow to moderate. Runoff potential for this site varies from low to moderate depending on soil hydrologic group and ground cover. In many cases, areas with greater than 75% ground cover have the greatest potential for high infiltration and lower runoff. An example of an exception would be where short-grasses form a strong sod and dominate the site. Areas where ground cover is less than 50% have the greatest potential to have reduced infiltration and higher runoff (refer to Part 630, NRCS National Engineering Handbook for detailed hydrology information). Rills and gullies should not typically be present. Water flow patterns should be barely distinguishable if at all present. Pedestals are only slightly present in association with bunchgrasses. Litter typically falls in place, and signs of movement are not common. Chemical and physical crusts are rare to non-existent. Cryptogamic crusts are present, but only cover 1-2% of the soil surface.

Recreational uses

The Stony Upland ecological site provides hunting opportunities for upland game species. The wide varieties of plants which bloom from spring until fall have an aesthetic value that appeals to visitors. Outside of plants, the extent offers a variety of cultural resources to view on the landscape based on the location of many of these sites on higher ground on the benches and fans which also provides a rich source of geology for exploration. The Stony Upland ecological site has access limitations when associated with roadways and trails. The land surface is a sound base for travel and camping in relation to erosion potential, however the cover of stones and boulders limits the ease, comfort, and functionality for all these uses.

Wood products

No appreciable wood products are present on the site. Isolated areas of limber pine and Rocky Mountain juniper exist within the Stony Upland ecological site that may offer a limited extent of firewood timber.

Other products

Herbs: The forb species of the Stony Upland ecological site have medicinal characteristics and have been used by the Native Americans in this area and more recently by the naturopathic profession. Ornamental Species: The forbs commonly found as well as the shrub component of these communities have been used in landscaping and xeriscaping.

Inventory data references

Information presented was derived from NRCS inventory data and historic range site descriptions. Field observations from range-trained personnel also were used. Those involved in the development of the new concept for the Stony Upland ecological site include Tricia Hatle, Range Management Specialist, US Department of the Interior-Bureau of Land Management (USDI-BLM); Karen Hepp, Range Management Specialist, USDI-BLM; and Marji Patz, Ecological Site Specialist, NRCS. Other sources used as references include USDA NRCS Water and Climate Center, USDA NRCS National Range and Pasture Handbook, USDI and USDA Interpreting Indicators of Rangeland Health Version IV, and USDA NRCS Soil Surveys from various counties. Quality control and quality assurance completed by NRCS: Dan Mattke, Area Resource Soil Scientist; Daniel Wood, MLRA Soil Survey Leader; John Hartung, Wyoming State Rangeland Management Specialist; James Bauchert, Wyoming State Soil Scientist; and Scott Woodall, Regional Quality Assurance Ecological Site Specialist. For specific data inquiries, contact the Powell, Wyoming Soil Survey Office (USDA-NRCS). Inventory Data References: Ocular field estimations observed by trained personnel were completed at each site. Then sites were selected where a 100-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 three of these estimated points, with two 21-foot X 21-foot square extended shrub plots). • Line Point Intercept (overstory and understory captured with soil cover). Height of herbaceous and woody cover is collected every three feet along established transect.) • Continuous Line Intercept (Woody Canopy Cover, with minimum gap of 0.2 foot for all woody species and succulents. Intercept height collected at each measurement.), • Gap Intercept (Basal Gap measured with a minimum gap requirement of 0.7 foot.), • Sample Point (Ten 1-meter square point photographs taken at set distances on transect. Read using the sample point computer program established by the High Plains Agricultural Research Center, WY). • Soil Stability (Slake Test – surface and subsurface samples collected and processed according to the soil stability guidelines provided by the Jornada Research Center, NM.)

Other references

Baker, William L. 2006. Fire and Restoration of Sagebrush Ecosystems. Wildlife Society Bulletin 34(1): 177-185.

Bestelmeyer, B., and J.R. Brown. 2005. State-and-transition models 101: a fresh look at vegetation change. The Quivira Coalition Newsletter, Vol. 7, No. 3.

Bestelmeyer, B., J.R. Brown, K.M. Havstad, B. Alexander, G. Chavez, and J.E. Herrick. 2003. Development and use of state and

transition models for rangelands. *Journal of Range Management* 56(2):114-126.

Bestelmeyer, B., J.E. Herrick, J.R. Brown, D.A. Trujillo, and K.M. Havstad. 2004. Land management in the American Southwest: a state-and-transition approach to ecosystem complexity. *Environmental Management* 34(1):38-51.

Herrick, J.E., J.W. Van Zee, K.M. Havstad, L.M. Burkett, and W.G. Whitford. 2005. Monitoring manual for grassland, shrubland and savanna ecosystems. Volume I Quick Start. USDA - ARS Jornada Experimental Range, Las Cruces, New Mexico.

Herrick, J.E., J.W. Van Zee, K.M. Havstad, L.M. Burkett, and W.G. Whitford. 2005. Monitoring manual for grassland, shrubland and savanna ecosystems. Volume II: Design, supplementary methods and interpretation. USDA - ARS Jornada Experimental Range, Las Cruces, New Mexico.

United States Department of Agriculture, Natural Resources Conservation Service. (electronic) National Water and Climate Center. Available online at <http://www.wcc.nrcs.usda.gov/>. Accessed November 2014.

United States Department of Agriculture, Natural Resources Conservation Service. 2009. Plant Guide: Cheatgrass. Prepared by Skinner et al., National Plant Data Center.

Pellant, M., P. Shaver, D. A. Pyke, and J. E. Herrick. 2005. Interpreting indicators of rangeland health. Version 4. Technical Reference 1734-6. USDI-BLM.

Ricketts, M. J., R. S. Noggles, and B. Landgraf-Gibbons. 2004. Pryor Mountain Wild Horse Range Survey and Assessment. USDA-Natural Resources Conservation Service.

Schoeneberger, P.J., D.A. Wysocki, E.C. Benham, and Soil Survey Staff. 2012. Field book for describing and sampling soils, Version 3.0. Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE .

Stringham, T.K. and W.C. Krueger. 2001. States, transitions, and thresholds: further refinement for rangeland applications. Agricultural Experiment Station, Oregon State University. Special Report 1024.

Stringham, T.K., W.C. Kreuger, and P.L Shaver. 2003. State and transition modeling: an ecological process approach. *Journal of Range Management* 56(2):106-113.

United States Department of Agriculture. Soil Survey Division Staff. 1993. Soil Survey Manual, United States Department of Agriculture Handbook No. 18, Chapter 3: Examination and Description of Soils. p.192- 196.

United States Department of Agriculture, Natural Resources Conservation Service. 1997. National Range and Pasture Handbook. (<http://www.glti.nrcs.usda.gov/technical/publications/nrph.html>). Accessed October 2014.

Trlica, M.J. 1999. Grass growth and response to grazing. Range . Colorado State University Cooperative Extension, Natural Resource Series. No. 6.108.

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA/NRCS). 2007. The PLANTS Database (<http://plants.usda.gov>). National Plant Data Center.

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA/NRCS), Soil Survey Staff. 2010. Keys to Soil Taxonomy, 11th Edition.

USDA/NRCS Soil survey manuals for various counties within MLRA 32X. Web soil survey is available online at: <https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>.

Western Regional Climate Center. 2014. Electronic station metadata. Available online at: <http://www.wrcc.dri.edu/summary/climsmwy.html>.

Approval

Kirt Walstad, 3/05/2025

Rangeland health reference sheet

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

Author(s)/participant(s)	Marji Patz
Contact for lead author	marji.patz@usda.gov; 307-271-3130
Date	01/19/2022
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

- 1. Number and extent of rills:** Rare to nonexistent. Some increase in rill development may occur on steeper slopes or on areas located below exposed bedrock or other water shedding areas where increased runoff may occur. Where rills are present, they should be fairly short (2-5 feet), <1 inch deep and somewhat widely spaced (4-8 feet). Rills may increase in length (3-6 feet) and decrease in spacing (3-6 feet) on slopes greater than 30 percent. A minor increase in rill development may be observed on all slopes following major thunderstorm or spring runoff events but should heal during the next growing season.

- 2. Presence of water flow patterns:** Barely observable. Some very minor evidence of water flow patterns may be found around perennial plant bases. They show little evidence of current erosion. They are expected to be short (3-6 feet), stable, sinuous, and not connected. There may be very minor evidence of deposition. Evidence of water flow may increase somewhat with slope.

- 3. Number and height of erosional pedestals or terracettes:** Perennial vegetation shows little evidence of erosional pedestalling (1 to 2% of individual plants). Plant roots are covered and litter remains in place around plant crowns. Terracettes should be absent or, if present, stable. A slight increase in both pedestal and terracette development may occur with increasing slope.

- 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 10-30%. Bare ground spaces should not be greater than 2 foot in diameter.

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

- 6. Extent of wind scoured, blowouts and/or depositional areas:** Rare to nonexistent. No evidence of wind generated soil movement is present. Wind caused blowouts and deposition are not present.

7. Amount of litter movement (describe size and distance expected to travel): Herbaceous and large woody litter not expected to move. Most litter resides in place with some redistribution downslope caused by water movement. The majority of litter accumulates at the base of plants. Some grass leaves and stems may accumulate in soil depressions adjacent to plants. Woody stems are not likely to move. However, some litter movement is expected (up to 6 feet) with increases in slopes >25% and/or increased runoff resulting from heavy thunderstorms.
-
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 3 (interspaces) to 6 (under plant canopy), but average values should be 4.0 or greater.
-
9. Soil surface structure and SOM content (include type of structure and A-horizon color and thickness): Soil data is limited for this site. Soil OM of 2 to 5% is expected.
-
10. Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff: Plant community consists of 50-80% grasses, 15% forbs, and 5-35% shrubs. Evenly distributed plant canopy (60-95%) and litter plus moderate infiltration rates result in minimal runoff. Basal cover is typically 5-15% for this site and does affect runoff on this site. Surface rock fragments of 5-20% provide stability to the site, but reduce infiltration
-
11. Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site): None.
-
12. Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):
- Dominant: Mid-stature, cool-season bunchgrasses >>>>
- Sub-dominant: perennial shrubs >>>> perennial forbs>>>>
- Other: tall-stature cool-season bunchgrasses = cool-season rhizomatous grasses = short-stature cool-season bunchgrasses
- Additional: Following a disturbance such as fire, drought, rodents or insects that remove woody vegetation, forbs and perennial grasses (herbaceous species) may dominate the community for a period of time. If a disturbance has not occurred for an extended period of time, woody species may continue to increase. These conditions would reflect a functional community phase within the reference state.
-
13. Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence): All age classes of perennial grasses should be present under average to above average growing conditions. There may be partial mortality on individual bunchgrasses and shrubs during drought periods, and complete mortality of individual plants during severe drought periods. Slight decadence in the principle shrubs could occur near the end of the fire cycle or during periods of extended drought, or insect infestations. In general, a mix of age classes should be expected with some dead and decadent plants present.
-
14. Average percent litter cover (%) and depth (in): Litter ranges from 5-15% of total canopy measurement with total litter (including beneath the plant canopy) from 30-50% expected. Herbaceous litter depth typically ranges from 5-15 mm. Woody litter can be up to a

couple inches (4-6 cm).

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):**
Average annual production is 350 lb/ac (392 kg/ha), and ranges from 200-500 lb/ac (224-560 kg/ha).
-

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: Bare ground greater than 35% is the most common indicator of a threshold being crossed. Rhizomatous wheatgrasses, Sandberg bluegrass, juniper and big sagebrush are common increasers. Common dandelion, thistles, and annual weeds such as cheatgrass and mustards are common invasive species in disturbed sites.
-

17. **Perennial plant reproductive capability:** All species are capable of reproducing, except in extreme drought years.
-