USDA Natural Resources Conservation Service

Ecological site R035XC308AZ
Limestone/Sandstone Hills 10-14" p.z.

Accessed: 05/03/2024

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.

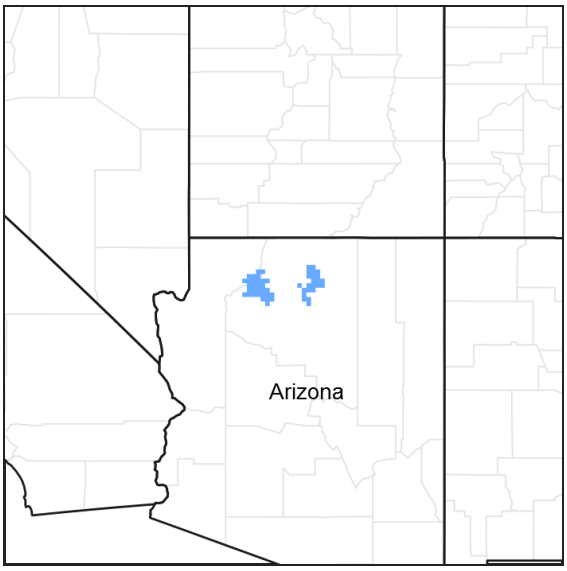

Figure 1. Mapped extent

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

MLRA notes

Major Land Resource Area (MLRA): 035X–Colorado Plateau

This ecological site is found in Common Resource Area 35.3 – the Colorado Plateau Sagebrush – Grasslands.

The Common Resource Area occurs within the Colorado Plateau Physiographic Province. It is characterized by a sequence of flat to gently dipping sedimentary rocks eroded into plateaus, valleys and deep canyons. Elevations range from 4800 to 6700 feet and precipitation averages 10 to 14 inches. The elevation range is lower (about 4500 to 6000) on the western side of the Colorado Plateau along the Grand Canyon, and moves up about 500 to 800 feet higher on the eastern side in the areas of the Navajo and Hopi Indian Reservations due to rain shadow effects from the Kaibab Plateau and Mogollon Rim. Common vegetation in this region includes Wyoming big sagebrush, Utah juniper, Colorado pinyon - cliffrose, Mormon tea, fourwing saltbush, blackbrush Indian ricegrass, needle and thread, western wheatgrass Galleta, black grama, blue grama, and sand dropseed. Sedimentary rock classes dominate the plateau with volcanic fields occurring for the most part near its margin. The soil temperature regime is mesic and the soil moisture regime is ustic aridic.

Similar sites

R035XC310AZ	**Limy Slopes 10-14" p.z.** Similar in plant community and geology; found on plateaus and rolling hills of limestone

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Bouteloua gracilis* (2) *Artemisia bigelovii*
Herbaceous	(1) *Juniperus osteosperma*

Physiographic features

This site occurs on steeper hillsides and escarpments that have shallow soils (<20") over limestone and sandstone. Surface and subsoil textures are extremely gravelly loam. Rock outcrop is common. Overall slopes range from 15 to 60 percent, but there can be small areas with flatter or steeper slopes within the site.

Table 2. Representative physiographic features

Landforms	(1) Hill (2) Escarpment
Flooding frequency	None
Ponding frequency	None
Elevation	1,463–2,042 m
Slope	15–60%
Aspect	Aspect is not a significant factor

Climatic features

Winter/Summer moisture ratios range from 70:30 to 60:40. Late spring is usually the driest period, followed by summer rains falling from June to September; this moisture originates in the Gulf of Mexico and creates brief, intense convective thunderstorms. Fall moisture can be sporadic. Regular winter precipitation in the form of snow generally falls from October to May and is the result of fronts originating in the Pacific. Summer daytime temperatures are commonly 95 - 100 F and on occasion exceed 105 F. Winter air temperatures can regularly go below 10 F and have been recorded below - 20 F.

Table 3. Representative climatic features

Frost-free period (average)	168 days
Freeze-free period (average)	193 days
Precipitation total (average)	356 mm

Influencing water features

The soil moisture on this ecological site comes from precipitation. The site does not benefit significantly from run-on moisture. Shallow bedrock areas will concentrate water in deeper soil pockets, where most of the vegetation production occurs. Because of the shallow soils, larger rainfall events will not be entirely captured by the site. This site contributes runoff to other ecological sites.

Soil features

Soils are very shallow to shallow.
Surface and subsoil textures are extremely gravelly loam.
Parent materials are alluvium, colluvium and residuum from limestone and sandstone.
Geologic formation is Kaibab limestone and Moenkopi sandstone.
Available water capacity is very low.
Hazard of erosion by water and/or wind is moderate.
Soils are non-saline, non-sodic with a pH of 7.9-8.0.

Soil moisture regime is ustic aridic.

Map Units Correlated to This Site include:

SSA 699 Hualapai-Havasupai Area MU 55 Winona;
SSA 701 Grand Canyon Area MU's 66 Winona, 81 Meriwhitica, 98 Puertecito Family, 99 Meriwhitica Family;
SSA 707 Little Colorado River Area MU's 26 Mellenthin extremely stony, 29 Wayneco, 40 Puertecito, 43 Reef.

Table 4. Representative soil features

Parent material	(1) Alluvium–limestone and sandstone
Surface texture	(1) Extremely gravelly loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Moderate
Soil depth	15–51 cm
Surface fragment cover <=3"	20–60%
Surface fragment cover >3"	5–20%
Available water capacity (0-101.6cm)	1.4–2.64 cm
Calcium carbonate equivalent (0-101.6cm)	32–54%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	7.4–9
Subsurface fragment volume <=3" (Depth not specified)	50–60%
Subsurface fragment volume >3" (Depth not specified)	10–20%

Ecological dynamics

The historic climax plant community (HCPC) for a site in North America is the plant community that existed at the time of European immigration and settlement. It is the plant community that was best adapted to the unique combination of environmental factors associated with the site. The historic climax plant community was in dynamic equilibrium with its environment. It is the plant community that was able to avoid displacement by the suite of disturbances and disturbance patterns (magnitude and frequency) that naturally occurred within the area occupied by the site. Natural disturbances, such as drought, fire, grazing of native fauna, and insects, were inherent in the development and maintenance of these plant communities. The effects of these disturbances are part of the range of characteristics of the site that contribute to that dynamic equilibrium. Fluctuations in plant community structure and function caused by the effects of these natural disturbances establish the boundaries of dynamic equilibrium. They are accounted for as part of the range of characteristics for an ecological site. Some sites may have a small range of variation, while others have a large range.
The historic climax plant community of an ecological site is not a precise assemblage of species for which the proportions are the same from place to place or from year to year. In all plant communities, variability is apparent in productivity and occurrence of individual species. Spatial boundaries of the communities; however, can be recognized by characteristic patterns of species composition, association, and community structure. The HCPC for this ecological site has been estimated by sampling relict or relatively undisturbed sites and/or reviewing historic records.
Plant communities that are subjected to abnormal disturbances and physical site deterioration or that are protected

from natural influences, such as fire and grazing, for long periods seldom typify the historic climax plant community. The physical site deterioration caused by the abnormal disturbance results in the crossing of a threshold or irreversible boundary to another state, or equilibrium, for the ecological site. There may be multiple thresholds and states possible for an ecological site, determined by the type and or severity of abnormal disturbance. The known states and transition pathways for this ecological site are described in the accompanying state and transition model.
The Plant Community Plant Species Composition table provides a list of species and each specie's or group of species' annual production in pounds per acre (air-dry weight) expected in a normal rainfall year. Low and high production yields represent the modal range of variability for that species or group of species across the extent of the ecological site.
The Annual Production by Plant Type table provides the median air-dry production and the fluctuations to be expected during favorable, normal, and unfavorable years.
The present plant community on an ecological site can be compared to the various common vegetation states that can exist on the site. The degree of similarity is expressed through a similarity index. To determine the similarity index, compare the production of each species to that shown in the plant community description. For each species, count no more than the maximum amount shown for the species, and for each group, count no more than the maximum shown for the group. Divide the resulting total by the total representative value shown in the Annual Production by Plant Type table for the reference plant community. Variations in production due to above or below normal rainfall, incomplete growing season or utilization must be corrected before comparing it to the site description. The Worksheet for Determining Similarity Index is useful in making these corrections. The accompanying growth curve can be used as a guide for estimating percent of growth completed.

The State and Transition model shows the most common occurring plant communities likely to be encountered on this ecological site. This model may not show every possible plant community, but only those that are most prevalent and observed through field inventory. As more data is collected and research is available, these plant communities may be revised, removed, and even added to reflect the ecological dynamics of this site.

This site occurs on bedrock-controlled hills of Kaibab limestone and is sometimes intermixed with Moenkopi sandstone. This site may or may not be dominated by Wyoming big sagebrush on north-facing slopes; sagebrush may be limited to interfingerings of cooler, moister areas or in protected areas, such as behind rocks.

State and transition model

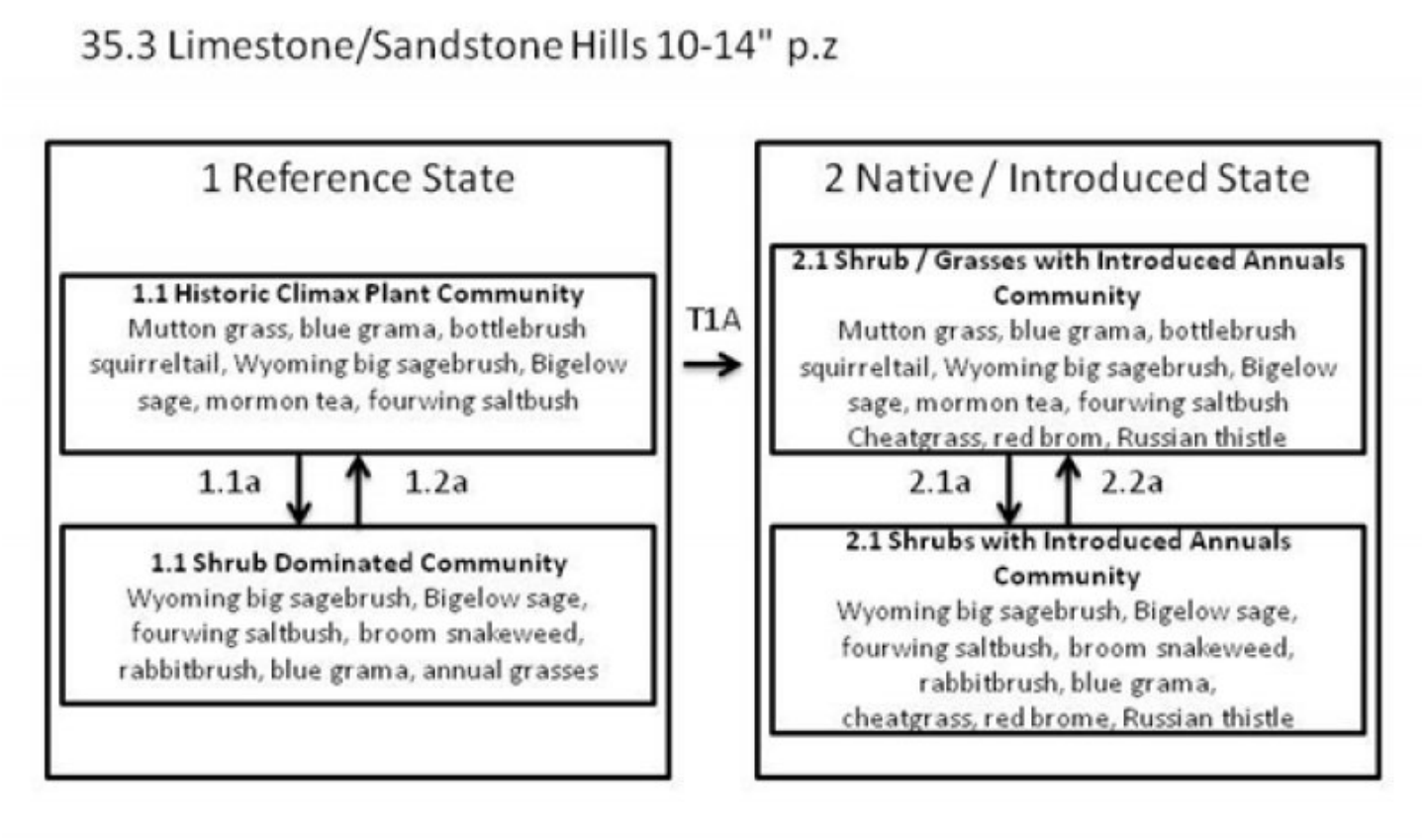

Figure 4. 353 LimstoneSandstoneHills S&T

State 1
Reference State

Community 1.1
Historic Climax Plant Community

Figure 5. 35.3 Limestone/Sandstone Hills

The dominant aspect of the site is a grass-shrub mix. Major grasses are muttongrass, blue grama and bottlebrush squirreltail. The dominant shrubs are Wyoming big sagebrush and/or Bigelow sage, fourwing saltbush, and Mormon tea. With severe disturbance, plants that will increase are Wyoming big sagebrush and broom snakeweed; plants that will invade are annual forbs.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	336	448	560
Shrub/Vine	168	224	280
Forb	6	17	22
Total	**510**	**689**	**862**

Table 6. Ground cover

Tree foliar cover	0-1%
Shrub/vine/liana foliar cover	1-2%
Grass/grasslike foliar cover	1-2%
Forb foliar cover	0-1%
Non-vascular plants	0%
Biological crusts	0%
Litter	0%
Surface fragments >0.25" and <=3"	0%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	0%

Table 7. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	–	0-1%
>0.15 <= 0.3	–	–	15-20%	–
>0.3 <= 0.6	–	10-15%	–	–
>0.6 <= 1.4	–	–	–	–
>1.4 <= 4	0-2%	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Figure 7. Plant community growth curve (percent production by month). AZ3504, 35.3 10-14" p.z. bottlebrush squirreltail. Growth occurs in late winter, spring, and fall. Plants often remain green through the winter..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	5	15	35	25	10	0	0	5	5	0	0

Figure 8. Plant community growth curve (percent production by month). AZ3508, 35.3 10-14" p.z. Wyoming big sagebrush. Most growth occurs in spring and early summer. Stem elongation and seed set occur in the fall..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	5	15	30	20	10	10	10	0	0

Figure 9. Plant community growth curve (percent production by month). AZ3514, 35.3 10-14" p.z. muttongrass. Growth begins in spring and continues with the summer rains..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	5	15	20	20	20	10	10	0	0	0

Figure 10. Plant community growth curve (percent production by month). AZ3531, 35.3 10-14" p.z. all sites. Growth begins in the spring and continues through the summer..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	1	3	17	18	10	19	20	10	1	1	0

Community 1.2
Shrub Dominated Community

This plant community is dominated by shrubs, including Wyoming big sagebrush, Bigelow sage, fourwing saltbush, broom snakeweed, rabbitbrush. The perennial grasses are primarily sod forming grasses. Annuals grasses and forbs are more abundant.

Pathway 1.1a
Community 1.1 to 1.2

Drought, prolonged periods of winter dominated moisture patterns, reduction of normal fire cycles, and unmanged grazing will reduce the perennial grass component on the site, and allow shrubs to increase.

Pathway 2.1a
Community 1.2 to 1.1

Normal precipitation patterns with well managed grazing and/or rest will allow native perennial bunchgrasses and other palatable shrubs to increase in the plant community. Allowing natural fires to burn will accelerate recovery.

Conservation practices

Prescribed Burning
Prescribed Grazing

State 2
Natives / Introduced State

The plant communities in the Natives /Introduced state are the same as in the reference state, but the plant communities now contain introduced annuals such as red brome, cheatgrass, and Russian thistle that compete with the native species on the site.

Community 2.1
Natives with Introduced Annuals

This plant community resembles the historic climax plant community, but introduced annuals are now part of the plant community and compete with the native species. The biotic integrity, fire intensity/frequency, and/or hyrdologic function on the site are altered from the reference state.

Community 2.2
Shrubs with Introduced Annuals

Native shrubs species dominate the site. Perennial grasses are primarily the sod forming grasses. Introduced annuals such as red brome, cheatgrass, and Russian thistle are part of the plant community and compete with the natives. Distrubances such as drought, fire, and grazing can allow the introduced species to continue to increase on the site.

Pathway 2.1a
Community 2.1 to 2.2

Drought, prolonged periods of winter dominated moisture patterns, reduction of normal fire cycles, and unmanged grazing will reduce the perennial grass component on the site, and allow shrubs to increase.

Pathway 2.2a
Community 2.2 to 2.1

Normal precipitation patterns with well managed grazing and/or rest will allow native perennial bunchgrasses and other palatable shrubs to increase in the plant community. Allowing natural fires to burn will accelerate recovery, but may increase introduced annuals on the site.

Conservation practices

Prescribed Burning
Prescribed Grazing

Transition T1A
State 1 to 2

Introduction of non-native annuals

Additional community tables

Table 8. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Grasses**			336–560	
	muttongrass	POFE	*Poa fendleriana*	168–224	–
	blue grama	BOGR2	*Bouteloua gracilis*	112–168	–
	squirreltail	ELELE	*Elymus elymoides ssp. elymoides*	56–112	–
	desert needlegrass	ACSP12	*Achnatherum speciosum*	28–56	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	17–28	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	17–28	–
	New Mexico feathergrass	HENE5	*Hesperostipa neomexicana*	17–28	–
	Grass, annual	2GA	*Grass, annual*	0–11	–
	Grass, perennial	2GP	*Grass, perennial*	6–11	–
Forb					
2	**Forbs**			6–22	
	blue grama	BOGR2	*Bouteloua gracilis*	27–54	–
	Forb, annual	2FA	*Forb, annual*	0–11	–
	Forb, perennial	2FP	*Forb, perennial*	6–11	–
	rose heath	CHER2	*Chaetopappa ericoides*	6–11	–
	globemallow	SPHAE	*Sphaeralcea*	0–6	–
Shrub/Vine					
3	**Shrubs**			168–280	
	Bigelow sage	ARBI3	*Artemisia bigelovii*	84–112	–
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	84–112	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	56–84	–
	mormon tea	EPVI	*Ephedra viridis*	28–56	–
	squirreltail	ELELE	*Elymus elymoides ssp. elymoides*	27–54	–
	Stansbury cliffrose	PUST	*Purshia stansburiana*	6–28	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	6–17	–
	Fremont's mahonia	MAFR3	*Mahonia fremontii*	0–11	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–11	–

Animal community

Wildlife species on site are mule deer, cottontail rabbit, blacktail jackrabbit, lizards, coyote, pronghorn antelope and snakes.

Type locality

Location 1: Coconino County, AZ	
Township/Range/Section	T32N R5W S14
General legal description	National Canyon Quad - Tenderfoot Mesa area, Havasupai Indian Reservation
Location 2: Coconino County, AZ	

General legal description	Highway 89 North from Flagstaff between the Highway 160 Tuba City turnoff and Bitter Springs, Coconino County, Arizona.

Other references

Updates and revisions for this ESD were conducted as part of a 2007-2012 Interagency Technical Assistance Agreement between the Bureau of Indian Affairs–Navajo Region and the NRCS-Arizona.

Contributors

Dan Carroll
Harmon Hodgkinson
Harmon S. Hodgkinson
Jennifer Puttere
Karlynn Huling
Larry D. Ellicott
Stephen Cassady

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)	Karlynn Huling
Contact for lead author	State Rangeland Management Specialist, NRCS-Arizona State Office, Phoenix,AZ
Date	03/24/2006
Approved by	S. Cassady
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** A few rills may form due to loamy surface textures, moderate permeability, very rapid runoff, and steep slopes, but they are not likely in most areas due to extensive surface cover of rock fragment armor and the large amount of rock fragments in the soil profile.

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2. **Presence of water flow patterns:** Water flow patterns may be common due to moderate permeability, shallow depth of bedrock, very rapid runoff and steep slopes. There will be more water flow patterns in steeper areas and in areas adjacent to large expanses of rock outcrop.

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3. **Number and height of erosional pedestals or terracettes:** Some pedestals and terracettes may form, but they will be very short.

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground ranges from 0-3%. Areas with greater cover of rock fragments and/or rock outcrop will have less bare ground. Drought may cause an increase in bare ground. This site has only 1 inch of available water capacity, so the potential to produce plant cover is very low, except in areas where plants have access to water in bedrock cracks.

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5. **Number of gullies and erosion associated with gullies:** None

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6. **Extent of wind scoured, blowouts and/or depositional areas:** None

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7. **Amount of litter movement (describe size and distance expected to travel):** Herbaceous, fine woody and some coarse woody litter will be transported in water flow pathways. Most coarse woody litter will remain under shrub and tree canopies. There may be more litter movement in areas that are adjacent to large expanses of rock outcrop.

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil surface textures are mostly loam and very fine sandy loam. All surface horizons contain a significant amount of rock fragments (gravel and/or cobbles). Most soils have 40-80% cover of rock fragments (mostly gravels and cobbles with some stones.) When well vegetated or covered with rock armor, the soils have a high resistance to both water and wind erosion.

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil surface structure is usually granular (weak fine) or subangular blocky (weak to moderate, fine to medium). There are a few areas with platy (weak, moderate to thick) structure. Surface thickness range is 2-4 inches. Color is variable depending upon parent material.

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** This site is characterized by a relatively even distribution of both shrubs and grasses across the landscape, except in areas with a lot of rock outcrop. There aer usually a few forbs and possibly a few trees. Canopy cover range is 25-35% and is almost evenly split between shrubs and grasses. Basal cover range is 5-20%; higher basal cover values usually occur on sites with more grass. There may be a 1% cover of cryptogams. The plant cover (especially basal cover) is reduced by the large amount of large rock fragments and/or bedrock ground cover. Both cover values decrease during a prolonged drought. This type of plant community is slightly to moderately effective at capturing and storing precipitation.

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11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** None. These soils are not easily compacted due to extensive cover of rock fragment armor and the high volume of rock fragments in the surface horizons of the profile. Inclusions without a significant amount of rock fragments are easily compacted, at least 2-4 inches. A few areas have a naturally platy surface structure.

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12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

Dominant: shrubs >

Sub-dominant: cool season bunchgrasses >

Other: Minor: warm season bunchgrasses >cacti = forbs = trees
Trace: Agave family

Additional:

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** All plant functional groups are adapted to survifal except in the most severe droughts. Severe winter droughts affect shrubs and trees the most. Severe summer droughts affect grasses the most.

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14. **Average percent litter cover (%) and depth (in):** Litter consists of a combination of herbaceous and woody. Litter amounts increase during the first few eyars of drought, then decrease in later years.

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** 300-400 pounds per acre (dry weight) in drought years, 400-550 pounds per acre in median years, 550-650 pounds per acre in wet years.

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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:** Wyoming big sagebrush is native to the site, but has the potential to increase and dominate after heavy grazing. Broom snakeweed, Douglas rabbitbrush, pricklypear cactus (Opuntia), and cholla cactus (Cylindropuntia) are natives that have the potential to increase and dominate the site after a sagebrush fire and heavy grazing. Cheatgrass, red brome, and redstem filaree are exotic annuals that are becomind endemic to the site regardless of management or fire frequency. They may become dominant plants on the site after a sagebrush fire, even with conservative or no grazing.

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17. **Perennial plant reproductive capability:** All plants native to the site are adapted to the climate and are capable of producing seeds, stolons and rhizomes except during the most severe droughts.
