USDA Natural Resources
Conservation Service

Ecological site R035XY230UT
Semidesert Shallow Sandy Loam (Shadscale)

Accessed: 05/13/2025

General information

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

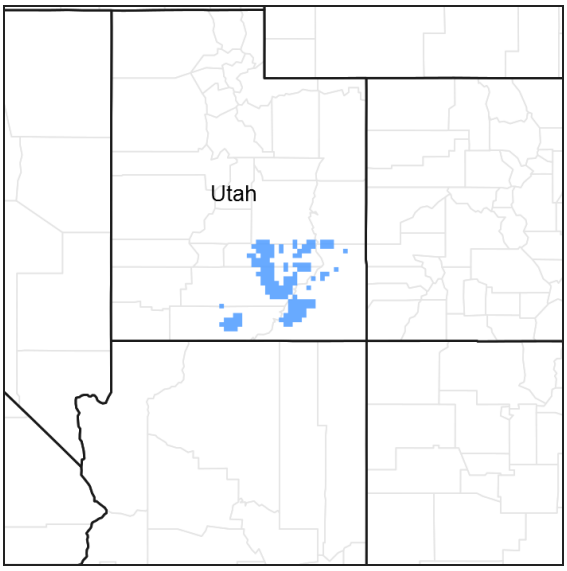


Figure 1. Mapped extent

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 occurs in the northern portion of MLRA 35, Colorado Plateau Province. It is found principally in the Canyon Lands and High Plateaus of Utah sections within that MLRA. This area has been stucturally uplifted over time while rivers flowing across it were cutting down into its bedrock. Areas of shale, sandstone, limestone, dolomite, and volcanic rock outcrop are found throughout the region.

Classification relationships

Modal Soil: Skos — loamy-skeletal, mixed (calc.), mesic Lithic Ustic Torriorthents

Type Location: Cedar Mesa Rims

Associated sites

R035XY018UT	**Talus Slope (Blackbrush-Shadscale)**
R035XY115UT	**Desert Sand (Sand Sagebrush)**
R035XY133UT	**Desert Shallow Sandy Loam (Blackbrush)**

R035XY215UT	**Semidesert Sandy Loam (4-Wing Saltbush)**
R035XY221UT	**Semidesert Shallow Loam (Utah Juniper-Pinyon)**
R035XY223UT	**Semidesert Shallow Clay (Mat Saltbush)**
R035XY233UT	**Semidesert Shallow Sandy Loam (Blackbrush)**
R035XY236UT	**Semidesert Shallow Sandy Loam (Utah Juniper, Blackbrush)**
R035XY239UT	**Semidesert Shallow Clay (Shadscale-Utah Juniper)**
R035XY242UT	**Semidesert Gravelly Loam (Shadscale)**

Similar sites

R035XY130UT	**Desert Shallow Sandy Loam (Shadscale)** This site is similar to R035XY230UT in plant composition; however it differs in production due to its location in the desert ecological zone.
R035XY242UT	**Semidesert Gravelly Loam (Shadscale)** This site is similar to site R035XY230UT in plant species compositon, but differs due to its stony characteristics.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Atriplex confertifolia* (2) *Ephedra cutleri*
Herbaceous	(1) *Pleuraphis jamesii* (2) *Achnatherum hymenoides*

Physiographic features

This site is located on mountain slopes, mesa tops, benches, hillsides, ridges, alluvial fans, and cuestas. Runoff is slow to moderate. Flooding and ponding are rare due to local landscape positions and the dry nature of the ecosystem. Slopes are generally low to moderate (0-30%) but can range up to 70%.

Table 2. Representative physiographic features

Landforms	(1) Mesa (2) Structural bench (3) Alluvial fan
Flooding frequency	None
Ponding frequency	None
Elevation	1,463–2,073 m
Slope	2–30%
Ponding depth	0 cm
Water table depth	0 cm
Aspect	Aspect is not a significant factor

Climatic features

The climate is characterized by hot summers and cool winters where large fluctuations in daily temperatures are common. Approximately 70-75% of moisture occurs from March-October as convection thunderstorms. Precipitation is variable from month to month and from year to year but averages between 7.5-9 inches. Snow packs are generally light and not persistent.

Table 3. Representative climatic features

Frost-free period (average)	180 days
Freeze-free period (average)	250 days
Precipitation total (average)	229 mm

Influencing water features

There are no water features influencing this site.

Soil features

This site occurs on shallow to moderately deep soils. The dry surface layer color is typically reddish or grayish and the surface soil textures range from sandy loams to very fine sandy loams which can include a stony or channery modifier. These soils are poorly developed, well drained, and have moderate water holding capacities. Soil temperature regime is mesic and moisture regime is ustic aridic. Erosion potential of soils on reference state sites typically depends on surface rock fragments. Sites with greater than 30% rock fragments have lower wind and water erosion potentials than sites with less than 30% surface rock fragments. Biological crust cover is characterized as crustless with the possible occurrence of light cyanobacteria and/or isolated lichen and moss pinnacles. This site has been used in the following soils surveys and has been correlated to the following components:

UT631—Henry Mountains Area—Canyon family, Rizno, Shedado, Travessilla
UT633—Canyonlands Area—Leanto
UT638—San Juan County, Central—Skos
UT685—Capital Reef National Park—Remorris, Simel, Abra family;
UT686—Escalante Grand Staircase National Monument—Daklos, Skyvillage

Typical Soil Profile:
A—0-4 inches; (channery/stony) sandy loam; slightly calcareous; moderately alkaline
C—4-8 inches; channery loam; moderately calcareous; moderately alkaline
R—8+ inches; hard sandstone (may have fractures)

Table 4. Representative soil features

Parent material	(1) Residuum–sandstone (2) Colluvium–shale
Surface texture	(1) Channery sandy loam (2) Gravelly fine sandy loam (3) Fine sandy loam
Family particle size	(1) Sandy
Drainage class	Well drained
Permeability class	Very slow to moderately rapid
Soil depth	3–51 cm
Surface fragment cover <=3"	10–85%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	1.12–8.41 cm
Calcium carbonate equivalent (0-101.6cm)	1–30%
Electrical conductivity (0-101.6cm)	0–4 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–5

Soil reaction (1:1 water) (0-101.6cm)	7.4–8.4
Subsurface fragment volume <=3" (Depth not specified)	0–30%
Subsurface fragment volume >3" (Depth not specified)	0–10%

Ecological dynamics

This site developed under Colorado Plateau ecological conditions and the natural influences of climate and grazing. The dynamics described in this site description were determined through the study of rangeland relic areas, areas protected from excessive disturbance and influences such a improper livestock grazing and damaging recreational activities. Literature reviews, trends in plant community dynamics, and historical accounts have also been considered. Community phases, community pathways, states, transitions, thresholds, and restoration pathways have been determined through similar studies and experiences.

This ecological site is found on very shallow to moderately deep, poorly developed soils in Major Land Resource Area (MLRA) 35. Vegetation on salt desert shrub lands is generally very sparse and thus fire did not carry well and therefore is not part of the historic natural disturbance regime (Simonin, 2001). Due to scarcity of local water sources this site was minimally influenced by large grazing ungulates before European settlement. Drought and other climatic conditions was the major natural disturbances influencing this site.

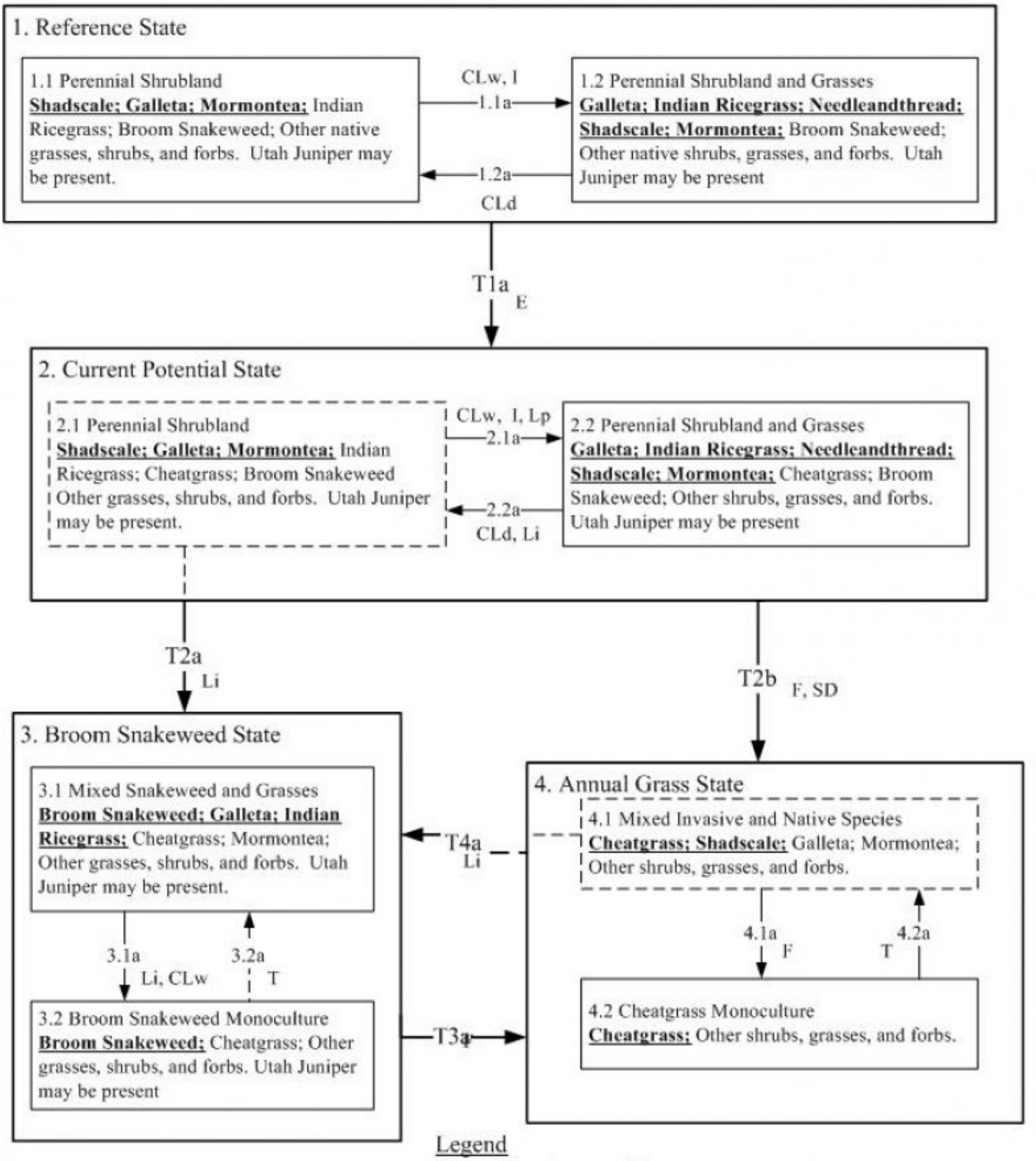
This site has been grazed by domestic livestock since they were introduced into the area. This introduction of livestock with it's use of fencing, and the development of reliable water sources have impacted the disturbance regime of this site. Improper livestock grazing (i.e., continuous season long grazing, heavy stocking rates, etc.) can cause this site to depart from it's reference plant communities and allow annual grasses, such as cheatgrass, to invade, and broom snakeweed to increase dramatically. These annual grasses can increase the sites fine fuel loads and make fire more prevalent, increasing the possibility that it will convert to an annual grassland community(Simonin, 2001).

As vegetative communities respond to changes in management or natural influences that move them to different ecological states, a return to previous states may not be possible. The amount of energy needed to affect vegetative shifts depends on present biotic and abiotic features and the desired results.

The following diagram depicts the most commonly occurring plant communities fornd on this ecological site. These plant communities may not represent every possibility, but they are the most prevalent and repeatable. As more data are collected, some of these plant communities may be revised or removed, and new ones added. This State and Transition model was developed using range data collected in 2006 and 2007 in Canyonlands National Park in Southeastern Utah as part of a national park soil survey update. Both ocular and measured data was collected and utilized. Other range data collected by the NRCS (1982) was also used.

State and transition model

R035XY230UT Semidesert Shallow Sandy Loam (Shadscale)



Legend

CLw = Climate wet periods
CLd = Climate dry periods
I = Insect infestations associated with wet periods
E = Establishment of non-native invasive species
Li = Improper livestock grazing
Lp = Proper livestock grazing
F = Fire
SD = Surface disturbances, such as off road vehicle use, development, etc.
T = Time without disturbances

State 1
Reference State

This Reference State represents that natural range of variability that dominates the dynamics of this ecological site. This state includes the biotic communities that would become established on the ecological site if all successional sequences were completed without interferences by man under the present environmental conditions. Natural disturbances are inherent in its development. This state is dominated by shadscale and perennial native bunchgrasses and forbs. Broom snakeweed, while not a climax species is present and its cover fluctuates in the different plant communities based on precipitation trends (Ralphs and Sanders, 2002) and perennial shrub nutrient competition (Tirmenstein, 1999). The primary disturbance mechanisms that are inherent to this state include precipitation fluctuations and it's associated insect infestations, as well as time without disturbances. Reference State: Community phases maintained by precipitation fluctuations, insects, and time. Indicators: A diverse perennial shrub, grass, and forb community that is dominated by shadscale, mormontea species (Cutler, Torrey, and/or green), James galleta, Indian ricegrass, and needle-and-thread. Feedbacks: The establishment of invasive species in the understory and climatic conditions that maintain the perennial shrub and grass community. At-risk Community Phase: All communities are at risk when nutrients become available for invasive species to establish. Trigger: Introduction of invasive species to fill available niches.

Community 1.1
Perennial Shrubland

Figure 4. Perennial Shrubland

This community phase is characterized by a dominance of shadscale and mormontea (Cutler, Torrey, and/or green). Broom snakeweed is minimally present. Native perennial warm and cool season grasses are present but do not dominate the site in terms of cover or production. Warm season grasses include James galleta, and cool season grasses include Indian ricegrass and needle-and-thread. Both perennial and annual forb production and cover are variable, peppergrass, yellow Cryptantha, and tansy aster are expected to be present. Other grasses, shrubs, and forbs may also be present and cover is variable. Utah juniper is a natural invader of this site; however juniper cover is minimal. Bare ground is minimal (10-25%), surface rock fragments are variable (5-50%), and biological crusts (5-25%) are characterized by light cyanobacteria and/or isolated moss and lichen pinnacles with little continuity. The following tables provide an example of the typical vegetative floristics of a community phase 1.1 plant community.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	168	224	280
Forb	56	112	168
Grass/Grasslike	56	112	168
Tree	–	6	11
Total	**280**	**454**	**627**

Table 6. Ground cover

Tree foliar cover	0-5%
Shrub/vine/liana foliar cover	10-20%
Grass/grasslike foliar cover	5-15%
Forb foliar cover	5-10%
Non-vascular plants	0%
Biological crusts	2-25%
Litter	3-8%
Surface fragments >0.25" and <=3"	5-50%
Surface fragments >3"	0%
Bedrock	0-5%
Water	0%
Bare ground	10-25%

Table 7. Canopy structure (% cover)

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

Community 1.2
Perennial Shrubland and Grasses

Figure 6. Perennial Shrubland with Grasses

This community phase is characterized by a dominance of native perennial warm and cool season grasses, where native shrubs are also present. Warm season grasses include James galleta and sand dropseed and cool season grasses include Indian ricegrass, needle-and-thread, and purple threeawn. The dominant native shrubs include shadscale and mormontea. Broom snakeweed is minimally present. Both perennial and annual forb production and cover are variable with peppergrass, yellow Cryptantha, and tansy aster expected to be present. Other grasses,

shrubs, and forbs may also be present and cover is variable. Utah juniper is a natural invader of this site; however juniper cover is minimal. Bare ground is minimal (10-25%), surface rock fragments are variable (5-50%), and biological crusts (5-25%) are characterized by light cyanobacteria and/or isolated moss and lichen pinnacles with little continuity. The following tables provide an example of the typical vegetative floristics of a community phase 1.2 plant community.

Table 8. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	112	224	336
Shrub/Vine	112	168	224
Forb	56	112	168
Tree	–	6	11
Total	**280**	**510**	**739**

Table 9. Ground cover

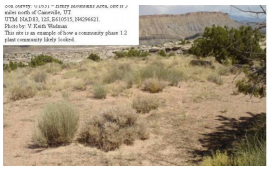
Tree foliar cover	0-5%
Shrub/vine/liana foliar cover	5-15%
Grass/grasslike foliar cover	15-25%
Forb foliar cover	5-10%
Non-vascular plants	0%
Biological crusts	5-25%
Litter	3-8%
Surface fragments >0.25" and <=3"	5-50%
Surface fragments >3"	0%
Bedrock	0-5%
Water	0%
Bare ground	10-25%

Table 10. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	5-10%	5-10%	5-10%
>0.15 <= 0.3	–	10-15%	5-10%	5-10%
>0.3 <= 0.6	–	3-8%	0-5%	5-10%
>0.6 <= 1.4	0-5%	0-5%	0-5%	0-5%
>1.4 <= 4	0-5%	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Pathway 1.1a
Community 1.1 to 1.2

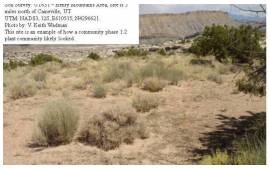
Perennial Shrubland



Perennial Shrubland and Grasses

This community pathway occurs as natural events, such as periods of average to above average precipitation, favor the establishment and propagation of native perennial grasses. Insect infestations, that are often associated with these wet periods, can cause a decline in shadscale, which also allows for increased grass production due to additional available nutrients.

Pathway 1.2a
Community 1.2 to 1.1



Perennial Shrubland and Grasses

Perennial Shrubland

This pathway occurs as natural events, such as drought, disfavor the propagation of native perennial grasses and favors the establishment and proliferation of native shrubs, which are more drought tolerant.

State 2
Current Potential State

This state is similar to the reference state in plant species composition and ecological dynamics except there are now invasive species present. Typically cheatgrass, tansy mustard, and Russian thistle have become established. The native perennial shrubs and grasses still dominate the site in terms of both cover and production. Broom snakeweed has not yet increased to a point where it is driving the ecological dynamics of the site; however it may be slightly more prevalent in state two than in state one. Current Potential State: Community phases maintained by fluctuating climatic events and domestic livestock grazing. Indicators: A diverse shrub, forb, and grass community dominated by shadscale, mormontea, Indian ricegrass, James galleta, and needle-and-thread. Invasive species are now present. Feedbacks: Increased occurrence of invasive species, such as broom snakeweed and cheatgrass. Fluctuating precipitation and properly managed livestock grazing that allows for the continued maintenance of the perennial grass and shrub community. At Risk Community Phase: All phases are at risk as invasive species continue to out-compete native perennial vegetation. Community phase 2.1 is especially at risk. This phase can transition into the broom snakeweed state (state 3) with prolonged improperly managed livestock grazing. Trigger: Increased establishment and propagation of invasive species such as cheatgrass and broom snakeweed; typically, caused by a decrease in the fire return interval and prolonged improperly managed livestock grazing.

Community 2.1
Perennial Shrubland with Invasive Species.

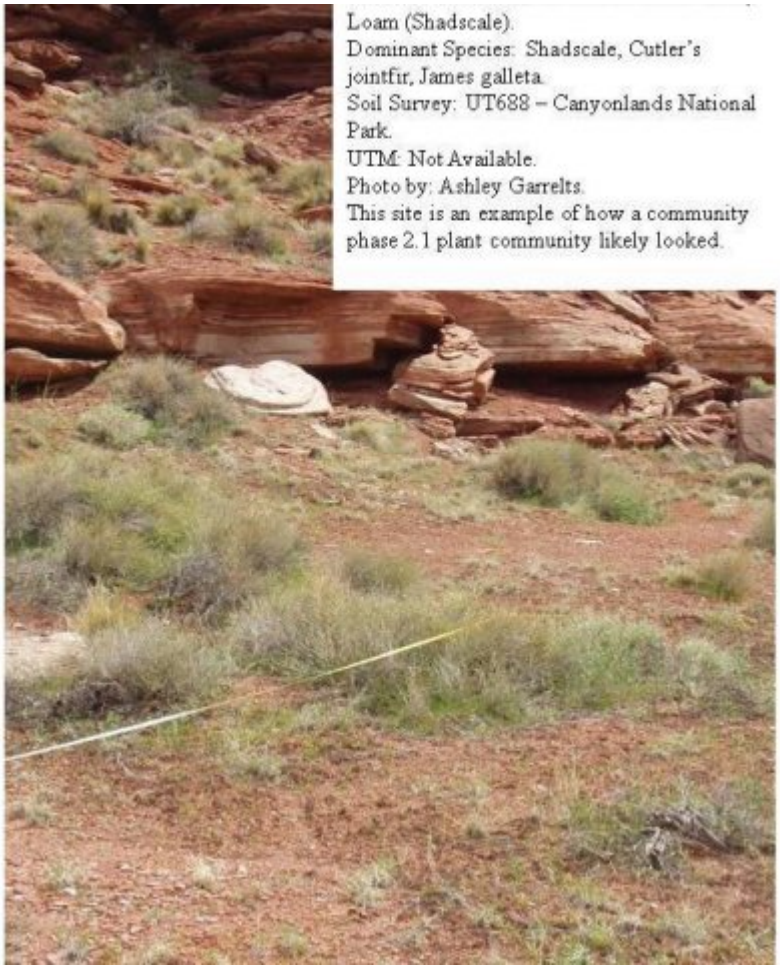


Figure 8. Perennial Shrubland with Invasive Species.

This community phase is characterized by a dominance of shadscale and mormontea (Cutler, Torrey, and/or green). Broom snakeweed is minimally present. Native perennial warm and cool season grasses are present but do not dominate the site in terms of cover or production. Warm season grasses include James galleta and sand dropseed, and cool season grasses include Indian ricegrass and needle-and-thread. Both perennial and annual forb production and cover are variable with peppergrass, yellow Cryptantha, and tansy aster are expected to be present. Invasive species such as tansy mustard, cheatgrass, and Russian thistle are now be present in the understory. Other grasses, shrubs, and forbs may also be present and cover is variable. Utah juniper is a natural invader on this site; however juniper cover will be minimal. Bare ground is minimal (10-25%), surface rock fragments are variable (5-50%), and biological crusts (5-25%) are characterized by light cyanobacteria and/or isolated moss and lichen pinnacles with little continuity. The following tables provide an example of the typical vegetative floristics of a community phase 2.1 plant community.

Table 11. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	168	224	280
Forb	56	112	168
Grass/Grasslike	56	112	168
Tree	–	6	11
Total	**280**	**454**	**627**

Table 12. Ground cover

Tree foliar cover	0-5%
Shrub/vine/liana foliar cover	10-20%
Grass/grasslike foliar cover	5-20%

Forb foliar cover	5-10%
Non-vascular plants	0%
Biological crusts	5-25%
Litter	3-8%
Surface fragments >0.25" and <=3"	5-50%
Surface fragments >3"	0%
Bedrock	0-5%
Water	0%
Bare ground	10-25%

Table 13. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	0-5%	5-10%	5-10%
>0.15 <= 0.3	–	5-15%	10-20%	5-10%
>0.3 <= 0.6	–	0-5%	0-5%	5-10%
>0.6 <= 1.4	0-5%	0-5%	0-5%	0-5%
>1.4 <= 4	0-5%	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 2.2
Perennial Shrubland with Grasses & Invasive Species.

This community phase is characterized by a dominance of native perennial warm and cool season grasses, where native shrubs are present. Warm season grasses include James galleta and sand dropseed and cool season grasses include Indian ricegrass, needle-and-thread, and purple threeawn. The dominant native shrubs include shadscale and mormontea species (Cutler, Torrey, and/or green). Broom snakeweed is minimally present. Both perennial and annual forb production and cover are variable with peppergrass, yellow Cryptantha, and tansy aster expected to be present. Invasive species such as, cheatgrass, tansy mustard, and Russian thistle are now present. Other grasses, shrubs, and forbs may also be present and cover is variable. Utah juniper is a natural invader of this site; however cover will be minimal. Bare ground is minimal (10-25%), surface rock fragments are variable (5-50%), and biological crusts (5-25%) are characterized by light cyanobacteria and/or isolated moss and lichen pinnacles with little continuity. The following tables provide an example of the typical vegetative floristics of a community phase 2.2 plant community.

Table 14. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	112	224	336
Shrub/Vine	112	168	224
Forb	56	112	168
Tree	–	6	11
Total	**280**	**510**	**739**

Table 15. Ground cover

Tree foliar cover	0-5%
Shrub/vine/liana foliar cover	5-15%
Grass/grasslike foliar cover	15-25%
Forb foliar cover	5-10%
Non-vascular plants	0%
Biological crusts	5-25%
Litter	3-8%
Surface fragments >0.25" and <=3"	5-50%
Surface fragments >3"	0%
Bedrock	0-5%
Water	0%
Bare ground	10-25%

Table 16. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	5-10%	5-10%	5-10%
>0.15 <= 0.3	–	10-15%	10-20%	5-10%
>0.3 <= 0.6	–	5-10%	0-5%	5-10%
>0.6 <= 1.4	0-5%	0-5%	0-5%	0-5%
>1.4 <= 4	0-5%	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Pathway 2.1a
Community 2.1 to 2.2

This community pathway occurs as events, such as periods of average to above average precipitation, properly managed livestock grazing, and time without disturbances favor the establishment and propagation of native perennial grasses. Insect infestations that are associated with wet periods are also responsible for the decline in shadscale, which allows for increased grass production due to available nutrients.

Pathway 2.2a
Community 2.2 to 2.1

This pathway occurs when events, such as drought and improper livestock grazing, disfavor the propagation of native perennial grasses and favor the establishment and proliferation of native shrubs.

State 3
Broom Snake Weed State

This state is characterized by a dominance of broom snakeweed. Native perennial grasses and shrubs may also be present depending on which community phase the plant community represents. Native shrubs include shadscale and mormontea species, and native grasses include James galleta, Indian ricegrass, and needle-and-thread. Invasive species such as cheatgrass, tansy mustard, and Russian thistle are typically present in all community phases. Other grasses, forbs, or shrubs may or may not be present and cover is variable. Broom Snakeweed State: Community phases maintained by improper livestock grazing, time with out disturbances, and fluctuating

precipitation trends. Indicators: A community dominated by broom snakeweed and other invasive species, where native perennial grass and shrubs may also be present. Feedbacks: A fire or other disturbance that decreases the broom snakeweed cover and allows for the proliferation of cheatgrass. Conditions that allow for continued dominance of broom snakeweed. At Risk Community Phase: All phases are at risk for invasion and dominance of cheatgrass. Trigger: A fire or other disturbance that removes the broom snakeweed and allows for the dominance of cheatgrass.

Community 3.1
Mixed Snakeweed and Grasses

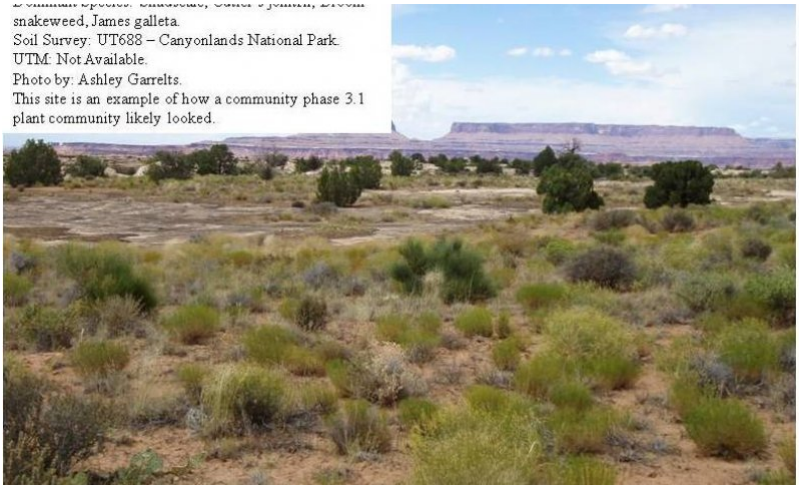


Figure 11. Mixed Broom Snakeweed with Invasive Species.

This community phase is characterized by a dominance of broom snakeweed, with some occurrence of native perennial grasses, shrubs, and invasive species. Native species typically include shadscale, mormontea species (Torrey's Cutler, green), James galleta, Indian ricegrass, and needle-and-thread. Invasive species typically include tansy mustard, cheatgrass, and Russian thistle. Utah juniper is known to invade this community phase. Other grasses, forbs, and shrubs may also be present and cover is variable. Bare ground is minimal (25-30%), surface rock fragments are variable (5-50%), and biological crusts (5-25%) are characterized by light cyanobacteria and/or isolated moss and lichen pinnacles with little continuity. The following tables provide an example of the typical vegetative floristics of a community phase 3.1 plant community.

Table 17. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	112	224	336
Grass/Grasslike	84	112	140
Forb	28	56	112
Tree	–	6	11
Total	**224**	**398**	**599**

Table 18. Ground cover

Tree foliar cover	0-5%
Shrub/vine/liana foliar cover	25-35%
Grass/grasslike foliar cover	5-15%
Forb foliar cover	5-15%
Non-vascular plants	0%
Biological crusts	5-25%
Litter	3-8%
Surface fragments >0.25" and <=3"	5-50%

Surface fragments >3"	0%
Bedrock	0-5%
Water	0%
Bare ground	25-30%

Table 19. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	5-15%	5-10%	5-10%
>0.15 <= 0.3	–	15-25%	10-20%	5-10%
>0.3 <= 0.6	–	5-10%	0-5%	5-10%
>0.6 <= 1.4	0-5%	0-5%	0-5%	0-5%
>1.4 <= 4	0-5%	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 3.2
Broom Snakeweed Monoculture

Figure 13. Broom Snakeweed Monoculture.

This community phase is characterized by a complete monoculture of broom snakeweed with minimal occurrence of other invasive and/or native species. Native perennial grasses and shrubs are no longer present. Utah juniper may be present. Bare ground (25-50%) has increased, surface rock fragments are variable (5-50%), and biological crusts (0-10%) are characterized by light cyanobacteria with present. The following tables provide an example of the typical vegetative floristics of a community phase 3.2 plant community.

Table 20. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	168	280	392
Forb	28	56	84
Grass/Grasslike	28	56	84
Tree	–	6	11
Total	**224**	**398**	**571**

Table 21. Ground cover

Tree foliar cover	0-5%
Shrub/vine/liana foliar cover	20-30%
Grass/grasslike foliar cover	5-15%
Forb foliar cover	5-15%
Non-vascular plants	0%
Biological crusts	0-10%
Litter	3-8%
Surface fragments >0.25" and <=3"	5-50%
Surface fragments >3"	0%
Bedrock	0-5%
Water	0%
Bare ground	25-50%

Table 22. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	5-10%	0-5%	0-5%
>0.15 <= 0.3	–	15-25%	0-5%	0-5%
>0.3 <= 0.6	–	0-5%	0-5%	0-5%
>0.6 <= 1.4	0-5%	–	–	–
>1.4 <= 4	0-5%	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Pathway 3.1a
Community 3.1 to 3.2

Mixed Snakeweed and Grasses

Broom Snakeweed Monoculture

This pathway occurs as events such as, improper livestock grazing and wet periods favors the increased establishment of broom snake weed. Increased precipitation has been shown to boost broom snakeweed production (Ralphs and Sanders, 2002) and due to broom snakeweed's ability to out compete grasses (Tirmenstein, 1999), increased moisture can lead to a decrease in grass cover and production in this state.

Pathway 3.2a
Community 3.2 to 3.1

Broom Snakeweed Monoculture

Mixed Snakeweed and Grasses

This pathway occurs as time without disturbance allows for the re-establishment of native perennial grasses and shrubs. This pathway may take years to complete.

State 4
Annual Grass State

This state is characterized by a dominance of annual grasses, on the Colorado Plateau, this is typically cheatgrass. Cheatgrass dramatically affects the soil/plant/water relationships of a site. Research has shown that plant species differs substantially in it's effects on soil water content and temperature, and on their effects on the frequency and intensity of disturbance. After cheatgrass has invaded a site, the fundamental nutrient cycling processes, root pores, mycorrhizal associations, microbial species, and soil organic material change (Chapin et al. 1997; Belnap and Phillips, 2001). These alterations may eventually create ecologically impoverished sites that are very difficult, if not impossible, to restore to functionally diverse perennial herbaceous and woody communities. The competitiveness of cheatgrass and its ability to quickly establish after a disturbance make this state extremely resistant to change and resilient after a disturbance. Annual Grass State: Community phase maintained by fire and time without disturbance Indicators: A site dominated by cheatgrass, where other invasive species, such as broom snakeweed may or may not be present Feedbacks: Improper livestock grazing that may allow for the reestablishment and dominance of broom snakeweed. A self sustaining disturbance regime, such as fire and a rapid uptake of moisture in the spring, that allows cheatgrass to flourish on the site. At-risk Community Phase: Plant community 4.1 is most at risk. The community phase may transition into the broom snakeweed phase through prolonged improperly managed livestock grazing. Trigger: Prolonged improper livestock grazing that may allow for the reestablishment of broom snakeweed.

Community 4.1
Mixed Invasive Species

This community phases is characterized by a dominance of cheatgrass. Native shrubs and grasses may also be present and may include shadscale, mormontea species (Torrey's, Cutler, green), Indian ricegrass, James galleta, and needle-and-thread. Invasive species such as broom snakeweed, tansy mustard, annual Cryptantha, and Russian thistle are typically present. Utah juniper is typically not present in this community phase. Other shrubs, grasses, and forbs may or may not be present and cover is variable. Bare ground (5-20%) is minimal, surface rock fragments (5-50%) are variable, and biological crusts (0-10%) are characterized by light cyanobacteria with occasional moss or lichen pinnacles, when present. The following tables provide an example of the typical vegetative floristics of a community phase 4.1 plant community.

Table 23. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	112	224	336
Shrub/Vine	112	168	224
Forb	56	112	168
Tree	–	6	11
Total	**280**	**510**	**739**

Table 24. Ground cover

Tree foliar cover	0-5%
Shrub/vine/liana foliar cover	5-15%

Grass/grasslike foliar cover	20-35%
Forb foliar cover	5-10%
Non-vascular plants	0%
Biological crusts	5-25%
Litter	3-8%
Surface fragments >0.25" and <=3"	5-50%
Surface fragments >3"	0%
Bedrock	0-5%
Water	0%
Bare ground	10-25%

Table 25. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	5-15%	5-10%	5-10%
>0.15 <= 0.3	–	5-10%	20-35%	5-10%
>0.3 <= 0.6	–	0-5%	0-5%	5-10%
>0.6 <= 1.4	0-5%	0-5%	0-5%	0-5%
>1.4 <= 4	0-5%	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 4.2
Cheatgrass Monoculture

This plant community is characterized by a complete monoculture of cheatgrass, other grasses and shrubs do not occur. Invasive annual forbs may also be present, depending on current climatic conditions. This plant community is self-enhancing through frequent fire (every 5-10 years). Bare ground (5-15%) is minimal and biological crusts (1-5%) are characterized by light cyanobacteria in the interspaces. The following tables provide an example of the typical vegetative floristics of a community phase 4.2 plant community.

Table 26. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	224	560	897
Forb	11	22	45
Shrub/Vine	–	17	34
Total	**235**	**599**	**976**

Table 27. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	0%
Grass/grasslike foliar cover	40-50%
Forb foliar cover	0-5%

Non-vascular plants	0%
Biological crusts	1-5%
Litter	5-10%
Surface fragments >0.25" and <=3"	5-50%
Surface fragments >3"	0%
Bedrock	0-5%
Water	0%
Bare ground	5-10%

Table 28. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	20-40%	0-5%
>0.15 <= 0.3	–	–	20-40%	0-5%
>0.3 <= 0.6	–	–	–	0-5%
>0.6 <= 1.4	–	–	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Pathway 4.1a
Community 4.1 to 4.2

This pathway occurs as events, such as a fire, favor the continued establishment and proliferation of cheatgrass.

Pathway 4.2a
Community 4.2 to 4.1

This pathway occurs as events such as time without disturbance allows for some reestablishment of native shrubs, grasses, and forbs, and other less invasive species, such as broom snakeweed, tansy mustard, and Russian thistle. Heavy spring grazing can also decrease the competitiveness of cheatgrass (Zouhar, 2003), allowing for some establishment of other plant species.

Transition T1a
State 1 to 2

Transition from the Reference State (State 1) to the Current Potential State (State 2). This transition occurs due to the establishment invasive plant species, including cheatgrass, tansy mustard, Russian thistle, annual Cryptantha, and annual stickseed. Events triggering this event include can include and combination of improper livestock grazing, extended drought, poorly managed off road vehicle (OHV) use, etc. However cheatgrass and other invasive species have been known to establish into intact perennial plant communities without disturbance triggers.

Transition T2a
State 2 to 3

Transition from Current Potential State (State 2) to the Broom Snakeweed State (State 3). This transition occurs as events, such as sustained improper livestock grazing, favor the dominance of broom snakeweed. Due to the unpalatable and toxic nature of broom snakeweed, increased domestic livestock grazing, especially cattle, can

result in a decrease of perennial grasses and shadscale and an increase in broom snakeweed. Grazing by sheep is less destructive due to the animal's ability to more readily consume snakeweed, especially in winter; however improper sheep grazing will still result in plant community changes. Community phase 2.1 is most likely to transition into this state with prolonged improper grazing. For sites in community phase 2.2, improper grazing may transition it into either a plant community phase 2.1 and if improper grazing continues without influences by fire, into state 3 due to increased broom snakeweed establishment.

Transition T2b
State 2 to 4

Transition for Current Potential State (State 2) to the Annual Grass State (State 4). This transition occurs as events, such as fire or other surface disturbance, favor the dominance of cheatgrass. Cheatgrass typically invades the sites interspaces and once this species dominates, the amount and continuity of fine fuels can increase until fire can fully eliminate the shrub/forb/perennial grass component and completes the conversion to a cheatgrass dominated site that can persist for long periods of time. Once this occurs, it is difficult for these species to reestablish themselves, because not only has the fire return interval been shortened, but the soil and other abiotic factors may have been altered.

Transition T3a
State 3 to 4

Transition from Broom Snakeweed State (State 3) to Annual Grass State (State 4). This transition occurs as events favor the increased establishment and dominance of cheatgrass. Typically this occurs due to fire. Broom snakeweed is highly combustible and is generally killed by severe fire (Tirmenstein, 1999). The rate of broom snakeweed recovery depends on fire severity, so many times a hot fire will trigger a direct transition into a cheatgrass monoculture (community phase 4.2). A cooler, less severe fire triggers a transition into a mixed invasive species community that will be dominated by cheatgrass (community phase 4.1).

Transition T4a
State 4 to 3

Transition from Annual Grass State (State 4) to Broom Snakeweed State (State3). This transition occurs as events favor the establishment and dominance of broom snakeweed. This transition may occur after prolonged improper livestock grazing, which decreases fine fuels and allows for the reestablishment of broom snakeweed due to an increase in the fire return interval. Because of the unpalatable nature of broom snakeweed, increased domestic livestock grazing, especially cattle, can result in a decrease of grasses and an increase of snakeweed. Grazing by sheep is less destructive due to the animal's ability to more readily consume snakeweed. Cheatgrass, while tolerant of grazing, can be reduced by heavy spring grazing due to its palatability. Heavy spring grazing also reduces seed production, which decreases it abundance on a site (Zouhar, 2003).

Additional community tables

Table 29. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
0	**Dominant Shrubs**			62–112	
	shadscale saltbush	ATCO	*Atriplex confertifolia*	56–90	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	6–22	–
3	**Sub-Dominant Shrubs**			112–140	
	Bigelow sage	ARBI3	*Artemisia bigelovii*	0–22	–
	Cutler's jointfir	EPCU	*Ephedra cutleri*	0–17	–
	Torrey's jointfir	EPTO	*Ephedra torreyana*	0–17	–
	mormon tea	EPVI	*Ephedra viridis*	0–17	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–11	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–6	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–6	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–6	–
	blackbrush	CORA	*Coleogyne ramosissima*	0–6	–
Grass/Grasslike					
0	**Dominant Grasses**			28–56	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	11–22	–
1	**Sub-Dominant Grasses**			56–84	
	Grass, perennial	2GP	*Grass, perennial*	0–11	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–11	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–11	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–6	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–6	–
	squirreltail	ELEL5	*Elymus elymoides*	0–6	–
Forb					
2	**Forbs**			56–112	
	Jones' pepperweed	LEMOJ	*Lepidium montanum var. jonesii*	0–34	–
	hoary tansyaster	MACA2	*Machaeranthera canescens*	0–28	–
	buckwheat	ERIOG	*Eriogonum*	0–17	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–11	–
	Forb, perennial	2FP	*Forb, perennial*	0–11	–
	Brenda's yellow cryptantha	CRFL5	*Cryptantha flava*	0–6	–
	Forb, annual	2FA	*Forb, annual*	0–6	–
Tree					
4	**Trees**			0–11	
	Utah juniper	JUOS	*Juniperus osteosperma*	0–11	–

Table 30. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
0	**Dominant Shrubs**			39–90	
	shadscale saltbush	ATCO	*Atriplex confertifolia*	28–56	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	11–34	–
3	**Sub-Dominant Shrubs**			78–112	
	Bigelow sage	ARBI3	*Artemisia bigelovii*	0–34	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–11	–
	blackbrush	CORA	*Coleogyne ramosissima*	0–11	–
	Cutler's jointfir	EPCU	*Ephedra cutleri*	0–11	–
	Torrey's jointfir	EPTO	*Ephedra torreyana*	0–11	–
	mormon tea	EPVI	*Ephedra viridis*	0–11	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–11	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–6	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–6	–
Grass/Grasslike					
0	**Dominant Grasses**			67–168	
	James' galleta	PLJA	*Pleuraphis jamesii*	28–84	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	28–56	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	11–28	–
1	**Sub-Dominant Grasses**			22–84	
	Grass, perennial	2GP	*Grass, perennial*	0–22	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–22	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–17	–
	squirreltail	ELEL5	*Elymus elymoides*	0–11	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–11	–
Forb					
2	**Forbs**			84–112	
	Jones' pepperweed	LEMOJ	*Lepidium montanum var. jonesii*	0–39	–
	hoary tansyaster	MACA2	*Machaeranthera canescens*	0–22	–
	buckwheat	ERIOG	*Eriogonum*	0–22	–
	Forb, perennial	2FP	*Forb, perennial*	0–11	–
	Brenda's yellow cryptantha	CRFL5	*Cryptantha flava*	0–11	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–11	–
	Forb, annual	2FA	*Forb, annual*	0–6	–
Tree					
4	**Trees**			0–11	
	Utah juniper	JUOS	*Juniperus osteosperma*	0–11	–

Table 31. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)

Shrub/Vine					
0	**Dominant Shrubs**			62–112	
	shadscale saltbush	ATCO	*Atriplex confertifolia*	50–78	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	11–34	–
3	**Sub-Dominant Shrubs**			112–140	
	Bigelow sage	ARBI3	*Artemisia bigelovii*	0–22	–
	Cutler's jointfir	EPCU	*Ephedra cutleri*	0–17	–
	Torrey's jointfir	EPTO	*Ephedra torreyana*	0–17	–
	mormon tea	EPVI	*Ephedra viridis*	0–17	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–11	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–6	–
	blackbrush	CORA	*Coleogyne ramosissima*	0–6	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–6	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–6	–
Grass/Grasslike					
0	**Dominant Grasses**			28–56	
	James' galleta	PLJA	*Pleuraphis jamesii*	11–22	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	11–22	–
	cheatgrass	BRTE	*Bromus tectorum*	6–11	–
1	**Sub-Dominant Grasses**			56–84	
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–11	–
	Grass, annual	2GA	*Grass, annual*	0–11	–
	Grass, perennial	2GP	*Grass, perennial*	0–11	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–11	–
	squirreltail	ELEL5	*Elymus elymoides*	0–6	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–6	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–6	–
Forb					
2	**Forbs**			56–112	
	Jones' pepperweed	LEMOJ	*Lepidium montanum var. jonesii*	0–34	–
	hoary tansyaster	MACA2	*Machaeranthera canescens*	0–28	–
	Forb, perennial	2FP	*Forb, perennial*	0–11	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–11	–
	Forb, annual	2FA	*Forb, annual*	0–6	–
	Brenda's yellow cryptantha	CRFL5	*Cryptantha flava*	0–6	–
	tansymustard	DESCU	*Descurainia*	0–6	–
	woolly plantain	PLPA2	*Plantago patagonica*	0–6	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–6	–
Tree					
4	**Trees**			0–11	
	Utah juniper	JUOS	*Juniperus osteosperma*	0–11	–

Table 32. Community 2.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
0	**Dominant Shrubs**			50–90	
	shadscale saltbush	ATCO	*Atriplex confertifolia*	28–45	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	22–45	–
3	**Sub-Dominant Shrubs**			67–112	
	Bigelow sage	ARBI3	*Artemisia bigelovii*	0–34	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–11	–
	blackbrush	CORA	*Coleogyne ramosissima*	0–11	–
	Cutler's jointfir	EPCU	*Ephedra cutleri*	0–11	–
	Torrey's jointfir	EPTO	*Ephedra torreyana*	0–11	–
	mormon tea	EPVI	*Ephedra viridis*	0–11	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–11	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–6	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–6	–
Grass/Grasslike					
0	**Dominant Grasses**			73–168	
	James' galleta	PLJA	*Pleuraphis jamesii*	28–84	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	28–56	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	11–28	–
	cheatgrass	BRTE	*Bromus tectorum*	6–11	–
1	**Sub-Dominant Grasses**			22–84	
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–22	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–17	–
	squirreltail	ELEL5	*Elymus elymoides*	0–11	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–11	–
	Grass, annual	2GA	*Grass, annual*	0–11	–
	Grass, perennial	2GP	*Grass, perennial*	0–11	–
Forb					
2	**Forbs**			84–112	
	Jones' pepperweed	LEMOJ	*Lepidium montanum var. jonesii*	0–39	–
	hoary tansyaster	MACA2	*Machaeranthera canescens*	0–22	–
	Forb, perennial	2FP	*Forb, perennial*	0–11	–
	Brenda's yellow cryptantha	CRFL5	*Cryptantha flava*	0–11	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–11	–
	Forb, annual	2FA	*Forb, annual*	0–6	–
	tansymustard	DESCU	*Descurainia*	0–6	–
	woolly plantain	PLPA2	*Plantago patagonica*	0–6	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–6	–
Tree					

4	**Trees**			0–11	
	Utah juniper	JUOS	*Juniperus osteosperma*	0–11	–

Table 33. Community 3.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
0	**Dominant Shrubs**			112–168	
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	112–168	–
3	**Sub-Dominant Shrubs**			56–112	
	shadscale saltbush	ATCO	*Atriplex confertifolia*	0–45	–
	Bigelow sage	ARBI3	*Artemisia bigelovii*	0–17	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–11	–
	blackbrush	CORA	*Coleogyne ramosissima*	0–11	–
	Cutler's jointfir	EPCU	*Ephedra cutleri*	0–11	–
	Torrey's jointfir	EPTO	*Ephedra torreyana*	0–11	–
	mormon tea	EPVI	*Ephedra viridis*	0–11	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–6	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–6	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–6	–
Grass/Grasslike					
0	**Dominant Grasses**			50–84	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	28–39	–
	cheatgrass	BRTE	*Bromus tectorum*	11–22	–
	James' galleta	PLJA	*Pleuraphis jamesii*	11–22	–
1	**Sub-Dominant Grasses**			28–50	
	purple threeawn	ARPU9	*Aristida purpurea*	0–17	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–11	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–11	–
	Grass, annual	2GA	*Grass, annual*	0–11	–
	Grass, perennial	2GP	*Grass, perennial*	0–6	–
	squirreltail	ELEL5	*Elymus elymoides*	0–6	–
Forb					
2	**Forbs**			45–84	
	Jones' pepperweed	LEMOJ	*Lepidium montanum var. jonesii*	0–28	–
	Forb, annual	2FA	*Forb, annual*	0–11	–
	Forb, perennial	2FP	*Forb, perennial*	0–11	–
	tansymustard	DESCU	*Descurainia*	0–11	–
	cryptantha	CRYPT	*Cryptantha*	0–6	–
	hoary tansyaster	MACA2	*Machaeranthera canescens*	0–6	–
	woolly plantain	PLPA2	*Plantago patagonica*	0–6	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–6	–
Tree					
4	**Trees**			0–11	
	Utah juniper	JUOS	*Juniperus osteosperma*	0–11	–

Table 34. Community 3.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
0	**Dominant Shrubs**			112–224	
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	112–224	–
3	**Sub-Dominant Shrubs**			28–56	
	shadscale saltbush	ATCO	*Atriplex confertifolia*	0–22	–
	Torrey's jointfir	EPTO	*Ephedra torreyana*	0–11	–
	mormon tea	EPVI	*Ephedra viridis*	0–11	–
	Cutler's jointfir	EPCU	*Ephedra cutleri*	0–6	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–6	–
Grass/Grasslike					
0	**Dominant Grasses**			28–56	
	cheatgrass	BRTE	*Bromus tectorum*	28–56	–
1	**Sub-Dominant Grasses**			0–28	
	Grass, annual	2GA	*Grass, annual*	0–17	–
	Grass, perennial	2GP	*Grass, perennial*	0–11	–
Forb					
2	**Forbs**			28–56	
	Jones' pepperweed	LEMOJ	*Lepidium montanum var. jonesii*	0–22	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–11	–
	Forb, annual	2FA	*Forb, annual*	0–11	–
	Forb, perennial	2FP	*Forb, perennial*	0–11	–
	tansymustard	DESCU	*Descurainia*	0–11	–
	cryptantha	CRYPT	*Cryptantha*	0–6	–
Tree					
4	**Trees**			0–11	
	Utah juniper	JUOS	*Juniperus osteosperma*	0–11	–

Table 35. Community 4.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
0	**Dominant Shrubs**			28–112	
	shadscale saltbush	ATCO	*Atriplex confertifolia*	6–56	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	22–56	–
3	**Sub-Dominant Shrubs**			11–56	
	Cutler's jointfir	EPCU	*Ephedra cutleri*	0–11	–
	Torrey's jointfir	EPTO	*Ephedra torreyana*	0–11	–
	mormon tea	EPVI	*Ephedra viridis*	0–11	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–6	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–6	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–6	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–6	–
	blackbrush	CORA	*Coleogyne ramosissima*	0–6	–
Grass/Grasslike					
0	**Dominant Grasses**			112–224	
	cheatgrass	BRTE	*Bromus tectorum*	112–224	–
1	**Sub-Dominant Grasses**			0–112	
	James' galleta	PLJA	*Pleuraphis jamesii*	0–112	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–56	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–28	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–28	–
	Grass, annual	2GA	*Grass, annual*	0–11	–
	Grass, perennial	2GP	*Grass, perennial*	0–11	–
Forb					
0	**Dominant Forbs**			56–112	
	tansymustard	DESCU	*Descurainia*	56–112	–
	prickly Russian thistle	SATR12	*Salsola tragus*	22–84	–
2	**Sub-Dominant Forbs**			0–56	
	buckwheat	ERIOG	*Eriogonum*	0–17	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–17	–
	Forb, annual	2FA	*Forb, annual*	0–11	–
	Forb, perennial	2FP	*Forb, perennial*	0–11	–
Tree					
4	**Trees**			0–11	
	Utah juniper	JUOS	*Juniperus osteosperma*	0–11	–

Table 36. Community 4.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Grasses**			336–560	
	cheatgrass	BRTE	*Bromus tectorum*	336–560	–
Forb					
2	**Forbs**			0–22	
	prickly Russian thistle	SATR12	*Salsola tragus*	0–22	–
	tansymustard	DESCU	*Descurainia*	0–11	–
	Forb, annual	2FA	*Forb, annual*	0–6	–
	white blue-eyed grass	SIAL3	*Sisyrinchium albidum*	0–6	–
Shrub/Vine					
3	**Shrubs**			0–28	
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–28	–

Animal community

--Threatened and Endangered Species--
This section will be populated as more information becomes available.

--Wildlife Interpretations--
A scarcity of water and cover limits the species richness and abundance of large mammals. This site however does provide good grazing conditions for pronghorn antelope, deer, and elk, due to the occurrence of shadscale which is a preferred fall and winter browse species, especially for deer. In many places, however, populations will be small and have little grazing impact on the site.

When this site occurs adjacent to two-needle pinyon and Utah juniper communities, which provide better cover, sightings of large mammals becomes more common. The hot climate and lack of water favors small mammals, which have an easier time finding shelter, food, and water to live. Many species of rats, mice, squirrels, bats, and chipmunks can be observed, along with coyotes and foxes.

Different types of songbirds can be found on sites adjacent to Utah juniper/two-needle pinyon, including many species of sparrows, juncos, blackbirds, and wrens. Birds of prey including hawks, falcons, and osprey can also sometimes be seen hunting the small mammals. Lizards are generally the most visible and can be observed during the day sunning themselves on rock outcrops or darting in and out of the plant canopy. Species may include the northern whiptail, desert spiny, and the colorful western collard lizard (NPS.gov, 2008).

--Grazing Interpretations--
This site provides fair grazing conditions for livestock during fall, winter, and spring. There is generally a low availability of nutritious forage; however shadscale does provide good winter grazing conditions for sheep. This site often lacks natural perennial water sources, which can influence it's suitability for livestock grazing. The dominant shrub species, shadscale, provides good browse for domestic sheep and goats in the winter, spring, and fall. Cattle typically will only utilize the fruits/seeds of shadscale due to the spiny nature of the plant (Simonin, 2001). Sub-dominant shrubs include fourwing saltbush, mormontea species, blackbrush, and Bigelow sagebrush, which can provide good winter browse for cattle, sheep, and goats. The presence of grasses including James galleta, Indian ricegrass, and needle-and-thread, provide good spring and fall grazing conditions for cattle, horses, and sheep. Forb composition and annual production depends primarily on precipitation amounts and thus create challenges when used in making livestock grazing management decisions. However, forb composition should be monitored for species diversity, as well as for poisonous or injurious plant communities which may be detrimental to livestock when grazed. Before making specific grazing management recommendations, an on-site evaluation must be made.

Hydrological functions

The soils associated with this ecological site are generally in Hydrologic Soil Group D due to the shallow depth

(NRCS National Engineering Handbook). These soils are saturated quickly due to high infiltration rates and shallow depth; once soils are saturated, run off potential is high. Hydrological groups are used in equations that estimate runoff from rainfall. These estimates are needed for solving hydrologic problems that arise in planning watershed-protection and flood-prevention projects and for designing structures for the use, control and disposal of water. Heavy grazing can alter the hydrology by decreasing plant cover and increasing bare ground. Fire can also affect hydrology, but its affect is variable. Fire intensity, fuel type, soil, climate, and topography can each have different influences. Fires can increase areas of bare ground and hydrophobic layers that reduce infiltration and increase runoff (National Range and Pasture Handbook, 2003)

Recreational uses

Recreation activities include aesthetic value and good opportunities for hiking. Prospects for camping and hunting are good when site is near two-needle pinyon and Utah juniper woodlands that provide some cover. Off road vehicle use is cautioned due to the harshness of the site and poor suitability for restoration if the site is disturbed.

Wood products

None

Other information

--Poisonous/Toxic Plant Communities--
Toxic plants associated with this site include broom snakeweed and Russian thistle.

Broom snakeweed contains steroids, terpenoids, saponins, and flavones that can cause abortions or reproductive failure in sheep and cattle, however cattle are most susceptible. These toxins are most abundant during active growth and leafing stage. Cattle and sheep will generally only graze broom snakeweed when other forage is unavailable, typically in winter when toxicity levels are at their lowest. (Knight and Walter, 2001)

Russian thistle is an invasive toxic plant, causing nitrate and to a lesser extent oxalate poisoning, which affects all classes of livestock. The buildup of nitrates in these plants is highly dependent upon environmental factors, such as after a rain storm during a drought, during periods with cool/cloudy days, and on soils high in nitrogen and low in sulfur and phosphorus, all which cause increased nitrate accumulation. Nitrate collects in the stems and can persist throughout the growing season. Clinical signs of nitrate poisoning include drowsiness, weakness, muscular tremors, increased heart and respiratory rates, staggering gait, and death. Conversely, oxalate poisoning causes kidney failure; clinical signs include muscle tremors, tetany, weakness, and depression. Poisoning generally occurs when livestock consume and are not accustomed to grazing oxalate-containing plants. Animals with prior exposure to oxalates have increased numbers of oxalate-degrading rumen microflora and thus are able to degrade the toxin before clinical poisoning can occur. (Knight and Walter, 2001)

--Invasive Plant Communities--
Generally as ecological conditions deteriorate and perennial vegetation decreases due to disturbance (fire, improper livestock grazing, drought, off road vehicle overuse, erosion, etc.) invasive forbs and grasses can invade the site. Of particular concern in semi-arid environments are cheatgrass, Russian thistle, kochia, halogeton, and annual mustards. The presence of these species will depend on soil properties and moisture availability; however, these invaders are highly adaptive and can flourish in many locations. Once established, complete removal is difficult but suppression may be possible. Shadscale ecological sites occur on a wide variety of saline soils and thus invading plants must be tolerant of such conditions.

--Fire Ecology--
The ability for this ecological site to carry fire depends primarily on it's present fuel load and plant moisture content. Sites with small fuel loads will burn more slowly and less intensely than sites with large fuel loads. Many semi-desert plant communities in the Colorado Plateau may have evolved without a significant influence of fire. Historically, shadscale dominated shrub communities were not heavily influenced by fire. However a year with exceptionally heavy winter rains can generate heavy stands of annual forbs and grasses. When fires do occur, the effect on the plant community may be extreme due to the sites harsh environment and slow rate of recovery. Slow recovery period following fire can allow for a cheatgrass invasion which can subsequently decrease the fire return interval. Also, shadscale plants may be killed, thus site recovery may require re-establishment from adjacent

unburned stands (Simonin, 2001).

Inventory data references

The data collected in 2005-2007 were in conjunction with the soil survey update for Arches and Canyonlands National Park. The vegetation data was collected in associated with a soil pit and geo-referenced. All the data is stored as hard copy files and in electronic format in the NRCS Utah State Office.

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Rangeland health reference sheet

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

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Date	10/15/2008
Approved by	Shane A. Green
Approval date	
Composition (Indicators 10 and 12) based on	Foliar Cover

Indicators

1. **Number and extent of rills:** A few rills occur throughout site in the reference state (1-3% cover). Rills may be 6 or more feet in length and are most likely to form below adjacent exposed bedrock or water flow patterns where sufficient water accumulates to cause erosion. The number of rills may increase immediately following episodic storm events, but should not persist more than one or two seasons due to coarse soil textures and frost-have recovery.

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2. **Presence of water flow patterns:** The occurrence of water flow patterns is frequent (5-10% cover) and occur throughout the site; however they may be masked by surface rock fragments. These water flow patterns are typically less than 5 feet long. As slope increase (>10%) water flow pattern occurrence (8-12% cover) and length (5-8ft) increases. An increase in water flow patterns in also expected after disturbance events such as episodic precipitation events.

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3. **Number and height of erosional pedestals or terracettes:** Minor pedestalling (1 inch) forms at base of plants as a result of natural wind erosion in the reference state; however terracettes are rare.

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** In the reference state bare ground is fairly uncommon (15-30%) and similar throughout all plant community phases. Bare ground is associated with water flow patterns; cyanobacteria cover, and plant interspaces. Areas with poorly developed biological soil crusts that are interpreted as functioning as bare ground (therefore they would be susceptible to raindrop splash erosion) should be recorded as bare ground. This site has about 5-50% surface rock cover. Ground cover is based on first raindrop impact, and bare ground is the opposite of ground cover. Ground cover + Bare ground = 100%.

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5. **Number of gullies and erosion associated with gullies:** Active cullies are generally nonexistent; however stable gullies may occur in landscape settings where increased runoff from adjacent sites may accumulate (such as areas

below exposed bedrock). Such gully development is expected to be limited to slopes exceeding 15% and adjacent to sites where runoff accumulation occurs. Any gullies present should show little sign of accelerated erosion and should be stabilized with perennial vegetation.

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6. **Extent of wind scoured, blowouts and/or depositional areas:** Slight wind generated soil movement is normal; however due to the abundance of surface rock fragments on some of the sites, wind erosion is typically limited to large wind events.

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7. **Amount of litter movement (describe size and distance expected to travel):** Most litter accumulates under or adjacent to plant bases, with some redistribution caused by water movement and wind. Fine litter (<1/4 inch in diameter) may be moved up to 2-3 feet and usually occur in water flow patterns and rills, with deposition occurring at obstruction. Woody stems (those greater than ¼ inch in diameter) are not likely to move under normal conditions.

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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):** This site should have a soil stability rating of 4-5 throughout the site. Surface texture varies from fine sandy loam to loam to gravelly/channery sandy loam.

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil surface varies from 0 to 4 inches. Structure is fine granular. Color is reddish brown (2.5YR4/4). The A horizon does not differ between interspaces and under plant canopies. Use the specific information for the soil you are assessing found in the published soil survey to supplement this description.

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Distribution of perennial grasses, forbs, shrubs, and any biological soil crusts (when present), in conjunction with rock fragments intercept raindrops reducing splash erosion. Due to surface rock fragments, plants and/or biological soil crusts are limited in how much they can effectively slow runoff and allow time for infiltration. However, when perennial grasses and shrubs decrease, reducing ground cover and increasing exposed bare ground and rock fragments, runoff is amplified and infiltration reduced.

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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; high percentages of cobbles, channers, and gravel may be found in all soil horizons and there may be layers of calcium carbonate or other naturally occurring hard layers found in the soil subsurface. These should not be considered to be compaction layers.

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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: 5-10% cool season perennial grasses (e.g. Indian ricegrass)
    10-20% warm season perennial grasses (e.g. galleta)
    5-15% sprouting shrubs (e.g. shadscale and mormontea)

    Sub-dominant: 0-5% rhizomatous shrubs (e.g. Cutler mormontea)

Other: Other shrubs, forbs, and grasses

Additional: Perennial and annual forbs can be expected to vary widely in their expression in the plant community based upon departures from average growing conditions. Biological crusts (lichen, moss, and cyanobacteria) may or my not be present and characterized as light cyanobacteria in the interspaces with moss and lichen pinnacles occurring under the shrub canopy.

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**): During years with average to above average precipitation, there should be very little mortality or decadence apparent in shrubs; however, shadscale die offs have been associated with historical periods of high soil moisture (Simonin, 2001). During and following drought shadscale may appear dead, due to leaf drop and many plants may die during a multi-year drought. All age classes of perennial grasses should be present under average growing conditions with age class expression likely subdued during years of below average precipitation. The reference state includes a mix of plants of various ages with some plants being dead or showing characteristics of decadence.

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14. **Average percent litter cover (%) and depth (in):** Littler cover (including under plants) ranges from 10-15 %, nearly all which should be fine litter, and concentrated under the plant canopy. Variability is due the herbaceous production differences from one year to the next. Depth is generally 1 leaf thickness in the interspaces and up to 1/4 inch under the plant canopies. Litter can increase up to 20% immediate following leaf drop or after favorable conditions increase native annual forb production.

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** 300-450 lbs/acre on an average year.

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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:** Known invasives species include cheatgrass (Bromus tectorum), broom snakeweed (Gutierrezia sarothrae), tansy mustard (Descurainia pinnata), Halogeton (Halogeton glomeratus), and Russian thistle (Salsola tragus).

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17. **Perennial plant reproductive capability:** All perennial plants should have the ability to reproduce sexually or asexually in most years, except in drought years.

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18. **Supporting Data::** NRCS (Ashley Garrelts/Dana Truman) 2006-2008 data from Canyonlands National Park. Simonin, Kevin A. 2001. Atriplex confertifolia. In: Fire Effects Information System. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/. Accessed July 30, 2008.
