USDA Natural Resources
Conservation Service

Ecological site R035XY118UT
Desert Sandy Loam (Fourwing Saltbush)

Accessed: 04/29/2024

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.

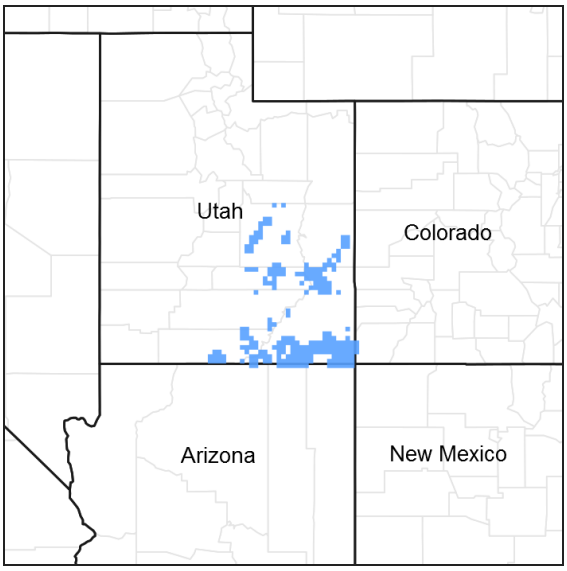


Figure 1. Mapped extent

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 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

Semiarid Benchlands and Canyonlands, 20-c and Arid Canyonlands, 20-d. (Woods et al. 2001)

Colorado Plateau Semidesert Province (arid grassland zone), 313. (Baily 1995)

Associated sites

R034BY104UT	**Desert Clay (Shadscale)**
R035XY009UT	**Alkali Flat (Greasewood)**
R035XY012UT	**Semiwet Saline Streambank (Fremont Cottonwood)**

R035XY015UT	**Sandy Bottom**
R035XY109UT	**Desert Loam (Shadscale)**
R035XY115UT	**Desert Sand (Sand Sagebrush)**
R035XY121UT	**Desert Sandy Loam (Blackbrush)**
R035XY122UT	**Desert Shallow Loam (Shadscale)**
R035XY124UT	**Desert Shallow Clay (Mat Saltbush)**
R035XY130UT	**Desert Shallow Sandy Loam (Shadscale)**
R035XY133UT	**Desert Shallow Sandy Loam (Blackbrush)**
R035XY136UT	**Desert Stony Loam (Shadscale-Bud Sagebrush)**
R035XY142UT	**Desert Very Shallow Gypsum (Torrey's Jointfir)**

Similar sites

R035XY215UT	**Semidesert Sandy Loam (4-Wing Saltbush)**
R035XY212UT	**Semidesert Sand (Fourwing Saltbush)**

Table 1. Dominant plant species

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

Physiographic features

This site typically occurs on nearly level to gently sloping sand sheets, stream and dry wash drainageway terraces and on broad valley bottoms. It also occurs on allivial fan benches, terraces, terrace reminants and toeslopes, and on eolian deposits found on structural benches.

Table 2. Representative physiographic features

Landforms	(1) Sand sheet (2) Terrace (3) Alluvial fan
Flooding frequency	None
Ponding frequency	None
Elevation	1,158–1,981 m
Slope	0–16%
Ponding depth	0 cm
Aspect	Aspect is not a significant factor

Climatic features

The climate is characterized by hot summers and cool to warm winters. Local weather patterns can be slightly modified by topographic conditions. Large fluctuations in daily temperatures are common. Mean annual high temperatures range from 65-74 degrees Fahrenheit and mean annual low temperatures range from 34-50 degrees Fahrenheit. Approximately 65-70% of moisture occurs as rain with peak periods from July thru October and March thru May. Summer convection thunderstorms and winter snows are the most common storm events. Precipitation is variable from month to month and from year to year but averages between 6-9 inches. Snow packs when present

are generally light and not persistent.

Table 3. Representative climatic features

Frost-free period (average)	200 days
Freeze-free period (average)	150 days
Precipitation total (average)	229 mm

Influencing water features

There are no water features directly influencing this site. Ephemeral drainageways sometimes pass through this site.

Soil features

The soils are deep to very deep, moderately developed, and well drained. The dry surface color is typically yellowish red to reddish brown. Runoff is normally low but can range to rapid. Permeability is moderately rapid to rapid. Soils on sites in the reference state generally have high wind and water erosion potential. The soil temperature and moisture regimes are mesic and typic aridic respectively.

Surface and subsurface textures are generally loamy fine sands, sands, fine sands, and fine loamy sands and may contain gravels. Soils are nonsaline slightly to moderately alkaline and the water holding capacity is fair. Biological crust cover is characterized as a weak crust, with light cyanobacteria and/or isolated moss clumps with no continuity or isolated pinnacles of lichen and moss with little continuity. This site has been used in the following soils surveys and has been correlated to the following components:

UT631 – Henry Mountains Area – Monue; Trachute
UT633 – Canyonlands Area – Bluechief; Nakai; Thoroughfare
UT638 – San Juan County, Central – Nakai; Oljeto Family
UT643 – San Juan County, Navajo Indian Reservation – Aneth; Moepitz; Monue;Nakai; Neskahi; Whit
UT685 – Capital Reef National Park – Moffat
UT686 – Escalante Grand Staircase National Monument – Nakai; Nepalto (moist)

Typical Soil Profile:
A--0-5 inches; loamy fine sand; slightly calcareous; moderately alkaline
Bw--5-16 inches; fine sandy loam; slightly calcareous; moderately alkaline
Bk--16-30 inches; very fine to fine sandy loam; strongly calcareous; strongly alkaline
C--30-60+ inches; loamy fine sand; moderately calcareous; moderately alkaline

Table 4. Representative soil features

Parent material	(1) Eolian sands–sandstone and shale
Surface texture	(1) Loamy fine sand (2) Fine sandy loam (3) Extremely cobbly loamy fine sand
Family particle size	(1) Sandy
Drainage class	Well drained to somewhat excessively drained
Permeability class	Moderately rapid to very rapid
Soil depth	102–152 cm
Surface fragment cover <=3"	0–20%
Surface fragment cover >3"	0–15%
Available water capacity (0-101.6cm)	7.87–17.78 cm

Calcium carbonate equivalent (0-101.6cm)	1–40%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–4
Soil reaction (1:1 water) (0-101.6cm)	7.9–8.5
Subsurface fragment volume <=3" (Depth not specified)	0–30%
Subsurface fragment volume >3" (Depth not specified)	0–30%

Ecological dynamics

This ecological site developed under MLRA 35, Colorado Plateau climatic conditions and included natural influences of herbivory, fire, and climate. This site typically occurs on the deep to very deep soils that are moderately well developed. Sites are dominated by Fourwing saltbush in the shrub layer with Torrey mormontea commonly occurring. The herbaceous layer is composed of a mix of native perennial warm and cool season grasses, including Indian ricegrass, needle-and-thread, James galleta, and several dropseed species.

This site is classified as a desert grassland plant community. The natural disturbance regime in these communities consisted in part of occasional wild fires that were started by both natural ignition as well as those set by Native Americans. Fires varied in size due to diverse topography that often include large expanses of exposed rock in the landscape that could limit fire spread. Also, warm season grasses were usually green during the thunderstorm season, and thus few lightning caused fires to likely occurred. Fire return intervals are estimated around 35-100+ years depending on fine fuel accumulations (Howard, 2003).

The introduction of domestic livestock and the use of fencing and reliable water sources have, in places, influenced the disturbance regime historically associated with this ecological site. In addition to influencing the sites natural fire regime, improperly managed livestock grazing (i.e., continuous season long grazing, heavy stocking rates, etc.) may cause native perennial grasses and shrubs to decrease while allowing invasive forbs, annual grasses and broom snakeweed to increase. Long term improper grazing may remove the native perennial grasses and shrubs from the system and create large bare interspaces which can increase erosion and provide opportunities for invasive plants to establish. Improper spring grazing can result in a decline of cool season grasses, while improper summer/early fall grazing can result in a decline of warm season grasses.

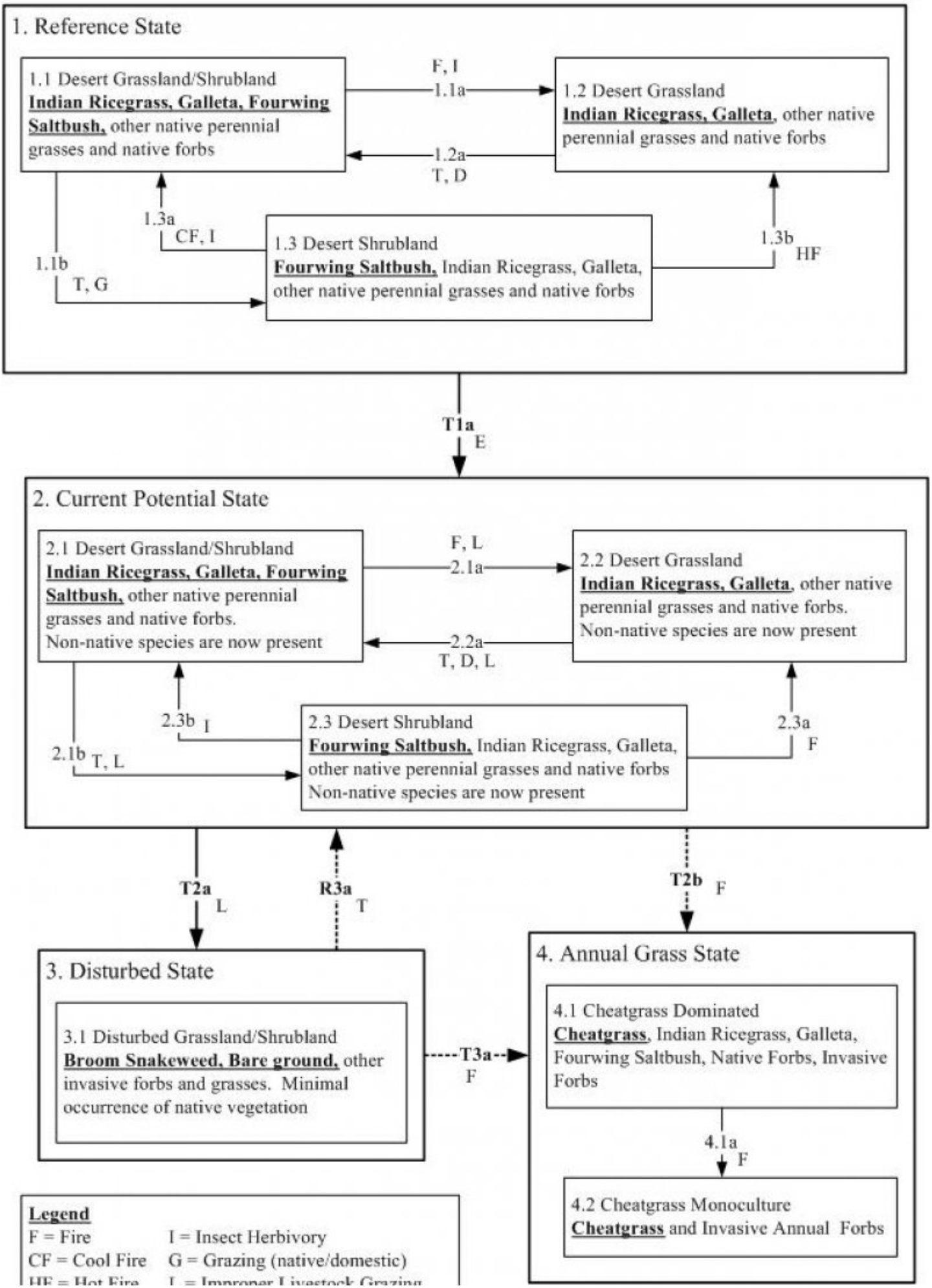
Other disturbance mechanisms include climatic fluctuations and insect herbivory. These disturbances can either facilitate the transition into different plant communities or the transition from one stable state to another, depending on severity and duration.

As vegetation communities respond to changes in management or natural influences that move them from one vegetative state to another, a return to previous states may not be possible without major energy inputs. 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, community pathways and transitional pathways found on thid site, it does does not necessarily depict all communities and pathways. These plant communities, however, are the most prevalent and repeatable. As more data are collected, some of these plant communities may be revised or removed, and new ones be added. This 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. Range data collected by the NRCS (1982) and GAP Analysis data collected by the RS/GIS Laboratory at USU (2000-2004) was also used.

State and transition model

R035XY118UT Desert Sandy Loam (Fourwing Saltbush)



D = Drought WP = Wet Period
E = Establishment of Non-native Species

State 1
Reference State

This reference state was determined by the study of rangeland relic areas, areas protected from excessive disturbance, as well as areas influenced by activities such as grazing and recreation. Literature reviews, trends in plant community dynamics, and historical accounts are also considered. This reference state represents the plant communities and ecological dynamics of the desert sandy loam, fourwing saltbush site. This state includes the biotic communities that can become established on this ecological site if all successional sequences are completed under the natural disturbance regime. This state is dominated by perennial warm and cool season grasses, where four-wing saltbush and mormontea species make up the dominant shrub canopy. In this state, both warm and cool season grass species are present, including Indian ricegrass and James galleta. Forb composition is variable. Primary disturbance mechanisms include occasional fire caused by lightning strikes and Native American ignition sources, climate fluctuations, insect herbivory, and native herbivore grazing. Timing of these natural disturbances dictates the what ecological dynamics occur. The reference state is self sustaining and resistant to change due to its high resistance to natural disturbances and it's high resilience following natural disturbances. When natural disturbances occur, the rate of recovery is relatively rapid due to niches being filled with highly adapted native vegetation. Reference State: Community phases influenced by infrequent fire, native herbivore grazing, insect herbivory, and weather. Indicators: A well developed perennial cool and warm season grass understory with fourwing saltbush forming the dominant visual aspect. Feedbacks: Extended drought and/or improper grazing that result in a reduction of native perennial plant vigor which may cause invasive species to become established in the understory, increased bare spaces, erosion, and soil loss. Infrequent but regular fires and/or properly managed grazing that maintain the perennial bunch grass understory and the establishment of shrubs. At-risk Community Phase: All communities in this state are at risk when native plants are stressed and/or nutrients become available for invasive plants to establish; plant community 1.3 is most at risk due to its limited understory. Trigger: Introduction and establishment of non-native invasive plants such as cheatgrass and Russian thistle.

Community 1.1
Desert Grassland/Shrubland.


This is an example of what a community phase 1.1 site probably looks like.
Dominant Species: Indian ricegrass, James galleta, Fourwing saltbush.
UTM: Not Available.
Location is in Canyonlands National Park, Island in the Sky District, Taylor Canyon.
Soil Survey 633-Canyonland Area.
Photo taken by: Dana K. Truman, NRCS, 2007.

Figure 4. Community Phase 1.1

This plant community phase is characterized by a fourwing saltbush overstory with a perennial cool and warm season grass understory. The dominant cool season grass is Indian ricegrass and the dominant warm season grass is James galleta. Other perennial grasses, shrubs, and forbs may or may not be present and cover is variable. Bare ground (40-50% cover) is common and biological crusts (1-10% cover) are characterized by light cyanobacteria in the interspaces, with an occasional isolated lichen or moss pinnacle under the plant canopy. 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)
Grass/Grasslike	84	168	252
Shrub/Vine	28	56	112
Forb	11	34	56
Total	**123**	**258**	**420**

Table 6. Soil surface cover

Tree basal cover	0%
Shrub/vine/liana basal cover	8-15%
Grass/grasslike basal cover	15-25%
Forb basal cover	0-10%
Non-vascular plants	0%
Biological crusts	1-10%
Litter	1-5%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	40-50%

Table 7. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	1-5%	1-10%	0-5%
>0.15 <= 0.3	–	1-10%	1-5%	1-5%
>0.3 <= 0.6	–	1-10%	10-20%	1-5%
>0.6 <= 1.4	–	0-5%	5-10%	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 1.2
Desert Grassland

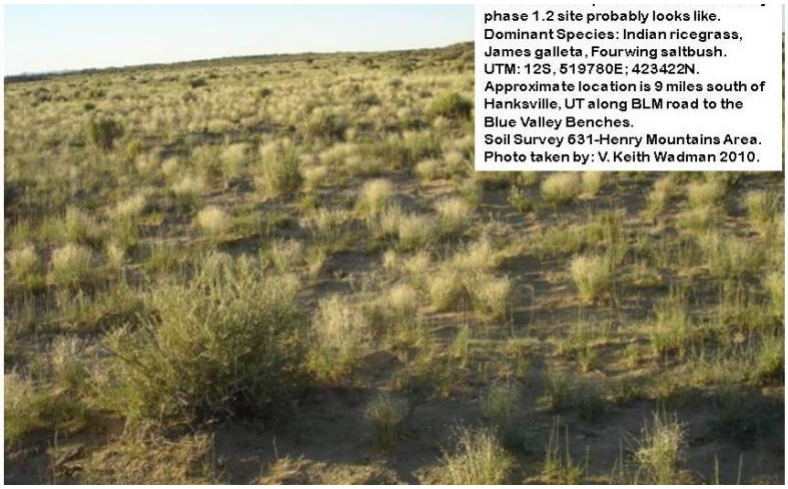


Figure 6. Community Phase 1.2

This plant community phase is characterized by well developed perennial warm and cool season grassland with occasional scattered fourwing saltbush, depending on disturbance history. Dominant grasses include Indian ricegrass, needle-and-thread, James galleta, and sand dropseed. Other perennial grasses, shrubs, and forbs my or may not be present and cover is variable. Bare ground (30-45% cover) is common and biological crusts (1-10% cover) are characterized by light cyanobacteria in the interspaces, with an occasional isolated lichen or moss pinnacle under the plant canopy. This plant community typically is a result of a fire in either plant community 1.2 or 1.3 and thus shrubs may or may not be present depending on when the fire occurred. 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	11	28	56
Forb	11	34	56
Total	**134**	**286**	**448**

Table 9. Soil surface cover

Tree basal cover	0%
Shrub/vine/liana basal cover	0-7%
Grass/grasslike basal cover	20-35%
Forb basal cover	0-10%
Non-vascular plants	0%
Biological crusts	1-10%
Litter	1-5%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	30-40%

Table 10. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	0-5%	1-10%	0-5%
>0.15 <= 0.3	–	0-5%	5-10%	1-5%
>0.3 <= 0.6	–	0-5%	10-20%	1-5%
>0.6 <= 1.4	–	0-5%	5-10%	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 1.3
Desert Shrubland

This plant community phase is characterized by a well developed shrub overstory with a minimally developed native perennial grass understory. Dominant shrub species include fourwing saltbush and mormontea. Dominant perennial cool and warm season grasses include Indian ricegrass and James galleta. Other perennial grasses, shrubs, and forbs may or may not be present and cover is variable. Bare ground (40-50% cover) is common and biological crusts (1-10% cover) are characterized by light cyanobacteria in the interspaces, with an occasional isolated lichen or moss pinnacle under the plant canopy. Due to increased bare ground and decreased perennial grass understory this plant community is most at risk for erosion, soil loss, and invasion by introduced species such as cheatgrass, annual mustard, and/or Russian thistle, as well as invasive native species including broom snakeweed. The following tables provide an example of the typical vegetative floristics of a community phase 1.3 plant community.

Table 11. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	56	112	196
Shrub/Vine	56	112	168
Forb	11	34	56
Total	**123**	**258**	**420**

Table 12. Soil surface cover

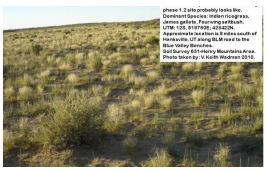
Tree basal cover	0%
Shrub/vine/liana basal cover	15-25%
Grass/grasslike basal cover	15-20%
Forb basal cover	1-10%
Non-vascular plants	0%
Biological crusts	1-10%
Litter	1-5%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	40-50%

Table 13. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	1-5%	1-5%	0-5%
>0.15 <= 0.3	–	5-10%	1-5%	1-5%
>0.3 <= 0.6	–	1-15%	5-10%	1-5%
>0.6 <= 1.4	–	0-5%	5-10%	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Pathway 1.1a
Community 1.1 to 1.2

Desert Grassland/Shrubland.



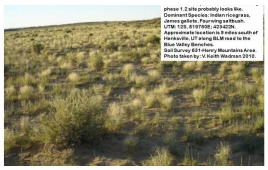
Desert Grassland

This pathway occurs when events, such as fire or shrub insect herbivory, favor the establishment of perennial native grasses and a reduction in the shrub canopy.

Pathway 1.1b
Community 1.1 to 1.3

This pathway occurs when events favor the establishment of native shrubs and a reduction in the perennial grass understory. Events may include time without disturbances, or improper grazing. This is the natural successional pathway from community 1.1 to 1.3

Pathway 1.2a
Community 1.2 to 1.1



Desert Grassland

Desert Grassland/Shrubland.

This pathway occurs when events favor the establishment of native shrubs with minimal loss of the perennial grass understory. Events may include time without disturbances or mild drought.

Pathway 1.3a
Community 1.3 to 1.1

This pathway occurs when events, such as a cool fire or insect herbivory, favor a minimal decrease in the shrub canopy and the increased establishment of native perennial grasses

Pathway 1.3b
Community 1.3 to 1.2

This pathway occurs when events, such as a hot fire, favors the establishment of native perennial grasses with a major reduction or removal of the shrub canopy.

State 2
Current Potential State

This state is similar to the reference state except there are now non-native invasive plants established in the understory. This state is dominated by perennial warm and cool season grasses, where fourwing saltbush and various mormontea species make up the shrub canopy. Dominant grass species include Indian ricegrass and James galleta. Forb composition is variable. Primary disturbance mechanisms include fire, human induced fire suppression, weather fluctuations, domestic livestock grazing, insect herbivory, and native herbivore grazing. Timing and severity of these disturbances dictate the ecological dynamics that occur. Disturbances can lead to shifts in species composition that affect the nutrient cycling, soil-water relationships, hydrology, and soil stability. This state has lower resistance to disturbances and resilience after disturbance than the reference state due to the occurrence of invasive species and increased bare ground. Current Potential State: Community phases influenced by fire, native herbivore grazing, domestic livestock grazing, insect herbivory cycles, lack of disturbances, and weather. Indicators: A well developed perennial cool and warm season grass understory with fourwing saltbush forming the dominant visual aspect. Invasive plants are present. Feedbacks: Extended drought and/or improper grazing that result in a reduction of native perennial plant vigor which may cause invasive species to dominate the understory, increased bare spaces, erosion, and soil loss. Infrequent but regular fires and/or properly managed grazing that maintain the perennial bunch grass understory and the establishment of shrubs. At-risk Community Phase: All communities are at risk when cheatgrass is present in the understory due to increased fine fuels, which may decrease the natural fire return interval that could eventually lead the site into an annual grass state (State 4). All community phases are also subject to possible transition into the disturbed state (state 3) due to increased bare ground, and increased opportunities for soil erosion especially when site is exposed to improper livestock grazing. Trigger: Increase and/or establishment of broom snakeweed, and surface disturbances which increase soil erosion and loss; and/or increased establishment of invasive annuals such as cheatgrass and annual mustards which decrease the fire return interval. Restoration Pathway: None

Community 2.1
Desert Grassland/Shrubland

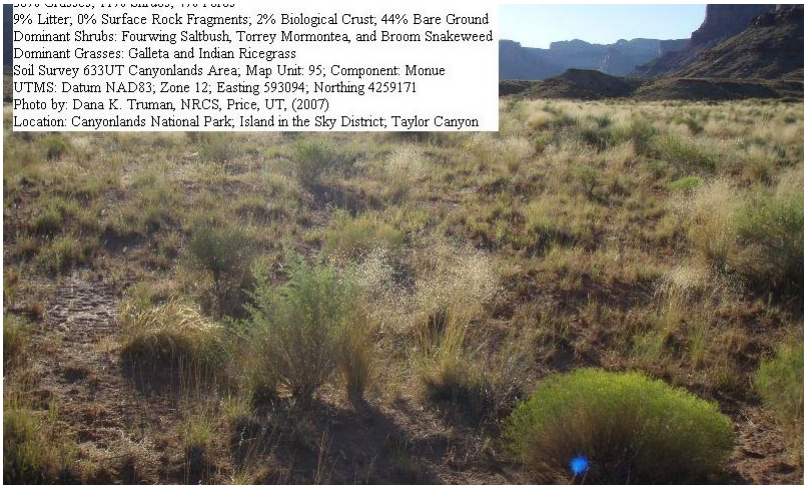


Figure 9. Community Phase 2.1

This plant community is characterized by a native perennial bunch grass understory with minimal occurrence of non-native invasive species. Fourwing saltbush forms the dominant shrub overstory. Commonly observed invasive plants include broom snakeweed, Russian thistle, cheatgrass, and annual mustards. Dominant perennial cool and warm season grasses include Indian ricegrass and James galleta. Other grasses, shrubs, and forbs my or may not be present and cover is variable. Bare ground (50-60% cover) is common and biological crusts (1-5% cover) are characterized by light cyanobacteria in the interspaces, with an occasional isolated lichen or moss pinnacle under the plant canopy. The following tables provide an example of the typical vegetative floristics of a community phase 2.1 plant community.

Table 14. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	84	168	252
Shrub/Vine	28	56	112
Forb	11	34	56
Total	**123**	**258**	**420**

Table 15. Soil surface cover

Tree basal cover	0%
Shrub/vine/liana basal cover	8-15%
Grass/grasslike basal cover	15-25%
Forb basal cover	0-10%
Non-vascular plants	0%
Biological crusts	1-5%
Litter	1-5%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	50-60%

Table 16. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	1-5%	1-10%	0-5%
>0.15 <= 0.3	–	1-10%	1-5%	1-5%
>0.3 <= 0.6	–	1-10%	10-20%	1-5%
>0.6 <= 1.4	–	0-5%	5-10%	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 2.2
Desert Grassland

Figure 11. Community Phase 2.2

This plant community phase is characterized by well developed perennial warm and cool season grassland with occasional scattered fourwing saltbush, depending on when the disturbance history. There is minimal occurrence of non-native invasive species. Grass species present include Indian ricegrass, James galleta, and cheatgrass. Commonly seen invasive forbs and shrubs include Russian thistle, broom snakeweed and annual mustards. Other grasses, shrubs, and forbs my or may not be present and cover is variable. Bare ground (50-60% cover) is common and biological crusts (1-5% cover) are characterized by light cyanobacteria in the interspaces, with an occasional isolated lichen or moss pinnacle under the plant canopy. This plant community typically is a result of a cool fire in either plant community 2.1 or 2.3 and thus shrubs may or may not be present depending on when the fire occurred. The following tables provide an example of the typical vegetative floristics of a community phase 2.2 plant community.

Table 17. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	112	224	336
Shrub/Vine	11	28	56
Forb	11	34	56
Total	**134**	**286**	**448**

Table 18. Soil surface cover

Tree basal cover	0%
Shrub/vine/liana basal cover	0-7%
Grass/grasslike basal cover	20-35%
Forb basal cover	0-10%
Non-vascular plants	0%

Biological crusts	1-5%
Litter	1-5%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	50-60%

Table 19. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	0-5%	1-10%	0-5%
>0.15 <= 0.3	–	0-5%	5-10%	1-5%
>0.3 <= 0.6	–	0-5%	10-20%	1-5%
>0.6 <= 1.4	–	0-5%	5-10%	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 2.3
Desert Shrubland

This plant community phase is characterized by a well developed shrub overstory with a minimally developed native perennial grass understory. Non-native invasive plants are present. Shrub species include fourwing saltbush, broom snakeweed, and various mormontea species, Grasses include Indian ricegrass, cheatgrass, and James galleta. Commonly occurring invasive forbs include annual mustards and Russian thistle. Other grasses, shrubs, and forbs my or may not be present and cover is variable. Bare ground (50-60% cover) is common and biological crusts (1-5% cover) are characterized by light cyanobacteria in the interspaces, with an occasional isolated lichen or moss pinnacle under the plant canopy. The following tables provide an example of the typical vegetative floristics of a community phase 2.3 plant community.

Table 20. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	56	112	196
Shrub/Vine	56	112	168
Forb	11	34	56
Total	**123**	**258**	**420**

Table 21. Soil surface cover

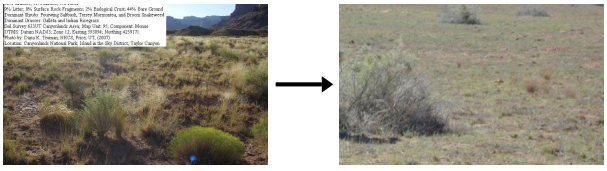
Tree basal cover	0%
Shrub/vine/liana basal cover	15-25%
Grass/grasslike basal cover	15-20%
Forb basal cover	1-10%
Non-vascular plants	0%

Biological crusts	1-5%
Litter	1-5%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	50-60%

Table 22. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	1-5%	1-5%	0-5%
>0.15 <= 0.3	–	5-10%	1-5%	1-5%
>0.3 <= 0.6	–	1-15%	5-10%	1-5%
>0.6 <= 1.4	–	0-5%	5-10%	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Pathway 2.1a
Community 2.1 to 2.2



Desert Grassland/Shrubland **Desert Grassland**

This pathway occurs when events favor the establishment of grasses with a complete removal of the shrub component. Events may include fire that allows for the reestablishment of the perennial grasses or grazing livestock in such a way that removes the shrub canopy.

Pathway 2.1b
Community 2.1 to 2.3

This pathway occurs when events favor the establishment of shrubs with a reduction in the grass understory. Events may include fire suppression, time, or grazing livestock in such a way that reduces the grass understory and allows for increased establishment of the shrub component.

Pathway 2.2a
Community 2.2 to 2.1

Desert Grassland **Desert Grassland/Shrubland**

This pathway occurs when events favor the establishment of shrubs with minimal loss of the grass understory.

Events may include time without disturbances, mild drought, or grazing livestock in such a way that allows for the increase of shrubs and decrease of grass species.

Pathway 2.3b
Community 2.3 to 2.1

This pathway occurs when events, such as insect herbivory, favor a decrease in shrub canopy. A variety of insects including Orthoptera, Lepidoptera, and Hemiptera feed on fourwing saltbush.

Pathway 2.3a
Community 2.3 to 2.2

This pathway occurs when events favor the establishment of native perennial grasses with a removal of the shrub canopy. Events typically include a cool fire that will significiently reduce or remove the shrubs, but still allow for establishment of native perennial grasses.

State 3
Disturbed State

This state is characterized by a dominance of broom snakeweed, Russian thistle, and various mormontea species, with minimal occurrence of the perennial warm and cool season grasses associated with this site. Fourwing saltbush may or may not be present. The primary disturbance mechanism is improperly managed domestic livestock grazing that maintains the broom snakeweed and bare ground. The shift in species composition, as well as the increased bare ground, affects the nutrient cycling, soil-water relationships, hydrology, and soil stability of this site. This state has lower resistance to disturbances and resilience after a disturbance than the previous two states. Disturbed State: Community phase maintained by improperly managed domestic livestock grazing. Indicators: A plant community dominated by broom snakeweed and Russian thistle, where bare ground is very common. Feedbacks: Improper domestic livestock grazing that allows for the continued establishment and maintenance of broom snakeweed and bare ground. Time without disturbances that may aid in the reestablishment of native perennial grasses and shrubs. At-risk Community Phase: All community phases are at risk when cheatgrass is present in the plant community and there are sufficient fine fuels to carry a fire. Trigger: Increased cheatgrass and a resulting decrease in the sites fire return interval. Restoration Pathway: Time with proper livestock grazing or other disturbance that allows native perennial vegetation to reclaim the site. This may take many years to accomplish.

Community 3.1
Disturbed Grassland/Shrubland

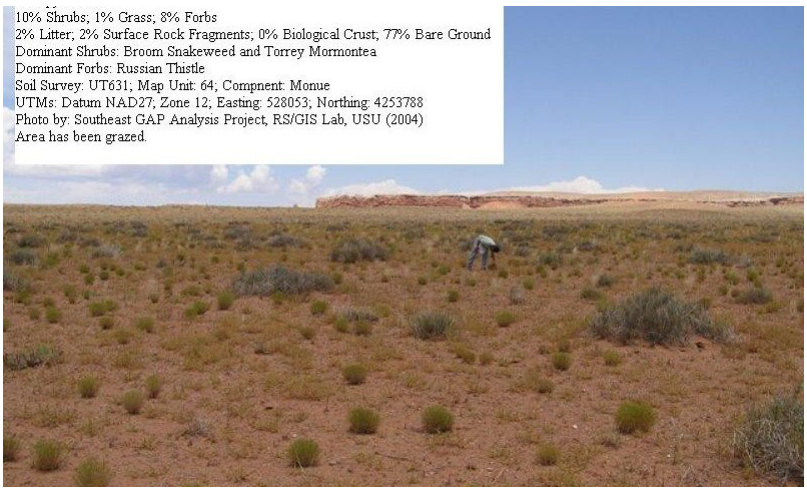


Figure 14. Community Phase 3.1

This plant community phase is characterized by a dominance of broom snakeweed and Russian thistle. The perennial warm and cool season grasses may or may not be present. Fourwing saltbush and Cutler's mormontea also may be present. Cheatgrass is typically present and other invasive forbs are variable. Bare ground (60-80% cover) is very common and the biological crust (0-5%) cover when present is characterized by light cyanobacteria in the interspaces, with an occasional isolated lichen or moss pinnacle under the plant canopy. This plant community is

most at risk when cheatgrass is present and fine fuel loads are sufficient to carry a fire, causing this community to be at risk of transitioning to an annual grass state (state 4). The following tables provide an example of the typical vegetative floristics of a community phase 3.1 plant community.

Table 23. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	56	84	112
Forb	28	56	84
Grass/Grasslike	11	22	45
Total	**95**	**162**	**241**

Table 24. Soil surface cover

Tree basal cover	0%
Shrub/vine/liana basal cover	5-10%
Grass/grasslike basal cover	1-10%
Forb basal cover	1-10%
Non-vascular plants	0%
Biological crusts	0-5%
Litter	1-5%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	60-80%

Table 25. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	0-5%	0-5%	0-5%
>0.15 <= 0.3	–	5-10%	1-10%	0-5%
>0.3 <= 0.6	–	0-5%	0-5%	5-10%
>0.6 <= 1.4	–	0-5%	0-5%	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

State 4
Annual Grass State

This states ecological processes are driven by the dominance of cheatgrass production. Other invasive, and some native plant species may also be present. Cheatgrass dramatically affects the soil/plant/water relationships of a site. Research has shown that it has substantial effects on soil water content and temperature, as well as impacts on the frequency and intensity of disturbance. After a cheatgrass invasion, a sites fundamental nutrient cycling processes, root pores, mycorrhizal associations, microbial species, and soil organic material are changed (Chapin et al. 1997;

Belnap and Phillips, 2001). These alterations may eventually create ecologically impoverished sites that are very difficult to restore to functionally. The competitiveness of cheatgrass and its ability to quickly establish after a disturbance make this state extremely resistance to change and resilient after a disturbance. Annual Grass State: Community phases maintained, in a self-sustaining manner, by frequent fire. Indicators: A site where ecological processes are driven by cheatgrass. Feedbacks: A self sustaining disturbance regime of frequent fire.

Community 4.1
Cheatgrass Dominated

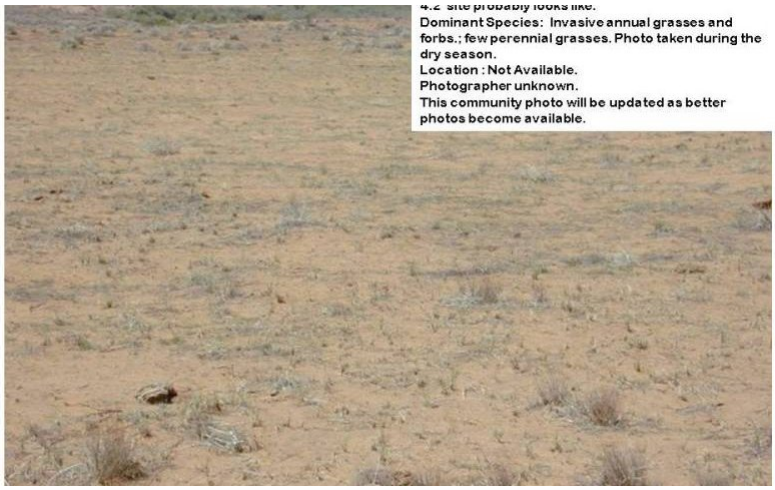


Figure 16. Community Phase 4.1 & 4.2.

This plant community is characterized by dominance of cheatgrass, other native species are present but no longer drive the ecological dynamics of the site. Bare ground is minimal (5-15% cover) due to the increase in litter and cheatgrass' dense establishment. Fire can carry through this community. Biological crusts (1-5% cover) are characterized by light cyanobacteria in the interspaces. The following tables provide an example of the typical vegetative floristics of a community phase 4.1 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	785
Shrub/Vine	28	56	84
Forb	11	22	45
Total	**263**	**638**	**914**

Table 27. Soil surface cover

Tree basal cover	0%
Shrub/vine/liana basal cover	0-2%
Grass/grasslike basal cover	60-80%
Forb basal cover	0-5%
Non-vascular plants	0%
Biological crusts	1-5%
Litter	5-10%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	5-15%

Table 28. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	0-40%	0-5%
>0.15 <= 0.3	–	–	0-50%	0-5%
>0.3 <= 0.6	–	0-2%	0-5%	0-5%
>0.6 <= 1.4	–	0-2%	0-5%	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 4.2
Cheatgrass Monoculture

This community is characterized by a complete monoculture of cheatgrass, where other grasses and shrubs do not occur. Invasive annual forbs may or may not 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 4.4 plant community.

Pathway 4.1a
Community 4.1 to 4.2

This pathway is characterized by frequently occurring fires (every 5-10 years) that allows for establishment of a cheatgrass monoculture.

Transition T1a
State 1 to 2

This transition is from the native perennial grass understory in the reference state to a state that contains invasive plants such as cheatgrass, Russian thistle, and annual mustards. Events that may trigger this event include fire, improper domestic livestock grazing, and extended drought that stress the native plants and allow nutrients to become available for more tolerant invasive species. Non-native, invasive species such as cheatgrass, however, have been known to invade into intact perennial plant communities where little to no disturbances have occurred. So while this transition may occur from any state in the reference state it typically will occur from community 1.3. Once invasive species have established in the understory a threshold has been crossed.

Transition T2a
State 2 to 3

This transition from the Current Potential State (State 2) to the Disturbed State (State 3). This transition occurs when events favor broom snakeweed to dominate the site. Bare ground increases and perennial/annual grass production decreases. Events typically include improperly managed domestic livestock grazing for extended periods of time. This transition may occur from any community in the current potential state. Once broom snakeweed and bare ground dominate, and drive the ecological dynamics of a site, a threshold has been crossed.

Transition T2b
State 2 to 4

This transition from the Current Potential State (State 2) to the Annual Grass State (State 4). This transition occurs when events allow cheatgrass to dominate the site. Bare ground typically will decrease as cheatgrass increases. A

hot, catastrophic fire occurring in any community in the current potential state can cause this transition to occur. This often causes an increase in the fire return interval. Once cheatgrass dominates and drives the ecological dynamics of a site, a threshold has been crossed.

Restoration pathway R3a
State 3 to 2

This restoration from the Disturbed State (State 3) to the Current Potential State (State 2). This restoration pathway occurs as native perennial shrubs and grasses are able to reclaim a site over time when improper livestock grazing and other disturbances are removed. For this to occur there must still be a seed source for native grasses and shrubs near or on the site. This restoration pathway may take many decades to complete and may not even be possible with the current knowledge.

Conservation practices

Prescribed Grazing
Native Plant Community Restoration and Management
Invasive Plant Species Control
Conservation Plan Development

Transition T3a
State 3 to 4

This transition is from the Disturbed State (State 3) to the Annual Grass state (State 4). This transition occurs when cheatgrass production is sufficient in the disturbed state for fire to be able to carry through the ecological site. Once cheatgrass drives the ecological dynamics of the site, a threshold has been crossed.

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**			11–56	
	fourwing saltbush	ATCA2	*Atriplex canescens*	11–56	–
3	**Sub-dominant Shrubs**			6–45	
	Cutler's jointfir	EPCU	*Ephedra cutleri*	0–17	–
	Torrey's jointfir	EPTO	*Ephedra torreyana*	0–17	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–11	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–6	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–6	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–6	–
Grass/Grasslike					
0	**Dominant Grasses**			90–196	
	James' galleta	PLJA	*Pleuraphis jamesii*	34–112	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	56–84	–
1	**Sub-dominant Grasses**			6–84	
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–28	–
	spike dropseed	SPCO4	*Sporobolus contractus*	0–28	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–28	–
	Grass, perennial	2GP	*Grass, perennial*	0–11	–
Forb					
2	**Forbs**			22–45	
	snowball sand verbena	ABFR2	*Abronia fragrans*	0–11	–
	rusty lupine	LUPU	*Lupinus pusillus*	0–11	–
	hoary tansyaster	MACA2	*Machaeranthera canescens*	0–11	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–11	–
	matted crinklemat	TILA6	*Tiquilia latior*	0–11	–
	Forb, annual	2FA	*Forb, annual*	0–6	–
	Forb, perennial	2FP	*Forb, perennial*	0–6	–
	pale evening primrose	OEPA	*Oenothera pallida*	0–6	–

Table 30. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
0	**Dominant Grasses**			112–224	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	56–112	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	28–56	–
	James' galleta	PLJA	*Pleuraphis jamesii*	28–56	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	11–28	–
1	**Sub-dominant Grasses**			11–56	
	spike dropseed	SPCO4	*Sporobolus contractus*	0–28	–
	Grass, perennial	2GP	*Grass, perennial*	0–11	–
Forb					
2	**Forbs**			22–45	
	rusty lupine	LUPU	*Lupinus pusillus*	0–11	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–11	–
	matted crinklemat	TILA6	*Tiquilia latior*	0–11	–
	hoary tansyaster	MACA2	*Machaeranthera canescens*	0–6	–
	pale evening primrose	OEPA	*Oenothera pallida*	0–6	–
	Forb, annual	2FA	*Forb, annual*	0–6	–
	Forb, perennial	2FP	*Forb, perennial*	0–6	–
	snowball sand verbena	ABFR2	*Abronia fragrans*	0–6	–
Shrub/Vine					
3	**Shrubs**			0–28	
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–11	–
	Cutler's jointfir	EPCU	*Ephedra cutleri*	0–6	–
	Torrey's jointfir	EPTO	*Ephedra torreyana*	0–6	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–6	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–6	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–6	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–6	–

Table 31. Community 1.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
0	**Dominant Shrubs**			56–112	
	fourwing saltbush	ATCA2	*Atriplex canescens*	56–112	–
3	**Sub-dominant Shrubs**			11–56	
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–11	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–11	–
	Cutler's jointfir	EPCU	*Ephedra cutleri*	0–11	–
	Torrey's jointfir	EPTO	*Ephedra torreyana*	0–11	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–6	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–6	–
Grass/Grasslike					
0	**Dominant Grasses**			56–112	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	28–56	–
	James' galleta	PLJA	*Pleuraphis jamesii*	28–56	–
1	**Sub-dominant Grasses**			6–56	
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–22	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–11	–
	spike dropseed	SPCO4	*Sporobolus contractus*	0–11	–
	Grass, perennial	2GP	*Grass, perennial*	0–6	–
Forb					
2	**Forbs**			22–45	
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–11	–
	matted crinklemat	TILA6	*Tiquilia latior*	0–11	–
	Forb, annual	2FA	*Forb, annual*	0–6	–
	Forb, perennial	2FP	*Forb, perennial*	0–6	–
	snowball sand verbena	ABFR2	*Abronia fragrans*	0–6	–
	rusty lupine	LUPU	*Lupinus pusillus*	0–6	–
	hoary tansyaster	MACA2	*Machaeranthera canescens*	0–6	–
	pale evening primrose	OEPA	*Oenothera pallida*	0–6	–

Table 32. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
0	**Dominant Shrubs**			11–56	
	fourwing saltbush	ATCA2	*Atriplex canescens*	6–28	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	6–28	–
3	**Sub-dominant Shrubs**			6–39	
	Cutler's jointfir	EPCU	*Ephedra cutleri*	0–17	–
	Torrey's jointfir	EPTO	*Ephedra torreyana*	0–17	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–11	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–6	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–6	–
Grass/Grasslike					
0	**Dominant Grasses**			84–196	
	James' galleta	PLJA	*Pleuraphis jamesii*	34–112	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	45–67	–
	cheatgrass	BRTE	*Bromus tectorum*	6–28	–
1	**Sub-dominant Grasses**			6–84	
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–28	–
	spike dropseed	SPCO4	*Sporobolus contractus*	0–28	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–28	–
	Grass, annual	2GA	*Grass, annual*	0–11	–
	Grass, perennial	2GP	*Grass, perennial*	0–11	–
Forb					
2	**Forbs**			22–45	
	prickly Russian thistle	SATR12	*Salsola tragus*	0–11	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–11	–
	Forb, annual	2FA	*Forb, annual*	0–6	–
	Forb, perennial	2FP	*Forb, perennial*	0–6	–
	snowball sand verbena	ABFR2	*Abronia fragrans*	0–6	–
	tansymustard	DESCU	*Descurainia*	0–6	–
	hoary tansyaster	MACA2	*Machaeranthera canescens*	0–6	–

Table 33. Community 2.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
0	**Dominant Grasses**			112–224	
	James' galleta	PLJA	*Pleuraphis jamesii*	50–112	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	56–84	–
	cheatgrass	BRTE	*Bromus tectorum*	6–28	–
1	**Sub-dominant Grasses**			11–112	
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–28	–
	spike dropseed	SPCO4	*Sporobolus contractus*	0–28	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–28	–
	Grass, annual	2GA	*Grass, annual*	0–17	–
	Grass, perennial	2GP	*Grass, perennial*	0–11	–
Forb					
2	**Forbs**			22–45	
	prickly Russian thistle	SATR12	*Salsola tragus*	0–11	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–11	–
	Forb, annual	2FA	*Forb, annual*	0–6	–
	Forb, perennial	2FP	*Forb, perennial*	0–6	–
	snowball sand verbena	ABFR2	*Abronia fragrans*	0–6	–
	tansymustard	DESCU	*Descurainia*	0–6	–
	hoary tansyaster	MACA2	*Machaeranthera canescens*	0–6	–
Shrub/Vine					
3	**Shrubs**			0–34	
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–17	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–11	–
	Cutler's jointfir	EPCU	*Ephedra cutleri*	0–6	–
	Torrey's jointfir	EPTO	*Ephedra torreyana*	0–6	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–6	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–6	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–6	–

Table 34. Community 2.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
0	**Dominant Shrubs**			56–112	
	fourwing saltbush	ATCA2	*Atriplex canescens*	28–56	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	22–34	–
	Cutler's jointfir	EPCU	*Ephedra cutleri*	6–22	–
3	**Sub-dominant Shrubs**			11–56	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	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	–
Grass/Grasslike					
0	**Dominant Grasses**			56–112	
	James' galleta	PLJA	*Pleuraphis jamesii*	28–56	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	11–28	–
	cheatgrass	BRTE	*Bromus tectorum*	6–28	–
1	**Sub-dominant Grasses**			6–56	
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–22	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–11	–
	spike dropseed	SPCO4	*Sporobolus contractus*	0–11	–
	Grass, annual	2GA	*Grass, annual*	0–6	–
	Grass, perennial	2GP	*Grass, perennial*	0–6	–
Forb					
2	**Forbs**			22–45	
	prickly Russian thistle	SATR12	*Salsola tragus*	0–11	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–11	–
	Forb, annual	2FA	*Forb, annual*	0–6	–
	Forb, perennial	2FP	*Forb, perennial*	0–6	–
	snowball sand verbena	ABFR2	*Abronia fragrans*	0–6	–
	tansymustard	DESCU	*Descurainia*	0–6	–
	hoary tansyaster	MACA2	*Machaeranthera canescens*	0–6	–

Table 35. Community 3.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
0	**Dominant Shrubs**			56–84	
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	56–84	–
3	**Sub-dominant Shrubs**			0–28	
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–28	–
	Cutler's jointfir	EPCU	*Ephedra cutleri*	0–11	–
	Torrey's jointfir	EPTO	*Ephedra torreyana*	0–11	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–6	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–6	–
Grass/Grasslike					
0	**Dominant Grasses**			6–22	
	cheatgrass	BRTE	*Bromus tectorum*	6–22	–
1	**Sub-dominant Grasses**			6–11	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–11	–
	James' galleta	PLJA	*Pleuraphis jamesii*	0–11	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–6	–
	Grass, annual	2GA	*Grass, annual*	0–6	–
	Grass, perennial	2GP	*Grass, perennial*	0–6	–
Forb					
2	**Forbs**			28–56	
	prickly Russian thistle	SATR12	*Salsola tragus*	28–56	–
	Forb, annual	2FA	*Forb, annual*	0–11	–
	Forb, perennial	2FP	*Forb, perennial*	0–11	–
	tansymustard	DESCU	*Descurainia*	0–11	–

Table 36. Community 4.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
0	**Dominant Grasses**			336–560	
	cheatgrass	BRTE	*Bromus tectorum*	280–448	–
	James' galleta	PLJA	*Pleuraphis jamesii*	11–56	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	11–56	–
1	**Sub-Dominant Grasses**			0–67	
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–45	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–11	–
	Grass, annual	2GA	*Grass, annual*	0–6	–
	Grass, perennial	2GP	*Grass, perennial*	0–6	–
Forb					
2	**Forbs**			6–22	
	prickly Russian thistle	SATR12	*Salsola tragus*	0–22	–
	tansymustard	DESCU	*Descurainia*	0–11	–
	white blue-eyed grass	SIAL3	*Sisyrinchium albidum*	0–6	–
	Forb, annual	2FA	*Forb, annual*	0–6	–
	Forb, perennial	2FP	*Forb, perennial*	0–6	–
Shrub/Vine					
3	**Shrubs**			0–56	
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–56	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–56	–
	Cutler's jointfir	EPCU	*Ephedra cutleri*	0–22	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–6	–

Table 37. Community 4.2 plant community composition

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

Animal community

--Wildlife Interpretation--
Small herds of mule deer and pronghorn antelope can be seen grazing/browsing on these sites, especially when near water sources and in the winter. 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. Lizards are the most visible and can be observed during the day. Species may include the northern whiptail, desert spiny, and the colorful western collard lizard. (NPS.gov, 2008)

--Livestock Interpretations--
This site provides good spring, fall, and winter grazing opportunities for livestock grazing due it's accessibility and available nutritious forage. This site can sometimes lack natural perennial water sources, which can influence the suitability for livestock grazing. The plant community is primarily composed of perennial grasses, with the majority of canopy cover being attributed to Indian ricegrass, James galleta, and sand dropseed. These grasses provide good forage for horses, cattle, and sheep in spring and fall. Fourwing saltbush provides good winter browse for cattle, sheep, and goats. Annual production depends on yearly precipitation amounts and thus creates challenges to those making livestock grazing management decisions. Forb composition should be monitored for species diversity, as well as for poisonous or injurious plant communities which may be detrimental to livestock if grazed. Livestock grazing should be based on a science based grazing management plan which should include an onsite inventory and evaluation.

Hydrological functions

The soils associated with this ecological site are generally in Hydrologic Soil Group B. Runoff potential is low and infiltration rates are moderate, depending on slope and ground cover/health (NRCS National Engineering Handbook). 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. In areas similar to the reference state where ground cover is adequate, infiltration is increased and runoff potential is decreased. In areas where ground cover is less than 50%, infiltration is reduced and runoff potential is increased.

Improper use by domestic livestock affects hydrology in two ways. 1. Trampling increases bulk density and breaks down soil aggregates. This results in decreased infiltration rates and increased runoff. 2. Decreasing plant cover and increasing bare ground can alter the sites hydrology. Fire can also affect site hydrology, but is quite variable. Fire intensity, fuel type, soil, climate, and topography can each have different influences. Fires can increase areas of bare ground and create 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, horseback riding, hunting, and off-road vehicle use. Camp sites are usually limited due to lack of sheltering trees or rock outcrop.

Wood products

None

Other information

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

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

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 can cause 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, including rain storms during a drought and during cool/cloudy periods. Soils high in nitrogen and low in sulfur and phosphorus can also 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--
As ecological conditions deteriorate and perennial vegetation decreases due to disturbance (fire, improperly managed livestock grazing, drought, off road vehicle overuse, erosion, etc.) invasive plants are more likely to become established on a site. Of particular concern in 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 possible.

Cheatgrass can establish itself into intact perennial grass and shrub communities, but disturbed communities are more susceptible to invasion and domination by this annual. If growing conditions are conducive for these invaders, they can create dense monocultures that can alter the nutrient cycling, erosion rates and fire regime of an area.

--Fire Ecology--
The ability for an ecological site to carry fire depends primarily on it's present fuel load and plant moisture content. Fire was a normal disturbance factor on this ecological site. The natural fire return interval is 30-100+ years, fires typically occurred in the fall (Howard, 2003). When a natural plant community is burned, perennial shrubs decrease and many successional stages may occur. Refer to the “Community Phase Data” section of this report. When the site is degraded by the presence of invasive species, the fire return interval is shortened due to increased flashy fuels. The shortened fire return interval is often sufficient to suppress the native plant community.

In degraded communities, fire could be used as a management tool by allowing fuels to build over several years, and then using carefully planned fire affect positive community change.

Inventory data references

The data collected in 2006-2007 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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Contributors

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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	01/01/2007
Approved by	Shane A. Green
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rills are not present in the reference state on the gentler slopes. Few rills present on slopes exceeding 10% and likely to form below adjacent exposed bedrock or water flow patterns where sufficient water accumulates to cause erosion. Rills present should be small, less than 6 feet in length. The number of rills can increase immediately following large storm events but should not persist more than one or two seasons due to coarse soil textures and frost-heave recovery.

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2. **Presence of water flow patterns:** The occurrence of water flow patterns is rare (0-3% cover) on all slopes in the reference state, and are typically less than 3 feet long. As slopes increase (>10%) water flow pattern occurrence (3-8% cover) and length (3-5ft) also increases. An increase in water flow patterns is also expected after disturbance events such as precipitation events and increased wildlife use, which increases the percent of bare ground and erosion potential.

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3. **Number and height of erosional pedestals or terracettes:** The occurrence of pedestalling or terracetting in the reference state is rare; however 1 inch pedestalling of shrubs is acceptable, but there shoul be no exposed roots

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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 common (40-50%) and fairly similar throughout all plant community phases. Bare ground is associated with water flow patterns, rodent activity, and plant interspaces. Areas with poorly developed biological soils crust 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 can have up to 15% 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%.

5. **Number of gullies and erosion associated with gullies:** Active gullies are generally nonexistent; however, stable gullies may occur in landscape settings where increased runoff may have accumulated (such as areas below exposed bedrock). Gully development is expected to be limited to steep slopes, show little sign of accelerated erosion, and be stabilized with perennial vegetation.

6. **Extent of wind scoured, blowouts and/or depositional areas:** Slight wind generated soil movement is normal. Wind caused blowouts and depositions are mostly stable or have healed over. Slight coppice mounding around Cutler mormontea, when present is common. Increased wind generated soil movement can occur after severe (multi-year) drought or severe wind events.

7. **Amount of litter movement (describe size and distance expected to travel):** Most litter resides in place with some redistribution caused by water movement and wind. Fine litter (<¼ inch in diameter) may be moved up to 2-3 ft and usually occurs in water flow patterns and rills, with deposition occurring at obstruction. The majority of litter accumulates at the base of plants or in soil depression adjacent to the plant. Woody stems (those greater than .25 inch in diameter) are not likely to move under normal conditions.

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 sand to very fine sandy loam. As sites depart from the reference state to a state dominated by invasive annuals soil surfaces textures are expected to become siltier.

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil surface 3-5 inches deep and structure is weak thick platy. The A-horizon color ranges from a light reddish brown (5YR 6/4) to a reddish yellow (7.5YR 6/6). Surface textures are typically loamy fine sands. The A-horizon would be expected to be more strongly developed under plant canopies. It is important if you are sampling to observe the A-horizon under plant canopies as well as the interspaces. Use the specific information for the soil you are assessing found in the published soil survey to supplement this description.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** The presence of perennial grasses, shrubs will break raindrop impact and splash erosion. The spatial distribution of vascular plants, non-vascular communities (when present), and interspaces provide detention storage and surface roughness that slows down runoff, allowing time for infiltration. When perennial grasses decrease, reducing ground cover and increasing bare ground, runoff can increase and infiltration would be reduced.

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** None. A few soils have bedrock at 30+ inches. Naturally occurring soils horizons may be harder than the surface because of an accumulation of clay or calcium carbonate and should not be considered as compaction layers.

12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live**

foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):

Dominant: Perennial bunchgrasses (Indian ricegrass > Galleta > Dropseeds) > non-sprouting shrubs (Fourwing saltbush)

Sub-dominant: rhizomatous grasses (Sandhill muhly) = sprouting shrubs (Mormontea, Rabbitbrush, Sand sage) = forbs (globemallow, milkvetch) > Biological soil crust.

Other: Functional/structural groups may appropriately contain non-native species if their ecological function is the same as the native species in the reference state (e.g. Siberian Wheatgrass, Forage kochia etc.)
Biological soil crust is variable in it's expression where present on this site and is measured as a component of ground cover.
Forbs can be expected to vary widely in their expression in the plant community based upon departures from average growing conditions.

Additional: Temporal variability is caused by drought, insects, large precipitation events, and very infrequent fire. Spatial variability is caused by soil textures, proximity to runoff producing sites, etc.
Following a recent disturbance such as drought or insects that removes the woody vegetation, forbs and perennial grasses (herbaceous species) may dominate the community. If a disturbance has not occurred for an extended period of time, woody species may continue to increase crowding out the perennial herbaceous understory species. In either case, these conditions reflect a community phase within the reference state.

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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 either shrubs or grasses. During and following drought fourwing saltbush may appear dead, due to leaf drop and many plant may die during a multi-year drought. Some (up to 20%) perennial bunch grass mortality is expected during severe drought

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14. **Average percent litter cover (%) and depth (in):** Litter cover (including under plants) ranges from 5-10%, nearly all of which should fine litter. Variability is due to the herbaceous production differences from one year to the next. Depth is generally 1 leaf thickness in the interspaces and up to .25 inch under 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):** 200-350 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 invasive species include cheatgrass (Bromus tectorum), broom snakeweed (Gutierrezia sarothrae), tansy mustard (Descurainia pinnata), 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 during drought.

18. **Supporting Data::** NRCS (Dana Truman/Ashley Garrelts) 2006/2007 ESD data from Arches and Canyonlands National Parks.