USDA Natural Resources Conservation Service

Ecological site R035XY215UT
Semidesert Sandy Loam (4-Wing Saltbush)

Accessed: 05/09/2024

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.

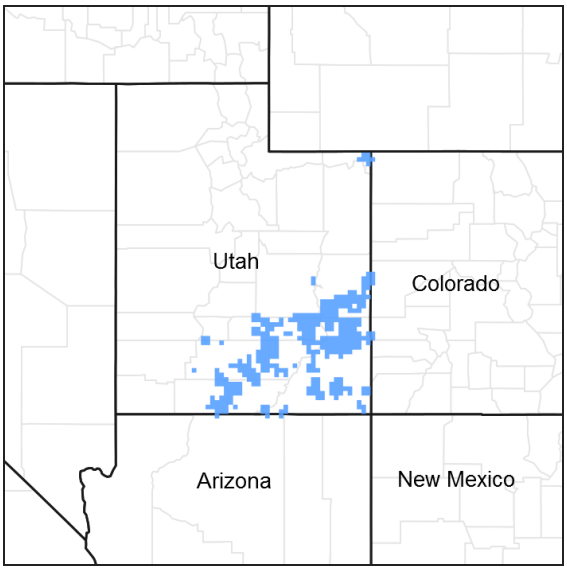


Figure 1. Mapped extent

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)

Ecological site concept

This site occurs in the semidesert zone of the Colorado and Green River Plateaus Region (MLRA 35) in Southern Utah. It is found on moderately deep to very deep, moderately developed soils found on mesa tops, high terraces, parks, broad valleys, and on eolian sand hillslopes at elevations between 4300 and 6600 feet. Average annual precipitation ranges from 8 to 12 inches. Soils are sandy loams, sands, and loamy sands derived from eolian deposits or alluvium derived from sandstone. Patchy well-developed biological crust cover is typical of the reference

state. The soil moisture regime is typic aridic and the soil temperature regime is mesic. The plant community is characterized by a productive perennial grassland composed of both cool and warm season grasses. Fourwing saltbush typically forms the dominant visual aspect on mesa tops, high terraces, and higher points in broad valleys; and winterfat typically forms the dominant visual aspect on sandy parks surrounded by monoliths, and lower points in broad valleys, i.e. landscape positions that accumulate finer surface soils due to moisture run-on. Indian ricegrass is generally dominant, with other grass species variable. Other commonly occurring grasses include James' galleta, needle-and-thread, blue grama, black grama, and sand dropseed. Black grama tends to be expressed with high summer precipitation, and may be overlooked under average conditions or with lower summer precipitation.

Associated sites

R035XY011UT	**Loamy Bottom (Basin Big Sagebrush)**
R035XY015UT	**Sandy Bottom**
R035XY109UT	**Desert Loam (Shadscale)**
R035XY126UT	**Desert Shallow Gypsum (Torrey's Jointfir)**
R035XY133UT	**Desert Shallow Sandy Loam (Blackbrush)**
R035XY142UT	**Desert Very Shallow Gypsum (Torrey's Jointfir)**
R035XY209UT	**Semidesert Loam (Wyoming Big Sagebrush)**
R035XY212UT	**Semidesert Sand (Fourwing Saltbush)**
R035XY216UT	**Semidesert Sandy Loam (Wyoming Big Sagebrush)**
R035XY218UT	**Semidesert Sandy Loam (Blackbrush)**
R035XY227UT	**Semidesert Shallow Sand (Utah Juniper-Pinyon)**
R035XY230UT	**Semidesert Shallow Sandy Loam (Shadscale)**
R035XY233UT	**Semidesert Shallow Sandy Loam (Blackbrush)**
R035XY236UT	**Semidesert Shallow Sandy Loam (Utah Juniper, Blackbrush)**
R035XY242UT	**Semidesert Gravelly Loam (Shadscale)**
R035XY260UT	**Semidesert Very Steep Stony Loam (Salina Wildrye)**
R035XY306UT	**Upland Loam (Basin Big Sagebrush)**
R048AY433UT	**Mountain Shallow Loam (Black Sagebrush)**

Similar sites

R035XY118UT	**Desert Sandy Loam (Fourwing Saltbush)**
R035XY212UT	**Semidesert Sand (Fourwing Saltbush)** Currently the way these sites have been revised there is very little difference in the different plant communities in the current potential state. The reference state reflects what may be found in Virginia Park (based on papers, photographs, and some data from GIS). There are really no differences in surface textures between these two sites based on data collected else where in the Needle's District of Canyonlands National Park, where Virginia and Chesler Parks are both located. Currently the revised sites are determined by soil subsurface textures and resulting soil component. Mido and Earlweed are both sandy soils and thus are correlated to the semidesert sand fourwing saltbush site; where as Mivida and other loamier soils are correlated to the semidesert sandy loam fourwing saltbush site.
R035XY218UT	**Semidesert Sandy Loam (Blackbrush)**

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Atriplex canescens*

Herbaceous	(1) *Achnatherum hymenoides* (2) *Pleuraphis jamesii*

Physiographic features

This site occurs on flat to rolling mesa tops, plateaus, fan terraces, broad valleys, benches, and alluvial fans. Runoff is typically influenced by micro-topography. Ponding and flooding does occur, however, its frequency is none to very rare and duration is minimal. Sites in lower areas on the landscape receive runoff while sites higher on the landscapes generate runoff. This can create differences in plant communities and disturbance regimes. Landform and position can also influence dominant shrubs species in the reference state (see the Community Phase section of this report).

Table 2. Representative physiographic features

Landforms	(1) Alluvial fan (2) Valley (3) Mesa
Flooding duration	Extremely brief (0.1 to 4 hours) to very brief (4 to 48 hours)
Flooding frequency	None to rare
Ponding duration	Very brief (4 to 48 hours) to brief (2 to 7 days)
Ponding frequency	None to rare
Elevation	1,311–2,012 m
Slope	1–15%
Ponding depth	0–8 cm
Aspect	Aspect is not a significant factor

Climatic features

The climate is characterized by hot summers and cool winters which can be slightly modified by local topographic conditions such as aspect. Large fluctuations in daily temperature are common. Approximately 70% of moisture occurs as convection thunderstorms. Precipitation is variable from month to month and from year to year, but averages range between 8-12 inches annually. Snow packs are generally light and not persistent. (Utah Climate Summaries 2008).

Table 3. Representative climatic features

Frost-free period (average)	140 days
Freeze-free period (average)	165 days
Precipitation total (average)	254 mm

Influencing water features

There are no water features influencing this site.

Soil features

Soils are moderately deep to very deep, moderately to well developed, and well drained. Typically the dry surface is yellowish red to reddish brown to brown. Runoff is low due to flatter slopes and high permeability; soils occurring on slopes greater than 20% may have a moderate runoff potential; however occurrences are rare. Soils on sites in the reference state generally have low wind and water erosion potential. The soil temperature and moisture regimes are mesic and ustic aridic respectively. Surface and subsurface textures are generally sandy loams, sands, and loamy sands. Soils are nonsaline and the water holding capacity is moderate. Biological soil crust cover varies by plant community phase, soil, aspect, elevation, etc. Ponding areas may be present within this site, especially in concave

landscapes. Generally, the surface soil textures in these concave areas are siltier and characterized by very fine sands. These soils are classified in the same series as surrounding areas, but are phased based on their associated fine textures or slopes. This site has been used in the following soil surveys and has been correlated to the following components:

UT623 – Emery Area – Mivida
UT624 – Grand County – Begay, Sazi
UT629 – Loa-Marysvale Area – Begay, Milok
UT631 – Henery Mountains Area – Begay, Bowdish variant, Mivida, Ortero Family, Palma, Shedado, Windwhistle, Yarts
UT633 – Canyonlands Area – Begay, Ignacio, Mivida, Redbank, Windwhistle, Sazi
UT636 – Panguitch Area – Henrrieville, Yarts
UT638 – San Juan County, Central – Mivida
UT643 – San Juan County, Navajo Indian Reservation – Begay, Whit, Sogzie
UT685 – Capital Reef National Park – Begay, Mivida, Aquima family, Milok, Progresso, Radnik;
UT686 – Escalante Grand Staircase National Monument – Ansazi, Barx, Begay-dry, Milok-cool, Mivida, Progresso, Sazi, Yarts, Yarts-dry
WY638 – Henrys Fork Area – Lanver, Milok, Yarts

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

Table 4. Representative soil features

Parent material	(1) Alluvium–sandstone
Surface texture	(1) Loamy very fine sand (2) Fine sandy loam (3) Loamy fine sand
Family particle size	(1) Sandy
Drainage class	Moderately well drained to well drained
Permeability class	Moderate to moderately rapid
Soil depth	51–152 cm
Surface fragment cover <=3"	0–15%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	7.62–27.94 cm
Calcium carbonate equivalent (0-101.6cm)	0–40%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–10
Soil reaction (1:1 water) (0-101.6cm)	7.4–9
Subsurface fragment volume <=3" (Depth not specified)	0–30%
Subsurface fragment volume >3" (Depth not specified)	0%

Ecological dynamics

This ecological site developed under Colorado Plateau climatic conditions that included the natural influences of herbivory, fire, and climate. The plant community is characterized by a productive perennial grassland composed of both cool and warm season grasses. Fourwing saltbush typically forms the dominant visual aspect on mesa tops, high terraces, and higher points in broad valleys; and winterfat typically forms the dominant visual aspect on sandy parks surrounded by monoliths, and lower points in broad valleys, i.e. landscape positions that accumulate finer surface soils due to moisture run-on. A consistent relationship between vegetation community and landscape position or soil properties suggests that two different ecological sites may be present; however, fourwing saltbush may also be present or dominant in these lower positions, and data are not currently strong enough to support two sites. Indian ricegrass is generally dominant, with other grass species variable. Other commonly occurring grasses include James' galleta, needle-and-thread, blue grama, black grama, and sand dropseed. Black grama tends to be expressed with high summer precipitation, and may be overlooked under average conditions or with lower summer precipitation. This palatable warm season grass may also have been more frequent and abundant prior to widespread overgrazing (e.g. Schmutz et al. 1967).

The natural disturbance regime consisted of infrequent fires ignited by both natural causes and by Native Americans. Fires were often infrequent and small due to the areas broken topography (i.e. large expanses of exposed rock in the landscape), the fact that warm season grasses are usually green during the thunderstorm season, and that few lightning strikes actually occurred (Kleiner and Harper 1972, Loope 1977). It is estimated that the historic fire regime was 35-100+ years, depending on fine fuel accumulations (Howard 2003). Current fire return intervals on these desert grassland plant communities are hard to quantify due to recent annual grass invasions, which have dramatically changed the sites present fire regime.

Historically the Colorado Plateau experienced only light grazing by native ungulates whose populations were kept in check by native predators such as mountain lions and wolves (Mack and Thompson 1982, Cole et al. 1997, Schwinning et al. 2008). Livestock grazing by cattle was introduced to this region in the 1880s, and many areas were impacted by grazing at some level (Neff et al. 2005), although inaccessible reference locations do exist for this ecological site. One of the most significant impacts of livestock grazing in this arid region has been damage to biological soil crust (BSC), including reductions in species diversity, cover, and alteration of species composition, with simplified communities of cyanobacteria replacing lichen and moss species that may take decades to recover (e.g Evans and Belnap 1999, Belnap and Eldridge 2003). The loss of BSC reduces soil stability, and soil moisture holding capacity, and consequently increases erosion potential (Evans and Belnap 1999, Belnap and Eldridge 2003, Harris et al. 2003, Neff et al. 2005).

This ecological site has been grazed by domestic livestock since they were first introduced into the area. Before grazing began, fires would often only carry on this site when several good moisture years created sufficient fuels for them to burn. With the introduction of domestic livestock, however, these fuel loads have typically been reduced, lengthening the fire return interval and allowing shrubs to increase on the site at the expense of grasses. Conversely, the introduction of cheatgrass, which accompanied livestock grazing but is not restricted to grazed areas, has led to a shorter fire return interval in some cases, which promotes a cheatgrass dominated state.

In addition to influencing the fire regime, improperly managed livestock grazing (i.e., continuous season long grazing, heavy stocking rates, etc.) may alter plant community composition. Indian ricegrass is typically dominant or co-dominant in reference conditions for these grasslands (Kleiner and Harper 1972, Loope 1977, Tuhey and MacMahon 1988, Romme 1993, Bich et al.). James' galleta, blue grama, black grama, and dropseed species are common associates (Loope 1977, Tuhey and MacMahon 1988, Romme 1993). With grazing, Indian ricegrass tends to decrease, and James' galleta and dropseed species increase, vegetative cover and BSC decrease, snakeweed increases, and invasive species may become more abundant (although invasive species may also readily invade ungrazed relict communities (Kleiner and Harper 1972, Loope 1977, Jeffries and Klopatek 1987, Romme 1993, Bich et al. 1995). With continued heavy grazing vegetative cover further decreases, BSC are further damaged and soil destabilized, and invasive annual plants may become dominant, while even James' galleta and dropseed species decline (Jameson 1962, Loope 1977, Romme 1993). Shrub invasion and increase makes these grasslands susceptible to blowouts and erosion.

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 opportunities for invasive plants to dominate. Timing of grazing also affects the ecological dynamics of this ecological site. Spring grazing results in a decline of cool season grasses, while summer/early fall grazing results in a decline of warm season grasses.

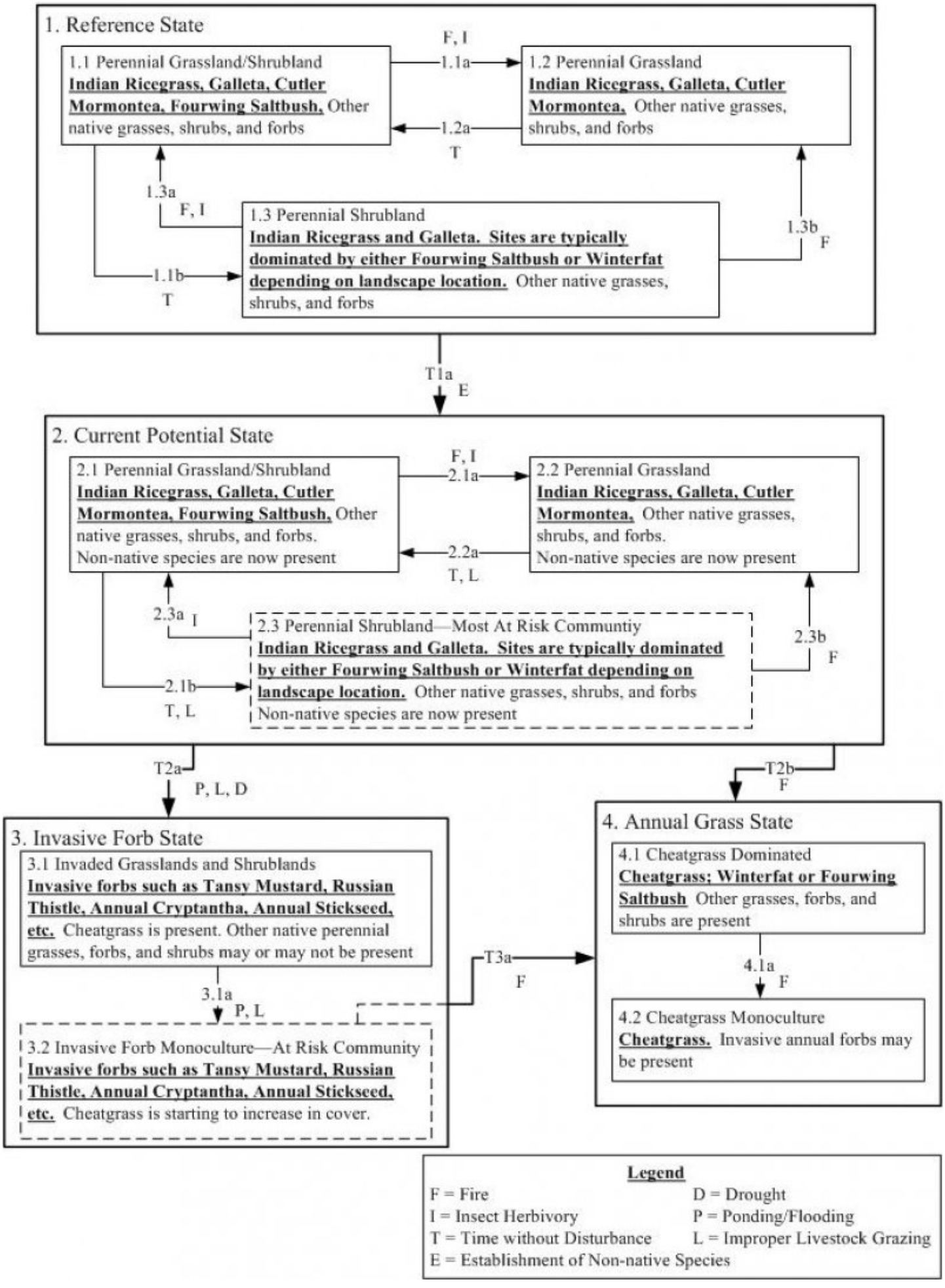
Other disturbance mechanisms include extended drought, extended ponding/flooding, and insect herbivory, all of which can affect soil/water/vegetation relationships. These disturbances can cause the site to transition into different plant communities and/or cause them to transition from one stable state to another, depending on their severity and duration.

As vegetation communities respond to changes in management or natural influences that cause them to move to other states, 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 State and Transition diagram describes the most commonly occurring plant communities found on this site. They do 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 may be added. This model was developed using range data collected in 2006 and 2007 in Arches and Canyonlands National Park in Southeastern Utah. Both ocular and measured data was collected and utilized. Data collected by the Soil Conservation Service in 1999 and GAP Analysis data collected by the RS/GIS Laboratory at USU (2000-2004) was also used.

State and transition model

R035XY215UT Semidesert Sandy Loam (Fourwing Saltbush)



State 1
Reference State

The reference state is determined by study of rangeland relic areas, i.e. areas protected from excessive disturbances and influences, such as improper livestock grazing and damaging recreational activities. 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 semidesert sandy loam, fourwing saltbush site. This state includes the biotic communities that 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 fourwing saltbush, winterfat, and Cutler's jointfir make up the shrub canopy. In this state, both warm and cool season grass species occur; however, typically one cool and one warm season species dominates the site. Utah juniper can naturally invade on the moderately deep soil components when this site is in close proximity to juniper dominated ecological sites. Due to the aggressive competitive nature of Utah juniper to out compete understory species, blow-out areas are common where this species occurs; however, these instances occur on a small scale at the margins of the site, and thus far a juniper dominated state has not been observed. Primary disturbance mechanisms include infrequent fire, insect herbivory, weather fluctuations, and native herbivore grazing. Timing of these natural disturbances dictates the ecological dynamics that can occur. The reference state is self sustaining and resistant to change due to its high resistance to natural disturbances and high resilience following natural disturbances. When natural disturbances do occur, the rate of recovery is relatively rapid due to niches being filled with highly adapted native vegetation. Reference State: Plant communities influenced by infrequent fire, insects, native herbivore grazing, and climate fluctuations. Indicators: A well developed perennial cool and warm season grass understory with winterfat and/or fourwing saltbush forming the dominant visual aspect. Feedbacks: Infrequent but regular fires to maintain the perennial grass understory and the establishment of shrubs. At-risk Community Phase: All communities are at risk when native plants are stressed and nutrients become available for invasive plants to establish, particularly 1.3 where the native perennial bunchgrass understory is limited and nutrients may be available for the establishment of invasive species; however non-native invasive species have been known to establish into intact perennial plant communities with little to no disturbances. Trigger: Improper livestock grazing and the establishment of non-native invasive plant species.

Community 1.1
Perennial Grassland/Shrubland

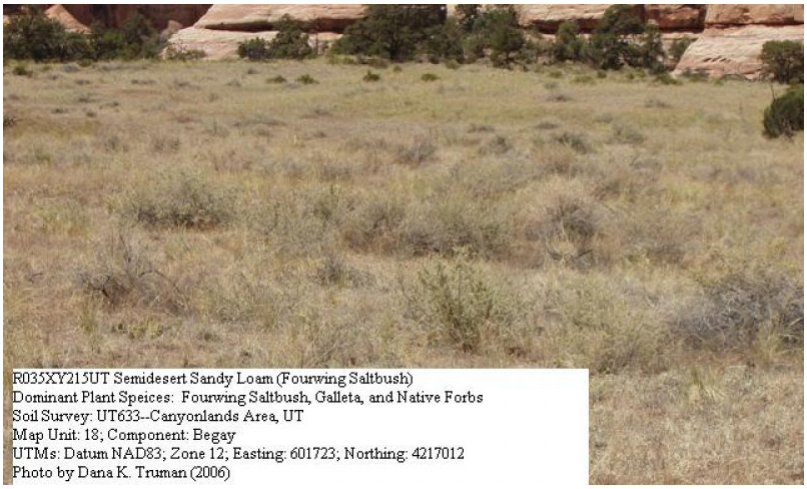


Figure 6. Perennial grasses and shrubs.

This plant community is characterized by a perennial warm and cool season grass understory, where fourwing saltbush, winterfat and Cutler’s jointfir make up the shrub canopy. Dominant grasses are Indian ricegrass and James' galleta, while blue grama, black grama, needle-and-thread, and dropseed may also be locally important. Shrub cover is generally 1-5% fourwing saltbush, 1-10% winterfat, and 5-20% Cutler's jointfir. Other perennial grasses, shrubs, and forbs may or may not be present and cover is variable. Bare ground is minimal (5-25% cover). Biological crust (10-50% cover) is characterized by cyanobacteria, pinnacled lichen, and moss with little continuity. Typically, moss and lichen clumps will be concentrated under the plant canopy and cyanobacteria will be found in the interspaces. The following tables provide an example 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	112	336	673
Shrub/Vine	56	168	224
Forb	11	34	56
Tree	1	6	11
Total	**180**	**544**	**964**

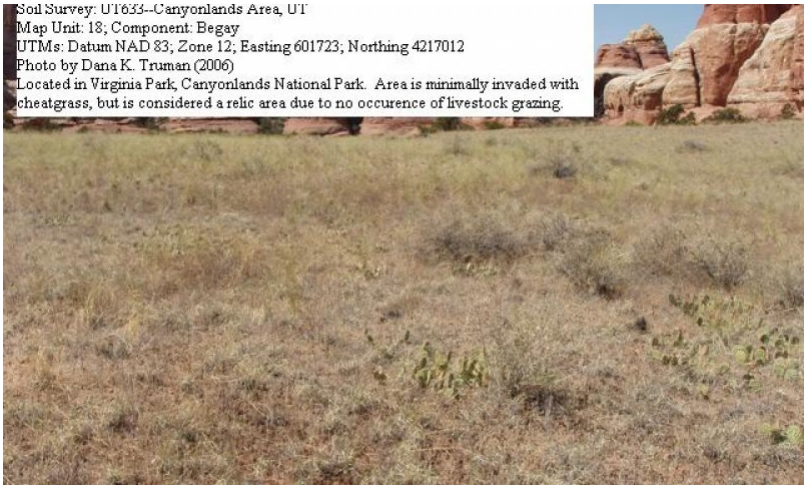
Table 6. Ground cover

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

Table 7. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	1-5%	1-20%
>0.15 <= 0.3	–	0-10%	2-10%	1-5%
>0.3 <= 0.6	–	5-20%	5-30%	5-15%
>0.6 <= 1.4	–	1-5%	1-5%	–
>1.4 <= 4	0-5%	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 1.2
Perennial Grassland



This plant community is characterized by a diverse understory of cool and warm season grasses, and a minimal amount of shrub overstory. Cutler's jointfir is generally the most common shrub species present, but fourwing saltbush and/or winterfat may also be present. Dominant grasses include Indian ricegrass and James' galleta. Other grasses, forbs, and shrubs typically are present but cover and production is variable. Bare ground is rare (1-5% cover) and biological crust (30-40% cover) is characterized by cyanobacteria and pinnacled lichen and moss clumps. When compared to community phase 1.1, moss and lichen clumps can be seen in the interspaces along with cyanobacteria and not just under the plant canopy. The following tables provide an example 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	280	448	897
Shrub/Vine	45	84	112
Forb	11	28	56
Tree	1	6	11
Total	**337**	**566**	**1076**

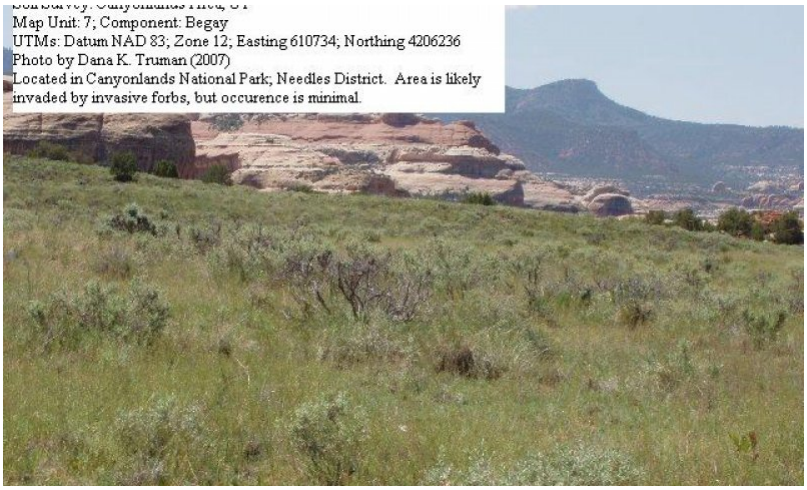
Table 9. Ground cover

Tree foliar cover	0-5%
Shrub/vine/liana foliar cover	5-10%
Grass/grasslike foliar cover	40-60%
Forb foliar cover	1-5%
Non-vascular plants	0%
Biological crusts	30-40%
Litter	10-30%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	1-5%

Table 10. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	1-5%	1-5%
>0.15 <= 0.3	–	5-10%	5-20%	1-5%
>0.3 <= 0.6	–	–	10-40%	–
>0.6 <= 1.4	–	1-5%	1-10%	–
>1.4 <= 4	0-5%	0-3%	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 1.3
Perennial Shrubland



This plant community is characterized by a dominance of perennial shrubs and a fairly well developed perennial warm and cool season grass understory. The dominant shrub are winterfat, fourwing saltbush, or, with winterfat or fourwing dominance often dependent on landform and landscape position or Cutler's jointfir.. Dominant grasses include Indian ricegrass and James' galleta. Other grasses, forbs, and shrubs typically are present but cover and production is variable. Bare ground is variable (5-35% cover) and biological crust (5-50% cover) is characterized by isolated to continuous moss and lichen pinnacles with light cyanobacteria mosaics. The following tables provide an example 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	224	392
Shrub/Vine	78	280	392
Forb	11	67	90
Tree	1	6	11
Total	**146**	**577**	**885**

Table 12. Ground cover

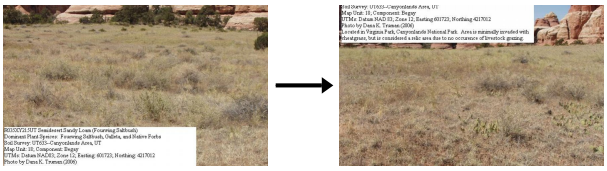
Tree foliar cover	0-5%
Shrub/vine/liana foliar cover	10-25%
Grass/grasslike foliar cover	10-40%

Forb foliar cover	5-25%
Non-vascular plants	0%
Biological crusts	5-50%
Litter	5-15%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	5-35%

Table 13. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	1-10%	1-10%
>0.15 <= 0.3	–	–	1-20%	1-15%
>0.3 <= 0.6	–	5-20%	5-30%	0-5%
>0.6 <= 1.4	–	1-10%	0-1%	–
>1.4 <= 4	0-5%	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Pathway 1.1a
Community 1.1 to 1.2



Perennial Grassland/Shrubland

Perennial Grassland

This pathway occurs when events such as fire or insect herbivory favor an increase in perennial grass establishment with a reduction in shrub canopy.

Pathway 1.1b
Community 1.1 to 1.3

Perennial Grassland/Shrubland

Perennial Shrubland

This pathway occurs when time without disturbances favors an increase in perennial shrub establishment with a minimal reduction in grass and forb diversity and production. This the natural successional pathway for this site without disturbances.

Pathway 1.2a
Community 1.2 to 1.1

Perennial Grassland **Perennial Grassland/Shrubland**

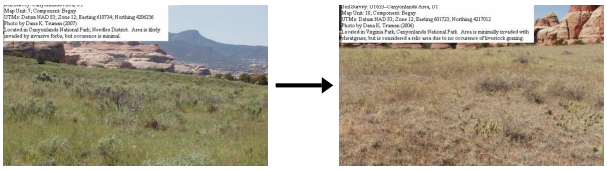
This pathway occurs when time without disturbances favors an increase in shrub establishment with a minimal decrease in perennial grass and forb diversity and cover. This is the natural successional pathway between community 1.2 and 1.1.

Pathway 1.3a
Community 1.3 to 1.1

Perennial Shrubland **Perennial Grassland/Shrubland**

This pathway occurs when events favor an increase in perennial grass establishment and a decrease in shrub cover and diversity, including insect herbivory and patchy fire.

Pathway 1.3b
Community 1.3 to 1.2



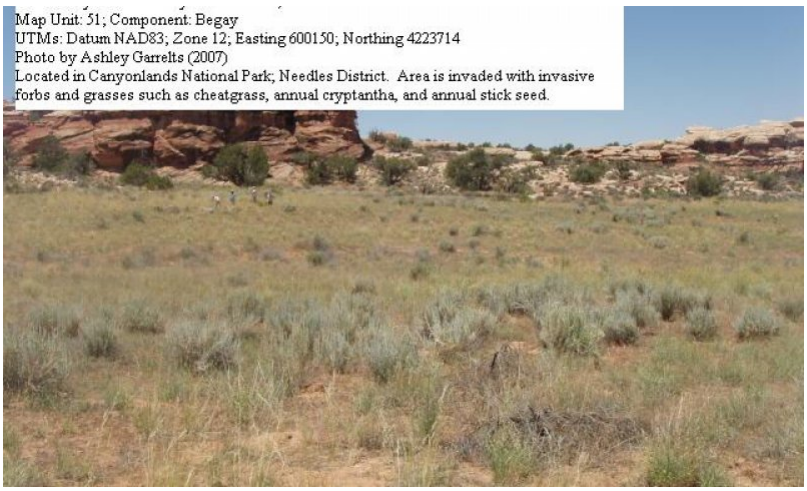
Perennial Shrubland **Perennial Grassland**

This pathway occurs when a large fires favor an increase in perennial grass establishment and a complete removal of the shrub canopy.

State 2
Current Potential State

This state is similar to the reference state except that non-native plants are now present in all plant community phases. A shift in species composition will affect the nutrient cycling, soil-water relationships, hydrology, and soil stability. Dominant grasses include both warm and cool season species; however heavy spring grazing will generally remove the cool season grasses such as Indian ricegrass, and heavy late summer and early fall grazing will remove the warm season grasses such as black grama and James' galleta. Utah juniper is still a common invader of shallower soil components, creating blowout areas and increasing erosion. This state is losing resistance to disturbances and resilience after disturbance. Invasive plants are beginning to fill available niches and become established on the site. Current Potential State: Plant communities influenced by both natural and man influenced events, including rodent activity, OHV overuse, improper livestock grazing, insect herbivory, fire, time without disturbances, and climatic fluctuations. Indicators: A perennial cool and warm season grass understory with fourwing saltbush, and/or winterfat forming the dominant visual aspect, when present. Non-native species are now present in all plant communities. Feedbacks: Extended drought, improper livestock grazing, or other disturbance that change the ecological dynamics of the site. Infrequent but regular fires or properly managed domestic livestock grazing to maintain the understory and the establishment of shrubs. At-risk Community Phase: All communities are at risk; however plant community 2.3 is most at risk due to its limited understory. Trigger: Disturbance that facilitates the dominance of invasive forbs and/or grasses.

Community 2.1
Perennial Grassland/Shrubland



This plant community is characterized by a native perennial grass understory with minimal occurrence of invasive species. Fourwing saltbush, winterfat, and/or Cutler's jointfir form the dominant shrub overstory. Grasses found on this site include Indian ricegrass and cheatgrass; other grasses may also be present and cover varies from site to site. Commonly observed invasive plants include cheatgrass, annual Cryptantha, stickseed, tansy mustard, woolly plantain, broom snakeweed, and Russian thistle. Other forbs and shrubs may also be present, but their occurrence is variable. Surface cracking and physical crusts are common on sites where ponding has occurred. Biological crusts (5-40% cover) are characterized by cyanobacteria in the interspaces with moss and lichen pinnacles under the shrub canopy, or by continuous moss and lichen pinnacles in the interspaces. Bare ground is variable (2-45% cover) depending on this biological crust cover. The following tables provide an example 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	112	392	560
Shrub/Vine	56	168	280
Forb	11	56	112
Tree	1	6	11
Total	**180**	**622**	**963**

Table 15. Ground cover

Tree foliar cover	0-5%
Shrub/vine/liana foliar cover	5-25%
Grass/grasslike foliar cover	20-50%
Forb foliar cover	5-20%
Non-vascular plants	0%
Biological crusts	5-40%
Litter	2-10%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	2-45%

Table 16. Canopy structure (% cover)

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

Community 2.2
Perennial Grassland

This plant community is characterized by native perennial grasses with some occurrence of invasive plants. The native shrub canopy has been almost entirely or completely removed, or is in recovery. Commonly seen grasses include Indian ricegrass and cheatgrass. Other grasses are present but species composition varies between sites. Perennial grass diversity has declined and invasive plants have increased. Species of particular concern are cheatgrass, Russian thistle, halogeton, annual Cryptantha, stickseed, woolly plantain, and tansy mustard. Other forbs may be present and cover is variable. Surface cracking and physical crusts are common on sites where ponding has occurred. Biological crusts (5-45% cover) are characterized by cyanobacteria in the interspaces with moss and lichen pinnacles under the shrub canopy or by continuous moss and lichen pinnacles in the interspaces. Bare ground is variable (5-30% cover) depending on biological crust cover. The following tables provide an example 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	448	897
Forb	56	112	168
Shrub/Vine	11	56	84
Tree	1	6	11
Total	**180**	**622**	**1160**

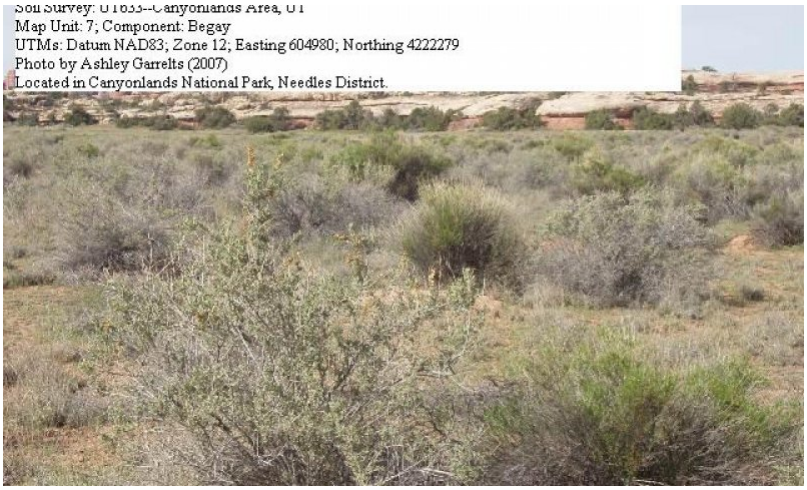
Table 18. Ground cover

Tree foliar cover	0-5%
Shrub/vine/liana foliar cover	2-5%
Grass/grasslike foliar cover	30-50%
Forb foliar cover	5-30%
Non-vascular plants	0%
Biological crusts	5-45%
Litter	2-10%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	5-30%

Table 19. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	1-5%	1-5%
>0.15 <= 0.3	–	5-10%	5-15%	5-20%
>0.3 <= 0.6	–	–	10-30%	5-10%
>0.6 <= 1.4	–	1-5%	1-5%	–
>1.4 <= 4	0-5%	0-3%	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 2.3
Perennial Shrubland



This plant community is characterized by a dominance of perennial shrubs and a moderately developed grass and forb understory. The dominant shrubs are Cutler's jointfir and winterfat or fourwing saltbush depending on landform and landscape position. Commonly occurring grasses include Indian ricegrass and cheatgrass. Other grasses are present but species composition varies between sites. Invasive forbs are also present and may include wooly plantain, stickseed, annual Cryptantha, tansy mustard, and Russian thistle. Other forbs and shrubs may also be present and cover between sites fluctuates. Bare ground is variable (5-60% cover) biological crusts (5-50% cover)

is characterized by isolated to continuous moss and lichen pinnacles with light cyanobacteria mosaics. The following tables provide an example 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	168	336	448
Shrub/Vine	112	280	392
Forb	56	112	168
Tree	1	6	11
Total	**337**	**734**	**1019**

Table 21. Ground cover

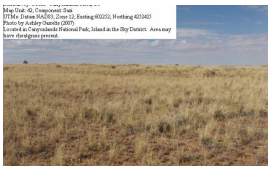
Tree foliar cover	0-5%
Shrub/vine/liana foliar cover	10-25%
Grass/grasslike foliar cover	10-50%
Forb foliar cover	5-30%
Non-vascular plants	0%
Biological crusts	5-50%
Litter	5-10%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	5-60%

Table 22. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	5-15%	5-20%
>0.15 <= 0.3	–	–	5-10%	5-10%
>0.3 <= 0.6	–	2-25%	5-30%	0-5%
>0.6 <= 1.4	–	0-10%	–	–
>1.4 <= 4	0-5%	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Pathway 2.1a
Community 2.1 to 2.2

Perennial Grassland/Shrubland



Perennial Grassland

This pathway occurs when events favor an increase in grass establishment with almost complete removal of the shrub canopy. Events may include fire, insect herbivory, or grazing livestock in such a way that it removes the shrub canopy.

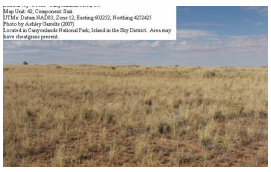
Pathway 2.1b
Community 2.1 to 2.3

Perennial Grassland/Shrubland

Perennial Shrubland

This pathway occurs when events favor an increase in perennial shrub establishment with a reduction in the grass/forb understory. Events may include long periods of time without fire or other disturbance, and/or grazing livestock in such a way that it removes the grasses and forbs from the understory.

Pathway 2.2a
Community 2.2 to 2.1



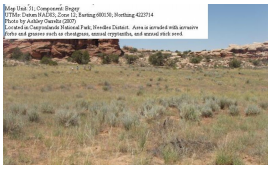
Perennial Grassland

Perennial Grassland/Shrubland

This pathway occurs when events, such as time without fire or other disturbance and/or improper livestock grazing favor an increase in shrub establishment with a minimal decrease in the grass and forb understory.

Pathway 2.3a
Community 2.3 to 2.1

Perennial Shrubland

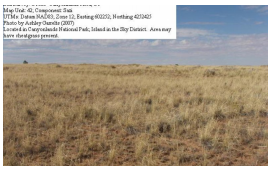


Perennial Grassland/Shrubland

This pathway occurs when events favor an increase in grass establishment with a minimal decrease in shrub cover and diversity. Events could include patchy fire, insect herbivory, or grazing livestock in such a way that it reduces the shrub canopy.

Pathway 2.3b
Community 2.3 to 2.2

Perennial Shrubland



Perennial Grassland

This pathway occurs when fire results in the total removal of the shrub canopy and a subsequent increase in perennial grass establishment.

State 3
Invasive Forb State

This state is characterized by the dominance of invasive forbs/shrubs. These species may include, but are not limited to Russian thistle, cheatgrass, tansy mustard, broom snakeweed, annual stickseed, and annual Cryptantha. One or more invasive species has increased to a point where they influence or drive the disturbance regime and nutrient cycle. Russian thistle and/or cheatgrass are the most likely species to establish and dominate. Russian thistle is a prolific reproducer; one plant can produce up to 250,000 seeds, which are dispersed by the wind when the dead plant “tumbles” across the landscape. While generally considered an unwanted weed, Russian thistle may actually help disturbed sites recover more quickly. If topsoil is present, Russian thistle roots are invaded by mycorrhizal fungi, and because this plant does not form associations with these fungi, both the plant and root are killed. This causes increased mycorrhizal fungi in the soil and an increased chance for other plants to establish through the aid of these fungi associations. Land managers however, must be aware that without proper management, other invasive annuals, such is cheatgrass, may become established instead of the desirable native species. If topsoil is missing, mycorrhizal fungi and Russian thistle can persist for relatively long periods of time (Howard 1992). The competitiveness of these invasive species and their ability to quickly establish after a disturbance, makes this state extremely resistance to change and resilient after a disturbance. Invasive Forb State: Community phases influenced by improper grazing and weather cycles. Indicators: A complete understory of invasive forbs and/or broom snakeweed where native perennial shrubs, grasses, and forbs are minimally present. Feedbacks: Improper livestock grazing and weather cycles that maintain the dominance of invasive forbs/shrubs with minimal decrease in native perennial grasses, shrubs, and forbs. Increased occurrence of cheatgrass, decreasing the fire return interval. Flooding and alluvial deposits that facilitate the establishment of sand sagebrush. Trigger: The increased establishment of cheatgrass, caused by a decrease in the fire return interval, which facilitates the continued removal of other grasses, shrubs, and forbs.

Community 3.1
Invaded Grasslands and Shrublands

This plant community is characterized by a dominance of invasive forb species, including annual Cryptantha, stickseed, woolly plantain, tansy mustard, and Russian thistle. Perennial grasses may also be present. Cheatgrass is typically found in the plant community, but does not drive the ecological dynamics. When present, the shrub canopy is usually dense because disturbance factors have reduced the understory and nutrients are available for an enhanced shrub canopy. Bare ground (10-50% cover) is variable, but more common in this state than in state 1 or 2. Biological crusts (5-40% cover) are variable depending on bare ground and are characterized by light

cyanobacteria or by continuous moss and lichen pinnacles. Sites affected by ponding may have a physical crust and surface cracking. Due to the dominance of annual forbs, annual production is variable. Years with low annual precipitation will have low annual production and years with higher annual precipitation will have high annual production. Shrub annual production is variable because this site may be characterized by either dense or sparse shrub cover. The following tables provide an example 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)
Forb	224	560	785
Shrub/Vine	56	336	560
Grass/Grasslike	112	224	336
Tree	1	6	11
Total	**393**	**1126**	**1692**

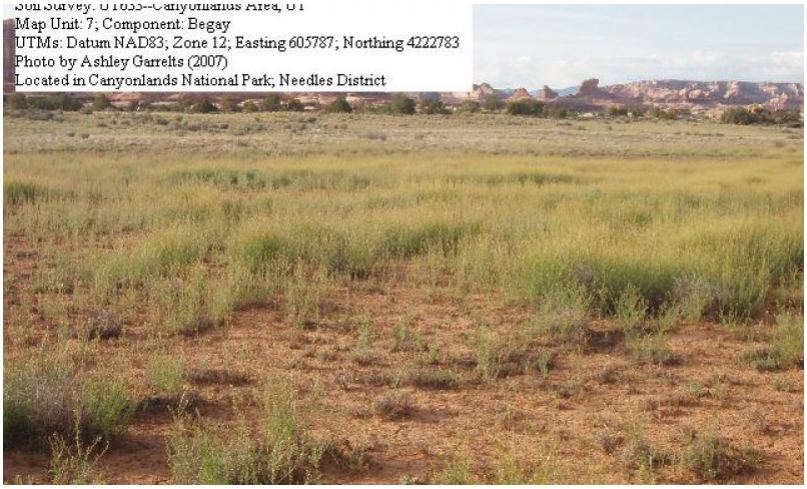
Table 24. Ground cover

Tree foliar cover	0-5%
Shrub/vine/liana foliar cover	5-25%
Grass/grasslike foliar cover	5-30%
Forb foliar cover	5-60%
Non-vascular plants	0%
Biological crusts	5-40%
Litter	2-15%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	10-50%

Table 25. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	0-5%	3-5%	0-5%
>0.15 <= 0.3	–	5-10%	2-20%	5-20%
>0.3 <= 0.6	–	2-5%	5-30%	5-8%
>0.6 <= 1.4	–	2-5%	5-10%	–
>1.4 <= 4	0-5%	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 3.2
Invasive Forb Monoculture



This plant community is characterized by a complete monoculture of invasive forbs and is the most at risk plant community for this state, due to the absences of native vegetation and its conduciveness to cheatgrass dominance. Russian thistle, tansy mustard, annual Cryptantha, stickseed, and woolly plantain dominate and drive the ecological dynamics of the site. Many times this site may be a complete monoculture of one of these invasive forbs (typically tansy mustard or Russian thistle). Surface cracking and physical crusts are common and soil stability is very low. Bare ground (30-50% cover) is common and biological crusts (5-20% cover) are characterized by light cyanobacteria and occasional isolated moss and lichen pinnacles. Due to the dominance of annual forbs, annual production is variable; years with low annual precipitation will have low annual production and years with higher annual precipitation will have high annual production. The following tables provide an example the typical vegetative floristics of a community phase 3.2 plant community.

Table 26. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Forb	224	560	785
Shrub/Vine	56	336	560
Grass/Grasslike	28	56	112
Total	**308**	**952**	**1457**

Table 27. Ground cover

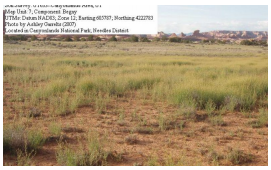
Tree foliar cover	0%
Shrub/vine/liana foliar cover	0%
Grass/grasslike foliar cover	5-20%
Forb foliar cover	5-50%
Non-vascular plants	0%
Biological crusts	5-20%
Litter	2-15%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	30-50%

Table 28. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	0-5%	0-5%
>0.15 <= 0.3	–	–	5-10%	5-50%
>0.3 <= 0.6	–	–	5-10%	5-8%
>0.6 <= 1.4	–	–	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Pathway 3.1a
Community 3.1 to 3.2

Invaded Grasslands and Shrublands



Invasive Forb Monoculture

This pathway occurs as events such as frequent ponding, or improper livestock grazing allow for the increased establishment of invasive annual forbs and a complete removal of the native perennial grass and shrub components.

State 4
Annual Grass State

This state's ecological processes are driven by the dominance of cheatgrass, where native and invasive plant species may also be present. Cheatgrass dramatically affects the soil/plant/water relationships of a site. 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 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 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

This plant community is characterized by the dominance of cheatgrass, where 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 easily carry through this community. Biological crusts (1-5% cover) are characterized by light cyanobacteria in the interspaces. The following tables provide an example the typical vegetative floristics of a community phase 4.1 plant community.

Table 29. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	224	560	897
Shrub/Vine	56	112	224
Forb	56	84	112
Tree	–	–	–
Total	**336**	**756**	**1233**

Table 30. Ground cover

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

Table 31. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	0-40%	0-25%
>0.15 <= 0.3	–	0-5%	0-80%	0-50%
>0.3 <= 0.6	–	0-10%	–	0-5%
>0.6 <= 1.4	–	0-15%	–	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 4.2
Cheatgrass Monoculture

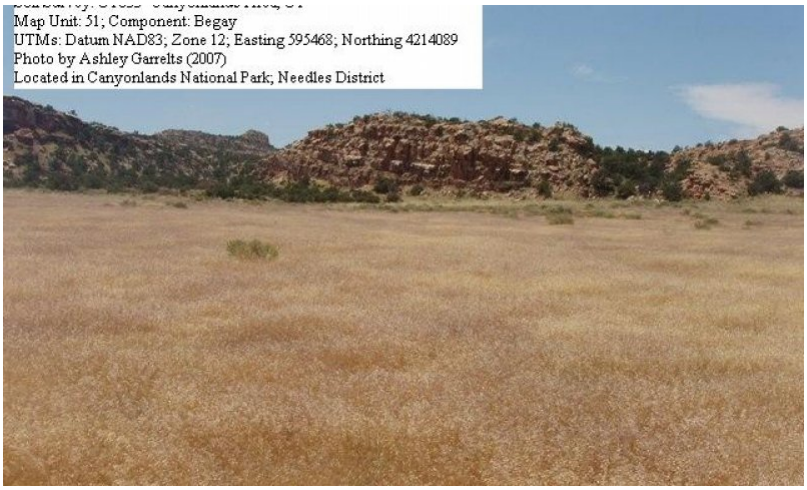


Figure 16. Cheatgrass monoculture.

This plant community is characterized by a complete monoculture of cheatgrass, where 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 the typical vegetative floristics of a community phase 4.2 plant community.

Table 32. 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	–	–	–
Total	**235**	**582**	**942**

Table 33. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	0%
Grass/grasslike foliar cover	60-80%
Forb foliar 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 34. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	5-10%	0-5%
>0.15 <= 0.3	–	–	10-60%	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

Cheatgrass Dominated **Cheatgrass Monoculture**

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

Transition from Reference State (State 1) to Current Potential State (State 2). This transition is from the native perennial warm and cool season grass understory in the reference state to a state that contains invasive plants, both non-natives and natives. Once non-natives are found in the plant community a threshold has been crossed. Improper livestock grazing, prolonged drought, fire, ponding/flooding, etc. may increase the reference state's susceptibility for invasion; however, without an available seed source of invasive and/or non-native species, the plant communities will likely remain in the reference state. Non-native invasive species such as cheatgrass may invade intact perennial plant communities with little to no disturbances.

Transition T2A
State 2 to 3

Transition from Current Potential State (State 2) to Invasive Forb State (State 3). This transition is from the current potential state into a state dominated by invasive forb species. This transition occurs when events favor the increased establishment and dominance of invasive plants. Events may include prolonged ponding/flooding, improper livestock grazing, extended drought, or other large surface disturbance that would facilitate the removal of

the native plants and the dominance of invasive forbs. Once the invasive forbs drive the ecological dynamics of the site a threshold has been crossed.

Transition T2B
State 2 to 4

Transition from Current Potential State (State 2) to Annual Grass State (State 4). This transition is from the current potential state into a state dominated by cheatgrass. This transition occurs as events favor the increased establishment and dominance of cheatgrass. Typically, this occurs when a series of fires leads to an increase in cheatgrass and a subsequent decrease in the fire return interval. Once cheatgrass drives the ecological dynamics of the site a threshold has been crossed.

Transition T3A
State 3 to 4

Transition from Invasive Forb State (State 3) to Annual Grass State (State 4). This transition occurs as events favor the replacement of the invasive forbs with cheatgrass. Sites that are dominated by tansy mustard in the invaded state may actually facilitate this transition, due to its ability to provide the litter needed for the germination of cheatgrass. The fire return interval decreases due to increased fine fuel accumulations facilitating the dominance of cheatgrass. Once cheatgrass dominates and drives the ecological dynamics of the site a threshold has been crossed.

Transition T3a
State 3 to 4

Transition from Current Potential State (State 3) to Annual Grass State (State 4). This transition is from the invasive forb state into a state dominated by cheatgrass. This transition occurs as events favor the increased establishment and dominance of cheatgrass. Typically this occurs as a series of fires which lead to an increase in cheatgrass and a subsequent decrease in the fire return interval. Once cheatgrass drives the ecological dynamics of the site a threshold has been crossed.

Additional community tables

Table 35. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
0	**Dominant Shrubs**			22–112	
	fourwing saltbush	ATCA2	*Atriplex canescens*	6–84	–
	Cutler's jointfir	EPCU	*Ephedra cutleri*	17–56	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	6–17	–
3	**Sub-dominant Shrubs**			0–56	
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–84	–
	blackbrush	CORA	*Coleogyne ramosissima*	0–34	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–22	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–11	–
Grass/Grasslike					
0	**Dominant Grasses**			45–336	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	17–168	–
	James' galleta	PLJA	*Pleuraphis jamesii*	56–168	–
1	**Sub-dominant Grasses**			0–112	
	black grama	BOER4	*Bouteloua eriopoda*	0–84	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–84	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–67	–
	James' galleta	PLJA	*Pleuraphis jamesii*	0–34	–
	spike dropseed	SPCO4	*Sporobolus contractus*	0–34	–
	Grass, perennial	2GP	*Grass, perennial*	0–28	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–17	–
Forb					
0	**Dominant Forbs**			11–34	
	nodding buckwheat	ERCE2	*Eriogonum cernuum*	6–17	–
2	**Sub-dominant Forbs**			6–17	
	hoary tansyaster	MACA2	*Machaeranthera canescens*	0–11	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–11	–
	cushion buckwheat	EROV	*Eriogonum ovalifolium*	0–8	–
	common sunflower	HEAN3	*Helianthus annuus*	0–6	–
	lobeleaf groundsel	PAMU11	*Packera multilobata*	0–6	–
	Forb, annual	2FA	*Forb, annual*	0–6	–
	Forb, perennial	2FP	*Forb, perennial*	0–6	–
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–6	–
	desert trumpet	ERIN4	*Eriogonum inflatum*	0–6	–
Tree					
4	**Trees**			0–6	
	Utah juniper	JUOS	*Juniperus osteosperma*	0–6	–

Table 36. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
0	**Dominant Shrubs**			8–45	
	Cutler's jointfir	EPCU	*Ephedra cutleri*	6–34	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	2–11	–
3	**Sub-dominant Shrubs**			39–50	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–11	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–11	–
	blackbrush	CORA	*Coleogyne ramosissima*	0–11	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–11	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–6	–
Grass/Grasslike					
0	**Dominant Grasses**			112–336	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	56–168	–
	James' galleta	PLJA	*Pleuraphis jamesii*	17–168	–
1	**Sub-dominant Grasses**			112–336	
	spike dropseed	SPCO4	*Sporobolus contractus*	0–112	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–112	–
	blue grama	BOGR2	*Bouteloua gracilis*	0–67	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–67	–
	black grama	BOER4	*Bouteloua eriopoda*	0–34	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–17	–
	Grass, perennial	2GP	*Grass, perennial*	0–11	–
Forb					
2	**Forbs**			11–28	
	hoary tansyaster	MACA2	*Machaeranthera canescens*	0–11	–
	Forb, annual	2FA	*Forb, annual*	0–11	–
	Forb, perennial	2FP	*Forb, perennial*	0–11	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–11	–
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–6	–
	buckwheat	ERIOG	*Eriogonum*	0–6	–
	pale evening primrose	OEPA	*Oenothera pallida*	0–6	–
	lobeleaf groundsel	PAMU11	*Packera multilobata*	0–6	–
Tree					
4	**Natural Invading Trees**			0–4	
	Utah juniper	JUOS	*Juniperus osteosperma*	0–4	–

Table 37. Community 1.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
0	**Dominant Grasses**			34–224	
	winterfat	KRLA2	*Krascheninnikovia lanata*	56–224	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	11–112	–
	James' galleta	PLJA	*Pleuraphis jamesii*	22–112	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	22–112	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	1–11	–
1	**Sub-dominant Grasses**			56–168	
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–67	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–56	–
	spike dropseed	SPCO4	*Sporobolus contractus*	0–56	–
	Grass, perennial	2GP	*Grass, perennial*	0–11	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–11	–
	black grama	BOER4	*Bouteloua eriopoda*	0–11	–
	blue grama	BOGR2	*Bouteloua gracilis*	0–11	–
Forb					
2	**Forbs**			11–67	
	Forb, annual	2FA	*Forb, annual*	0–22	–
	Esteve's pincushion	CHST	*Chaenactis stevioides*	0–22	–
	common sunflower	HEAN3	*Helianthus annuus*	0–17	–
	longbeak streptanthella	STLO4	*Streptanthella longirostris*	0–17	–
	hoary tansyaster	MACA2	*Machaeranthera canescens*	0–11	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–11	–
	yellow spiderflower	CLLU2	*Cleome lutea*	0–11	–
	Forb, perennial	2FP	*Forb, perennial*	0–11	–
Shrub/Vine					
3	**Shrubs**			224–280	
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–224	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–224	–
	mormon tea	EPVI	*Ephedra viridis*	0–34	–
	Cutler's jointfir	EPCU	*Ephedra cutleri*	0–17	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–11	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–11	–
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–6	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–6	–
Tree					
4	**Trees**			0–6	
	Utah juniper	JUOS	*Juniperus osteosperma*	0–6	–

Table 38. Community 2.1 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**			56–112	
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–84	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–67	–
	blackbrush	CORA	*Coleogyne ramosissima*	0–34	–
	Cutler's jointfir	EPCU	*Ephedra cutleri*	0–22	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–22	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–11	–
Grass/Grasslike					
0	**Dominant Grasses**			112–280	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	6–168	–
	cheatgrass	BRTE	*Bromus tectorum*	6–112	–
2	**Sub-dominant Grasses**			112–224	
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–168	–
	James' galleta	PLJA	*Pleuraphis jamesii*	0–112	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–67	–
	black grama	BOER4	*Bouteloua eriopoda*	0–34	–
	blue grama	BOGR2	*Bouteloua gracilis*	0–34	–
	Grass, annual	2GA	*Grass, annual*	0–22	–
	Grass, perennial	2GP	*Grass, perennial*	0–22	–
	spike dropseed	SPCO4	*Sporobolus contractus*	0–11	–
Forb					
0	**Dominant Forbs**			6–34	
	woolly plantain	PLPA2	*Plantago patagonica*	6–34	–
2	**Sub-dominant Forbs**			22–50	
	tansymustard	DESCU	*Descurainia*	0–22	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–22	–
	stickseed	LAPPU	*Lappula*	0–17	–
	hoary tansyaster	MACA2	*Machaeranthera canescens*	0–11	–
	pale evening primrose	OEPA	*Oenothera pallida*	0–11	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–11	–
	Forb, annual	2FA	*Forb, annual*	0–11	–
	Forb, perennial	2FP	*Forb, perennial*	0–11	–
	Esteve's pincushion	CHST	*Chaenactis stevioides*	0–6	–
Tree					
4	**Trees**			0–6	
	Utah juniper	JUOS	*Juniperus osteosperma*	0–6	–

Table 39. Community 2.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
0	**Dominant Shrubs**			11–34	
	fourwing saltbush	ATCA2	*Atriplex canescens*	11–34	–
3	**Sub-dominant Shrubs**			22–45	
	Cutler's jointfir	EPCU	*Ephedra cutleri*	0–22	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–11	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–11	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–6	–
Grass/Grasslike					
0	**Dominant Grasses**			56–448	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	17–224	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	17–224	–
	cheatgrass	BRTE	*Bromus tectorum*	6–17	–
1	**Sub-dominant Grasses**			112–336	
	James' galleta	PLJA	*Pleuraphis jamesii*	0–90	–
	spike dropseed	SPCO4	*Sporobolus contractus*	0–78	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–67	–
	blue grama	BOGR2	*Bouteloua gracilis*	0–67	–
	Grass, annual	2GA	*Grass, annual*	0–11	–
	Grass, perennial	2GP	*Grass, perennial*	0–11	–
Forb					
2	**Forbs**			56–112	
	stickseed	LAPPU	*Lappula*	0–39	–
	woolly plantain	PLPA2	*Plantago patagonica*	0–28	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–22	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–17	–
	Forb, annual	2FA	*Forb, annual*	0–17	–
	Forb, perennial	2FP	*Forb, perennial*	0–17	–
	cryptantha	CRYPT	*Cryptantha*	0–17	–
	hoary tansyaster	MACA2	*Machaeranthera canescens*	0–11	–
	tansymustard	DESCU	*Descurainia*	0–6	–
Tree					
4	**Trees**			0–6	
	Utah juniper	JUOS	*Juniperus osteosperma*	0–6	–

Table 40. Community 2.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
0	**Dominant Shrubs**			11–84	
	fourwing saltbush	ATCA2	*Atriplex canescens*	11–168	–
3	**Sub-dominant Shrubs**			112–269	
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–224	–
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0–28	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–28	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–17	–
	basin big sagebrush	ARTRT	*Artemisia tridentata ssp. tridentata*	0–17	–
	Cutler's jointfir	EPCU	*Ephedra cutleri*	0–11	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–11	–
Grass/Grasslike					
0	**Dominant Grasses**			17–90	
	cheatgrass	BRTE	*Bromus tectorum*	11–56	–
	sixweeks fescue	VUOC	*Vulpia octoflora*	6–34	–
1	**Sub-dominant Grasses**			224–308	
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–168	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–168	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–140	–
	blue grama	BOGR2	*Bouteloua gracilis*	0–112	–
	James' galleta	PLJA	*Pleuraphis jamesii*	0–112	–
	Grass, annual	2GA	*Grass, annual*	0–17	–
	Grass, perennial	2GP	*Grass, perennial*	0–17	–
Forb					
0	**Dominant Forbs**			6–112	
	woolly plantain	PLPA2	*Plantago patagonica*	6–78	–
	tansymustard	DESCU	*Descurainia*	6–67	–
2	**Sub-dominant Forbs**			28–101	
	Forb, annual	2FA	*Forb, annual*	0–34	–
	cryptantha	CRYPT	*Cryptantha*	0–34	–
	stickseed	LAPPU	*Lappula*	0–34	–
	Forb, perennial	2FP	*Forb, perennial*	0–22	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–11	–
	Townsend daisy	TOWNS	*Townsendia*	0–6	–
	pale evening primrose	OEPA	*Oenothera pallida*	0–6	–
Tree					
4	**Trees**			0–6	
	Utah juniper	JUOS	*Juniperus osteosperma*	0–6	–

Table 41. Community 3.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
0	**Dominant Shrubs**			11–224	
	fourwing saltbush	ATCA2	*Atriplex canescens*	11–224	–
3	**Sub-dominant Shrubs**			56–280	
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–224	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–112	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–22	–
	Cutler's jointfir	EPCU	*Ephedra cutleri*	0–17	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–11	–
Grass/Grasslike					
0	**Dominant Grasses**			6–22	
	cheatgrass	BRTE	*Bromus tectorum*	6–22	–
1	**Sub-dominant Grasses**			168–224	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–168	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–112	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–112	–
	James' galleta	PLJA	*Pleuraphis jamesii*	0–50	–
	sixweeks fescue	VUOC	*Vulpia octoflora*	0–17	–
	Grass, annual	2GA	*Grass, annual*	0–11	–
	Grass, perennial	2GP	*Grass, perennial*	0–11	–
Forb					
2	**Forbs**			224–560	
	tansymustard	DESCU	*Descurainia*	0–224	–
	stickseed	LAPPU	*Lappula*	0–168	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–95	–
	cryptantha	CRYPT	*Cryptantha*	0–73	–
	woolly plantain	PLPA2	*Plantago patagonica*	0–73	–
	Forb, annual	2FA	*Forb, annual*	0–56	–
	Forb, perennial	2FP	*Forb, perennial*	0–28	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–28	–
	pale evening primrose	OEPA	*Oenothera pallida*	0–6	–
Tree					
4	**Trees**			0–6	
	Utah juniper	JUOS	*Juniperus osteosperma*	0–6	–

Table 42. Community 3.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
0	**Dominant Grasses**			6–56	
	cheatgrass	BRTE	*Bromus tectorum*	6–56	–
1	**Sub-dominant Grasses**			0–28	
	sixweeks fescue	VUOC	*Vulpia octoflora*	0–17	–
	Grass, annual	2GA	*Grass, annual*	0–11	–
	Grass, perennial	2GP	*Grass, perennial*	0–11	–
Forb					
2	**Forbs**			224–560	
	tansymustard	DESCU	*Descurainia*	0–336	–
	stickseed	LAPPU	*Lappula*	0–168	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–95	–
	cryptantha	CRYPT	*Cryptantha*	0–73	–
	woolly plantain	PLPA2	*Plantago patagonica*	0–73	–
	Forb, annual	2FA	*Forb, annual*	0–56	–
	Forb, perennial	2FP	*Forb, perennial*	0–28	–

Table 43. Community 4.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
0	**Dominant Grasses**			448–560	
	cheatgrass	BRTE	*Bromus tectorum*	448–560	–
1	**Other Grasses**			6–112	
	James' galleta	PLJA	*Pleuraphis jamesii*	0–56	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–56	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–45	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–11	–
	sixweeks fescue	VUOC	*Vulpia octoflora*	0–11	–
	Grass, annual	2GA	*Grass, annual*	0–6	–
	Grass, perennial	2GP	*Grass, perennial*	0–6	–
Forb					
2	**Forbs**			67–84	
	prickly Russian thistle	SATR12	*Salsola tragus*	0–56	–
	tansymustard	DESCU	*Descurainia*	0–56	–
	stickseed	LAPPU	*Lappula*	0–22	–
	cryptantha	CRYPT	*Cryptantha*	0–22	–
	Forb, annual	2FA	*Forb, annual*	0–11	–
	Forb, perennial	2FP	*Forb, perennial*	0–11	–
	tall tumblemustard	SIAL2	*Sisymbrium altissimum*	0–11	–
Shrub/Vine					
3	**Shrubs**			0–112	
	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 44. 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	–
	tall tumblemustard	SIAL2	*Sisymbrium altissimum*	0–6	–

Animal community

--Wildlife Interpretation--
Small herds of mule deer, pronghorn antelope, and elk 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. Many species of rats, mice, squirrels, bats, and chipmunks can be observed, along with coyotes and foxes. On sites where Utah juniper is invading or where Utah juniper sites are adjacent, birds are the most visible wildlife species that can be observed; however sightings may be rare due to the sparseness of tree canopies. Species may include juniper titmice, scrub jays, pinyon jays, and black throated gray warblers, and sparrows. 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) Plant Community 4.1 (cheatgrass monoculture) is especially difficult for wildlife use because forage and structural diversity is limited.

--Grazing Interpretations--
This site provides good spring, fall, and winter grazing conditions for livestock due accessibility and available nutritious forage. Yet, this site may lack natural perennial water sources, which can influence the suitability for livestock grazing. The plant community is primarily grasses, with the majority of canopy cover being attributed to Indian ricegrass, needle-and-thread, James galleta and sand dropseed. These grasses provide good spring and fall grazing conditions for all classes of livestock. Shrubs, including fourwing saltbush, Cutler's jointfir, and winterfat and provide good winter browse for cattle, sheep, and goats. Cutler jointfir is typically only browsed by livestock in the fall and winter due to its poor nutritional value in the spring and summer. Forb composition and annual production depends primarily on precipitation amounts and thus is challenging to use in livestock grazing management decisions. However, forb composition should be monitored for species diversity, as well as poisonous or injurious plant communities which may be detrimental to livestock if grazed. Before making specific grazing management recommendations, an onsite evaluation must be made.

Plant community 4.1 (cheatgrass monoculture) is difficult to graze with domestic livestock because the forage availability is dependant on a single species response to time and amount of precipitation, as well as is dominated by species with low nutritional value.

Hydrological functions

The soils associated with this ecological site are generally in Hydrologic Soil Group B. On these sites 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. Heavy use by domestic livestock affects hydrology in two ways. Trampling increases bulk density and breaks down soil aggregates. This results in decreased infiltration rates and increased runoff. Heavy grazing can also alter the hydrology by decreasing plant cover and increasing bare ground. Fire can also affect hydrology, but it 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.

Different plant communities affect hydrology in different ways. Weedy communities such as states 3 and 4 alter the hydrology by changing the surface soil texture. Soil surfaces will typically become siltier which reduces infiltration and increases runoff potential. (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. Camping 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.

--Toxic Species--
Toxic plants associated with this site include woolly locoweed, broom snakeweed, sand sagebrush and Russian thistle.

Woolly locoweed is toxic to all classes of livestock and wildlife. This plant is palatable and has similar nutrient value to alfalfa, which may cause animals to consume it even when other forage is available. Many locoweed species contain swainsonine (indolizdine alkaloid) and are poisonous at all stages of growth. Poisoning will become evident after 2-3 weeks of continuous grazing and is associated with 4 major symptoms: 1) neurological damage, 2) emaciation, 3) reproductive failure and abortion, and 4) congestive heart failure linked with “high mountain disease”.

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 graze broom snakeweed when other forage is unavailable, typically in winter when toxicity levels are at their lowest.

Sand sagebrush is toxic to horses, but not to other livestock and wildlife ruminants. This plant contains sesquiterpene lactones and monoterpenes, where toxic concentrations are greatest in the late fall and winter. Horses develop neurological signs and exhibit abnormal behavior, such as ataxia and the tendency to fall down, after eating sand sagebrush for several days. (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. 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, over grazing, drought, off road vehicle overuse, erosion, etc.) undesirable plants can invade the site. Of particular concern on this site are cheatgrass, Russian thistle, 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 has been shown to be able to establish into intact perennial grass and shrub communities, but disturbed communities are more susceptible to invasion and domination by invasive this species. If growing conditions are conducive to invaders and their disturbance is not removed, these plants can create dense monocultures that can alter the nutrient cycling, erosion rates and the fire regime of the area.

--Fire Ecology--
The ability for this ecological site to carry fire depends primarily on its present fuel load and plant moisture content. Fire was a fairly rare disturbance in this sites reference state plant community. The natural fire return interval is 30-100+ years, where fires typically occurred in the fall. When the natural plant community is burned, perennial shrubs decrease and many successional stages can then occur. Refer to the Community Phase Data section of this report. When this site is degraded by the presence of invasive plants, the fire return interval can be shortened due to increased flashy fuels. The shortened fire return interval is often sufficient to suppress the native plant community. (Howard, 2003)

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.

For the Sogzie component, data were collected as part of a contract to update draft MLRA35 Ecological Sites. The vegetation data was collected on representative soil components, and was geo-referenced. All data is stored as hard copy files and in an electronic format in the NRCS Utah State Office. High intensity sampling (Caudle et al. 2013) was used to describe this ecological site. Site characteristics such as aspect, slope, elevation and UTMS were recorded for each plot, along with complete species inventory by ocular percent cover. The line-point intercept method was used to measure foliar cover, groundcover, and vegetation structure. At 100 points along a 200 foot transect, ground cover and intercepted plant species were recorded by height. The first hit method (Herrick et al. 2009) was used to generate the foliar cover values entered in the community phase composition tables. Annual production was estimated using the double-weight sampling method outlined in the National Range and Pasture Handbook and in Sampling Vegetation Attributes (NRCS 2003 and Interagency Technical Reference 1999 pgs. 102 - 115). For herbaceous vegetation, ten 9.6 square foot circular sub-plots were evenly distributed along a 200 foot transect. For woody and larger herbaceous species, production was estimated in four 21x21 foot square plots along the same transect. Weight units were collected for each species encountered in the production plots. The number of weight units for each species is then estimated for all plots.

Type locality

Location 1: Garfield County, UT	
Township/Range/Section	T34 S R8 E S4

Other references

Baily, R.G. 1995. Description of the ecoregions of the United Sates. Available http://www.fs.fed.us/land/ecosysmgmt/ecoreg1_home.html. Accessed February 27, 2008.

Belnap, J. and S.L. Phillips. 2001. Soil biota in an ungrazed grassland: response to annual grass (Bromus tectorum) invasion. Ecological Applications. 11:1261-1275.

Belnap, J. and D. Eldridge. 2003. Disturbance and recovery of biological soil crusts. Pages 363-383 Biological soil crusts: structure, function, and management. Springer, Berlin Heidelberg.

Bich, B. S., J. L. Butler, and C. A. Schmidt. 1995. Effects of differential livestock use on key plant species and rodent populations witihin selected Oryzopsis hymenoides/Hilaria jamesii communities of Glen Canyon National Recreation Area. The Southwestern Naturalist 40:281-287.

Chapin, S.F., B.H. Walker, R.J. Hobbs, D.U. Hooper, J.H. Lawton, O.E. Sala, and D. Tilman. 1997. Biotic control over the functioning of ecosystems. Science. 277:500-504

Cole, K. L., N. Henderson, and D. S. Shafer. 1997. Holocene vegetation and historic grazing impacts at Capitol Reef National Park reconstructed using packrat middens. Great Basin Naturalist 57:315-326.

Cox R.D. and V.J. Anderson. 2004. Increasing native diversity of cheatgrass-dominated rangeland through assisted succession. Journal of Range Management. 57:203-210.

Evans, R. D. and J. Belnap. 1999. Long-term consequences of disturbance on Nitrogen dynamics in an arid ecosystem. Ecology 80:150-160.

Harris, A. T., G. P. Asner, and M. E. Miller. 2003. Changes in vegetation structure after long-term grazing in pinyon-juniper ecosystems: integrating imaging spectroscopy and field studies. Ecosystems 6:368-383.

Howard, Janet L. 2003. Atriplex canescens. 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 on February 25, 2008.

Jameson, D. A. 1962. Effects of burning on a galleta-black grama range invaded by juniper. Ecology 43:760-763.

Jeffries, D. L. and J. M. Klopatek. 1987. Effects of grazing on the vegetation of the blackbrush association. Journal

of Range Management 40:390-393.

Kleiner, E. F. and K. T. Harper. 1972. Environment and community organization in grasslands of Canyonlands National Park. Ecology 53:299-309.

Knight, A.P. and R.G. Walter. 2001. A guide to plant poisoning of animals in North America. Teton NewMedia. Jackson, WY.

Loope, W. L. 1977. Relationships of vegetation to environment in Canyonlands National Park.

Mack, R. N. and J. N. Thompson. 1982. Evolution in steppe with few large, hooved mammals. The American Naturalist 119:757-773.

National Engineering Handbook. US Department of Agriculture, Natural Resources Conservation Service. Available: http://www.info.usda.gov/CED/Default.cfm#National%20Engineering%20Handbook. Accessed February 25, 2008.

Neff, J. C., R. L. Reynolds, J. Belnap, and P. Lamothe. 2005. Multi-decadal impacts of grazing on soil physical and biogeochemical properties in southeast Utah. Ecological Applications 15:87-95.

NRCS Grazing Lands Technology Institute. 2003. National Range and Pasture Handbook. Fort Worth, TX, USA: US Department of Agriculture, Natural Resources Conservation Service, 190-VI-NRPH.

NPS.gov. 2008. Canyonlands National Park. Nature and Science. Available: http://www.nps.gov/cany/naturescience/. Accessed on January 4, 2008.

Romme, W. H. 1993. Plant communities of Capitol Reef National Park, Utah. National Park Service, Cooperative Park Studies Unit, Nothern Arizona University.

Schmutz, E. M., C. C. Michaels, and B. R. Judd. 1967. Boysag Point: a relict area on the north rim of Grand Canyon in Arizona. Journal of Range Management 20:363-369.

Schwinning, S., J. Belnap, D. R. Bowling, and J. R. Ehleringer. 2008. Sensitivity of the Colorado Plateau to change: climate, ecoystems, and society. Ecology and Society 13:28.

Tuhey, J. S. and J. A. MacMahon. 1988. Vegetation and relict communities of Glen Canyon National Recreation Area. US Department of the Interior, National Park Service, Rocky Mountain Regional Office.

Tilley, D.J. 2007. Reintroducing native plants to the American West. Aberdeen Plant Materials Center, Aberdeen, ID, USA: US Department of Agriculture. Available: http://plant-materials.nrcs.usda.gov/idpmc/publications.html. Accessed February 22, 2008.

Utah Climate Summaries. 2008. Available: http://www.wrcc.dri.edu/summary/climsmut.html. Accessed on February 25, 2008.

Utah Division of Wildlife Resources. 2007.

Woods, A.J., D.A. Lammers, S.A. Bryce, J.M. Omernik, R.L. Denton, M. Domeier, and J.A. Comstock. 2001. Ecoregions of Utah (color poster with map, descriptive text, summary tables, and photographs). Reston, Virginia, U.S. Geological Survey (map scale 1:1,175,000).

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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	02/27/2008
Approved by	Shane A. Green
Approval date	
Composition (Indicators 10 and 12) based on	Foliar Cover

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%) 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. Interspaces with well developed biological crusts may resemble pedestals, but they are actually a characteristic of the crust formation. These well developed biological soil crusts are typically seen in community phase 1.3 (shrub dominated) of the reference state.

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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 relatively uncommon typically ranging from 5 to 25%. In the reference state bare ground ranges from 5 to 25%. Plant community phase 1.2, which is dominated by perennial bunch grasses, has the least occurrence of bare ground (5-10%), while community phase 1.3, which is dominated by perennial shrubs, has the most (5-35%). Most bare ground is associated with water flow patterns and rodent activity. Areas with well developed biological soil crust should not be counted as bare ground. 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%.

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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.

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6. **Extent of wind scoured, blowouts and/or depositional areas:** Slight wind generated soil movement is normal and wind caused blowouts and depositions are mostly stable or have healed over. Wind caused deposition at the base of shrubs and trees is stabilized by biological soil crusts, when present or litter Increased wind generated soil movement can occur after severe (multi-year) drought or severe wind events.. Areas that are invaded with scattered Utah juniper are more susceptible to blowouts, which may persist for long periods due to the aggressive competitive nature of the juniper, which limits immediately adjacent plant growth.

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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 (<1/4 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. Sites with well developed crust cover such as plant community 1.3, may exhibit litter being trapped by the crust pinnacles. The majority of litter accumulates at the base of plants or in soil depression adjacent to the plant. Woody stems (those greater than 1/4 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 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.

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil surface is 3-7 inches deep and structure is weak thick platy. The A-horizon color ranges from a yellowish red (5YR5/6) to a reddish brown (5YR5/3). 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.

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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, and any well developed biological soil crusts (moss, pinnacled lichen, and light cyanobacteria) 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.

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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. 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

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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: 10-30% cool season perennial grasses (e.g. Indian ricegrass and needleandthread)
    10-20% warm season perennial grasses (e.g. Galleta and/or blue grama and dropseeds)

    Sub-dominant: 1-10% sprouting shrubs (e.g. Fourwing saltbush and/or winterfat)
    5-20% sprouting or rhizomatous shrubs (e.g. Cutler mormontea)

    Other: Other forbs, shrubs, grasses, and trees (e.g. Utah Juniper)
    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) should be present but are variable based on plant community and state. In the reference state biological crust cover is characterized by cyanobacteria, pinnacled lichen, and moss with little continuity. Typically moss and lichen clumps will be concentrated under the plant canopy and cyanobacteria will be found in the interspaces.

    Additional: Functional/structural groups may appropriately contain non-native species if their ecological function is the same as the native species in 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. Extended ponding and insect herbivory may also cause fourwing saltbush to show mortality. Winterfat will also shed its leaves during drought and is typically drought tolerant similar to fourwing saltbush. Some perennial bunch grass mortality is expected during severe drought. Perennial bunch grasses in areas protected from grazing may be wolfy, particularly sand dropseed (Sporobolus cryptandrus) and spike dropseed (Sporobolus contractus).

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14. **Average percent litter cover (%) and depth (in):** Litter cover (including under plants) ranges from 5-40%, nearly all of which should fine litter. Depth is generally 1 leaf thickness in the interspaces and up to 1/4 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):** Annual production ranges from 300-500 lbs/acre in 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), annual stickseed (Lappula sp.), annual Cryptantha (Cryptantha sp.), 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.

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