USDA Natural Resources
Conservation Service

Ecological site R036XY315UT
Upland Shallow Loam (pinyon-Utah juniper)

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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.

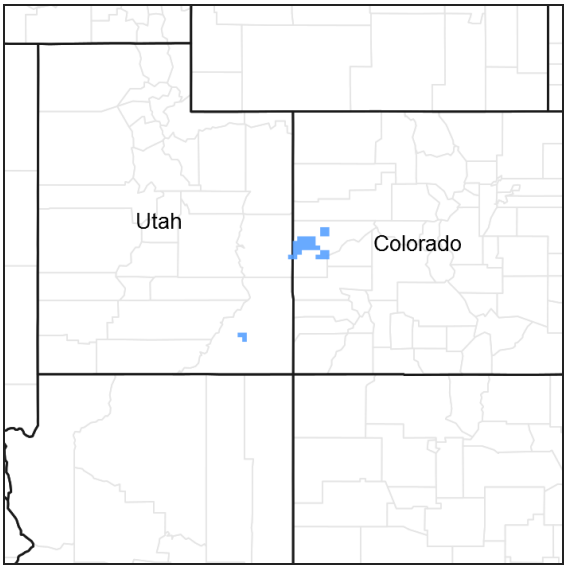


Figure 1. Mapped extent

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.

Classification relationships

--Semiarid Benchlands and Canyonlands Ecoregion (Woods, A. J. et. Al, 2001)

--Intermountain Semidesert and Desert Province, 341 (Bailey, 1995)

Associated sites

R036XY306UT	**Upland Loam (big sagebrush)**
R036XY307UT	**Upland Loam (pinyon-Utah juniper)**
R036XY328UT	**Upland Very Steep Stony Loam (pinyon-Utah juniper)**

Similar sites

R036XY316UT	**Upland Shallow Loam (littleleaf mountain mahogany)** Similar soils, but plant community has more species of shrubs and forbs.
R035XY315UT	**Upland Shallow Loam (Pinyon-Utah Juniper) AWC <3** This site is similar to the D36 site, except for location. This site is located in D35.

Table 1. Dominant plant species

Tree	(1) *Pinus edulis* (2) *Juniperus osteosperma*
Shrub	(1) *Artemisia*
Herbaceous	Not specified

Physiographic features

This site occurs on plateaus, structural benches, mesa tops, ledges, escarpments and cuestas slopes. This site is usually found in a complex with exposed bedrock or rock outcrop. Run-off is variable, and is greatly influenced by micro-topography. Typically slopes range from 3-10% however; sites may occur on sites with up to 50% slope.

Table 2. Representative physiographic features

Landforms	(1) Mesa (2) Hill (3) Structural bench
Flooding frequency	None
Ponding frequency	None
Elevation	1,859–2,256 m
Slope	3–10%
Aspect	Aspect is not a significant factor

Climatic features

The climate is characterized by warm summers, cool winters. The climate is modified by local topographic conditions, such as aspect. Mean annual high temperatures range from 62-65 degrees Fahrenheit and mean annual low temperatures range from 35-40 degrees Fahrenheit. Much of the rainfall occurs as convective storms in late summer and early fall; about 20-30% percent of the total precipitation fall in July and August. Snow packs are generally light and not persistent, about 15 to 20 percent of the total precipitation falls as snow. May and June are typically the driest months, with average annual precipitation ranging from 12-14 inches.

Table 3. Representative climatic features

Frost-free period (average)	175 days
Freeze-free period (average)	178 days
Precipitation total (average)	356 mm

Influencing water features

There are no water features influencing this site.

Soil features

The soils are shallow to very shallow and well drained. Typically the surface layer is a light reddish brown. Runoff is negligible to high depending on slope and these soils typically have a moderately rapid permeability. The soils temperature and moisture regimes are mesic and aridic ustic, respectively. Surface textures and subsurface textures are generally fine sandy loams and may have up to 15-20% flagstones and/or channers on the surface and throughout the soil profile. Soils are nonsaline and moderately alkaline. Biological soil crust cover varies by plant community phase, soil, aspect, elevation, etc. This site has been used in the following soil surveys and has been correlated to the following components:

UT638—Natural Bridges National Monument, UT – Gladel

Typical Soil Profile:
A—0-5 inches; (flaggy) fine sandy loam; light reddish brown; moderately alkaline
Bw—5-10 inches; (flaggy) fine sandy loam; light reddish brown; moderately alkaline
Bk—10-15 inches; (flaggy) fine sandy loam; pinkish gray; moderately alkaline
R—15 inches; hard reddish brown sandstone

Table 4. Representative soil features

Surface texture	(1) Fine sandy loam (2) Flaggy fine sandy loam (3) Channery fine sand
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Moderate to moderately rapid
Soil depth	10–51 cm
Surface fragment cover <=3"	0–15%
Surface fragment cover >3"	0–10%
Available water capacity (0-101.6cm)	3.81–6.35 cm
Calcium carbonate equivalent (0-101.6cm)	5–15%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	1–3
Soil reaction (1:1 water) (0-101.6cm)	7.4–9
Subsurface fragment volume <=3" (Depth not specified)	15–35%
Subsurface fragment volume >3" (Depth not specified)	0–5%

Ecological dynamics

This site developed under Colorado Plateau climatic conditions and included natural influences of herbivory fire, and climate; however due to the remote location, broken topography, and lack of perennial water sources this area rarely served as habitat for herds of native herbivores or large frequent historic fires. This ecological site occurs on the shallow to very shallow, moderately developed soils found on mesa tops, hills, and structural benches in Major Land Resource Area (MLRA) 36—Southwestern Plateaus, Mesas, and Foothills. The precipitation and climate of MLRA 36 are conducive to producing Pinyon/juniper, sagebrush, and grassland complexes.

Pinyon and Juniper communities throughout the West have received a lot of attention because many areas have experienced increases in the spatial extent and density of trees (Miller and Wigand 1994). In MLRA 36, the woodland expansion began during the late 1800s (Tausch et al. 1981). The causes of woodland expansion are being studied, and are often attributed to an increase in the fire return interval, introduction of livestock grazing, shifts in climate, and increases in atmospheric CO2 (Miller and Rose 1999). The natural disturbance regime on shallow soils historically dominated by Pinyon and Utah juniper in the Colorado Plateau area is unique and little is understood (Miller and Tausch 2001; Floyd et al. 2004). Historic fire return intervals are long, possibly indicating that fire did not play a frequent role in community dynamics. Pinyon and Juniper communities near Mesa Verde were established before European settlement with a fire return interval of greater than 400 years (Floyd et al. 2000).

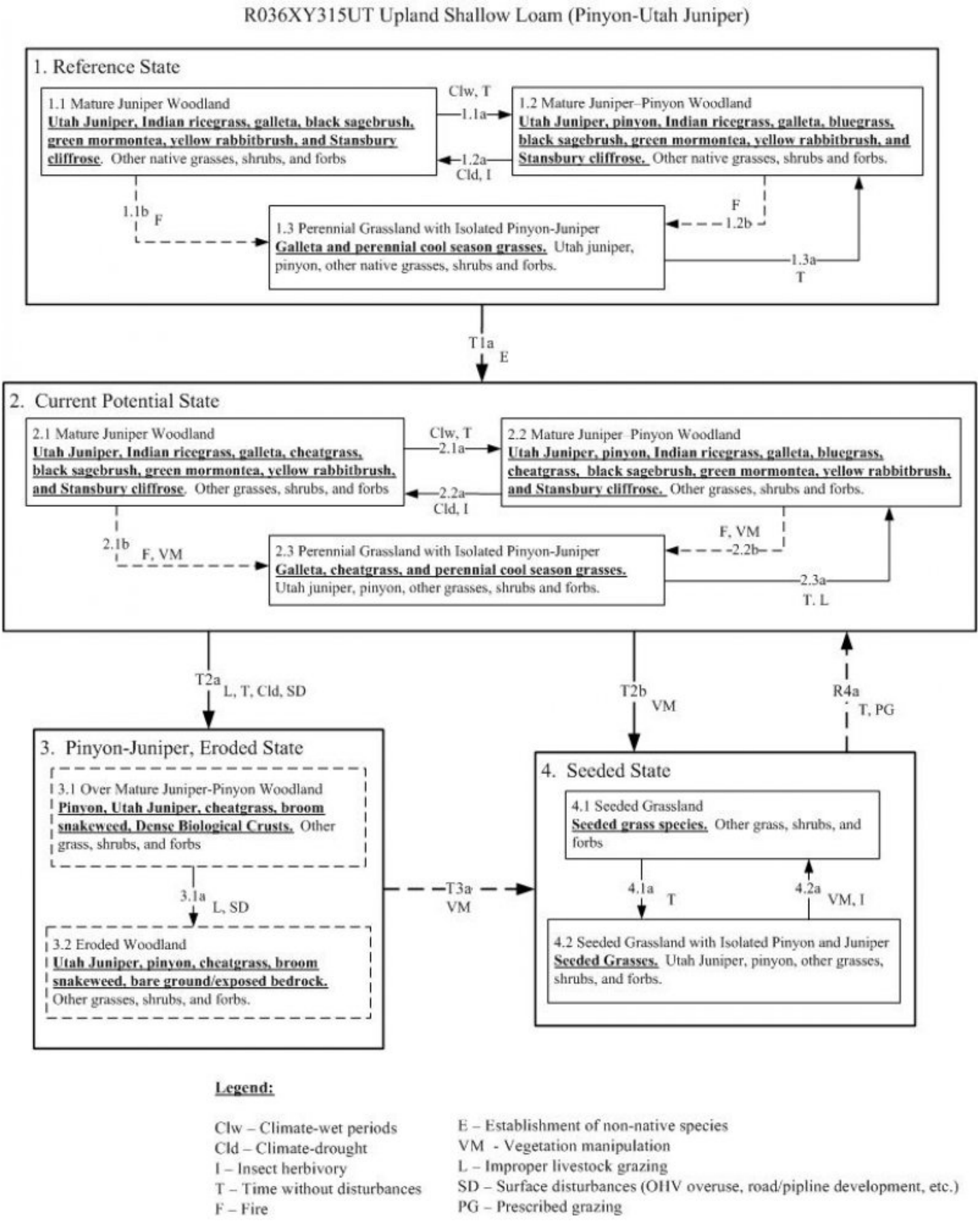
Drought and insects appear to be the main driving factors in many of the Pinyon/Juniper communities. Bentancourt (1993), noted that Pinyon and Juniper woodlands in the southwest appear to be more susceptible to large die offs

during droughts, than in other locations. As severe droughts persist, the Pinyon trees, being more susceptible to drought and insects, seem to die out, while the Utah juniper trees survive. This action could open the canopy for a few years and with sufficient moisture, grasses and forbs would be expected to respond favorably.

The communities of mature Pinyon and Juniper are stable, but fragile. Disturbances such as improper grazing (continuous season long grazing, heavy stocking rates, etc.), recreation activities, etc., can remove herbaceous vegetation and compact the soils. The unpredictability of the annual growing conditions and the shallow soils make these communities susceptible to the loss of understory and the resulting accelerated erosion. This ecological site has been grazed by domestic livestock since they were introduced into the area, though grazing has been light due to the lack of water and difficult terrain. The introduction of domestic livestock and the use of fencing and reliable water sources have influenced the disturbance regime of this site. As of this date, invasive annual grasslands that are so common in the Great Basin after a severe disturbance are not as prevalent on this ecological site in MLRA 36, potentially due to the remote location, the climate, and/or the soils.

As vegetation communities respond to changes in management or natural occurrences, thresholds can be crossed, which usually means that a return to the previous state may not be possible without major energy inputs. The amount of energy input needed to affect vegetative shifts depends on the present biotic and abiotic features and the desired results. The following diagram does not necessarily depict all the transition and states that this site may exhibit, but it does show some of the most common plant communities that can occur on the site and the transition pathways among the communities. These plant communities may not represent every possibility, but they are the most prevalent and repeatable. As more data is collected, some of these plant communities will be revised or removed, and new ones may be added. None of these plant communities should necessarily be thought of as the “desired plant community. The main purpose for including any description of a plant community here is to capture the current knowledge and experience at the time of this revision.

State and transition model



State 1
Reference

Community 1.1
Mature Juniper Woodland

This community phase is dominated by Utah Juniper. Pinyon trees are more susceptible to drought, insects, and disease than Utah Juniper trees. In fact, it is difficult to identify methods beside fire that naturally reduce Utah juniper on shallow soils. After long periods of drought weaken the Pinyon trees, beetle kills can become quite extensive, as was witnessed in 2006-2007 after the drought in 2000-2004. Drought periods can also weaken and reduce the understory, and as a result, this community supports less grass and herbaceous species than community phase 1.2. Plant establishment is mainly limited by the available moisture provided episodically for the necessary duration. Biological crusts are highly developed and diversified in the large interspaces between trees.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	168	280	392
Tree	56	168	280
Grass/Grasslike	28	56	112
Forb	17	28	39
Total	**269**	**532**	**823**

Table 6. Ground cover

Tree foliar cover	15-30%
Shrub/vine/liana foliar cover	10-20%
Grass/grasslike foliar cover	10-20%
Forb foliar cover	5-10%
Non-vascular plants	0%
Biological crusts	25-50%
Litter	1-5%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0-10%
Bedrock	5-10%
Water	0%
Bare ground	20-30%

Table 7. Canopy structure (% cover)

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

Community 1.2
Mature Pinyon-Juniper Woodland

This community is characterized by a mature Pinyon and Utah juniper woodland. The prevailing weather patterns favor an increase of Pinyon and Utah juniper canopy with an understory of grasses and forbs. This phase supports a diverse understory of cool and warm season grasses including Indian ricegrass, Needle and thread, and Galleta, along with several forbs. Depending on the timing of precipitation, cool season grasses, like Indian ricegrass or warm season grasses like galleta could be dominant. Interspaces supporting highly developed lichen crusts are common.

Table 8. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	168	280	392
Tree	56	168	280
Grass/Grasslike	56	112	168
Forb	17	28	39
Total	**297**	**588**	**879**

Table 9. Ground cover

Tree foliar cover	15-30%
Shrub/vine/liana foliar cover	10-20%
Grass/grasslike foliar cover	15-25%
Forb foliar cover	5-10%
Non-vascular plants	0%
Biological crusts	25-50%
Litter	1-5%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	1-10%
Bedrock	5-10%
Water	0%
Bare ground	20-30%

Table 10. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	5-8%	1-10%
>0.15 <= 0.3	–	0-5%	10-15%	1-5%
>0.3 <= 0.6	–	5-10%	1-5%	–
>0.6 <= 1.4	0-5%	5-10%	–	–
>1.4 <= 4	15-30%	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 1.3
Perennial Grassland with Isolated Pinyon-Juniper

The overall aspect of this community phase is grassland with scattered Pinyon and Utah juniper. The herbaceous

understory has a mix of grasses and forbs. This community phase is a result of a crown fire or sufficiently large and hot ground fire that will kill many of the trees, combined with sufficient seed-banks and moisture for reestablishment of grasses and forbs. It is common that after a crown fire many patches of trees will remain unburned, because of fire's unpredictability and broken topography. In most areas of MLRA 36, the surrounding landscape will typically support unburned Pinyon / Juniper communities, therefore trees can quickly reestablish (Milne et al 1996).

Table 11. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	280	448	616
Shrub/Vine	56	112	168
Forb	28	56	84
Tree	–	11	17
Total	**364**	**627**	**885**

Table 12. Ground cover

Tree foliar cover	0-10%
Shrub/vine/liana foliar cover	5-10%
Grass/grasslike foliar cover	40-60%
Forb foliar cover	5-10%
Non-vascular plants	0%
Biological crusts	25-50%
Litter	10-20%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0-10%
Bedrock	5-10%
Water	0%
Bare ground	1-5%

Table 13. Canopy structure (% cover)

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

Pathway 1.1A
Community 1.1 to 1.2

This pathway occurs when events such as a moist climate cycle, favor Pinyon and perennial bunch grass establishment. Currently this pathway is assumed to occur, although it has not been documented in the recent past.

Following several above average precipitation years and lack of surface disturbances, native perennial bunch grasses and other herbaceous plants will reestablish.

Pathway 1.1B
Community 1.1 to 1.3

This pathway is very unlikely, but can occur when a fire is able to move through the community typically in spring to mid-summer. This can happen during two general situations, 1) a fire can carry in the understory after several wet years allow fine fuels to become contiguous, or 2) as the woodland approaches the later stages of development and canopies become dense (typically in areas with dense Pinyon pine), crown sizes can increase and the community becomes susceptible to crown fires.

Pathway 1.2A
Community 1.2 to 1.1

This pathway occurs during and after events such as drought or beetle infestations. Droughts and insects can kill Pinyon trees, increasing nutrient availability in the system. Due to the natural conditions of drought, grasses typically do not take up the extra nutrients; instead, Utah Juniper is able to use these nutrients and became the dominant overstory tree.

Pathway 1.2B
Community 1.2 to 1.3

This pathway is very unlikely but can occur when a fire is able to move through the community typically in spring to mid-summer. This can happen during two general situations, first, a fire can carry in the understory after several wet years allow fine fuels to become contiguous or second, as the woodland approaches the later stages of development and canopies become dense (typically in areas with dense Pinyon pine), crown sizes can increase and the community becomes susceptible to crown fires.

Pathway 1.3A
Community 1.3 to 1.2

This pathway occurs when the climate is conducive to the establishment and maintenance of trees. More energy is taken-up and stored in the trees as the length between fires and droughts increase. This facilitates tree establishment and growth. In addition, if shrubs establish on the site they can provide safe-sites for tree establishment furthering the presence of trees.

State 2
Current Potential

This state is very similar to the reference state, except that non-native grasses and/or forbs are now present in all phases. The current potential state may include naturalized or invasive nonnative species. The primary disturbance mechanisms for this state include natural and human caused disturbances. Drought, insects, and occasional fire still influence the community shifts; however, domestic livestock grazing, recreational activities, and other man caused disturbances now present. Plant communities within the current potential state are more likely managed and used for various purposes by man, with out significant alteration in plant community composition or production. In time, continuous surface disturbances (i.e. improper grazing, off highway vehicles (OHV) use, recreational activities, etc.) will likely stress the native perennial grasses and allow for non-natives species to increase. This shift in species composition could affect nutrient cycling, hydrology and soil stability. At this time there is no known way to effectively remove the non-native plants from the site once they have become established. Therefore, this site is often irreversibly altered from the reference state

Characteristics and indicators. Current Potential State: Community phases maintained by drought, insects, infrequent crown fires, domestic livestock grazing, and vegetation manipulation. Indicators: A developed understory co-existing with a canopy of older Pinyon and juniper. Feedbacks: Infrequent, but regular droughts to reduce tree cover, and allow for the establishment of grasses and forbs in the understory. Long fire intervals that result in an increase in tree establishment and loss of the herbaceous understory. At-risk Community Phase: Communities 2.1

and 2.2 are at risk of moving into State 3 when remaining native understory plants are stressed and introduced species are dominant. Trigger: Canopy closure and or presence of invasive species have increased to the point where they influence the nutrient cycling and disturbance regime. Seeding of naturalized species after significant amounts of vegetation management or natural disturbance.

Community 2.1
Mature Juniper Woodland

This community phase is dominated by Utah juniper, and is the second most common phase both temporally and spatially at this time of revision. As we understand today, Pinyon trees are more susceptible to drought, insects and disease than Utah Juniper. In fact, it is difficult to identify methods beside fire that naturally reduce juniper on shallow soils. After long periods of drought weaken the Pinyon trees, beetle kills can become quite extensive, as was witnessed in 2006-2007 after the drought in 2000-2004. Drought periods can also weaken and reduce the understory, and as a result, this community supports less grass and herbaceous species than community phase 2.2. Plant establishment is mainly limited by the available moisture. Biological crusts are highly developed and diversified in the large interspaces between trees.

Table 14. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	168	280	392
Tree	56	168	280
Grass/Grasslike	28	56	112
Forb	17	28	39
Total	**269**	**532**	**823**

Table 15. Ground cover

Tree foliar cover	15-30%
Shrub/vine/liana foliar cover	10-20%
Grass/grasslike foliar cover	10-20%
Forb foliar cover	5-10%
Non-vascular plants	0%
Biological crusts	35-50%
Litter	1-5%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0-10%
Bedrock	5-10%
Water	0%
Bare ground	20-30%

Table 16. Canopy structure (% cover)

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

Community 2.2
Mature Pinyon-Juniper Woodland

This community phase was the most commonly found at the time of this revision. The prevailing climate and weather patterns favored the development of an open canopy of Pinyon and Utah juniper with an understory of grasses and forbs. This phase supports a diverse understory of grasses including native and non-native species, along with several forbs. Interspaces supporting highly developed lichen crusts are common.

Table 17. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	168	280	392
Tree	56	168	280
Grass/Grasslike	56	112	168
Forb	17	28	39
Total	**297**	**588**	**879**

Table 18. Ground cover

Tree foliar cover	15-30%
Shrub/vine/liana foliar cover	10-20%
Grass/grasslike foliar cover	15-25%
Forb foliar cover	5-10%
Non-vascular plants	0%
Biological crusts	25-50%
Litter	1-5%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0-10%
Bedrock	5-10%
Water	0%
Bare ground	20-30%

Table 19. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	0-5%	5-8%	1-10%
>0.15 <= 0.3	–	0-5%	10-15%	1-5%
>0.3 <= 0.6	–	5-10%	1-5%	–
>0.6 <= 1.4	0-5%	5-10%	–	–
>1.4 <= 4	15-30%	–	–	–
>4 <= 12	5-10%	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 2.3
Grassland with Isolated Pinyon-Juniper

This is the most temporary community phase at this time of revision. The overall impression is grassland with scattered Pinyon and Utah juniper. The herbaceous understory has a mix of grasses and forbs. This community phase is a result of a crown fire or sufficiently large and hot ground fire that killed many of the trees combined with sufficient seed-banks and moisture to reestablish grasses and forbs. Because of the varied nature of fires combined with the broken topography, patches of trees will remain even after a large crown fire. In most of MLRA 36, the surrounding landscape will typically support unburned Pinyon juniper communities, therefore trees can quickly reestablish (Milne et al 1996).

Table 20. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	280	448	616
Shrub/Vine	56	112	168
Forb	28	56	84
Tree	6	11	17
Total	**370**	**627**	**885**

Table 21. Ground cover

Tree foliar cover	0-10%
Shrub/vine/liana foliar cover	5-10%
Grass/grasslike foliar cover	40-60%
Forb foliar cover	5-10%
Non-vascular plants	0%
Biological crusts	25-50%
Litter	10-20%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0-10%
Bedrock	5-10%
Water	0%
Bare ground	1-5%

Table 22. Canopy structure (% cover)

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

Pathway 2.1A
Community 2.1 to 2.2

This pathway occurs when events like a moist climate cycle favor Pinyon and perennial bunch grass establishment. Currently this pathway is assumed to occur, although it has not been documented in the recent past. Following several above average precipitation years and lack of surface disturbances, native perennial bunch grasses and other herbaceous plants will reestablish.

Pathway 2.1B
Community 2.1 to 2.3

This pathway is unlikely but can occur when managers decide to remove trees through mechanical means, or if a fire is able to move through the community, typically in spring to mid-summer. This can happen during two general situations, 1) a fire can carry in the understory after several wet years allow fine fuels to become contiguous, or 2) as the woodland approaches the later stages of development and canopies become dense (typically in areas with dense Pinyon pine); crown sizes can increase and the community becomes susceptible to crown fires. Reseeding after the removal of the trees may be necessary to return the natives to the community, which would take this community phase into state 4.

Pathway 2.2A
Community 2.2 to 2.1

This pathway occurs during and after events that favor Utah juniper establishment over Pinyon. Drought and insects can kill the Pinyon trees, increasing the nutrient availability in the system. Due to the natural conditions of drought, grasses typically do not take up the extra nutrients; instead, Utah juniper is able to use the extra nutrients and became the dominant overstory tree.

Pathway 2.2B
Community 2.2 to 2.3

This pathway is unlikely but can occur when managers decide to remove trees through mechanical means, or if a fire is able to move through the community typically in spring to mid-summer. This can happen during two general situations. 1) fire can carry in the understory after several wet years allow fine fuels to become contiguous, or 2) as the woodland approaches the later stages of development and canopies become dense (typically in areas with dense Pinyon pine); crown sizes can increase and the community becomes susceptible to crown fires. Reseeding after the removal of the trees may be necessary to return the natives to the community; however that would push the community into state 4.

Pathway 2.3A
Community 2.3 to 2.2

This pathway occurs when the climate is conducive to the establishment and maintenance of trees. More and more

energy is taken-up and stored in the trees as the length between fires and droughts increase. This facilitates tree establishment and growth. In addition, if shrubs establish on the site, they can provide safe-sites for trees establishment furthering the presence of trees.

State 3
Eroded

This state occurs when natural or management actions have allowed trees to become very mature and have effectively closed out the understory. The primary disturbance mechanisms for this state include increased erosion, improper grazing, and other surface disturbances, such as recreational activities. This state has the lowest resiliency and resistance of any state in this description.

Characteristics and indicators. Eroded state: Community phases maintained by time, drought, and erosion. Indicators: A lack of understory with a canopy of older Pinyon and Juniper, where plant interspaces very large and connected. Feedbacks: Increased tree establishment, drought, surface disturbances, heavy rainfall, erosion, and loss of biological crusts that facilitate the continued erosion of this site. Infrequent, but regular droughts to reduce tree cover, coupled with adequate moisture to support and increase the herbaceous understory and biological crusts. At-risk Community Phase: Community 3.1 is most at risk when the biological crusts are severely disturbed. However one this state is reached there may be no feasible way back to the Current Potential State, due to the large amounts of monetary and energy inputs that would be needed. Trigger: Seeding of naturalized species after significant amounts of vegetation management or catastrophic natural disturbance.

Community 3.1
Over Mature Juniper-Pinyon Woodland

This community phase occurs when natural or management actions allow for the increase in Pinyon and Utah juniper and a decrease in the grass and forb understory. It is dominated by large trees and bare interspaces.

Table 23. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Tree	112	224	336
Shrub/Vine	28	56	84
Grass/Grasslike	17	34	50
Forb	11	17	22
Total	**168**	**331**	**492**

Table 24. Ground cover

Tree foliar cover	30-45%
Shrub/vine/liana foliar cover	5-10%
Grass/grasslike foliar cover	1-10%
Forb foliar cover	5-10%
Non-vascular plants	0%
Biological crusts	40-60%
Litter	1-5%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0-10%
Bedrock	5-10%
Water	0%
Bare ground	10-15%

Table 25. Canopy structure (% cover)

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

Community 3.2
Pinyon-Juniper Woodland

This community phase is observable due to active erosion under the Pinyon and Utah juniper canopy. Nutrient cycling declines in this state and erosion increases with possible facilitation of desertification (Belnap 1995).

Table 26. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Tree	112	224	336
Shrub/Vine	28	56	84
Grass/Grasslike	17	22	50
Forb	11	17	22
Total	**168**	**319**	**492**

Table 27. Ground cover

Tree foliar cover	30-45%
Shrub/vine/liana foliar cover	5-10%
Grass/grasslike foliar cover	1-10%
Forb foliar cover	5-10%
Non-vascular plants	0%
Biological crusts	0-20%
Litter	1-5%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0-10%
Bedrock	5-10%
Water	0%
Bare ground	40-60%

Table 28. Canopy structure (% cover)

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

Pathway 3.1A
Community 3.1 to 3.2

This pathway occurs when events like improper grazing, off road vehicle overuse, establishment of roads, etc. cause surface disturbance and results in erosion increases. Once the soil starts moving it will typically erode down to the bedrock.

State 4
Seeded

This state is a result of a large amount of management actions. The trees were removed and adapted grasses established. This state reflects the desired management goals. If grazing tolerant species were established these communities can better withstand grazing and other disturbances. Due to the shallow soils and unpredictable precipitations patterns, it is difficult to establish grasses from seed, so this state may be hard to achieve.

Characteristics and indicators. Seeded state: Community phases maintained by time without disturbances and vegetation manipulation, Indicators: A developed perennial herbaceous understory of seeded species, typically non-natives, co-existing with some Pinyon and Utah juniper. Feedbacks: Moist cycles that maintain perennial bunch grasses. Loss of the herbaceous understory and an increase in tree establishment. At-risk Community Phase: All communities are at risk if they are allowed to transition into state 3. Restoration Pathway: Reestablishment of native and introduced species through time and proper management.

Community 4.1
Seeded Grassland

This community phase appears as a grassland with scattered shrubs and trees due to the presence of bedrock. The vegetative production is typically higher than in the current potential state, depending on grass species seeded; however the grass is still sparse due to the shallow soils and presence of bedrock.

Table 29. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	560	897	1121
Shrub/Vine	56	84	112
Forb	45	56	67
Tree	–	–	–
Total	**661**	**1037**	**1300**

Table 30. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	0-10%
Grass/grasslike foliar cover	50-70%
Forb foliar cover	0-5%
Non-vascular plants	0%
Biological crusts	0-5%
Litter	3-8%
Surface fragments >0.25" and <=3"	0-5%
Surface fragments >3"	0-15%
Bedrock	5-10%
Water	0%
Bare ground	20-40%

Table 31. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	0-5%	5-10%	0-5%
>0.15 <= 0.3	–	0-5%	10-30%	0-5%
>0.3 <= 0.6	–	0-5%	30-50%	0-2%
>0.6 <= 1.4	–	0-5%	5-10%	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Community 4.2
Seeded Grassland with Isolated Pinyon-Juniper

This community phase has a dense under story of introduced grasses and forbs, but a canopy of Pinyon and Utah juniper are establishing. Native perennial grasses, forbs, and shrubs may also be starting to establish. Interspaces are filled with biological crusts and herbaceous plants.

Table 32. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	560	897	1121
Shrub/Vine	56	84	112
Tree	28	56	112
Forb	45	56	67
Total	**689**	**1093**	**1412**

Table 33. Ground cover

Tree foliar cover	5-10%
Shrub/vine/liana foliar cover	5-10%
Grass/grasslike foliar cover	50-70%

Forb foliar cover	0-5%
Non-vascular plants	0%
Biological crusts	0-5%
Litter	3-8%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0-10%
Bedrock	5-10%
Water	0%
Bare ground	20-40%

Table 34. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	0-5%	5-10%	0-5%
>0.15 <= 0.3	–	0-5%	10-30%	0-5%
>0.3 <= 0.6	–	0-5%	30-50%	0-2%
>0.6 <= 1.4	0-5%	0-5%	5-10%	–
>1.4 <= 4	1-5%	–	–	–
>4 <= 12	0-5%	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Pathway 4.1A
Community 4.1 to 4.2

This pathway occurs when events favor the establishment of shrubs and tress, including long periods with out disturbances.

Pathway 4.2A
Community 4.2 to 4.1

This pathway occurs as trees and shrubs are removed from the community, either naturally through insect herbivory or through vegetation manipulation by man.

Transition T1A
State 1 to 2

Transition T2A
State 2 to 3

This transition is from a state that has resistance and resilience to withstand some disturbances to a state that has lost much of the natural resistance and resilience. At this point natural and/or management actions have decreased the understory to a point where erosion increases. Reduced influence from fire, insects, and drought could cause the tree canopy to close, effectively reducing the herbaceous understory thus facilitating the transition. Improper grazing combined with periods of drought and increased surface disturbance can facilitate this transition because soil stability is lost and susceptibility to soil loss increases. Of particular concern during this transition is the reduction of biological crusts due to surface disturbance and or soil compaction. The soil compaction can reduce the ability for biological crusts to survive thus affecting the nutrient cycling and the soil stability (Belnap 1995).

Transition T2B
State 2 to 4

This transition is a result of a reduction in the tree canopy and reestablishment of grasses and other herbaceous species. Because of the shallow soils and the unpredictable precipitation, this pathway should be used cautiously. However, if the community is approaching state 3, due to a loss of understory combined with surface disturbance, this pathway could be preferable. This pathway may facilitate the recovery of the soils and the biological crust community. An unlikely but possible fire could also be cause for the use of this pathway. Reseeding after a fire may be the only way to successfully restore the ecological dynamics to a site. Either way this pathway involves large energy and monetary inputs by man.

Transition T3A
State 3 to 4

This transition may not be possible. Because of the shallow soils and the unpredictable precipitation, this pathway should be used cautiously. This pathway may facilitate the recovery of the soils and the biological crust community. This pathway involves large energy and monetary inputs by man.

Restoration pathway R4A
State 4 to 2

This pathway occurs as a result of long periods without disturbance and the community is allowed to develop ecosystem functions. This could be through prescribed grazing with domestic livestock to favor the development of native grasses over the introduced species.

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**			112–224	
	mormon tea	EPVI	*Ephedra viridis*	56–112	–
	black sagebrush	ARNO4	*Artemisia nova*	56–112	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	6–56	–
	Stansbury cliffrose	PUST	*Purshia stansburiana*	6–56	–
3	**Sub-Dominant Shrubs**			0–67	
	Utah serviceberry	AMUT	*Amelanchier utahensis*	0–28	–
	Bigelow sage	ARBI3	*Artemisia bigelovii*	0–28	–
	black sagebrush	ARNO4	*Artemisia nova*	0–28	–
	littleleaf mountain mahogany	CEIN7	*Cercocarpus intricatus*	0–28	–
	alderleaf mountain mahogany	CEMO2	*Cercocarpus montanus*	0–28	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–28	–
	Fremont's mahonia	MAFR3	*Mahonia fremontii*	0–28	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–28	–
	sulphur-flower buckwheat	ERUM	*Eriogonum umbellatum*	0–22	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–17	–
	Utah serviceberry	AMUTU	*Amelanchier utahensis var. utahensis*	0–17	–
	Bigelow sage	ARBI3	*Artemisia bigelovii*	0–17	–

	fourwing saltbush	ATCA2	*Atriplex canescens*	0–17	–
	littleleaf mountain mahogany	CEIN7	*Cercocarpus intricatus*	0–17	–
	alderleaf mountain mahogany	CEMO2	*Cercocarpus montanus*	0–17	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–17	–
	Fremont's mahonia	MAFR3	*Mahonia fremontii*	0–17	–
	sumac	RHUS	*Rhus*	0–17	–
	roundleaf buffaloberry	SHRO	*Shepherdia rotundifolia*	0–17	–
	mountain snowberry	SYOR2	*Symphoricarpos oreophilus*	0–17	–
Grass/Grasslike					
0	**Dominant Grasses**			22–45	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	11–22	–
	James' galleta	PLJA	*Pleuraphis jamesii*	11–22	–
1	**Sub-Dominant Grasses**			0–34	
	Grass, perennial	2GP	*Grass, perennial*	0–17	–
	desert needlegrass	ACSP12	*Achnatherum speciosum*	0–17	–
	blue grama	BOGR2	*Bouteloua gracilis*	0–17	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–17	–
	squirreltail	ELEL5	*Elymus elymoides*	0–17	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–17	–
	saline wildrye	LESAS	*Leymus salinus ssp. salinus*	0–17	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–17	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–17	–
Forb					
2	**Forbs**			11–34	
	rock goldenrod	PEPU7	*Petradoria pumila*	0–17	–
	Utah penstemon	PEUT	*Penstemon utahensis*	0–6	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–6	–
	stemless four-nerve daisy	TEAC	*Tetraneuris acaulis*	0–6	–
	Forb, annual	2FA	*Forb, annual*	0–6	–
	Forb, perennial	2FP	*Forb, perennial*	0–6	–
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–6	–
	Wright's bird's beak	COWR2	*Cordylanthus wrightii*	0–6	–
	Brenda's yellow cryptantha	CRFL5	*Cryptantha flava*	0–6	–
	desert trumpet	ERIN4	*Eriogonum inflatum*	0–6	–
	rusty lupine	LUPU	*Lupinus pusillus*	0–6	–
	lobeleaf groundsel	PAMU11	*Packera multilobata*	0–6	–
Tree					
4	**Trees**			45–168	
	twoneedle pinyon	PIED	*Pinus edulis*	291–336	–
	Utah juniper	JUOS	*Juniperus osteosperma*	168–252	–
	Utah juniper	JUOS	*Juniperus osteosperma*	28–112	–
	twoneedle pinyon	PIED	*Pinus edulis*	17–56	–

Table 36. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
1	**Dominant Shrubs**			112–224	
	mormon tea	EPVI	*Ephedra viridis*	56–112	–
	black sagebrush	ARNO4	*Artemisia nova*	56–112	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	6–56	–
	Stansbury cliffrose	PUST	*Purshia stansburiana*	6–56	–
2	**Sub-Dominant Shrubs**			0–67	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–17	–
	Utah serviceberry	AMUTU	*Amelanchier utahensis var. utahensis*	0–17	–
	Bigelow sage	ARBI3	*Artemisia bigelovii*	0–17	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–17	–
	littleleaf mountain mahogany	CEIN7	*Cercocarpus intricatus*	0–17	–
	alderleaf mountain mahogany	CEMO2	*Cercocarpus montanus*	0–17	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–17	–
	Fremont's mahonia	MAFR3	*Mahonia fremontii*	0–17	–
	sumac	RHUS	*Rhus*	0–17	–
	roundleaf buffaloberry	SHRO	*Shepherdia rotundifolia*	0–17	–
	mountain snowberry	SYOR2	*Symphoricarpos oreophilus*	0–17	–
Grass/Grasslike					
3	**Dominant Grasses**			34–67	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	11–22	–
	James' galleta	PLJA	*Pleuraphis jamesii*	11–22	–
	Sandberg bluegrass	POSE	*Poa secunda*	11–22	–
4	**Sub-Dominant Grasses**			0–45	
	Grass, perennial	2GP	*Grass, perennial*	0–17	–
	desert needlegrass	ACSP12	*Achnatherum speciosum*	0–17	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–17	–
	blue grama	BOGR2	*Bouteloua gracilis*	0–17	–
	squirreltail	ELEL5	*Elymus elymoides*	0–17	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–17	–
	saline wildrye	LESAS	*Leymus salinus ssp. salinus*	0–17	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–17	–
Forb					
5	**Forbs**			11–34	
	rock goldenrod	PEPU7	*Petradoria pumila*	0–17	–
	Forb, annual	2FA	*Forb, annual*	0–11	–
	Forb, perennial	2FP	*Forb, perennial*	0–11	–
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–6	–

	Wright's bird's beak	COWR2	*Cordylanthus wrightii*	0–6	–
	Brenda's yellow cryptantha	CRFL5	*Cryptantha flava*	0–6	–
	desert trumpet	ERIN4	*Eriogonum inflatum*	0–6	–
	rusty lupine	LUPU	*Lupinus pusillus*	0–6	–
	lobeleaf groundsel	PAMU11	*Packera multilobata*	0–6	–
	Utah penstemon	PEUT	*Penstemon utahensis*	0–6	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–6	–
	stemless four-nerve daisy	TEAC	*Tetraneuris acaulis*	0–6	–
Tree					
6	**Trees**			45–168	
	twoneedle pinyon	PIED	*Pinus edulis*	28–112	–
	Utah juniper	JUOS	*Juniperus osteosperma*	17–56	–

Table 37. Community 1.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Dominant Grasses**			28–112	
	James' galleta	PLJA	*Pleuraphis jamesii*	28–112	–
2	**Sub-Dominant Grasses**			0–420	
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–224	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–224	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–56	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–17	–
	desert needlegrass	ACSP12	*Achnatherum speciosum*	0–17	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–17	–
	blue grama	BOGR2	*Bouteloua gracilis*	0–17	–
	squirreltail	ELEL5	*Elymus elymoides*	0–17	–
	saline wildrye	LESAS	*Leymus salinus ssp. salinus*	0–17	–
	Grass, perennial	2GP	*Grass, perennial*	0–17	–
Forb					
3	**Forbs**			28–56	
	rock goldenrod	PEPU7	*Petradoria pumila*	0–17	–
	Forb, annual	2FA	*Forb, annual*	0–11	–
	Forb, perennial	2FP	*Forb, perennial*	0–11	–
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–6	–
	Wright's bird's beak	COWR2	*Cordylanthus wrightii*	0–6	–
	Brenda's yellow cryptantha	CRFL5	*Cryptantha flava*	0–6	–
	desert trumpet	ERIN4	*Eriogonum inflatum*	0–6	–
	rusty lupine	LUPU	*Lupinus pusillus*	0–6	–
	lobeleaf groundsel	PAMU11	*Packera multilobata*	0–6	–
	Utah penstemon	PEUT	*Penstemon utahensis*	0–6	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–6	–
	stemless four-nerve daisy	TEAC	*Tetraneuris acaulis*	0–6	–

	stemless four-nerve daisy	TEAC	*Tetraneuris acaulis*	0–6	–
Shrub/Vine					
4	**Shrubs**			56–112	
	black sagebrush	ARNO4	*Artemisia nova*	0–56	–
	mormon tea	EPVI	*Ephedra viridis*	0–56	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–17	–
	Fremont's mahonia	MAFR3	*Mahonia fremontii*	0–17	–
	Stansbury cliffrose	PUST	*Purshia stansburiana*	0–17	–
	sumac	RHUS	*Rhus*	0–17	–
	roundleaf buffaloberry	SHRO	*Shepherdia rotundifolia*	0–17	–
	mountain snowberry	SYOR2	*Symphoricarpos oreophilus*	0–17	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–17	–
	littleleaf mountain mahogany	CEIN7	*Cercocarpus intricatus*	0–17	–
	alderleaf mountain mahogany	CEMO2	*Cercocarpus montanus*	0–17	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–17	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–17	–
	Utah serviceberry	AMUTU	*Amelanchier utahensis var. utahensis*	0–17	–
	Bigelow sage	ARBI3	*Artemisia bigelovii*	0–17	–
Tree					
5	**Trees**			0–11	
	Utah juniper	JUOS	*Juniperus osteosperma*	0–11	–
	twoneedle pinyon	PIED	*Pinus edulis*	0–6	–

Table 38. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
1	**Dominant Shrubs**			112–224	
	mormon tea	EPVI	*Ephedra viridis*	56–112	–
	black sagebrush	ARNO4	*Artemisia nova*	56–112	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	6–56	–
	Stansbury cliffrose	PUST	*Purshia stansburiana*	6–56	–
2	**Sub-Dominant Shrubs**			0–67	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–17	–
	Utah serviceberry	AMUTU	*Amelanchier utahensis var. utahensis*	0–17	–
	Bigelow sage	ARBI3	*Artemisia bigelovii*	0–17	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–17	–
	littleleaf mountain mahogany	CEIN7	*Cercocarpus intricatus*	0–17	–
	alderleaf mountain mahogany	CEMO2	*Cercocarpus montanus*	0–17	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–17	–
	Fremont's mahonia	MAFR3	*Mahonia fremontii*	0–17	–

	sumac	RHUS	*Rhus*	0–17	–
	roundleaf buffaloberry	SHRO	*Shepherdia rotundifolia*	0–17	–
	mountain snowberry	SYOR2	*Symphoricarpos oreophilus*	0–17	–
Grass/Grasslike					
3	**Dominant Grasses**			22–45	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	11–22	–
	cheatgrass	BRTE	*Bromus tectorum*	6–22	–
	James' galleta	PLJA	*Pleuraphis jamesii*	11–22	–
4	**Sub-Dominant Grasses**			0–34	
	saline wildrye	LESAS	*Leymus salinus ssp. salinus*	0–17	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–17	–
	Russian wildrye	PSJU3	*Psathyrostachys juncea*	0–17	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–17	–
	Grass, annual	2GA	*Grass, annual*	0–17	–
	Grass, perennial	2GP	*Grass, perennial*	0–17	–
	desert needlegrass	ACSP12	*Achnatherum speciosum*	0–17	–
	crested wheatgrass	AGCR	*Agropyron cristatum*	0–17	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–17	–
	blue grama	BOGR2	*Bouteloua gracilis*	0–17	–
	squirreltail	ELEL5	*Elymus elymoides*	0–17	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–17	–
Forb					
5	**Forbs**			11–34	
	rock goldenrod	PEPU7	*Petradoria pumila*	0–17	–
	Utah penstemon	PEUT	*Penstemon utahensis*	0–6	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–6	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–6	–
	stemless four-nerve daisy	TEAC	*Tetraneuris acaulis*	0–6	–
	Forb, annual	2FA	*Forb, annual*	0–6	–
	Forb, perennial	2FP	*Forb, perennial*	0–6	–
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–6	–
	Wright's bird's beak	COWR2	*Cordylanthus wrightii*	0–6	–
	Brenda's yellow cryptantha	CRFL5	*Cryptantha flava*	0–6	–
	tansymustard	DESCU	*Descurainia*	0–6	–
	desert trumpet	ERIN4	*Eriogonum inflatum*	0–6	–
	rusty lupine	LUPU	*Lupinus pusillus*	0–6	–
	lobeleaf groundsel	PAMU11	*Packera multilobata*	0–6	–
Tree					
6	**Trees**			45–168	
	Utah juniper	JUOS	*Juniperus osteosperma*	28–112	–
	twoneedle pinyon	PIED	*Pinus edulis*	17–56	–

Table 39. Community 2.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Shrub/Vine					
1	**Dominant Shrubs**			112–224	
	black sagebrush	ARNO4	*Artemisia nova*	56–112	–
	mormon tea	EPVI	*Ephedra viridis*	56–112	–
	Stansbury cliffrose	PUST	*Purshia stansburiana*	6–56	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	6–56	–
2	**Sub-Dominant Shrubs**			0–67	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–17	–
	Utah serviceberry	AMUTU	*Amelanchier utahensis var. utahensis*	0–17	–
	Bigelow sage	ARBI3	*Artemisia bigelovii*	0–17	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–17	–
	sumac	RHUS	*Rhus*	0–17	–
	roundleaf buffaloberry	SHRO	*Shepherdia rotundifolia*	0–17	–
	mountain snowberry	SYOR2	*Symphoricarpos oreophilus*	0–17	–
	littleleaf mountain mahogany	CEIN7	*Cercocarpus intricatus*	0–17	–
	alderleaf mountain mahogany	CEMO2	*Cercocarpus montanus*	0–17	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–17	–
	Fremont's mahonia	MAFR3	*Mahonia fremontii*	0–17	–
Grass/Grasslike					
3	**Dominant Grasses**			34–67	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	11–22	–
	cheatgrass	BRTE	*Bromus tectorum*	6–22	–
	James' galleta	PLJA	*Pleuraphis jamesii*	11–22	–
	Sandberg bluegrass	POSE	*Poa secunda*	11–22	–
4	**Sub-Dominant Grasses**			0–45	
	Grass, annual	2GA	*Grass, annual*	0–17	–
	Grass, perennial	2GP	*Grass, perennial*	0–17	–
	desert needlegrass	ACSP12	*Achnatherum speciosum*	0–17	–
	crested wheatgrass	AGCR	*Agropyron cristatum*	0–17	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–17	–
	blue grama	BOGR2	*Bouteloua gracilis*	0–17	–
	squirreltail	ELEL5	*Elymus elymoides*	0–17	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–17	–
	saline wildrye	LESAS	*Leymus salinus ssp. salinus*	0–17	–
	Russian wildrye	PSJU3	*Psathyrostachys juncea*	0–17	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–17	–
Forb					
5	**Forbs**			11–34	
	rock goldenrod	PEPU7	*Petradoria pumila*	0–17	–
	Forb, annual	2FA	*Forb, annual*	0–11	–

	Forb, perennial	2FP	*Forb, perennial*	0–11	–
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–6	–
	Wright's bird's beak	COWR2	*Cordylanthus wrightii*	0–6	–
	Brenda's yellow cryptantha	CRFL5	*Cryptantha flava*	0–6	–
	tansymustard	DESCU	*Descurainia*	0–6	–
	desert trumpet	ERIN4	*Eriogonum inflatum*	0–6	–
	rusty lupine	LUPU	*Lupinus pusillus*	0–6	–
	lobeleaf groundsel	PAMU11	*Packera multilobata*	0–6	–
	Utah penstemon	PEUT	*Penstemon utahensis*	0–6	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–6	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–6	–
	stemless four-nerve daisy	TEAC	*Tetraneuris acaulis*	0–6	–
Tree					
6	**Trees**			45–168	
	twoneedle pinyon	PIED	*Pinus edulis*	28–112	–
	Utah juniper	JUOS	*Juniperus osteosperma*	17–56	–

Table 40. Community 2.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Dominant Grasses**			28–112	
	James' galleta	PLJA	*Pleuraphis jamesii*	28–112	–
	cheatgrass	BRTE	*Bromus tectorum*	6–22	–
2	**Sub-Dominant Grasses**			112–420	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–224	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–224	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–56	–
	rush lemonweed	PSJU2	*Psoralidium junceum*	0–17	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–17	–
	saline wildrye	LESAS	*Leymus salinus ssp. salinus*	0–17	–
	Grass, annual	2GA	*Grass, annual*	0–17	–
	Grass, perennial	2GP	*Grass, perennial*	0–17	–
	desert needlegrass	ACSP12	*Achnatherum speciosum*	0–17	–
	crested wheatgrass	AGCR	*Agropyron cristatum*	0–17	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–17	–
	blue grama	BOGR2	*Bouteloua gracilis*	0–17	–
	squirreltail	ELEL5	*Elymus elymoides*	0–17	–
Forb					
3	**Forbs**			28–56	
	rock goldenrod	PEPU7	*Petradoria pumila*	0–17	–
	Utah penstemon	PEUT	*Penstemon utahensis*	0–6	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–6	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–6	–

	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–6	–
	stemless four-nerve daisy	TEAC	*Tetraneuris acaulis*	0–6	–
	Forb, annual	2FA	*Forb, annual*	0–6	–
	Forb, perennial	2FP	*Forb, perennial*	0–6	–
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–6	–
	Wright's bird's beak	COWR2	*Cordylanthus wrightii*	0–6	–
	Brenda's yellow cryptantha	CRFL5	*Cryptantha flava*	0–6	–
	tansymustard	DESCU	*Descurainia*	0–6	–
	desert trumpet	ERIN4	*Eriogonum inflatum*	0–6	–
	rusty lupine	LUPU	*Lupinus pusillus*	0–6	–
	lobeleaf groundsel	PAMU11	*Packera multilobata*	0–6	–
Shrub/Vine					
4	**Shrubs**			56–112	
	mormon tea	EPVI	*Ephedra viridis*	0–56	–
	black sagebrush	ARNO4	*Artemisia nova*	0–56	–
	littleleaf mountain mahogany	CEIN7	*Cercocarpus intricatus*	0–17	–
	alderleaf mountain mahogany	CEMO2	*Cercocarpus montanus*	0–17	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–17	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–17	–
	Fremont's mahonia	MAFR3	*Mahonia fremontii*	0–17	–
	Stansbury cliffrose	PUST	*Purshia stansburiana*	0–17	–
	sumac	RHUS	*Rhus*	0–17	–
	roundleaf buffaloberry	SHRO	*Shepherdia rotundifolia*	0–17	–
	mountain snowberry	SYOR2	*Symphoricarpos oreophilus*	0–17	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–17	–
	Utah serviceberry	AMUTU	*Amelanchier utahensis var. utahensis*	0–17	–
	Bigelow sage	ARBI3	*Artemisia bigelovii*	0–17	–
Tree					
5	**Trees**			0–11	
	Utah juniper	JUOS	*Juniperus osteosperma*	0–11	–
	twoneedle pinyon	PIED	*Pinus edulis*	0–6	–

Table 41. Community 3.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Dominant Grasses**			6–22	
	cheatgrass	BRTE	*Bromus tectorum*	6–22	–
2	**Sub-Dominant Grasses**			0–11	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–11	–
	James' galleta	PLJA	*Pleuraphis jamesii*	0–11	–
	Russian wildrye	PSJU3	*Psathyrostachys juncea*	0–6	–
	crested wheatgrass	AGCR	*Agropyron cristatum*	0–6	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–6	–
	squirreltail	ELEL5	*Elymus elymoides*	0–6	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–6	–
	Grass, annual	2GA	*Grass, annual*	0–6	–
	Grass, perennial	2GP	*Grass, perennial*	0–6	–
Forb					
3	**Forbs**			0–17	
	Forb, annual	2FA	*Forb, annual*	0–6	–
	Forb, perennial	2FP	*Forb, perennial*	0–6	–
	Wright's bird's beak	COWR2	*Cordylanthus wrightii*	0–6	–
	Brenda's yellow cryptantha	CRFL5	*Cryptantha flava*	0–6	–
	tansymustard	DESCU	*Descurainia*	0–6	–
	lobeleaf groundsel	PAMU11	*Packera multilobata*	0–6	–
	rock goldenrod	PEPU7	*Petradoria pumila*	0–6	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–6	–
Shrub/Vine					
4	**Dominant Shrubs**			6–28	
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	6–28	–
5	**Sub-Dominant Shrubs**			0–28	
	black sagebrush	ARNO4	*Artemisia nova*	0–11	–
	mormon tea	EPVI	*Ephedra viridis*	0–11	–
	Stansbury cliffrose	PUST	*Purshia stansburiana*	0–6	–
	roundleaf buffaloberry	SHRO	*Shepherdia rotundifolia*	0–6	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–6	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–6	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–6	–
Tree					
6	**Trees**			112–224	
	Utah juniper	JUOS	*Juniperus osteosperma*	56–112	–
	twoneedle pinyon	PIED	*Pinus edulis*	56–112	–

Table 42. Community 3.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Dominant Grasses**			6–22	
	cheatgrass	BRTE	*Bromus tectorum*	6–22	–
2	**Sub-Dominant Grasses**			0–28	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–11	–
	James' galleta	PLJA	*Pleuraphis jamesii*	0–11	–
	Russian wildrye	PSJU3	*Psathyrostachys juncea*	0–6	–
	crested wheatgrass	AGCR	*Agropyron cristatum*	0–6	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–6	–
	squirreltail	ELEL5	*Elymus elymoides*	0–6	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–6	–
	Grass, annual	2GA	*Grass, annual*	0–6	–
	Grass, perennial	2GP	*Grass, perennial*	0–6	–
Forb					
3	**Forbs**			0–11	
	Forb, annual	2FA	*Forb, annual*	0–6	–
	Forb, perennial	2FP	*Forb, perennial*	0–6	–
	Wright's bird's beak	COWR2	*Cordylanthus wrightii*	0–6	–
	Brenda's yellow cryptantha	CRFL5	*Cryptantha flava*	0–6	–
	tansymustard	DESCU	*Descurainia*	0–6	–
	lobeleaf groundsel	PAMU11	*Packera multilobata*	0–6	–
	rock goldenrod	PEPU7	*Petradoria pumila*	0–6	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–6	–
Shrub/Vine					
4	**Dominant Shrubs**			6–28	
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–28	–
5	**Sub-Dominant Shrubs**			0–28	
	black sagebrush	ARNO4	*Artemisia nova*	0–11	–
	mormon tea	EPVI	*Ephedra viridis*	0–11	–
	Stansbury cliffrose	PUST	*Purshia stansburiana*	0–6	–
	roundleaf buffaloberry	SHRO	*Shepherdia rotundifolia*	0–6	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–6	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–6	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–6	–
Tree					
6	**Trees**			112–224	
	Utah juniper	JUOS	*Juniperus osteosperma*	56–112	–
	twoneedle pinyon	PIED	*Pinus edulis*	56–112	–

Table 43. Community 4.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Grasses**			560–897	
	crested wheatgrass	AGCR	*Agropyron cristatum*	0–897	–
	Russian wildrye	PSJU3	*Psathyrostachys juncea*	0–897	–
	cheatgrass	BRTE	*Bromus tectorum*	6–22	–
	Grass, annual	2GA	*Grass, annual*	0–22	–
	Grass, perennial	2GP	*Grass, perennial*	0–22	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–11	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–11	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–11	–
Forb					
2	**Forbs**			34–56	
	alfalfa	MEDIC	*Medicago*	0–56	–
	Forb, annual	2FA	*Forb, annual*	0–17	–
	Forb, perennial	2FP	*Forb, perennial*	0–17	–
	Wright's bird's beak	COWR2	*Cordylanthus wrightii*	0–6	–
	Brenda's yellow cryptantha	CRFL5	*Cryptantha flava*	0–6	–
	tansymustard	DESCU	*Descurainia*	0–6	–
	lobeleaf groundsel	PAMU11	*Packera multilobata*	0–6	–
	rock goldenrod	PEPU7	*Petradoria pumila*	0–6	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–6	–
Shrub/Vine					
3	**Shrubs**			0–84	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–11	–
	black sagebrush	ARNO4	*Artemisia nova*	0–11	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–11	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–11	–
	mormon tea	EPVI	*Ephedra viridis*	0–11	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	6–11	–
	Stansbury cliffrose	PUST	*Purshia stansburiana*	0–11	–
	roundleaf buffaloberry	SHRO	*Shepherdia rotundifolia*	0–11	–

Table 44. Community 4.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Grasses**			560–897	
	crested wheatgrass	AGCR	*Agropyron cristatum*	0–897	–
	Russian wildrye	PSJU3	*Psathyrostachys juncea*	0–897	–
	cheatgrass	BRTE	*Bromus tectorum*	6–22	–
	Grass, annual	2GA	*Grass, annual*	0–22	–
	Grass, perennial	2GP	*Grass, perennial*	0–22	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–11	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–11	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–11	–
Forb					
2	**Forbs**			34–56	
	alfalfa	MEDIC	*Medicago*	0–56	–
	Forb, annual	2FA	*Forb, annual*	0–17	–
	Forb, perennial	2FP	*Forb, perennial*	0–17	–
	Wright's bird's beak	COWR2	*Cordylanthus wrightii*	0–6	–
	Brenda's yellow cryptantha	CRFL5	*Cryptantha flava*	0–6	–
	tansymustard	DESCU	*Descurainia*	0–6	–
	lobeleaf groundsel	PAMU11	*Packera multilobata*	0–6	–
	rock goldenrod	PEPU7	*Petradoria pumila*	0–6	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–6	–
Shrub/Vine					
3	**Shrubs**			0–84	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–11	–
	black sagebrush	ARNO4	*Artemisia nova*	0–11	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–11	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–11	–
	mormon tea	EPVI	*Ephedra viridis*	0–11	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	6–11	–
	Stansbury cliffrose	PUST	*Purshia stansburiana*	0–11	–
	roundleaf buffaloberry	SHRO	*Shepherdia rotundifolia*	0–11	–
Tree					
4	**Trees**			28–56	
	Utah juniper	JUOS	*Juniperus osteosperma*	28–56	–
	twoneedle pinyon	PIED	*Pinus edulis*	0–28	–

Animal community

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

--Wildlife Interpretations--

The scarcity of water up on the mesas limits the species richness and the abundance of large mammals. This site provides thermal cover and limited forage opportunities for mule deer and elk. Birds, bats, lizards, snakes and rodents are more common. Birds from several families are common, from hawks to sparrows. Golden eagles and red-tailed hawks are common as well as the great horned-owl. Species typical of pinyon juniper areas including black-chinned and rufous hummingbirds, and several fly catchers, wood peckers. Corvids will use this site for nesting and foraging. Several species of rodents forage and occupy this site including desert cottontail, black tailed jack rabbit, Colorado chipmunk, white–tailed antelope squirrel, Apache pocket mouse, and several species of Peromyscus. Coyotes and kit foxes will also forage in the area; however dens are likely to be located in other ecological sites due to shallow soils and/or presence rocks fragments and rock outcrop. Bats (Myotis, Pipisturellus, and others) can be observed in this ecological site, but are likely limited to areas near water or canyons.

--Grazing Interpretations--
This site provides fair grazing conditions for livestock during spring, summer, and fall when in good ecological condition due to accessibility and nutritious forage. However, this site often lacks natural perennial water sources, which can influence the suitability grazing. Care should be taken to maintain the native perennial grasses and shrubs due to the poor suitability for re-seeding or restoring this site. The suitability for reseeding and/or restoration is poor due to the lack of precipitation at critical times and shallow soil characteristics.

The plant community is primarily shrubs, including black sagebrush, mormontea, rabbitbrush, and cliffrose, which provide browse for cattle, sheep, and goats. Cattle will typically only use mormontea in the late fall and winter when nutrient needs can not be met by palatable shrubs and dormant grasses alone. Rabbitbrush is rarely used as forage by livestock species. The presence of grasses, including Indian ricegrass, galleta, and Nevada bluegrass, provide grazing habitat for all classes of livestock. Utah juniper and pinyon pine provide good cover for livestock. 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.

Hydrological functions

The soils associated with this ecological site are generally in Hydrologic Soil Group D. Here runoff potential is high and infiltrations rates are relatively slow when the profile is wet, depending on slope and ground cover/health. This is explained by the shallow nature of the soils (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 increase and runoff potential is decreased. In areas where ground cover is less than 50%, infiltration is reduced and run-off potential is increased. Heavy used by livestock affects hydrology is two ways. Trampling increases bulk density and breaks down soil aggregates. This results in decreased infiltration rates and increased runoff. Heavy grazing can alter the hydrology by decreasing plant cover and increasing bare ground. Fire can also affect hydrology, but it is variable. Fire intensity, fuel type, soil, climate, and topography can each have different influences. Fire can increase areas of bare ground and hydrophobic layer that reduce infiltration and increase runoff.

Recreational uses

Recreation activities include aesthetic value and opportunities for camping, hiking and hunting. The more open canopy, gentle slopes, and proximity of this site to the canyon walls, makes this site popular for hiking trails. The tall trees and opens understory creates camp sites that provide shade and protection from the wind. Trees provide screening values for camping and picnicking. In addition, during certain years, this site provides good opportunities for pinyon nut collection.

Wood products

This site is a good site for gathering fence posts or firewood.

Other information

--Poisonous/Toxic Plant Communities--
Toxic plants associated with this site include woolly locoweed and broom snakeweed. Woolly locoweed is toxic to all classes of livestock and wildlife. Locoweed is palatable and has similar nutrient value to alfalfa, which may cause animals to consume it even when other forage is available. Locoweed contains swainsonine (indolizdine alkaloid) and is 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 typically only graze broom snakeweed when other forage is unavailable and generally in winter when toxicity levels are at their lowest. (Knight and Walter, 2001)

Potentially toxic plants associated with this site include Wyoming big sagebrush. Wyoming big sagebrush contains sesquiterpene lactones and monoterpenes which have been suspected of being toxic to sheep. An experimental dosage of ¾ lbs of big sagebrush fed to sheep for three days was found to be lethal. (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, cool/cloudy days, and soils high in nitrogen and low in sulfur and phosphorus, all which cause increased nitrate accumulation. Nitrate collects in the stems and can persist throughout the growing season. Clinical signs of nitrate poisoning include drowsiness, weakness, muscular tremors, increased heart and respiratory rates, staggering gait, and death. Conversely, oxalate poisoning causes kidney failure; clinical signs include muscle tremors, tetany, weakness, and depression. Poisoning generally occurs when livestock consume and are not accustomed to grazing oxalate-containing plants. Animals with prior exposure to oxalates have increased numbers of oxalate-degrading rumen microflora and thus are able to degrade the toxin before clinical poisoning can occur. (Knight and Walter, 2001)

--Invasive Plant Communities--
Generally as ecological conditions deteriorate and perennial vegetation decreases due to disturbance (fire, over grazing, drought, off road vehicle overuse, erosion, etc.) annual forbs and grasses will invade the site. Of particular concern in semi-arid environments are the non-native annual invaders including cheatgrass, Russian thistle, kochia, halogeton, and annual mustards. The presence of these species will depend on soil properties and moisture availability; however, these invaders are highly adaptive and can flourish in many locations. Once established, complete removal is difficult but suppression may be possible.

Inventory data references

The data collected in 2005-2007 were in conjunction with the soil survey update for Natural Bridges National Monument. 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

Other references

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Approval

Kirt Walstad, 1/06/2025

Rangeland health reference sheet

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

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Date	11/04/2008
Approved by	Kirt Walstad
Approval date	
Composition (Indicators 10 and 12) based on	Foliar Cover

Indicators

1. **Number and extent of rills:** Some rills are found throughout the site. Rills often begin at lower end of a water flow pattern or below exposed bedrock where water has accumulated sufficiently to cause erosion. Several rills may connect. Rills may be actively eroding with sharp sides as much as 2 inches high. Most rills will be 6 inches or less wide. Rills may extend 20 or more feet in length. Number of rills will be greater on the steeper slopes (>20 %) associated with this site but length of rills may be less on these slopes (as gullies are more likely to form on steep slopes).

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2. **Presence of water flow patterns:** Water flow patterns frequently form on soil surface as water flows from exposed bedrock and from undisturbed areas of biological crusts but not at sufficient quantity to cause erosion. The spaces between biological crusts seem to serve as water storage and flow patterns. Water flow patterns are often connected forming a branching pattern. Water flow patterns may exceed 30 feet in length on gentle (<10 %) sloping land, growing longer on steeper slopes.

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3. **Number and height of erosional pedestals or terracettes:** Short pedestals are often found at plant bases growing along sides of rills, but there should be no exposed roots. The interspaces between well formed biological crusts have an appearance of being pedestals. Teracettes form behind debris dams of small to medium sized branches in water flow patterns.

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground in the reference state is expected to range from 16-30 %. Except where covered by plant canopy cover, the primary areas of bare ground are in water flow patterns, and rills. Note that much of the area is covered with biological crusts which should not be recorded as bare ground; however there are some areas of weakly developed crust that may function as bare ground (raindrop splash, runoff, etc.) and should be so recorded as such.

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5. **Number of gullies and erosion associated with gullies:** A few gullies are found throughout the site and often begin

where rills converge or below exposed bedrock where sufficient water has accumulated to cause erosion. Gullies will deepen until bedrock is reached. Once bedrock is reached, a gully will continue to erode soil from the edges and become wider. Gullies will seldom be deeper than 20 inches because of shallow soil (<20 inches) depth. Gullies may be 4 or more feet wide.

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6. **Extent of wind scoured, blowouts and/or depositional areas:** The occurrence of wind scoured, blowouts, and/or depositional areas are rare. Trees intercept wind and prevent wind generated soil movement.

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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 (<¼ inch in diameter) may be moved in water flow patterns and rills, with deposition occurring at obstruction. Sites with well developed crust cover, 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 ¼ inch in diameter) are not likely to move under normal conditions. In areas below exposed bedrock, it is possible that gullies may remove litter from base of juniper and pinyon trees.

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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 5-6 throughout the site. Surface textures range from fine sandy loams to flaggy/gravelly/channery fine sandy loams.

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil surface is 3-5 inches deep and structure is typically described as fine granular. The A-horizon color is a light reddish brown (5YR6/3). 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, trees 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. The tree canopy is effective in intercepting rain drops and preventing splash erosion but configuration of crowns and litter accumulation under crowns forms micro-topography that may help accumulate water for more rapid runoff, particularly if bare soil lies below the outer edge of the canopy.

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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):** A compaction layer is not expected on this site; however, bedrock lies within 20 inches or less of the soil surface. Naturally occurring layers of hard calcium carbonate and/or unweathered parent material may also be found in the soil, but should not be considered a compaction layer.

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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: 15-30% trees (e.g. Two Needle Pinyon and Utah Juniper)
25-50% various species of biological crusts (e.g. moss, lichen, and cyanobacteria)

Sub-dominant: 10-20% shrubs (e.g. black sagebrush, green mormontea, and yellow rabbitbrush)
15-20% perennial grasses (e.g. Indian Ricegrass, Galleta, and Nevada Blue Grass)

Other: Other forbs, shrubs, and grasses

Additional: Perennial and annual forbs can be expected to vary widely in their expression in the plant community based upon departures from average growing conditions. 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):** Mix of young, medium aged, and old pinyon and Utah juniper are expected to be found on this site. During years with average to above average precipitation, there should be very little mortality or decadence apparent in either shrubs or grasses. Old and young tree mortality and decadence naturally occurs during severe droughts. Insects and droughts may combine to increase death of pinyon. Insects may also cause some death and decadence of sagebrush during natural cycles.

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14. **Average percent litter cover (%) and depth (in):** Litter cover ranges from 1-5%. Most litter accumulates at below and to the side of live plants, and thus percent litter will be just slightly above percent of canopy cover. Litter associated with forbs is less than .10 inches deep, while litter under shrubs is .25 to .5 inches deep and litter under trees is 100% and .5 to 1 inches deep. Bare interspaces of water flow patterns, rill, and gullies do not have litter except where debris dams occur. Very little litter is found on areas of biological crusts

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** 350 to 450 pounds per acre in 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 Information:** NRCS (Dana Truman) 2006 ESD data from Natural Bridges National Monument.
