USDA Natural Resources
Conservation Service

Ecological site R036XY307UT
Upland 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.

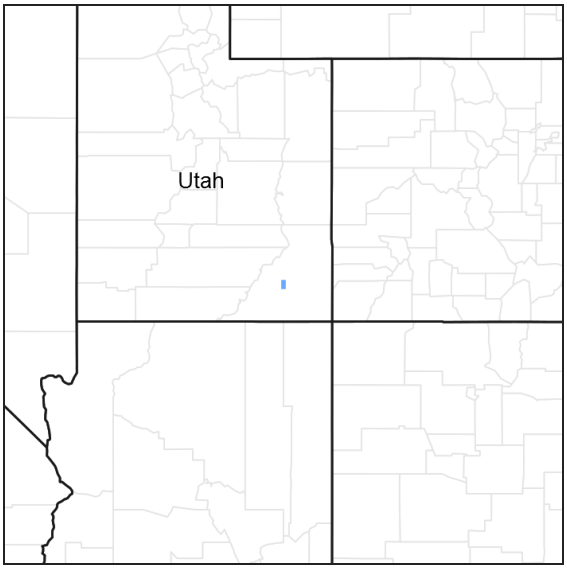


Figure 1. Mapped extent

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, et. al, 2001)
Intermountain Semidesert and Desert Province, 341 (Bailey, 1995)

Associated sites

R036XY315UT	**Upland Shallow Loam (pinyon-Utah juniper)**

Similar sites

R036XY306UT	**Upland Loam (big sagebrush)** Upland Loam (Big Sagebrush) 036XY306UT – Distinguished by the age class of the trees that occur on the site. Upland Loam (Big Sagebrush) typically has young (post-European settlement) age class trees, and Upland Loam (Pinyon – Utah juniper) typically has old age class (pre-European settlement) age class trees dominating. Upland Loam (Big Sagebrush) typically occurs on flatter slopes near the interior of mesas, lacking micro topography and Upland Loam (Pinyon – Utah juniper) typically occurs on soils with an abundance of micro topography near the edges of mesas.

Table 1. Dominant plant species

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

Physiographic features

This site most commonly occurs on mesa edges and structural benches, but may also occur on cuestas, plateaus, hills, and ridges. Run-off is variable, and is greatly influenced by micro-topography. This site has low to medium runoff on slopes less than 12 percent and very rapid runoff on slopes greater than 12 percent. Typically slopes range from 2-40%.

Table 2. Representative physiographic features

Landforms	(1) Mesa (2) Structural bench
Flooding frequency	None
Ponding frequency	None
Elevation	5,500–7,500 ft
Slope	2–40%
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)	14 in

Influencing water features

There are no water features influencing this site.

Soil features

This site is characterized by small hummocks, with an abundance of microtopography. The soils are deep to very deep and well drained. Typically the surface layer is a dark yellowish brown sandy loam and the sub surface is a brown to light reddish brown sandy loam to sandy clay loam. These soils are well developed with moderately high water holding capacities. Surface fragments range from 0 to 5% and are described as gravels. Average annual soil loss in potential is approximately 0.5 to 2.0 tons/acre. This site has been used in the following soil surveys and has been correlated to the following components:

UT638—Natural Bridges National Monument, UT – Plumasano

Typical Soil Profile:

A—0-2 inches; dark yellowish brown; sandy loam; week fine granular; slightly alkaline (pH 7.6)
Bw—2-11 inches; brown; sandy loam; weak medium subangular blocky; slightly alkaline (pH 7.6)
Bk1—11-27 inches; light brown; sandy loam; massive; slightly alkaline (pH 7.6)
Bk2—27-43 inches; strong brown; fine sandy loam; massive; slightly alkaline (pH 7.4)
Bk3—43-53 inches; light reddish brown; fine sandy loam; massive; slightly alkaline (pH 7.8)
Bk4—53-65 inches; light brown; sandy clay loam; massive; slightly alkaline (pH 7.6)

The combined thickness of the Bk horizons in 36 to 60 inches. This soil may at times have a C horizon.

Table 4. Representative soil features

Surface texture	(1) Sandy loam (2) Fine sandy loam
Family particle size	(1) Loamy
Drainage class	Well drained to somewhat excessively drained
Permeability class	Moderate to moderately rapid
Soil depth	20–60 in
Surface fragment cover <=3"	0–5%
Surface fragment cover >3"	0%
Available water capacity (0-40in)	6–7 in
Calcium carbonate equivalent (0-40in)	10–15%
Electrical conductivity (0-40in)	0–2 mmhos/cm
Sodium adsorption ratio (0-40in)	6–8
Soil reaction (1:1 water) (0-40in)	7.5–8
Subsurface fragment volume <=3" (Depth not specified)	0–5%
Subsurface fragment volume >3" (Depth not specified)	0%

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 large herds of native herbivores or large, frequent fires. This ecological site occurs on the deep to very deep, well developed soils found on mesa edges 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.

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 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, soils, or other factors.

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.

--Reference State (State 1)--
The Reference State has been determined by study of rangeland relic areas, areas protected from excessive disturbance, and areas under influences such as grazing and recreational uses. Through literature review, historical accounts and observations of trends in plant community dynamics under a variety of uses have been considered. Community phases, community pathways, states, transitions, thresholds, and restoration pathways have been determined through similar studies and experience.

This state represents the natural range of variability that historically dominated the dynamics of this ecological site. This state includes the biotic communities that would have been expressed on the ecological site if all successional sequences were completed without interferences by man under the present environmental conditions; natural disturbances are inherent in its development. It was in a natural dynamic equilibrium with the historic biotic, abiotic, climatic factors at the time of European immigration and settlement. The dominant aspect of this site is Pinyon and Utah Juniper with an understory of big sagebrush and associated grasses. Fluctuations in species compositions and relative production may change from year to year dependant upon abnormal precipitation or other climatic factors. The primary disturbance mechanisms for this site in reference condition include drought, insects, and very rare fire. Because catastrophic disturbances like a crown fire or drought happen with long intervals, these communities have long periods of succession, (i.e. long periods of dense Pinyon and Juniper)—200-400 years. In the semi-arid environment of this ecological site, fine fuels are typically not continuous, reducing the likelihood of short fire return intervals. Typically, fires occurred in late spring through mid summer following several wet years that allowed the fine fuels to become more contiguous (Baisan and Swetnam, 1990, and Swetnam and Baisan, 1996). The timing of drought, and fire, coupled with surface disturbance can dictate whether the community can stay within the reference state or if the community transitions into another state

Reference state: Community phases maintained by drought, insects, and infrequent fires.

Indicators: A well developed understory co-existing with a canopy of older Pinyon and Utah juniper.

Feedbacks: Infrequent, but regular droughts to reduce tree cover and allow for a productive herbaceous understory. The loss of native herbaceous understory species that results in opportunities for erosion.

At-risk Community Phase: All communities are at risk when native plants in the understory are stressed, and nutrients become available for non-natives to establish.

Trigger: Decrease of native plants in the understory and the introduction of non-native plants to fill the available niches.

--Transition from Reference State (State 1) to Current Potential State (State 2)--
T1a– This transition from the native perennial bunchgrass and shrub understory in the reference state to a state that has been invaded by naturalized species such as crested wheatgrass (blown in), cheatgrass, and annual wheatgrass. This transition occurs as natural and/or management actions favor an increase in non-native grasses and forbs, especially annuals. Possible events include the mere presence of invasive species, improper livestock grazing, extended droughts, and fire combined with an available seed source of non-native species.

--Current Potential State (State 2)--
This state is very similar to the reference state, except that non-native grasses and/or forbs are present in all phases. The current potential state may include naturalized or invasive non-native species. The primary disturbance mechanisms include all those found in the reference state as well as human induced disturbances, including improper domestic livestock grazing and recreation activities, including off highway vehicle (OHV) overuse. Plant communities within the current potential state are more likely managed and used for various purposes by man, without significant alteration in plant community composition or production. In time, continued surface disturbances, will likely stress the native plant species and allow for non-native 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 this site, once they have become established. Therefore this site is often irreversibly altered from the reference state.

Current Potential State: Community phases maintained by drought, insects, and infrequent fires, domestic livestock grazing, and vegetation manipulation by man.

Indicators: A well developed understory co-existing with a canopy of older Pinyon and Utah juniper.

Feedbacks: Infrequent, but regular droughts to reduce tree cover and allow for a productive herbaceous understory. Rarely, short fire intervals that result in complete loss of the perennial native shrub and grass community and an increase in non-native invasive annual grasses. Vegetation manipulation by man, such as chaining, burning, seeding, etc.

At-risk Community Phase: All plant communities are at risk for the increased establishment of annual grasses and forbs; however plant community 2.2 is likely most at risk due to its limited understory.

Trigger: Frequent fire return interval that allows for in the complete dominance of annual grasses and forbs. Vegetation manipulation by man.

--Transition from Current Potential State (State 2) to Invasive Annual State (State 3)--
T2a – This transition occurs as the fire return interval decreases and allows for cheatgrass or other invasive grasses and forbs to dominate and control the ecological dynamics of the site. Once cheatgrass controls these dynamics an ecological threshold has been crossed.

--Transition from Current Potential State (State 2) to Seeded State (State 4)--
T2b – This transition occurs when after high amounts of energy inputs by man have been put into the system. The trees and/or shrubs have been removed with vegetation manipulation techniques (i.e. chemical, mechanical, or fire) and introduced species that are adapted to the area and management needs have been established.

--Invasive Annual State (State 3)--
This state is recognized by the predominance of invasive annuals. Invasive annuals have increased to a point where they influence or drive the disturbance regime and the nutrient cycle and energy flow, altering it from the regimes and cycles associated with sagebrush ecosystems. Research has shown that plant species differ substantially in their effects on soil water content and temperature and their effects on the frequency and intensity of disturbance. Once exotic plants like cheatgrass or Russian thistle have invaded a site fundamental nutrient cycling processes are known to change (Chapin et al., 1997). Energy flow in this state is severely suppressed, with photosynthesis occurring only during a brief period in the spring. Cheatgrass invasion has also been shown to change the composition root pores, mycorrhizal associations, and assemblages of microbial species potentially

affecting soil structure and the rate of soil organic matter decomposition (Belknap and Phillips, 2001). The altered disturbance regime and the loss of soil organic matter could create ecologically impoverished sites that are very difficult, if not impossible to restore to functionally diverse perennial herbaceous and woody communities.

Invasive Annuals State: Community phases maintained by fire, drought, livestock grazing; vegetation management, and time without disturbances.

Indicators: An annual grass or forb understory, where big sagebrush may or may not be present

Feedbacks: Short fire intervals, which maintain the annual grass and forb understory. Longer fire intervals, vegetation management, or livestock grazing that allows for the sagebrush overstory to reestablish.

At-risk Community Phase: Community 3.2 is the most at risk when cheatgrass or other annuals completely dominate the site, shortening the fire return interval that maintains the annual grass/forb community.

--Transition from Invasive Annuals State (State 3) to Seeded State (State 4)--
T3a – Successful completion of this transition is difficult with current knowledge of adapted plants, soil preparation and seed techniques. Large amounts of input and management are required for the establishment of a perennial introduced/adapted grass. This transition occurs when the invasive annuals are treated and removed from dominance and the desired species (typically non-native perennials that can successfully compete) are seeded and established. At this time, restoring from the invasive annuals state directly to a native grass community has not been successful possibly due to changes in the soil caused by the cheatgrass.

--Seeded State (State 4)--
This state results from a significant vegetation manipulation that may include prescribed burning, chaining, disking, mowing, or other technique, with the introduction of non-native perennial grasses such as Crested wheatgrass or Russian wildrye. The dominant understory plant species are the seeded grasses and forbs. The community dynamics are similar to the Current Potential State. Depending on the species used for the reseeding practice, the site could have more resistance to fire as well as better tolerance to grazing pressure. This state may persist for long periods of time. Typically, big sagebrush will reestablish in the seeding to significant proportions within 30 years. Actively manipulating plant communities in the invasive annuals or Juniper invasion states to create a seeded range state is often the first step in assisted succession to restore natural plant communities back to something similar to the Current Potential State.

Seeded State: Community phases maintained by fire, continued vegetation manipulation, insect herbivory, drought, and time without disturbances.

Indicators: A developed perennial herbaceous understory of seeded species, typically non-natives, co-existing with a canopy of big sagebrush.

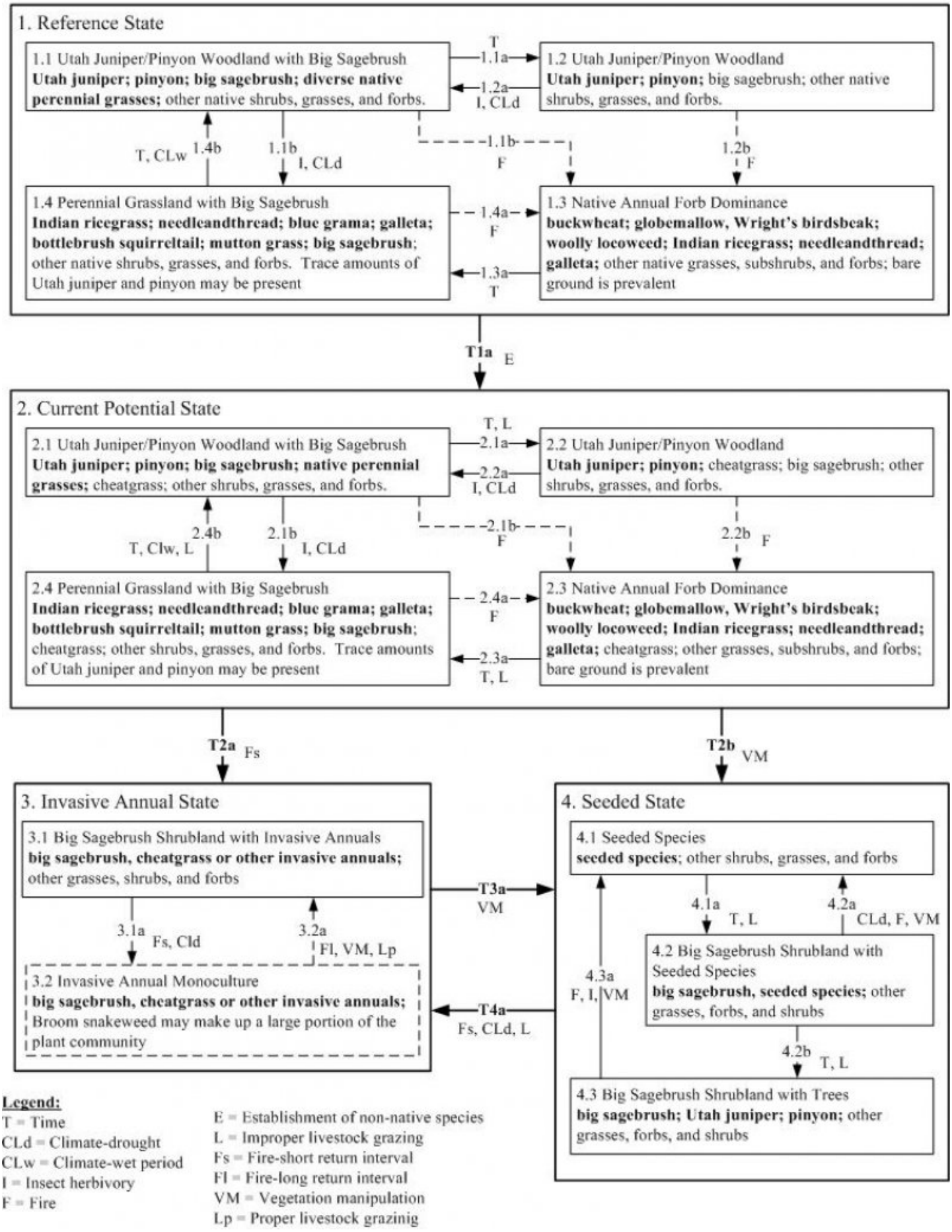
Feedbacks: Infrequent, but regular droughts that reduce grass cover. Moist cycles that maintain perennial bunch grasses. Fire, insect herbivory, and/or vegetation management that allows for the removal of trees. Improper grazing resulting in a loss of the herbaceous understory, an increase in invasive plants, and an increase in the fire return interval.

At-risk Community Phase: All communities are at risk when non-native invasive annual species increase to a point where they begin to drive the ecological dynamics of the site.

--Transition from Seeded State (State 4) to Invasive Annuals State (State 5)--
T4a – This transition occurs when events favor the establishment and dominance of invasive annuals. Events may include improper grazing which reduces the perennial bunch grasses, an extended drought, increased surface disturbance through off road vehicle use or other surface disturbance, or a shortened fire return interval, all of which can stress the native perennial bunchgrasses.

State and transition model

R036XY307UT Upland Loam (Pinyon-Utah Juniper)



State 1

Reference

The Reference state has been determined by study of rangeland relic areas, areas protected from excessive disturbance, and areas under influences such as grazing and recreational uses. Through literature review, historical accounts and observations of trends in plant community dynamics under a variety of uses have been considered. Community phases, community pathways, states, transitions, thresholds, and restoration pathways have been determined through similar studies and experience. This state represents the natural range of variability that historically dominated the dynamics of this ecological site. This state includes the biotic communities that would have been expressed on the ecological site if all successional sequences were completed without interferences by man under the present environmental conditions; natural disturbances are inherent in its development. It was in a natural dynamic equilibrium with the historic biotic, abiotic, climatic factors at the time of European immigration and settlement. The dominant aspect of this site is Pinyon and Utah Juniper with an understory of big sagebrush and associated grasses. Fluctuations in species compositions and relative production may change from year to year dependant upon abnormal precipitation or other climatic factors. The primary disturbance mechanisms for this site in reference condition include drought, insects, and very rare fire. Because catastrophic disturbances like a crown fire or drought happen with long intervals, these communities have long periods of succession, (i.e. long periods of dense Pinyon and Juniper)—200-400 years. In the semi-arid environment of this ecological site, fine fuels are typically not continuous, reducing the likelihood of short fire return intervals. Typically, fires occurred in late spring through mid summer following several wet years tha allowed the fine fuels to become more contiguous (Baisan and Swetnam, 1990, and Swetnam and Baisan, 1996). The timing of drought, and fire, coupled with surface disturbance can dictate whether the community can stay within the reference state or if the community transitions into another state Reference state: Community phases maintained by drought, insects, and infrequent fires. Indicators: A well developed understory co-existing with a canopy of older Pinyon and Utah juniper. Feedbacks: Infrequent, but regular droughts to reduce tree cover and allow for a productive herbaceous understory. The loss of native herbaceous understory species that results in opportunities for erosion. At-risk Community Phase: All communities are at risk when native plants in the understory are stressed, and nutrients become available for non-natives to establish. Trigger: Decrease of native plants in the understory and the introduction of non-native plants to fill the available niches.

Community 1.1
Utah Juniper and Pinyon Woodland with Big Sagebrush

This community phase is dominated by Utah Juniper and Pinyon, with a well developed shrub and perennial grass understory. Grasses present typically include Indian ricegrass, needle and thread, blue grama, bottlebrush squirreltail, galleta, and muttongrass. Other shrubs present besides Basin big sagebrush, include Winterfat, Fourwing saltbush, and Green mormontea. The presence of perennial and annual forbs varies greatly depending on soil, seed source, and growing conditions. Bare ground is typically limited due to well developed biological crusts; however both of these can vary greatly in their expressions when measured as first raindrop impact. Surface rock fragments range from 0 to 5% cover and are generally described as gravels.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	350	450	550
Tree	100	300	500
Shrub/Vine	100	250	350
Forb	5	50	100
Total	**555**	**1050**	**1500**

Table 6. Ground cover

Tree foliar cover	10-15%
Shrub/vine/liana foliar cover	10-20%
Grass/grasslike foliar cover	50-75%
Forb foliar cover	5-10%

Non-vascular plants	0%
Biological crusts	15-35%
Litter	5-10%
Surface fragments >0.25" and <=3"	0-5%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	15-35%

Table 7. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	–	5-10%	1-10%
>0.5 <= 1	–	0-5%	25-50%	1-5%
>1 <= 2	–	5-10%	25-50%	0-5%
>2 <= 4.5	–	5-10%	–	–
>4.5 <= 13	5-10%	–	–	–
>13 <= 40	5-10%	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Community 1.2
Utah Juniper and Pinyon Woodland

This community phase is characterized by a mature Pinyon and Utah juniper woodland. The prevailing weather patterns favor an increase on Pinyon and Utah juniper canopy with and understory of grasses and forbs. Grasses include Indian ricegrass, Needle and thread, Galleta, blue grama, and muttongrass. Depending on the timing of precipitation, cool season grasses or warm season grasses could dominate. The occurrence of big sagebrush and other shrubs decreases dramatically due to their inability to compete with the trees for nutrients. Interspaces supporting highly developed lichen crusts are common, but are variable depending on the amount and distribution of bare ground.

Table 8. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Tree	350	450	550
Grass/Grasslike	200	300	400
Shrub/Vine	25	75	125
Forb	5	50	100
Total	**580**	**875**	**1175**

Table 9. Ground cover

Tree foliar cover	15-25%
Shrub/vine/liana foliar cover	5-10%
Grass/grasslike foliar cover	45-65%
Forb foliar cover	5-10%

Non-vascular plants	0%
Biological crusts	25-45%
Litter	5-10%
Surface fragments >0.25" and <=3"	0-5%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	15-35%

Table 10. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	–	5-10%	1-10%
>0.5 <= 1	–	0-5%	20-40%	1-5%
>1 <= 2	–	5-10%	20-40%	0-5%
>2 <= 4.5	–	0-5%	–	–
>4.5 <= 13	5-20%	–	–	–
>13 <= 40	10-25%	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Community 1.3
Native Annual Forb Dominance

This community phase is rare due to it being a result of a fire, which is rare in the Colorado Plateau and MLRA 36. This phase is dominated by native annual and perennial forbs and grasses; although immediately following a fire it will be dominated by annual forbs. Commonly occurring forbs include Buckwheat species, Globemallow, Wright's birdsbeak, and Wooly locoweed; however these and forbs may or may not be present depending on seed source, soil conditions, and growing conditions. Commonly seen perennial grasses include Indian ricegrass, Needle and thread, and Galleta. Bare ground is most common in this community phase, when compared to the other phases in the reference state. Biological crust cover typically is very low immediately following a fire, but it may start to recover as early as the first following a fire; however this is greatly dependent upon biological soil crust condition before the fire, fire intensity, and structure of the vascular plant community (Belnap et al., 2001).

Table 11. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Forb	200	400	600
Grass/Grasslike	300	400	500
Shrub/Vine	0	0	0
Tree	0	0	0
Total	**500**	**800**	**1100**

Table 12. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	0%

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

Table 13. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	–	5-10%	1-10%
>0.5 <= 1	–	–	20-40%	10-20%
>1 <= 2	–	–	20-40%	10-20%
>2 <= 4.5	–	–	–	–
>4.5 <= 13	–	–	–	–
>13 <= 40	–	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Community 1.4
Perennial Grassland with Big Sagebrush

This community phase is dominated by perennial grasses and Basin big sagebrush. Grasses present typically include Indian ricegrass, Needle and thread, Blue grama, Galleta, Bottlebrush squirreltail, and Mutton grass. Other grasses, shrubs, and forbs may also be present but cover and species composition is variable. The reestablishment of trees is starting on this site, due to the “safe sites” created by the shrub canopy. Biological crusts have recovered to preburn conditions and bare ground is variable depending on biological crust cover.

Table 14. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	350	450	550
Shrub/Vine	100	200	300
Tree	75	100	125
Forb	5	50	100
Total	**530**	**800**	**1075**

Table 15. Ground cover

Tree foliar cover	3-5%
Shrub/vine/liana foliar cover	10-30%
Grass/grasslike foliar cover	50-75%

Forb foliar cover	5-10%
Non-vascular plants	0%
Biological crusts	15-35%
Litter	5-10%
Surface fragments >0.25" and <=3"	0-5%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	15-35%

Table 16. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	–	5-10%	1-10%
>0.5 <= 1	–	0-5%	25-50%	1-5%
>1 <= 2	–	10-20%	25-50%	0-5%
>2 <= 4.5	–	10-20%	–	–
>4.5 <= 13	0-5%	–	–	–
>13 <= 40	0-5%	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Pathway 1.1A
Community 1.1 to 1.2

This pathway follows natural succession for this ecological site. As time passes, Utah juniper and Pinyon increase and the diverse understory becomes limited. Trees, especially Utah juniper, are able outcompete shrubs and grasses for nutrients. As length between fires, insect infestations, and droughts increase, tree establishment and growth also increases and trees are able to dominate the site.

Pathway 1.1B
Community 1.1 to 1.3

This pathway is rare, and occurs following a devastating fire. Fires are atypical on the Colorado Plateau in Southeastern Utah where this site occurs. However, they can happen given the right conditions. 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 with dense Pinyon); crown sizes can increase and the community may become susceptible to crown fires.

Pathway 1.1C
Community 1.1 to 1.4

This pathway occurs as insect infestations and drought disfavor the establishment and growth of Pinyon and Utah juniper, allowing for the increase in available nutrients to native shrubs and perennial grasses.

Pathway 1.2A
Community 1.2 to 1.1

This pathway occurs as insect infestations and drought disfavor the establishment and growth of Pinyon and Utah

juniper, allowing for the increase in available nutrients to native shrubs and perennial grasses.

Pathway 1.2B
Community 1.2 to 1.3

This pathway is rare, and occurs following a devastating fire. Fires are atypical on the Colorado Plateau in Southeastern Utah where this site occurs. However, they can happen given the right conditions. 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 with dense Pinyon); crown sizes can increase and the community may become susceptible to crown fires.

Pathway 1.3A
Community 1.3 to 1.4

This community follows the natural successional pathway that occurs after a fire. With time perennial grasses tend to out-compete the annual and perennial forbs and dominate the ecological site. Big sagebrush, other shrubs, and trees are also reestablishing.

Pathway 1.4B
Community 1.4 to 1.1

This pathway is the natural successional pathway for this ecological site. Time combined with favorable climatic conditions allow for the reestablishment of Utah juniper and Pinyon on this site, with a minor decrease in the shrub understory.

Pathway 1.4A
Community 1.4 to 1.3

This pathway is rare, and occurs following a devastating fire. Fires are atypical on the Colorado Plateau in Southeastern Utah where this site occurs. This however can happen given the right conditions. 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 with dense Pinyon); crown sizes can increase and the community may become susceptible to crown fires.

State 2
Current Potential

This state is very similar to the reference state, except that non-native grasses and/or forbs are present in all phases. The current potential state may include naturalized or invasive non-native species. The primary disturbance mechanisms include all those found in the reference state as well as human induced disturbances, including improper domestic livestock grazing and recreation activities, including off highway vehicle (OHV) overuse. Plant communities within the current potential state are more likely managed and used for various purposes by man, without significant alteration in plant community composition or production. In time, continued surface disturbances, will likely stress the native plant species and allow for non-native 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 this site, once they have become established. Therefore this site is often irreversibly altered from the reference state. Current Potential State: Community phases maintained by drought, insects, and infrequent fires, domestic livestock grazing, and vegetation manipulation by man. Indicators: A well developed understory co-existing with a canopy of older Pinyon and Utah juniper. Feedbacks: Infrequent, but regular droughts to reduce tree cover and allow for a productive herbaceous understory. Rarely, short fire intervals that result in complete loss of the perennial native shrub and grass community and an increase in non-native invasive annual grasses. Vegetation manipulation by man, such as chaining, burning, seeding, etc. At-risk Community Phase: All plant communities are at risk for the increased establishment of annual grasses and forbs; however plant community 2.2 is likely most at risk due to its limited understory. Trigger: Frequent fire return interval that allows for in the complete dominance of annual grasses and forbs. Vegetation manipulation by man.

Community 2.1

Utah Juniper and Pinyon Woodland with Big Sagebrush

This community phase is dominated by Utah Juniper and Pinyon, with a well developed shrub and perennial grass understory. Grasses present typically include Cheatgrass, Indian ricegrass, Needle and thread, Blue grama, Bottlebrush squirreltail, Galleta, and muttongrass. Other shrubs present besides Basin big sagebrush include winterfat, fourwing saltbush, and green mormontea. The presence of perennial and annual forbs varies greatly depending on soil, seed source, and growing conditions. Bare ground is typically limited due to well developed biological crusts; however both of these can vary greatly in their expressions. Surface rock fragments range from 0 to 5% cover and are generally described as gravels.

Table 17. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	350	450	550
Tree	100	300	500
Shrub/Vine	100	250	350
Forb	5	50	100
Total	**555**	**1050**	**1500**

Table 18. Ground cover

Tree foliar cover	10-15%
Shrub/vine/liana foliar cover	10-20%
Grass/grasslike foliar cover	50-75%
Forb foliar cover	5-10%
Non-vascular plants	0%
Biological crusts	15-35%
Litter	5-10%
Surface fragments >0.25" and <=3"	0-5%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	15-35%

Table 19. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	–	5-10%	1-10%
>0.5 <= 1	–	0-5%	25-50%	1-5%
>1 <= 2	–	5-10%	25-50%	0-5%
>2 <= 4.5	0-5%	5-10%	–	–
>4.5 <= 13	10-15%	–	–	–
>13 <= 40	10-15%	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Community 2.2

Utah Juniper and Pinyon Woodland

This community phase is characterized by a mature Pinyon and Utah juniper woodland. The prevailing weather patterns favor an increase on Pinyon and Utah juniper canopy with and understory of grasses and forbs. Grasses include Cheatgrass, Indian ricegrass, Needle and thread, Galleta, Blue grama, and Muttongrass. Depending on the timing of precipitation, cool season grasses or war season grasses could dominate. The occurrence of big sagebrush and other shrubs decreases dramatically due to their inability to compete with the trees for nutrients. Interspaces supporting highly developed lichen crusts are common, but are variable depending on the amount and distribution of bare ground.

Table 20. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Tree	350	450	550
Grass/Grasslike	200	300	400
Shrub/Vine	25	75	125
Forb	5	50	100
Total	**580**	**875**	**1175**

Table 21. Ground cover

Tree foliar cover	15-25%
Shrub/vine/liana foliar cover	5-10%
Grass/grasslike foliar cover	45-65%
Forb foliar cover	5-10%
Non-vascular plants	0%
Biological crusts	25-45%
Litter	5-10%
Surface fragments >0.25" and <=3"	0-5%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	15-35%

Table 22. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	–	5-10%	1-10%
>0.5 <= 1	–	0-5%	20-40%	1-5%
>1 <= 2	–	5-10%	20-40%	0-5%
>2 <= 4.5	0-5%	0-5%	0-5%	–
>4.5 <= 13	5-20%	–	–	–
>13 <= 40	10-25%	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Community 2.3

Native Annual Forb Dominance

This community phase is rare due to it being a result of a fire, which is rare in the Colorado Plateau and MLRA 36. This phase is dominated by native annual and perennial forbs and grasses; although immediately following a fire it will be dominated by annual forbs. Commonly occurring forbs include Buckwheat species, Globemallow, Wright's birdsbeak, and Wooly locoweed; however these and forbs may or may not be present depending on seed source, soil conditions, and growing conditions. Commonly seen grasses include Cheatgrass, Indian ricegrass, Needle and thread, and Galleta. Bare ground is most common in this community phase, when compared to the other phases in the reference state. Biological crust cover typically is very low immediately following a fire, but it may start to recover as early as the first following a fire; however this is greatly dependent upon biological soil crust condition before the fire, fire intensity, and structure of the vascular plant community (Belnap et al., 2001).

Table 23. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Forb	200	400	600
Grass/Grasslike	300	400	500
Shrub/Vine	0	0	0
Tree	0	0	0
Total	**500**	**800**	**1100**

Table 24. Ground cover

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

Table 25. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	–	5-10%	1-10%
>0.5 <= 1	–	–	20-40%	10-20%
>1 <= 2	–	–	20-40%	10-20%
>2 <= 4.5	–	–	0-5%	–
>4.5 <= 13	–	–	–	–
>13 <= 40	–	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Community 2.4
Perennial Grassland with Big Sagebrush

Current Potential state--Perennial Grassland with Big Sagebrush--2.4 This community phase is dominated by perennial grasses and Basin big sagebrush. Grasses present typically include Cheatgrass, Indian ricegrass, Needle and thread, Blue grama, Galleta, Bottlebrush squirreltail, and Mutton grass. Other grasses, shrubs, and forbs may also be present but cover and species composition is variable. The reestablishment of trees is starting on this site, due to the “safe sites” created by the shrub canopy. Biological crusts have recovered to pre-burn conditions and bare ground is variable depending on biological crust cover.

Table 26. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	350	450	550
Shrub/Vine	100	200	300
Tree	75	100	125
Forb	5	50	100
Total	**530**	**800**	**1075**

Table 27. Ground cover

Tree foliar cover	3-5%
Shrub/vine/liana foliar cover	10-30%
Grass/grasslike foliar cover	50-70%
Forb foliar cover	5-10%
Non-vascular plants	0%
Biological crusts	15-35%
Litter	5-10%
Surface fragments >0.25" and <=3"	0-5%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	15-35%

Table 28. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	–	5-10%	1-10%
>0.5 <= 1	–	0-5%	25-50%	1-5%
>1 <= 2	–	10-20%	25-50%	0-5%
>2 <= 4.5	–	10-20%	–	–
>4.5 <= 13	0-5%	–	–	–
>13 <= 40	0-5%	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Pathway 2.1A

Community 2.1 to 2.2

This pathway follows the natural succession pathway for this ecological site. As time passes, Utah juniper and Pinyon increase and the diverse understory becomes limited. Trees, especially Utah juniper, are able outcompete shrubs and grasses for nutrients. As length between fires, insect infestations, and droughts increase, tree establishment and growth also increases and trees are able to take over and dominate the site. Improper livestock grazing may also facilitate this pathway.

Pathway 2.1B
Community 2.1 to 2.3

This pathway is rare, and occurs following a devastating fire. Fires are atypical on the Colorado Plateau in Southeastern Utah where this site occurs. This however can happen given the right conditions. 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 with dense Pinyon); crown sizes can increase and the community may become susceptible to crown fires.

Pathway 2.1C
Community 2.1 to 2.4

This pathway occurs as insect infestations and drought disfavor the establishment and growth of Pinyon and Utah juniper, allowing for the increase in available nutrients to native shrubs and perennial grasses.

Pathway 2.2A
Community 2.2 to 2.1

This pathway occurs as insect infestations and drought disfavor the establishment and growth of Pinyon and Utah juniper, allowing for the increase in available nutrients to native shrubs and perennial grasses.

Pathway 2.2B
Community 2.2 to 2.3

This pathway is rare, and occurs following a devastating fire. Fires are atypical on the Colorado Plateau in Southeastern Utah where this site occurs. This however can happen given the right conditions. 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 with dense Pinyon); crown sizes can increase and the community may become susceptible to crown fires.

Pathway 2.3A
Community 2.3 to 2.4

This community follows the natural successional pathway that occurs after a fire. With time perennial grasses tend to out-compete the annual and perennial forbs and dominate the ecological site. Big sagebrush, other shrubs, and trees are also reestablishing. Livestock grazing may accelerate this pathway.

Pathway 2.4B
Community 2.4 to 2.1

This pathway is the natural successional pathway for this ecological site. Time combined with favorable climatic conditions allow for the reestablishment of Utah juniper and Pinyon on this site, with a minor decrease in the shrub understory. Improper livestock grazing may also accelerate this pathway.

Pathway 2.4A
Community 2.4 to 2.3

This pathway is rare, and occurs following a devastating fire. Fires are atypical on the Colorado Plateau in Southeastern Utah where this site occurs. This however can happen given the right conditions. 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 with dense Pinyon); crown sizes can increase and the community may become susceptible to crown fires.

State 3
Invasive Annual

This state is recognized by the predominance of invasive annuals. Invasive annuals have increased to a point where they influence or drive the disturbance regime and the nutrient cycle and energy flow, altering it from the regimes and cycles associated with sagebrush ecosystems. Research has shown that plant species differ substantially in their effects on soil water content and temperature and their effects on the frequency and intensity of disturbance. Once exotic plants like cheatgrass or Russian thistle have invaded a site fundamental nutrient cycling processes are known to change (Chapin et al., 1997). Energy flow in this state is severely suppressed, with photosynthesis occurring only during a brief period in the spring. Cheatgrass invasion has also been shown to change the composition root pores, mycorrhizal associations, and assemblages of microbial species potentially affecting soil structure and the rate of soil organic matter decomposition (Belknap and Phillips, 2001). The altered disturbance regime and the loss of soil organic matter could create ecologically impoverished sites that are very difficult, if not impossible to restore to functionally diverse perennial herbaceous and woody communities. Invasive Annuals State: Community phases maintained by fire, drought, livestock grazing; vegetation management, and time without disturbances. Indicators: An annual grass or forb understory, where big sagebrush may or may not be present Feedbacks: Short fire intervals, which maintain the annual grass and forb understory. Longer fire intervals, vegetation management, or livestock grazing that allows for the sagebrush overstory to reestablish. At-risk Community Phase: Community 3.2 is the most at risk when cheatgrass or other annuals completely dominate the site, shortening the fire return interval that maintains the annual grass/forb community.

Community 3.1
Big Sagebrush Shrubland with Invasive Annuals

This community phase is dominated by an annual invasive understory with a big sagebrush canopy. Often, the sagebrush canopy is dense because disturbance factors have reduced the understory and nutrients are available. The interspaces are often bare, but may support slightly developed biological crusts.

Table 29. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	200	500	800
Shrub/Vine	50	100	200
Forb	50	75	100
Tree	0	10	15
Total	**300**	**685**	**1115**

Table 30. Ground cover

Tree foliar cover	0-4%
Shrub/vine/liana foliar cover	10-30%
Grass/grasslike foliar cover	20-50%
Forb foliar cover	0-15%
Non-vascular plants	0-1%
Biological crusts	0-10%
Litter	5-10%
Surface fragments >0.25" and <=3"	0-5%
Surface fragments >3"	0%
Bedrock	0%

Water	0%
Bare ground	40-70%

Table 31. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	–	10-40%	0-5%
>0.5 <= 1	–	0-5%	20-50%	0-5%
>1 <= 2	–	5-10%	0-5%	0-5%
>2 <= 4.5	–	5-15%	0-5%	–
>4.5 <= 13	–	–	–	–
>13 <= 40	–	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Community 3.2
Invasive Annual Monoculture

This community phase is characterized by an almost a complete monoculture of cheatgrass or other invasive annuals. This state is typically self-enhancing and potentially perpetual state if fires continue to be frequent. This community is especially difficult for many of the traditional sagebrush wildlife species because forage and structural diversity is limiting. This community is also difficult to graze with domestic livestock because the forage availability is dependant on a singles species response to the timing and amount of moisture.

Table 32. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	200	500	800
Shrub/Vine	25	50	100
Forb	10	20	40
Tree	0	0	0
Total	**235**	**570**	**940**

Table 33. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	0-5%
Grass/grasslike foliar cover	50-95%
Forb foliar cover	0-15%
Non-vascular plants	0%
Biological crusts	0-10%
Litter	10-25%
Surface fragments >0.25" and <=3"	0-5%
Surface fragments >3"	0%
Bedrock	0%

Water	0%
Bare ground	5-10%

Table 34. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	0-5%	10-40%	0-5%
>0.5 <= 1	–	0-5%	10-80%	0-5%
>1 <= 2	–	–	–	0-5%
>2 <= 4.5	–	–	–	–
>4.5 <= 13	–	–	–	–
>13 <= 40	–	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Pathway 3.1A
Community 3.1 to 3.2

This pathway occurs when events such as frequent fire or drought remove the big sagebrush, and facilitate the continued establishment of cheatgrass or other invasive annuals. Cheatgrass will typically invade/increase in shrub interspaces when sagebrush communities are degraded. Once the cheatgrass establishes the amount and continuity of fine fuels increases until fire eliminates the shrub component and completes the conversion to near monocultures of cheatgrass that can persist for long periods of time. Once a fire or a drought remove the big sagebrush, it is difficult to reestablish because, not only has the fire return interval been shortened to a time that will not allow sagebrush to reestablish, the soil and other abiotic factors have been altered.

Pathway 3.2A
Community 3.2 to 3.1

This pathway occurs when a longer fire return interval is facilitated through the use of firebreaks and/or fire suppression to allow perennial species to become established through natural processes or accelerated with vegetation manipulation techniques, including prescribed grazing.

State 4
Seeded

This state results from a significant vegetation manipulation that may include prescribed burning, chaining, disking, mowing, or other technique, with the introduction of non-native perennial grasses such as Crested wheatgrass or Russian wildrye. The dominant understory plant species are the seeded grasses and forbs. The community dynamics are similar to the Current Potential State. Depending on the species used for the reseeding practice, the site could have more resistance to fire as well as better tolerance to grazing pressure. This state may persist for long periods of time. Typically, big sagebrush will reestablish in the seeding to significant proportions within 30 years. Actively manipulating plant communities in the invasive annuals or Juniper invasion states to create a seeded range state is often the first step in assisted succession to restore natural plant communities back to something similar to the Current Potential state. Seeded State: Community phases maintained by fire, continued vegetation manipulation, insect herbivory, drought, and time without disturbances. Indicators: A developed perennial herbaceous understory of seeded species, typically non-natives, co-existing with a canopy of big sagebrush. Feedbacks: Infrequent, but regular droughts that reduce grass cover. Moist cycles that maintain perennial bunch grasses. Fire, insect herbivory, and/or vegetation management that allows for the removal of trees. Improper grazing resulting in a loss of the herbaceous understory, an increase in invasive plants, and an increase in the fire return interval. At-risk Community Phase: All communities are at risk when non-native invasive annual species increase to a point where they begin to drive the ecological dynamics of the site.

Community 4.1
Seeded Grassland

This community phase is dominated by introduced seeded grasses, with little to no production from big sagebrush or other shrubs. Typically this site has low species diversity, but higher production than the current potential or reference state. The seeded grasses are able to respond favorably to the available nutrients, and effectively compete with and limit the invasive species. Commonly seen grasses include Crested wheatgrass and Russian wildrye.

Table 35. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	500	800	1000
Shrub/Vine	100	150	200
Forb	40	50	60
Tree	0	0	0
Total	**640**	**1000**	**1260**

Table 36. 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%
Bedrock	0%
Water	0%
Bare ground	20-40%

Table 37. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	0-5%	5-10%	0-5%
>0.5 <= 1	–	0-5%	10-30%	0-5%
>1 <= 2	–	0-5%	30-50%	0-2%
>2 <= 4.5	–	0-5%	5-10%	–
>4.5 <= 13	–	–	–	–
>13 <= 40	–	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Community 4.2

Big Sagebrush Shrubland with Seeded Species

This community phase is represented by seeded species being co-dominant with big sagebrush. Bare interspaces supporting highly developed lichen crusts are common.

Table 38. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	500	800	1000
Shrub/Vine	100	200	300
Forb	40	50	60
Tree	0	0	0
Total	**640**	**1050**	**1360**

Table 39. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	10-30%
Grass/grasslike foliar cover	50-70%
Forb foliar cover	0-5%
Non-vascular plants	0-2%
Biological crusts	0-5%
Litter	3-8%
Surface fragments >0.25" and <=3"	0-5%
Surface fragments >3"	0%
Bedrock	0%
Water	0%
Bare ground	20-40%

Table 40. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	0-5%	5-10%	0-5%
>0.5 <= 1	–	0-5%	10-30%	0-5%
>1 <= 2	–	5-10%	30-50%	0-2%
>2 <= 4.5	–	5-10%	5-10%	–
>4.5 <= 13	–	5-10%	–	–
>13 <= 40	–	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Community 4.3
Big Sagebrush Shrubland with Trees

This community phase is dominated by big sagebrush, where it typically measures greater than 37% cover. Pinyon and Utah juniper may have encroached, however does not yet control the ecological site dynamics. If Pinyon and Utah juniper are present, big sagebrush cover is expected to be less. The understory supports sparse native herbaceous vegetation, including forbs and grasses, both natives and non-natives. Biological crusts are typically

well developed in the interspaces; however, bare ground is most common in this community phase.

Table 41. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	200	400	600
Shrub/Vine	150	300	350
Tree	5	30	60
Forb	40	50	60
Total	**395**	**780**	**1070**

Table 42. Ground cover

Tree foliar cover	5-15%
Shrub/vine/liana foliar cover	15-30%
Grass/grasslike foliar cover	25-50%
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%
Bedrock	0%
Water	0%
Bare ground	40-50%

Table 43. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	0-5%	5-10%	0-5%
>0.5 <= 1	–	0-5%	10-30%	0-5%
>1 <= 2	–	5-10%	30-50%	0-2%
>2 <= 4.5	0-5%	5-10%	5-10%	–
>4.5 <= 13	5-10%	5-10%	–	–
>13 <= 40	5-10%	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Pathway 4.1A
Community 4.1 to 4.2

This pathway occurs when events favor shrub establishment. Improper grazing can reduce the competitive ability of the grasses. Time without disturbance and/or years of good establishment of young sagebrush will also facilitate this pathway.

Pathway 4.2A

Community 4.2 to 4.1

This pathway occurs when events favor perennial bunchgrass establishment and a reduction in big sagebrush. These events may include drought that suppresses big sagebrush, a fire, and/or vegetation manipulation that removes big sagebrush, and allows the grasses to reestablish.

Pathway 4.2B
Community 4.2 to 4.3

This pathway occurs during long periods without disturbance. Pinyon and Utah juniper encroach, facilitated by the presence of shrubs (safe-sites). Perennial grasses and other understory species are reduced as trees become more dominant. Improper grazing and drought may accelerate this pathway.

Pathway 4.3A
Community 4.3 to 4.1

This pathway occurs when trees and shrubs are removed and nutrients are available for grasses and forbs. Sometimes seeded grasses can reestablish on-their-own, but often the species will need to be reseeded. Trees and shrubs can be removed through fire, mechanical or chemical methods. Nutrients are released, and sunlight can reach the understory resulting in an increase in herbaceous understory growth and development.

Transition T1A
State 1 to 2

This transition from the native perennial bunchgrass and shrub understory in the reference state to a state that has been invaded by naturalized species such as crested wheatgrass (blown in), cheatgrass, and annual wheatgrass. This transition occurs as natural and/or management actions favor an increase in non-native grasses and forbs, especially annuals. Possible events include the mere presence of invasive species, improper livestock grazing, extended droughts, and fire combined with an available seed source of non-native species.

Transition T2A
State 2 to 3

This transition occurs as the fire return interval decreases and allows for cheatgrass or other invasive grasses and forbs to dominate and control the ecological dynamics of the site. Once cheatgrass controls these dynamics an ecological threshold has been crossed.

Transition T2B
State 2 to 4

This transition occurs when after high amounts of energy inputs by man have been put into the system. The trees and/or shrubs have been removed with vegetation manipulation techniques (i.e. chemical, mechanical, or fire) and introduced species that are adapted to the area and management needs have been established.

Transition T3A
State 3 to 4

Successful completion of this transition is difficult with current knowledge of adapted plants, soil preparation and seed techniques. Large amounts of input and management are required for the establishment of a perennial introduced/adapted grass. This transition occurs when the invasive annuals are treated and removed from dominance and the desired species (typically non-native perennials that can successfully compete) are seeded and established. At this time, restoring from the invasive annuals state directly to a native grass community has not been successful possibly due to changes in the soil caused by the cheatgrass.

Restoration pathway R4A
State 4 to 3

This transition occurs when events favor the establishment and dominance of invasive annuals. Events may include improper grazing which reduces the perennial bunch grasses, an extended drought, increased surface disturbance through off road vehicle use or other surface disturbance, or a shortened fire return interval, all of which can stress the native perennial bunchgrasses.

Additional community tables

Table 44. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Shrub/Vine					
0	**Dominant Shrubs**			100–200	
	winterfat	KRLA2	*Krascheninnikovia lanata*	40–75	–
	basin big sagebrush	ARTRT	*Artemisia tridentata ssp. tridentata*	20–50	–
	mormon tea	EPVI	*Ephedra viridis*	20–50	–
3	**Other Shrubs**			0–50	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–25	–
	Bigelow sage	ARBI3	*Artemisia bigelovii*	0–25	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–25	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–25	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–25	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–25	–
	roundleaf buffaloberry	SHRO	*Shepherdia rotundifolia*	0–25	–
Grass/Grasslike					
0	**Dominant Grasses**			350–400	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	100–150	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	100–150	–
	James' galleta	PLJA	*Pleuraphis jamesii*	40–75	–
	muttongrass	POFE	*Poa fendleriana*	40–75	–
	blue grama	BOGR2	*Bouteloua gracilis*	40–75	–
	squirreltail	ELEL5	*Elymus elymoides*	40–75	–
1	**Sub-Dominant Grasses**			0–50	
	Grass, perennial	2GP	*Grass, perennial*	0–25	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–25	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–25	–
	western wheatgrass	PASM	*Pascopyrum smithii*	0–25	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–25	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–25	–
Forb					
2	**Forbs**			10–50	
	Forb, annual	2FA	*Forb, annual*	0–25	–
	Forb, perennial	2FP	*Forb, perennial*	0–25	–
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–25	–
	sego lily	CANU3	*Calochortus nuttallii*	0–25	–
	bastard toadflax	COUM	*Comandra umbellata*	0–25	–
	Wright's bird's beak	COWR2	*Cordylanthus wrightii*	0–25	–

	buckwheat	ERIOG	*Eriogonum*	0–25	–
	scarlet gilia	IPAGA3	*Ipomopsis aggregata ssp. aggregata*	0–25	–
	lobeleaf groundsel	PAMU11	*Packera multilobata*	0–25	–
	rock goldenrod	PEPU7	*Petradoria pumila*	0–25	–
	carpet phlox	PHHOC	*Phlox hoodii ssp. canescens*	0–25	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–25	–
Tree					
4	**Trees**			200–400	
	Utah juniper	JUOS	*Juniperus osteosperma*	100–200	–
	twoneedle pinyon	PIED	*Pinus edulis*	100–200	–

Table 45. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Shrub/Vine					
1	**Dominant Shrubs**			25–50	
	basin big sagebrush	ARTRT	*Artemisia tridentata ssp. tridentata*	5–50	–
2	**Other Shrubs**			5–25	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–5	–
	Bigelow sage	ARBI3	*Artemisia bigelovii*	0–5	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–5	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–5	–
	mormon tea	EPVI	*Ephedra viridis*	0–5	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–5	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–5	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–5	–
	roundleaf buffaloberry	SHRO	*Shepherdia rotundifolia*	0–5	–
Grass/Grasslike					
3	**Dominant Grasses**			200–300	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	50–100	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	50–100	–
	James' galleta	PLJA	*Pleuraphis jamesii*	30–50	–
	muttongrass	POFE	*Poa fendleriana*	30–50	–
	blue grama	BOGR2	*Bouteloua gracilis*	30–50	–
	squirreltail	ELEL5	*Elymus elymoides*	30–50	–
4	**Sub-Dominant Grasses**			0–50	
	Grass, perennial	2GP	*Grass, perennial*	0–25	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–25	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–25	–
	western wheatgrass	PASM	*Pascopyrum smithii*	0–25	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–25	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–25	–
Forb					

5	**Forbs**			10–50	
	Forb, annual	2FA	*Forb, annual*	0–25	–
	Forb, perennial	2FP	*Forb, perennial*	0–25	–
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–25	–
	sego lily	CANU3	*Calochortus nuttallii*	0–25	–
	bastard toadflax	COUM	*Comandra umbellata*	0–25	–
	Wright's bird's beak	COWR2	*Cordylanthus wrightii*	0–25	–
	buckwheat	ERIOG	*Eriogonum*	0–25	–
	scarlet gilia	IPAGA3	*Ipomopsis aggregata ssp. aggregata*	0–25	–
	lobeleaf groundsel	PAMU11	*Packera multilobata*	0–25	–
	rock goldenrod	PEPU7	*Petradoria pumila*	0–25	–
	carpet phlox	PHHOC	*Phlox hoodii ssp. canescens*	0–25	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–25	–
Tree					
6	**Trees**			300–450	
	Utah juniper	JUOS	*Juniperus osteosperma*	150–250	–
	twoneedle pinyon	PIED	*Pinus edulis*	150–250	–

Table 46. Community 1.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Dominant Grass**			250–400	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	100–150	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	100–150	–
	James' galleta	PLJA	*Pleuraphis jamesii*	50–100	–
2	**Sub-Dominant Grass**			0–150	
	Grass, perennial	2GP	*Grass, perennial*	0–25	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–25	–
	blue grama	BOGR2	*Bouteloua gracilis*	0–25	–
	squirreltail	ELEL5	*Elymus elymoides*	0–25	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–25	–
	western wheatgrass	PASM	*Pascopyrum smithii*	0–25	–
	muttongrass	POFE	*Poa fendleriana*	0–25	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–25	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–25	–
Forb					
3	**Forbs**			300–400	
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–100	–
	buckwheat	ERIOG	*Eriogonum*	0–100	–
	Wright's bird's beak	COWR2	*Cordylanthus wrightii*	0–50	–
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–50	–
	sego lily	CANU3	*Calochortus nuttallii*	0–25	–
	bastard toadflax	COUM	*Comandra umbellata*	0–25	–
	scarlet gilia	IPAGA3	*Ipomopsis aggregata ssp. aggregata*	0–25	–
	lobeleaf groundsel	PAMU11	*Packera multilobata*	0–25	–
	rock goldenrod	PEPU7	*Petradoria pumila*	0–25	–
	carpet phlox	PHHOC	*Phlox hoodii ssp. canescens*	0–25	–
	Forb, annual	2FA	*Forb, annual*	0–25	–
	Forb, perennial	2FP	*Forb, perennial*	0–25	–

Table 47. Community 1.4 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Shrub/Vine					
1	**Dominant Shrubs**			75–150	
	basin big sagebrush	ARTRT	*Artemisia tridentata ssp. tridentata*	5–100	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	25–75	–
	mormon tea	EPVI	*Ephedra viridis*	10–20	–
2	**Other Shrubs**			0–50	
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–25	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–25	–

	roundleaf buffaloberry	SHRO	*Shepherdia rotundifolia*	0–25	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–25	–
	Bigelow sage	ARBI3	*Artemisia bigelovii*	0–25	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–25	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–25	–
Grass/Grasslike					
3	**Dominant Grasses**			350–400	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	100–150	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	100–150	–
	James' galleta	PLJA	*Pleuraphis jamesii*	40–75	–
	muttongrass	POFE	*Poa fendleriana*	40–75	–
	blue grama	BOGR2	*Bouteloua gracilis*	40–75	–
	squirreltail	ELEL5	*Elymus elymoides*	40–75	–
4	**Sub-Dominant Grasses**			0–50	
	Grass, perennial	2GP	*Grass, perennial*	0–25	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–25	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–25	–
	western wheatgrass	PASM	*Pascopyrum smithii*	0–25	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–25	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–25	–
Forb					
5	**Forbs**			10–50	
	Forb, annual	2FA	*Forb, annual*	0–25	–
	Forb, perennial	2FP	*Forb, perennial*	0–25	–
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–25	–
	sego lily	CANU3	*Calochortus nuttallii*	0–25	–
	bastard toadflax	COUM	*Comandra umbellata*	0–25	–
	Wright's bird's beak	COWR2	*Cordylanthus wrightii*	0–25	–
	buckwheat	ERIOG	*Eriogonum*	0–25	–
	scarlet gilia	IPAGA3	*Ipomopsis aggregata ssp. aggregata*	0–25	–
	lobeleaf groundsel	PAMU11	*Packera multilobata*	0–25	–
	rock goldenrod	PEPU7	*Petradoria pumila*	0–25	–
	carpet phlox	PHHOC	*Phlox hoodii ssp. canescens*	0–25	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–25	–
Tree					
6	**Trees**			100–200	
	Utah juniper	JUOS	*Juniperus osteosperma*	50–100	–
	twoneedle pinyon	PIED	*Pinus edulis*	50–100	–

Table 48. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Shrub/Vine					
1	**Dominant Shrubs**			100–200	

1	**Dominant Shrubs**			100–200	
	winterfat	KRLA2	*Krascheninnikovia lanata*	40–75	–
	basin big sagebrush	ARTRT	*Artemisia tridentata ssp. tridentata*	5–75	–
	mormon tea	EPVI	*Ephedra viridis*	20–50	–
2	**Other Shrubs**			0–50	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–25	–
	Bigelow sage	ARBI3	*Artemisia bigelovii*	0–25	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–25	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–25	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–25	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–25	–
	roundleaf buffaloberry	SHRO	*Shepherdia rotundifolia*	0–25	–
Grass/Grasslike					
3	**Dominant Grasses**			350–400	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	100–150	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	100–150	–
	James' galleta	PLJA	*Pleuraphis jamesii*	40–75	–
	muttongrass	POFE	*Poa fendleriana*	40–75	–
	blue grama	BOGR2	*Bouteloua gracilis*	40–75	–
	squirreltail	ELEL5	*Elymus elymoides*	40–75	–
4	**Sub-Dominant Grasses**			0–50	
	Grass, annual	2GA	*Grass, annual*	0–25	–
	Grass, perennial	2GP	*Grass, perennial*	0–25	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–25	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–25	–
	western wheatgrass	PASM	*Pascopyrum smithii*	0–25	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–25	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–25	–
Forb					
5	**Forbs**			10–50	
	Forb, annual	2FA	*Forb, annual*	0–25	–
	Forb, perennial	2FP	*Forb, perennial*	0–25	–
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–25	–
	sego lily	CANU3	*Calochortus nuttallii*	0–25	–
	bastard toadflax	COUM	*Comandra umbellata*	0–25	–
	Wright's bird's beak	COWR2	*Cordylanthus wrightii*	0–25	–
	tansymustard	DESCU	*Descurainia*	0–25	–
	buckwheat	ERIOG	*Eriogonum*	0–25	–
	scarlet gilia	IPAGA3	*Ipomopsis aggregata ssp. aggregata*	0–25	–
	lobeleaf groundsel	PAMU11	*Packera multilobata*	0–25	–
	rock goldenrod	PEPU7	*Petradoria pumila*	0–25	–
	carpet phlox	PHHOC	*Phlox hoodii ssp. canescens*	0–25	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–25	–
	gooseberryleaf	SPGR3	*Sphaeralcea grossulariifolia*	0–25	

	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–25	–
Tree					
6	**Trees**			200–400	
	Utah juniper	JUOS	*Juniperus osteosperma*	100–200	–
	twoneedle pinyon	PIED	*Pinus edulis*	100–200	–

Table 49. Community 2.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Shrub/Vine					
1	**Dominant Shrubs**			25–50	
	basin big sagebrush	ARTRT	*Artemisia tridentata ssp. tridentata*	5–50	–
2	**Other Shrubs**			5–25	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–5	–
	Bigelow sage	ARBI3	*Artemisia bigelovii*	0–5	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–5	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–5	–
	mormon tea	EPVI	*Ephedra viridis*	0–5	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–5	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–5	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–5	–
	roundleaf buffaloberry	SHRO	*Shepherdia rotundifolia*	0–5	–
Grass/Grasslike					
3	**Dominant Grasses**			200–300	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	50–100	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	50–100	–
	James' galleta	PLJA	*Pleuraphis jamesii*	30–50	–
	muttongrass	POFE	*Poa fendleriana*	30–50	–
	blue grama	BOGR2	*Bouteloua gracilis*	30–50	–
	squirreltail	ELEL5	*Elymus elymoides*	30–50	–
	cheatgrass	BRTE	*Bromus tectorum*	5–25	–
4	**Sub-Dominant Grasses**			0–50	
	Grass, annual	2GA	*Grass, annual*	0–25	–
	Grass, perennial	2GP	*Grass, perennial*	0–25	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–25	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–25	–
	western wheatgrass	PASM	*Pascopyrum smithii*	0–25	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–25	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–25	–
Forb					
5	**Forbs**			10–50	
	Forb, annual	2FA	*Forb, annual*	0–25	–
	Forb, perennial	2FP	*Forb, perennial*	0–25	–
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–25	–

	sego lily	CANU3	*Calochortus nuttallii*	0–25	–
	bastard toadflax	COUM	*Comandra umbellata*	0–25	–
	Wright's bird's beak	COWR2	*Cordylanthus wrightii*	0–25	–
	tansymustard	DESCU	*Descurainia*	0–25	–
	buckwheat	ERIOG	*Eriogonum*	0–25	–
	scarlet gilia	IPAGA3	*Ipomopsis aggregata ssp. aggregata*	0–25	–
	lobeleaf groundsel	PAMU11	*Packera multilobata*	0–25	–
	rock goldenrod	PEPU7	*Petradoria pumila*	0–25	–
	carpet phlox	PHHOC	*Phlox hoodii ssp. canescens*	0–25	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–25	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–25	–
Tree					
6	**Trees**			300–450	
	Utah juniper	JUOS	*Juniperus osteosperma*	150–250	–
	twoneedle pinyon	PIED	*Pinus edulis*	150–250	–

Table 50. Community 2.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Dominant Grasses**			250–400	
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	100–150	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	100–150	–
	James' galleta	PLJA	*Pleuraphis jamesii*	50–100	–
	cheatgrass	BRTE	*Bromus tectorum*	5–25	–
2	**Sub-Dominant Grasses**			0–150	
	Grass, annual	2GA	*Grass, annual*	0–25	–
	Grass, perennial	2GP	*Grass, perennial*	0–25	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–25	–
	blue grama	BOGR2	*Bouteloua gracilis*	0–25	–
	squirreltail	ELEL5	*Elymus elymoides*	0–25	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–25	–
	western wheatgrass	PASM	*Pascopyrum smithii*	0–25	–
	muttongrass	POFE	*Poa fendleriana*	0–25	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–25	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–25	–
Forb					
3	**Forbs**			200–400	
	tansymustard	DESCU	*Descurainia*	0–100	–
	buckwheat	ERIOG	*Eriogonum*	0–100	–
	tall tumblemustard	SIAL2	*Sisymbrium altissimum*	0–100	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–100	–
	Wright's bird's beak	COWR2	*Cordylanthus wrightii*	0–50	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–50	–
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–50	–
	sego lily	CANU3	*Calochortus nuttallii*	0–25	–
	bastard toadflax	COUM	*Comandra umbellata*	0–25	–
	scarlet gilia	IPAGA2	*Ipomopsis aggregata ssp. attenuata*	0–25	–
	lobeleaf groundsel	PAMU11	*Packera multilobata*	0–25	–
	rock goldenrod	PEPU7	*Petradoria pumila*	0–25	–
	carpet phlox	PHHOC	*Phlox hoodii ssp. canescens*	0–25	–
	Forb, annual	2FA	*Forb, annual*	0–25	–
	Forb, perennial	2FP	*Forb, perennial*	0–25	–

Table 51. Community 2.4 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Shrub/Vine					
1	**Dominant Shrub**			75–150	
	basin big sagebrush	ARTRT	*Artemisia tridentata ssp. tridentata*	5–100	–

	winterfat	KRLA2	*Krascheninnikovia lanata*	25–75	–
	mormon tea	EPVI	*Ephedra viridis*	10–20	–
2	**Other Shrubs**			0–50	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–25	–
	Bigelow sage	ARBI3	*Artemisia bigelovii*	0–25	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–25	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–25	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–25	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–25	–
	roundleaf buffaloberry	SHRO	*Shepherdia rotundifolia*	0–25	–
Grass/Grasslike					
3	**Dominant Grasses**			350–400	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	100–150	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	100–150	–
	James' galleta	PLJA	*Pleuraphis jamesii*	40–75	–
	muttongrass	POFE	*Poa fendleriana*	40–75	–
	blue grama	BOGR2	*Bouteloua gracilis*	40–75	–
	squirreltail	ELEL5	*Elymus elymoides*	40–75	–
	cheatgrass	BRTE	*Bromus tectorum*	5–25	–
4	**Sub-Dominant Grasses**			0–50	
	Grass, annual	2GA	*Grass, annual*	0–25	–
	Grass, perennial	2GP	*Grass, perennial*	0–25	–
	purple threeawn	ARPU9	*Aristida purpurea*	0–25	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–25	–
	western wheatgrass	PASM	*Pascopyrum smithii*	0–25	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–25	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–25	–
Forb					
5	**Forbs**			10–50	
	Forb, annual	2FA	*Forb, annual*	0–25	–
	Forb, perennial	2FP	*Forb, perennial*	0–25	–
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–25	–
	sego lily	CANU3	*Calochortus nuttallii*	0–25	–
	bastard toadflax	COUM	*Comandra umbellata*	0–25	–
	Wright's bird's beak	COWR2	*Cordylanthus wrightii*	0–25	–
	buckwheat	ERIOG	*Eriogonum*	0–25	–
	scarlet gilia	IPAGA3	*Ipomopsis aggregata ssp. aggregata*	0–25	–
	lobeleaf groundsel	PAMU11	*Packera multilobata*	0–25	–
	rock goldenrod	PEPU7	*Petradoria pumila*	0–25	–
	carpet phlox	PHHOC	*Phlox hoodii ssp. canescens*	0–25	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–25	–
Tree					
6	**Trees**			100–200	

	Utah juniper	JUOS	*Juniperus osteosperma*	50–100	–
	twoneedle pinyon	PIED	*Pinus edulis*	50–100	–

Table 52. Community 3.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Dominant Grasses**			400–500	
	cheatgrass	BRTE	*Bromus tectorum*	400–500	–
2	**Sub-Dominant Grasses**			5–100	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–100	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–100	–
	James' galleta	PLJA	*Pleuraphis jamesii*	0–50	–
	blue grama	BOGR2	*Bouteloua gracilis*	0–50	–
	squirreltail	ELEL5	*Elymus elymoides*	0–50	–
	bluegrass	POA	*Poa*	0–10	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–10	–
	Grass, annual	2GA	*Grass, annual*	0–5	–
	Grass, perennial	2GP	*Grass, perennial*	0–5	–
Forb					
3	**Forbs**			10–50	
	Forb, annual	2FA	*Forb, annual*	0–25	–
	Forb, perennial	2FP	*Forb, perennial*	0–25	–
	cryptantha	CRYPT	*Cryptantha*	0–25	–
	tansymustard	DESCU	*Descurainia*	0–25	–
	stickseed	LAPPU	*Lappula*	0–25	–
	woolly plantain	PLPA2	*Plantago patagonica*	0–25	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–25	–
	tall tumblemustard	SIAL2	*Sisymbrium altissimum*	0–25	–
Shrub/Vine					
4	**Shrubs**			25–100	
	basin big sagebrush	ARTRT	*Artemisia tridentata ssp. tridentata*	0–100	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–75	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–25	–
	roundleaf buffaloberry	SHRO	*Shepherdia rotundifolia*	0–25	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–25	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	0–25	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0–25	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–25	–
	Bigelow sage	ARBI3	*Artemisia bigelovii*	0–25	–
	mormon tea	EPVI	*Ephedra viridis*	0–20	–
Tree					
5	**Trees**			0–50	
	Utah juniper	JUOS	*Juniperus osteosperma*	0–50	–
	twoneedle pinyon	PIED	*Pinus edulis*	0–50	–

Table 53. Community 3.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Grasses**			400–500	
	cheatgrass	BRTE	*Bromus tectorum*	400–500	–
Forb					
2	**Forbs**			0–50	
	Forb, annual	2FA	*Forb, annual*	0–25	–
	Forb, perennial	2FP	*Forb, perennial*	0–25	–
	tansymustard	DESCU	*Descurainia*	0–25	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–25	–
	tall tumblemustard	SIAL2	*Sisymbrium altissimum*	0–25	–
Shrub/Vine					
3	**Shrubs**			0–50	
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–50	–

Table 54. Community 4.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Grasses**			500–800	
	crested wheatgrass	AGCR	*Agropyron cristatum*	0–600	–
	Russian wildrye	PSJU3	*Psathyrostachys juncea*	0–600	–
	Grass, annual	2GA	*Grass, annual*	0–20	–
	Grass, perennial	2GP	*Grass, perennial*	0–20	–
	cheatgrass	BRTE	*Bromus tectorum*	5–20	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–10	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–10	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–10	–
Forb					
2	**Forbs**			30–50	
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–20	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–20	–
	tansymustard	DESCU	*Descurainia*	0–10	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–10	–
	tall tumblemustard	SIAL2	*Sisymbrium altissimum*	0–10	–
	Forb, annual	2FA	*Forb, annual*	0–5	–
	Forb, perennial	2FP	*Forb, perennial*	0–5	–
Shrub/Vine					
3	**Shrubs**			0–150	
	basin big sagebrush	ARTRT	*Artemisia tridentata ssp. tridentata*	0–200	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–100	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–100	–

Table 55. Community 4.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Grasses**			500–600	
	crested wheatgrass	AGCR	*Agropyron cristatum*	0–600	–
	Russian wildrye	PSJU3	*Psathyrostachys juncea*	0–600	–
	cheatgrass	BRTE	*Bromus tectorum*	5–20	–
	Grass, annual	2GA	*Grass, annual*	0–20	–
	Grass, perennial	2GP	*Grass, perennial*	0–20	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–10	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–10	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–10	–
Forb					
2	**Forbs**			30–50	
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–20	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–20	–
	tansymustard	DESCU	*Descurainia*	0–10	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–10	–
	tall tumblemustard	SIAL2	*Sisymbrium altissimum*	0–10	–
	Forb, annual	2FA	*Forb, annual*	0–5	–
	Forb, perennial	2FP	*Forb, perennial*	0–5	–
Shrub/Vine					
3	**Shrubs**			50–200	
	basin big sagebrush	ARTRT	*Artemisia tridentata ssp. tridentata*	0–200	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–100	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–100	–

Table 56. Community 4.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Grasses**			350–400	
	crested wheatgrass	AGCR	*Agropyron cristatum*	0–400	–
	Russian wildrye	PSJU3	*Psathyrostachys juncea*	0–400	–
	Grass, annual	2GA	*Grass, annual*	0–20	–
	Grass, perennial	2GP	*Grass, perennial*	0–20	–
	cheatgrass	BRTE	*Bromus tectorum*	5–20	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	0–10	–
	Sandberg bluegrass	POSE	*Poa secunda*	0–10	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–10	–
Forb					
2	**Forbs**			35–50	
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–20	–
	gooseberryleaf globemallow	SPGR2	*Sphaeralcea grossulariifolia*	0–20	–
	tansymustard	DESCU	*Descurainia*	0–10	–
	prickly Russian thistle	SATR12	*Salsola tragus*	0–10	–
	tall tumblemustard	SIAL2	*Sisymbrium altissimum*	0–10	–
	Forb, annual	2FA	*Forb, annual*	0–10	–
	Forb, perennial	2FP	*Forb, perennial*	0–10	–
Shrub/Vine					
3	**Shrubs**			150–300	
	basin big sagebrush	ARTRT	*Artemisia tridentata ssp. tridentata*	0–300	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–100	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	0–100	–
Tree					
4	**Trees**			10–30	
	Utah juniper	JUOS	*Juniperus osteosperma*	5–25	–
	twoneedle pinyon	PIED	*Pinus edulis*	5–25	–

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 marginal suitability for re-seeding or restoring this site.
The plant community is primarily shrubs, including sagebrush and mormontea 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. The presence of grasses, including Indian ricegrass, Galleta, and Blue grama, and Muttongrass, provide grazing habitat for all classes of livestock. Utah juniper and Pinyon provide good cover for livestock. Forb composition and total annual production depends primarily on precipitation timing and 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

--Hydrology--
The soils associated with this ecological site are generally in Hydrologic Soil Group B. Here 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 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. 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

--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

--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 big sagebrush, which 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

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Contributors

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Approval

Kirt Walstad, 1/14/2025

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.

Author(s)/participant(s)	Ashley Garrelts (NRSC) and Shane A. Green (NRCS)
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Date	10/28/2008
Approved by	Kirt Walstad
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rills are rarely found on this site. Any rills present should be short in length (less than 6 feet long) and only occur on lower part of steeper slopes, below exposed bedrock, or within microtopography commonly found on this site. Old rills should be weathered and muted in appearance. An increase in rill formation may be seen after disturbance events such as recent fire or heavy thunderstorms.

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2. **Presence of water flow patterns:** The presence of water flow patterns is common. Flow patterns occur in low places associated with microtopography commonly occurring on the site. They are long (more than 30 feet), and spaced about 20-30 yards apart.

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3. **Number and height of erosional pedestals or terracettes:** Plants should show little or no pedestialing. There should be no exposed roots. A few terracettes may occur on behind litter dams 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 15-35%. Much of the area is covered with well developed biological crusts which should not be recorded as bare ground; however there are some areas of weakly developed biological crusts that may function as bare ground (raindrop splash, runoff, etc.) and should be recorded as such. Bare ground is measured based on first raindrop impact, cover + bare ground = 100%.

5. **Number of gullies and erosion associated with gullies:** Gullies should not occur on this site in the reference state. There may be rare gullies present caused by run on water from adjacent sites such as exposed bed rock, small watersheds or dissected slopes.

6. **Extent of wind scoured, blowouts and/or depositional areas:** Very minor evidence of wind generated soil movement may be bareley discernible. Wind caused blowouts and depositions are not apparrent.

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) movement usually occurs in water flow patterns, with deposition occurring at obstruction. The majority of litter accumulates at the base of plants or in soil depressions adjacent to the plant. Woody stems (those greater than ¼ inch in diameter) are not likely to move under normal conditions

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** This site should have a soil stability rating of 5 throughout the site using the soil stability test kit. Surface textures are sandy loams. This site, in the reference condition, is resistant to erosion.

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil surface is 2-3 inches deep and structure is typically described as weak fine granular. The A-horizon color is a dark yellowish brown (10YR4/4). 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 in the interspaces. Use the specific information for the soil you are assessing found in the published soil survey to supplement this description.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** The presence of perennial cool and warm season grasses, shrubs, trees, and well developed biological crusts (moss, pinnacled lichen, etc.) are distributed to intercept raindrops, increase surface detention of water, increase infiltration, and reduce erosive energy of runoff. Configuration of tree crowns and litter accumulation under crowns may form a micro-topography that may accumulate water for more rapid runoff, particularly if bare soil lies below the outer edge of the canopy.

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. Some soils may have increase in clay content at 3 to 9 inches that could be mistaken for a compaction layer. Naturally occurring layers of hard calcium carbonate may also be found in the soils, but should not be considered a compaction layer.

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: 340-550 lbs/acre from perennial warm and cool season grasses (e.g. Indian ricegrass, needleandthread, blue grama, and galleta)

100-500 lbs/acre from trees (e.g. Utah juniper and pinyon)
100-350 lbs/acre from shrubs (e.g. basin big sagebrush, winterfat, and green mormontea)

Sub-dominant: 50-100 lbs/acre from native perennial and annual forbs

Other: Other forbs, shrubs, and grasses. Developed biological crusts are common, but do not necessarily drive the ecological dynamics for this ecological site.

Additional:

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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, in plant community 1.1; old pinyon and Utah juniper and expected in community 1.2; and young pinyon and Utah juniper are expected in community 1.4. During years with average to above average precipitation, there should be very little mortality or decadence apparent in either shrubs or grasses, except in a case where insect infestation has occurred. Slight decadence in the principle shrubs and trees may occur near the end of the fire cycle.

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14. **Average percent litter cover (%) and depth (in):** Litter cover (not including under plants) ranges from 5-10%. Most litter, however, accumulates below and to the side of live plants, and thus percent litter will be just slightly above percent canopy cover. Typically litter under shrubs is 1 leaf thickness, but is expected to increase during drought, when shrubs experience leaf drop. Litter under trees may be up to 1 inch deep.

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** 800-1100 lbs per 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 in all years, except in extreme drought years.

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18. **Supporting Data:** NRCS (Dana Truman) 2006 ESD data from Natural Bridges National Monument

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