USDA Natural Resources Conservation Service

Ecological site R028AY013NV
SHALLOW CALCAREOUS LOAM 8-10 P.Z.

Accessed: 05/08/2024

General information

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

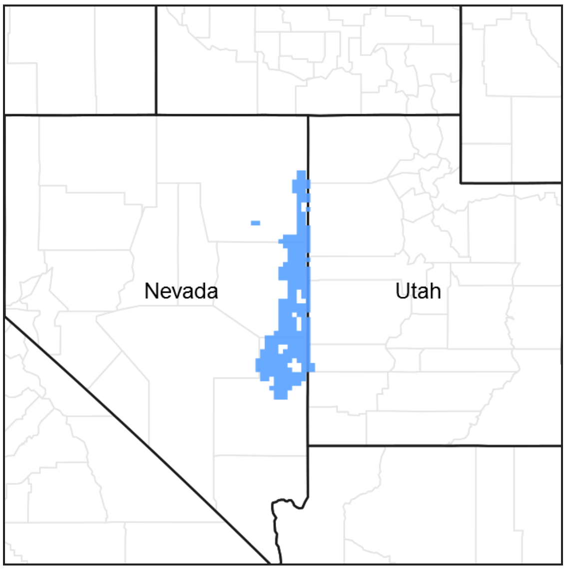


Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

MLRA notes

Major Land Resource Area (MLRA): 028A–Ancient Lake Bonneville

MLRA 28A occurs in Utah (82%), Nevada (16%), and Idaho (2%). It makes up about 36,775 square miles. A large area west and southwest of Great Salt Lake is a salty playa. This area is the farthest eastern extent of the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. It is an area of nearly level basins between widely separated mountain ranges trending north to south. The basins are bordered by long, gently sloping alluvial fans. The mountains are uplifted fault blocks with steep side slopes. They are not well dissected because of low rainfall in the MLRA. Most of the valleys are closed basins containing sinks or playa lakes. Elevation ranges from 3,950 to 6,560 ft. in the basins and from 6,560 to 11,150 ft. in the mountains. Most of this area has alluvial valley fill and playa lakebed deposits at the surface. Great Salt Lake is all that remains of glacial Lake Bonneville. A level line on some mountain slopes indicates the former extent of this glacial lake. Most of the mountains in the interior of this area consist of tilted blocks of marine sediments from Cambrian to Mississippian age. Scattered outcrops of Tertiary continental sediments and volcanic rocks are throughout the area. The average annual precipitation is 5 to 12 ins. in the valleys and is as much as 49 ins. in the mountains. Most of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. The driest period is from midsummer to early autumn. Precipitation in winter typically occurs as snow. The average annual temperature is 39 to 53 °F. The freeze-free period averages 165 days and ranges from 110 to 215 days, decreasing in length with elevation. The dominant soil orders in this MLRA are Aridisols, Entisols, and Mollisols. The soils in the area dominantly have a mesic or frigid soil temperature regime, an aridic or xeric soil moisture regime, and mixed mineralogy. They generally are well drained, loamy or loamy-skeletal, and very deep.

Ecological site concept

This site occurs on summits and sideslopes of fan remnants, piedmont slopes, hills and lower mountains on all aspects. Slopes range from 2 to 50 percent, but slope gradients of 2 to 15 percent are typical. Elevations range from 4800 to 7800 feet.
Average annual precipitation ranges from 8 to 10 inches, most occurring as snow or rain during the winter and spring months. Mean annual tempeature is 47 to 52 degrees F. The average growing season is about 100 to 150 days.
The soils of this site are shallow to moderately deep to a restrictive layer (duripan) that impedes plant rooting depth.
The reference state is dominated by black sagebrush, Indian ricegrass and needleandthread.

Associated sites

R024XY015NV	**DEEP SODIC FAN**
R024XY018NV	**CLAYPAN 10-12 P.Z.**
R028AY004NV	**SHALLOW CALCAREOUS SLOPE 8-10 P.Z.**
R028AY012NV	**LOAMY 5-8 P.Z.**

Similar sites

R028AY004NV	**SHALLOW CALCAREOUS SLOPE 8-10 P.Z.** Less productive site
R028AY027NV	**SHALLOW CALCAREOUS HILL 8-10 P.Z.** JUOS dominates visual aspect; less productive site
R028AY034NV	**SHALLOW CALCAREOUS SLOPE 10-14 P.Z.** PSSPS dominant grass
R028BY011NV	**SHALLOW CALCAREOUS LOAM 8-10 P.Z.** PLJA absent to rare and is not an increaser species
R028AY043NV	**SHALLOW CALCAREOUS LOAM 10-14 P.Z.** PSSPS dominant grass
R028AY036NV	**SHALLOW CLAY LOAM 12-14 P.Z.** PSSPS-ACTH7 codominant grasses
R028AY035NV	**SHALLOW CLAY LOAM 10-12 P.Z.** ACHY-ACTH7 codominant; less productive site
R028AY044NV	**SHALLOW CALCAREOUS HILL 6-8 P.Z.** TESP & EPNE codominant shrubs; may be seral stage to (028AY027NV) Shallow Calcareous Hill 8-10" PZ
R028AY047NV	**DROUGHTY CALCAREOUS LOAM 8-10 P.Z. (burned phase)** GRSP-ARNO4 codominant shrubs; may be seral stage to (028AY013NV) Shallow Calcareous Loam 8-10" PZ

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Artemisia nova*
Herbaceous	(1) *Achnatherum hymenoides* (2) *Hesperostipa comata*

Physiographic features

This site occurs on summits and sideslopes of fan remnants, hills and lower mountains. Slopes range from 2 to 30 percent, but slope gradients of 2 to 15 percent are typical. Elevations are 4800 to 7800 feet.

Table 2. Representative physiographic features

Landforms	(1) Hill (2) Fan remnant (3) Mountain slope
Flooding duration	Extremely brief (0.1 to 4 hours)
Flooding frequency	Very rare
Ponding frequency	None
Elevation	1,402–2,377 m
Slope	2–30%
Aspect	Aspect is not a significant factor

Climatic features

Nevada's climate is predominantly arid, with large daily ranges of temperature, infrequent severe storms, heavy snowfall in the higher mountains, and great location variations with elevation. Three basic geographical factors largely influence Nevada's climate: continentality, latitude, and elevation. Continentality is the most important factor. The strong continental effect is expressed in the form of both dryness and large temperature variations. Nevada lies on the eastern, lee side of the Sierra Nevada Range, a massive mountain barrier that markedly influences the climate of the State. The prevailing winds are from the west, and as the warm moist air from the Pacific Ocean ascend the western slopes of the Sierra Range, the air cools, condensation occurs and most of the moisture falls as precipitation. As the air descends the eastern slope, it is warmed by compression, and very little precipitation occurs. The effects of this mountain barrier are felt not only in the West but throughout the state, with the result that the lowlands of Nevada are largely desert or steppes. The temperature regime is also affected by the blocking of the inland-moving maritime air. Nevada sheltered from maritime winds, has a continental climate with well-developed seasons and the terrain responds quickly to changes in solar heating.
Nevada lies within the mid-latitude belt of prevailing westerly winds which occur most of the year. These winds bring frequent changes in weather during the late fall, winter and spring months, when most of the precipitation occurs. To the south of the mid-latitude westerlies, lies a zone of high pressure in subtropical latitudes, with a center over the Pacific Ocean. In the summer, this high-pressure belt shifts northward over the latitudes of Nevada, blocking storms from the ocean. The resulting weather is mostly clear and dry during the summer and early fall, with scattered thundershowers. The eastern portion of the state receives significant summer thunderstorms generated from monsoonal moisture pushed up from the Gulf of California, known as the North American monsoon. The monsoon system peaks in August and by October the monsoon high over the Western U.S. begins to weaken and the precipitation retreats southward towards the tropics (NOAA 2004).
The climate associated with this site is semiarid, characterized by cool, moist winters and warm, dry summers. Average annual precipitation is 8 to 10 inches. Mean annual air temperature is 47 to 52 degrees F. The average growing season is about 100 to 120 days.

Mean annual preciptiation at OASIS, NEVADA (265722) Climate station is 8.58 inches.

Monthly mean precipitation is:
January 0.65; February 0.58; March 0.69;
April 0.96; May 1.23; June 0.94; July 0.46;
August 0.62; September 0.47; October 0.76;
November 0.63; December 0.59.

Table 3. Representative climatic features

Frost-free period (average)	110 days
Freeze-free period (average)	0 days
Precipitation total (average)	229 mm

Influencing water features

There are no influencing water features associated with this site.

Soil features

The soils associated with this site are very shallow to moderately deep to a restrictive layer that impedes plant rooting depth. The available water holding capacity is very low to moderate. Soils are well drained, runoff is high to very high and the potential for sheet and rill erosion is slight to moderate. The soils have an ochric epipedon and are high in carbonates. The soil temperature regime is aridic bordering on xeric and the soil moisture regime is mesic. The soils are derived frome limestone parent material. Soil series associated with this site include: Abalan, Armespan, Chubard, Chuckmill, Chuckridge, Eastmore, Greatday, Gremmers, Grifleys, Holsine, Jericho, Jungo, Linco, and Ursine.

The representative soil series is Ursine, a loamy-skeletal, carbonatic, mesic shallow Xeric Haplodurids. Diagnostic horizons include an ochric epipedon from the soil surface to 7 inches, a calcic horizon from 5 to 18 inches, and a duripan and petrocalcic horizon from 18 to 70 inches. Clay content in the particle control section averages 10 to 20 percent. Rock fragments range from 35 to 55 percent and are mostly gravels. Reaction is slightly to moderately alkaline. Effervescence is strongly to violently effervescent. Lithology consists of limestone and detached pan fragments.

Table 4. Representative soil features

Parent material	(1) Alluvium–limestone
Surface texture	(1) Gravelly sandy loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Slow to moderately rapid
Soil depth	46–102 cm
Surface fragment cover <=3"	30–45%
Surface fragment cover >3"	2–10%
Available water capacity (0-101.6cm)	5.08–12.7 cm
Calcium carbonate equivalent (0-101.6cm)	15–50%
Electrical conductivity (0-101.6cm)	0 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	7.8–8.6
Subsurface fragment volume <=3" (Depth not specified)	35–55%
Subsurface fragment volume >3" (Depth not specified)	0–10%

Ecological dynamics

An ecological site is the product of all the environmental factors responsible for its development and it has a set of key characteristics that influence a site’s resilience to disturbance and resistance to invasives. Key characteristics include 1) climate (precipitation, temperature), 2) topography (aspect, slope, elevation, and landform), 3) hydrology (infiltration, runoff), 4) soils (depth, texture, structure, organic matter), 5) plant communities (functional groups, productivity), and 6) natural disturbance regime (fire, herbivory, etc.) (USDA-NRCS 2003). Biotic factors that influence resilience include site productivity, species composition and structure, and population regulation and regeneration (Chambers et al. 2013).

This ecological site is dominated by deep-rooted cool season, perennial bunchgrasses and long-lived shrubs (50+ years) with high root to shoot ratios. The dominant shrubs usually root to the full depth of the winter-spring soil moisture recharge, which ranges from 1.0 to over 3.0 m. (Comstock and Ehleringer 1992). Root length of mature sagebrush plants was measured to a depth of 2 meters in alluvial soils in Utah (Richards and Caldwell 1987). These shrubs have a flexible generalized root system with development of both deep taproots and laterals near the surface (Comstock and Ehleringer 1992).

In the Great Basin, the majority of annual precipitation is received during the winter and early spring. This continental semiarid climate regime favors growth and development of deep-rooted shrubs and herbaceous cool season plants using the C3 photosynthetic pathway (Comstock and Ehleringer 1992).

Winter precipitation and slow melting of snow results in deeper percolation of moisture into the soil profile. Herbaceous plants, that are more shallow-rooted than shrubs, grow earlier in the growing season and thrive on spring rains, while the deeper rooted shrubs lag in phenological development because they draw from deeply infiltrating moisture from snowmelt the previous winter.

Periodic drought regularly influences sagebrush ecosystems and drought duration and severity has increased throughout the 20th century in much of the Intermountain West. Major shifts away from historical precipitation patterns have the greatest potential to alter ecosystem function and productivity. Species composition and productivity can be altered by the timing of precipitation and water availability with the soil profile (Bates et al 2006).

Native insect outbreaks are also important drivers of ecosystem dynamics in sagebrush communities. Climate is generally believed to influence the timing of insect outbreaks especially a sagebrush defoliator, Aroga moth (Aroga websteri). Aroga moth infestations have occurred in the Great Basin in the 1960s, early 1970s, and is ongoing in Nevada since 2004 (Bentz, et al 2008). Thousands of acres of sagebrush have been impacted, with partial to complete die-off observed. Sites that still have an intact perennial herbaceous understory will benefit from sagebrush die-off, however, sites that are lacking this understory component will be open for cheatgrass invasion.

Black sagebrush is generally long-lived; therefore it is not necessary for new individuals to recruit every year for perpetuation of the stand. Infrequent large recruitment events and simultaneous low, continuous recruitment is the foundation of population maintenance (Noy-Meir 1973). Survival of the seedlings is dependent on adequate moisture conditions.

The perennial bunchgrasses that are co-dominant with the shrubs include Indian ricegrass, needleandthread, galleta and squirreltail. These species generally have somewhat shallower root systems than the shrubs, but root densities are often as high as or higher than those of shrubs in the upper 0.5 m but taper off more rapidly than shrubs. General differences in root depth distributions between grasses and shrubs results in resource partitioning in these shrub/grass systems.

The Great Basin sagebrush communities have high spatial and temporal variability in precipitation both among years and within growing seasons. Nutrient availability is typically low but increases with elevation and closely follows moisture availability. The invasibility of plant communities is often linked to resource availability. Disturbance can decrease resource uptake due to damage or mortality of the native species and depressed competition or can increase resource pools by the decomposition of dead plant material following disturbance. The invasion of sagebrush communities by cheatgrass has been linked to disturbances (fire, abusive grazing) that have resulted in fluctuations in resources (Chambers et al 2007).

The range and density of singleleaf pinyon and Utah juniper have increased since the middle of the nineteenth century (Tausch 1999, Miller and Tausch 2000). Causes for expansion and infilling of trees into sagebrush ecosystems include wildfire suppression, historic livestock grazing, and climate change (Bunting 1994). Mean fire return intervals prior to European settlement in black sagebrush ecosystems were greater than 100 years, however frequent enough to inhibit the infilling of singleleaf pinyon and Utah juniper into these low productive sagebrush cover types (Miller and Tausch 2000). Thus, trees were isolated to fire-safe areas such as rocky outcroppings and areas with low-productivity. An increase in crown density causes a decrease in understory perennial vegetation and an increase in bare ground. This allows for the invasion of non-native annual species such as cheatgrass. With annual species in the understory wildfire can become more frequent and increase in intensity. With frequent wildfires these plant communities can convert to annual species with a sprouting shrub and juvenile tree overstory.

This ecological site has low to moderate resilience to disturbance and resistance to invasion. Increased resilience increases with elevation, aspect, increased precipitation and increased nutrient availability. Six possible alternative stable states have been identified for this site.

Fire Ecology:
Fire is not a major ecological component of these community types (Winward 2001), and would be infrequent. Fire return intervals have been estimated at 100 to 200 years (Kitchen and McArthur 2007); however, fires were probably patchy and very infrequent due to the low productivity of these sites. Black sagebrush plants have no morphological adaptations for surviving fire and must reestablish from seed following fire (Wright et al. 1979). The ability of black sagebrush to establish after fire is mostly dependent on the amount of seed deposited in the seed bank the year before the fire. Seeds typically do not persist in the soil for more than 1 growing season (Beetle 1960). A few seeds may remain viable in soil for 2 years (Meyer 2008); however, even in dry storage, black sagebrush seed viability has been found to drop rapidly over time, from 81% to 1% viability after 2 and 10 years of storage, respectively (Stevens et al. 1981). Thus, repeated frequent fires can eliminate black sagebrush from a site, however black sagebrush in zones receiving 12 to 16 inches of annual precipitation have been found to have greater fire survival (Boltz 1994). In lower precipitation zones, spiny hopsage and/or shadscale may become the dominant shrub species following fire. Douglas' rabbitbrush and ephedra can also sprout after fire and become a dominant shrub on this site often with an understory of galleta, Sandberg bluegrass and/or cheatgrass and other weedy species.

The effect of fire on bunchgrasses relates to culm density, culm-leaf morphology, and the size of the plant. The initial condition of bunchgrasses within the site along with seasonality and intensity of the fire all factor into the individual species response. The two dominant grasses on this site, Indian ricegrass and needleandthread grass, have different responses to fire. Needleandthread is top-killed by fire but is likely to resprout if fire does not consume above ground stems (Akinsoji 1988, Bradley et al. 1992). In a study by Wright and Klemmedson (1965), season of burn rather than fire intensity seemed to be the crucial factor in mortality for needleandthread grass. Early spring season burning was found to kill the plants while August burning had no effect. Indian ricegrass is fairly fire tolerant (Wright 1985), which is likely due to its low culm density and below ground plant crowns. Indian ricegrass has been found to reestablish on burned sites through seed dispersed from adjacent unburned areas (Young 1983, West 1994). Thus the presence of surviving, seed producing plants is necessary for reestablishment of Indian ricegrass. Grazing management following fire to promote seed production and establishment of seedlings is important.

Galleta grass, a minor component of these ecological sites, has been found to increase following fire likely due to its rhizomatous root structure and ability to resprout (Jameson 1962). Sandberg bluegrass, another minor component of these ecological sites, has also been found to increase following fire likely due to its low stature and productivity (Daubenmire 1975). Both grass species may retard reestablishment of deeper rooted bunchgrasses. Repeated frequent fire in this community will eliminate black sagebrush, significantly decrease bunchgrass density on the site and facilitate the establishment of an annual weed community with varying amounts of galleta, Sandberg bluegrass, spiny hopsage, shadscale and rabbitbrush.

Singleleaf pinyon and Utah juniper are usually killed by fire, and are most vulnerable to fire when it is under four feet tall (Bradley et al. 1992). Larger trees, because they have foliage farther from the ground and thicker bark, can survive low severity fires but mortality does occur when 60% or more of the crown is scorched (Bradley et al. 1992). With the low production of the understory vegetation, high severity fires within this plant community were not likely and rarely became crown fires (Bradley et al. 1992, Miller and Tausch 2000). Tree density on this site increases with grazing management that favors the removal of fine fuels and management focused on fire suppression. With an increase of cheatgrass in the understory, fire severity is likely to increase. Utah juniper reestablishes by seed from nearby seed source or surviving seeds. Utah juniper begins to produce seed at about 30 years old (Bradley et al. 1992). Seeds establish best through the use of a nurse plant such as sagebrush and rabbitbrush (Everett and Ward 1984,Tausch and West 1988, Bradley et al. 1992).

State and transition model

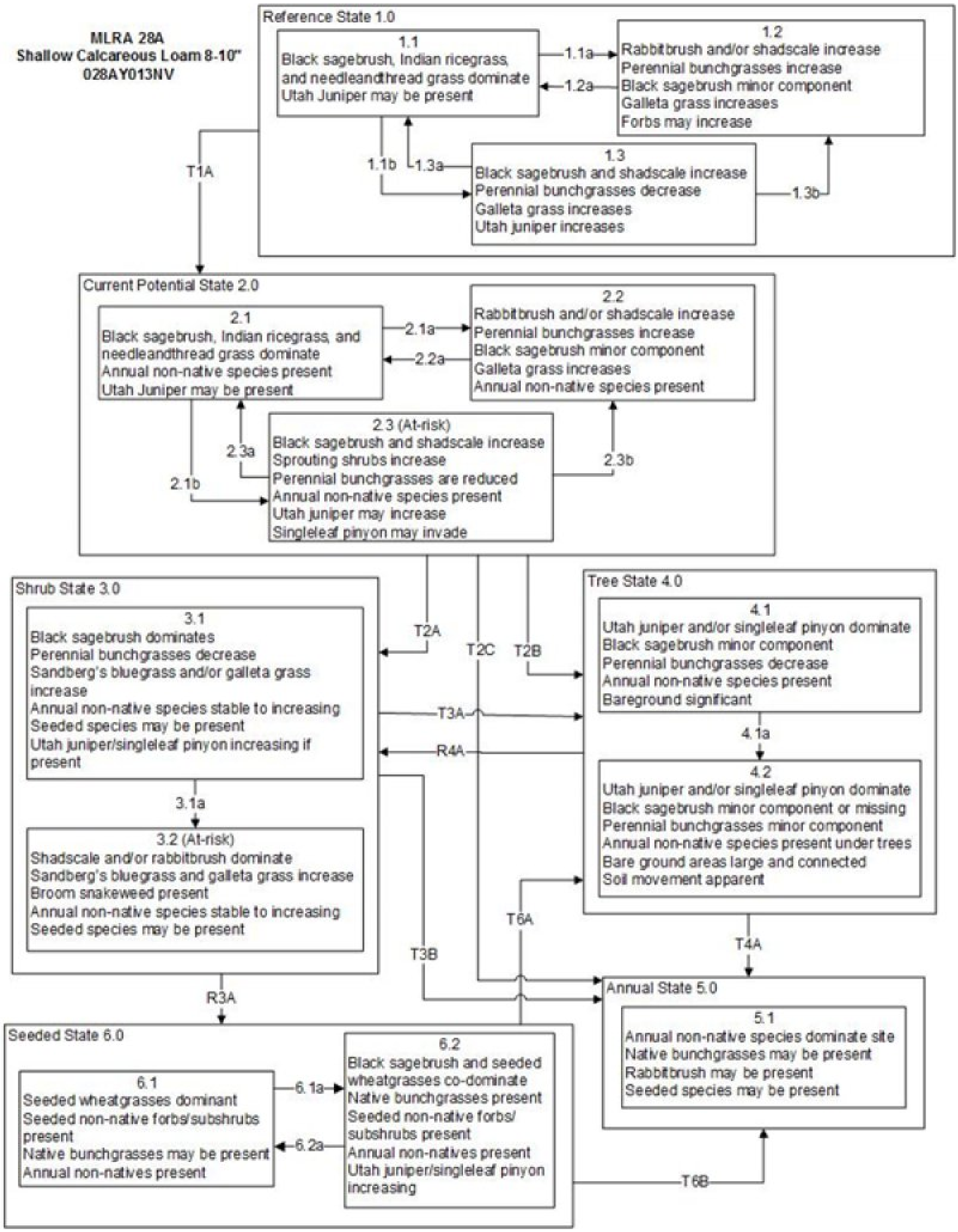


Figure 6. State and Transition Model

State 1
Reference State

The Reference State is a representative of the natural range of variability under pristine conditions. The Reference

State has three general community phases; a shrub-grass dominant phase, a shrub dominant phase and a grass dominate phase. State dynamics are maintained by interactions between climatic patterns and disturbance regimes. Negative feedbacks enhance ecosystem resilience and contribute to the stability of the state. These include the presence of all structural and functional groups, low fine fuel loads, and retention of organic matter and nutrients. Plant community phase changes are primarily driven by fire, periodic drought and/or insect or disease attack. Due to the nature and extent of disturbance in this site, all three plant community phases would likely occur in a mosaic across the landscape. Utah juniper may be present on the site, but will only occur as scattered trees and will not dominate the site.

Community 1.1
Community Phase

This community is dominated by black sagebrush in the overstory with Indian ricegrass and needleandthread grass dominant in the understory. Utah juniper may be present. Potential vegetative composition is about 45% grasses, 10% forbs and 45% shrubs. Approximate ground cover (basal and crown) is 15 to 25 percent.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	151	252	353
Shrub/Vine	148	245	342
Forb	34	56	78
Tree	3	7	11
Total	**336**	**560**	**784**

Community 1.2
Community Phase

This community phase is characteristic of a post-disturbance, early seral community phase. Indian ricegrass and needleandthread and other perennial bunchgrasses dominate. Sprouting shrubs such as Douglas' rabbitbrush, spiny hopsage, and shadscale may increase. Black sagebrush could still be present in unburned patches. Forbs may increase post-fire but will likely return to pre-burn levels within a few years. Galleta will generally increase following fire, but may decrease in below-average years of precipitation. Sandberg's bluegrass may also increase.

Community 1.3
Community Phase

Pathway a
Community 1.1 to 1.2

A low severity fire would decrease the overstory of sagebrush and allow for the understory perennial grasses to increase. Fires are typically low severity resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring facilitating an increase in fine fuels may be more severe and reduce sagebrush cover to trace amounts.

Pathway b
Community 1.1 to 1.3

Absence of disturbance over time, significant herbivory, chronic drought or combinations of these would allow the sagebrush overstory to increase and dominate the site. This will generally cause a reduction in perennial bunch grasses; however galleta grass may increase in the understory depending on the grazing management. Heavy spring grazing will favor an increase in sagebrush.

Pathway a

Community 1.2 to 1.1

Time and lack of disturbance will allow sagebrush to establish.

Pathway b
Community 1.2 to 1.2

High severity fire significantly reduces sagebrush cover leading to early/mid-seral community

Pathway a
Community 1.3 to 1.1

Low severity fire or Aroga moth infestation resulting in a mosaic pattern.

State 2
Current Potential State

This state is similar to the Reference State 1.0 and has three similar community phases. Ecological function has not changed in this state, but the resiliency of the state has been reduced by the presence of invasive weeds. These non-native species can be highly flammable, and promote fire where historically fire had been infrequent. Negative feedbacks enhance ecosystem resilience and contribute to the stability of the state. These include the presence of all structural and functional groups, low fine fuel loads and retention of organic matter and nutrients. Positive feedbacks decrease ecosystem resilience and stability of the state. These include the non-natives high seed output, persistent seed bank, rapid growth rate, ability to cross pollinate and adaptations for seed dispersal.

Community 2.1
Community Phase

This community phase is compositionally similar to the Reference State Community Phase 1.1 with the presence of non-native species in trace amounts. This community is dominated by black sagebrush in the overstory with Indian ricegrass and needleandthread grass dominant in the understory. Utah juniper may be present.

Community 2.2
Community Phase

This community phase is characteristic of a post-disturbance, early seral community where annual non-native species are present. Sagebrush is present in trace amounts; perennial bunchgrasses dominate the site. Depending on fire severity patches of intact sagebrush may remain. Rabbitbrush or other sprouting shrubs may be increasing. Annual non-native species are stable or increasing within the community. Galleta will generally increase following fire, but may decrease in below-average years of precipitation. Annual non-native species generally respond well after fire and may be stable or increasing within the community.

Community 2.3
Community Phase (At Risk)

Black sagebrush dominates the overstory and perennial bunchgrasses in the understory are reduced, either from competition with shrubs or from inappropriate grazing, or from both. Rabbitbrush may be a significant component. Galleta and/or Sandberg bluegrass may increase and become co-dominant with deep rooted bunchgrasses. Utah juniper may be present and without management will likely increase. Annual non-natives species may be stable or increasing due to lack of competition with perennial bunchgrasses. This site is susceptible to further degradation from grazing, drought, and fire. This community is at risk of crossing a threshold to either State 3.0 (grazing or fire) or State 4.0 (fire).

Pathway a
Community 2.1 to 2.2

A low severity fire (or brush management) would decrease the overstory of sagebrush and allow for the understory perennial grasses to increase. Fires are typically low severity resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring or a change in management favoring an increase in fine fuels may be more severe and reduce sagebrush cover to trace amounts. Annual non-native species are likely to increase after fire.

Conservation practices

Brush Management

Pathway b
Community 2.1 to 2.3

Absence of disturbance over time, chronic drought, inappropriate grazing management or combinations of these would allow the sagebrush overstory to increase and dominate the site. Inappropriate grazing management reduces the perennial bunchgrass understory; conversely galleta grass and/or Sandberg bluegrass may increase in the understory.

Pathway a
Community 2.2 to 2.1

Absence of disturbance over time and/or grazing management that favors the establishment and growth of sagebrush allows the shrub component to recover. The establishment of black sagebrush can take many years.

Pathway a
Community 2.3 to 2.1

Grazing management that reduces shrubs will allow for the perennial bunchgrasses in the understory to increase. Heavy late-fall/winter grazing may cause mechanical damage to sagebrush promoting the perennial bunchgrass understory. Brush treatments with minimal soil disturbance will also decrease sagebrush and release the perennial understory. Annual non-native species are present and may increase in the community. A low severity fire would decrease the overstory of sagebrush and allow for the understory perennial grasses to increase. Due to low fuel loads in this State, fires will likely be small creating a mosaic pattern.

Conservation practices

Brush Management

Pathway b
Community 2.3 to 2.2

Fire will decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses to dominate the site. Fires will typically be high intensity due to the dominance of sagebrush resulting in removal of the overstory shrub community. Annual non-native species respond well to fire and may increase post-burn.

State 3
Shrub State

This state has two community phases, one that is characterized by a black sagebrush overstory and the other with a shadscale or rabbitbrush overstory with a Sandberg bluegrass or galleta grass understory. The site has crossed a biotic threshold and site processes are being controlled by shrubs. Bare ground has increased and pedestalling of grasses may be excessive.

Community 3.1
Community Phase

Figure 8. P. Novak-Echenique_8/2013

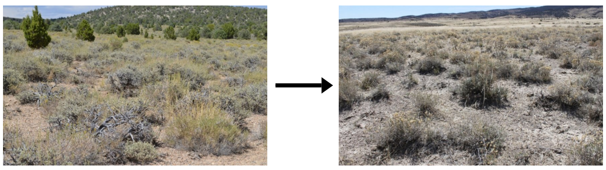
Black sagebrush dominates overstory while Sandberg bluegrass or galleta grass dominates the understory. Deep-rooted perennial bunchgrasses have significantly declined. Annual non-native species may be present. Bare ground and soil redistribution may be increasing. If present on the site, Utah juniper is increasing. The community phase may be at risk of transitioning into a Tree State or Annual State

Community 3.2
Community Phase (At Risk)

Figure 9. P. Novak-Echenique_5/2012

Shadscale and/or rabbitbrush dominate the overstory. Broom snakeweed may be present to increasing. Annual non-native species may be increasing and bare ground is significant. This site is at risk for an increase in invasive annual weeds.

Pathway a
Community 3.1 to 3.2



Community Phase **Community Phase (At Risk)**

Fire reduces black sagebrush to trace amounts and allows for sprouting shrubs such as rabbitbrush to dominate. Shadscale may also establish post-fire and become dominate. Inappropriate or excessive sheep grazing could also reduce cover of sagebrush and allow for shadscale or sprouting shrubs to dominate the community. Brush treatments with minimal soil disturbance would facilitate sprouting shrubs and galleta and/or Sandberg's bluegrass.

Conservation practices

Brush Management

Pathway a
Community 3.2 to 3.1

Community Phase (At Risk)

Community Phase

Time and lack of disturbance and/or grazing management that favors the establishment and growth of sagebrush allows for the shrub component to recover. The establishment of black sagebrush may take many years.

State 4
Tree State

This state has two community phases, which are characterized by a dominance of Utah juniper in the overstory. Singleleaf pinyon may play a significant role in the higher elevation ranges within this site. Black sagebrush and perennial bunchgrasses may still be present, but they are no longer controlling site resources. Soil moisture, soil nutrients and soil organic matter distribution and cycling have been spatially and temporally altered.

Community 4.1
Community Phase

Juniper trees dominate overstory, sagebrush is decadent and dying, deep rooted perennial bunchgrasses are decreasing. Recruitment of sagebrush cohorts is minimal. Annual non-natives may be present or increasing. Bare ground interspaces are large and connected.

Community 4.2
Community Phase

Juniper trees dominate overstory. Black sagebrush is decadent and dying with numerous skeletons present or sagebrush may be missing from the system. Bunchgrasses present in trace amounts and annual non-native species may dominate understory. Herbaceous species may be located primarily under the canopy or near the drip line of trees. Bare ground interspaces are large and connected. Soil movement may be apparent.

Pathway a
Community 4.1 to 4.2

Time and lack of disturbance or management action allows for tree cover and density to further increase and trees to out-compete the herbaceous understory species for sunlight and water.

State 5
Annual State

This state has one community phase. In this state, a biotic threshold has been crossed and state dynamics are driven by the dominance and persistence of the annual grass community which is perpetuated by a shortened fire return interval fire. The herbaceous understory is dominated by annual non-native species such as cheatgrass, halogeton, and mustards. Resiliency has declined and further degradation from fire facilitates a cheatgrass and sprouting shrub plant community. Fire return interval has shortened due to the dominance of cheatgrass in the understory and is a driver in site dynamics.

Community 5.1

Community Phase

Figure 10. P.Novak-Echenique 5/2012

Cheatgrass, mustards, halogeton and other annuals dominate the site. Halogeton more readily invades this site. Sprouting shrubs may be present. Erosion may be significant.

State 6
Seeded State

This state has two community phases, a grass-dominated phase and a shrub dominated phase. The grass phase is characterized by the dominance of seeded introduced wheatgrass species. Forage kochia and other desired seeded species including black sagebrush and native and non-native forbs may be present. The shrub phase is dominated by black sagebrush which has reestablished on the site.

Community 6.1
Community Phase

Introduced wheatgrass species and other non-native species such as forage kochia dominate the community. Native and non-native seeded forbs may be present. Trace amounts of black sagebrush may be present. Native bunchgrasses may be present. Annual non-native species present.

Community 6.2
Community Phase

Black sagebrush and seeded wheatgrass species co-dominate. Native bunchgrasses may be present. Annual non-native species stable to increasing.

Pathway a
Community 6.1 to 6.2

Inappropriate grazing management particularly during the growing season reduces perennial bunchgrass vigor and density and facilitates shrub establishment if a seed source is available.

Pathway a
Community 6.2 to 6.1

Low severity fire or brush management with minimal soil disturbance will reduce the sagebrush overstory and may allow seeded non-native grass species to become dominant. Native bunchgrasses may be present.

Conservation practices

Brush Management

Transition A
State 1 to 2

Introdcution on non-native plants

Transition A
State 2 to 3

Trigger: To Community Phase 3.1: Inappropriate cattle/horse grazing will decrease or eliminate deep rooted perennial bunchgrasses, increase Sandberg bluegrass and/ or galleta grass and favor shrub growth and establishment. To Community Phase 3.2: Severe fire will remove sagebrush overstory, decrease perennial bunchgrasses and enhance galleta and/or Sandberg's bluegrass. Soil disturbing brush treatments and/or inappropriate sheep grazing will reduce sagebrush and potentially increase sprouting shrubs and Sandberg's bluegrass and/or galleta grass. Slow variables: Long term decrease in deep-rooted perennial grass density and/or black sagebrush. Threshold: Loss of deep-rooted perennial bunchgrasses changes nutrient cycling, nutrient redistribution, and reduces soil organic matter. Loss of long-lived, black sagebrush changes the temporal distribution, and depending on the replacement shrub, the spatial distribution of nutrient cycling.

Transition B
State 2 to 4

Trigger: Absence of disturbance over time allows for Utah juniper or singleleaf pinyon dominance. Feedbacks and ecological processes: Trees increasingly dominate use of soil water resulting in decreasing herbaceous and shrub production and decreasing organic matter inputs, contributing to reductions in soil water availability to grasses and shrubs and increased soil erodibility. Slow variables: Long term increase in juniper and/or singleleaf pinyon density. Threshold: Trees overtop black sagebrush and out-compete shrubs for water and sunlight. Shrub skeletons exceed live shrubs in number. There is minimal recruitment of new shrub cohorts. Litter builds up underneath trees while bare ground increases in interspaces; this changes nutrient cycling and levels of organic matter in the soil. Redistribution of soil, organic matter and nutrients may occur with water and wind erosion.

Transition C
State 2 to 5

Trigger: Catastrophic fire or soil surface disturbance. Slow variables: Increased production and cover of non-native annual species. Threshold: Loss of deep-rooted perennial bunchgrasses and shrubs changes energy and nutrient capture and cycling both spatially and temporally within the community. Increased, continuous fine fuels modify the fire regime by changing intensity, size and spatial variability of fires.

Transition A
State 3 to 4

Trigger: Absence of disturbance over time allows for Utah juniper or singleleaf pinyon dominance. Feedbacks and ecological processes: Trees increasingly dominate use of soil water resulting in decreasing herbaceous and shrub production and decreasing organic matter inputs, contributing to reductions in soil water availability to grasses and shrubs and increased soil erodibility. Slow variables: Long-term increase in juniper and/or singleleaf pinyon density. Threshold: Trees overtop black sagebrush and out-compete shrubs for water and sunlight. Shrub skeletons exceed live shrubs in number. There is minimal recruitment of new shrub cohorts. Litter builds up underneath trees while bare ground increases in interspaces; this changes nutrient cycling and levels of organic matter in the soil.

Transition B
State 3 to 5

Trigger: Fire or treatments that disturb the soil and existing plant community (ex: failed restoration attempts). Slow variables: Increased seed production and cover of annual non-native species. Threshold: Increased, continuous fine fuels modify the fire regime by changing intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture and impact the nutrient cycling and distribution.

Restoration pathway A
State 3 to 6

Seeding of deep-rooted introduced bunchgrasses and other desired species; may be coupled with brush management and/or herbicide. Probability of success is low.

Conservation practices

Range Planting

Restoration pathway A
State 4 to 3

Removal of trees and range seeding in community phase 4.1. If restoration efforts fail, this site could transition to Annual State 5.0

Conservation practices

Brush Management
Range Planting

Transition A
State 4 to 5

Trigger: Catastrophic fire causing a stand replacement event. Inappropriate tree removal practices with soil disturbance will also cause a transition to Annual State 5. Slow variables: Increased production and cover of non-native annual species under tree canopies. Threshold: Closed tree canopy with non-native annual species dominant in the understory changes the intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture and impacts nutrient cycling and distribution.

Transition A
State 6 to 4

Trigger: Absence of disturbance over time and/or inappropriate grazing management facilitates the establishment and eventual dominance of Utah juniper or singleleaf pinyon. Slow variables: Long term increase in juniper and/or singleleaf pinyon density. Threshold: Trees out-compete understory species for water and sunlight. There is minimal recruitment of new shrub cohorts. Litter builds up underneath trees while bare ground increases in interspaces; this changes nutrient cycling and levels of organic matter in the soil. Redistribution of soil, organic matter and nutrients may occur with water and wind erosion.

Transition B
State 6 to 5

Trigger: Fire, inappropriate grazing management or treatments that disturb the soil and existing plant community (ex: failed restoration attempts). Slow variables: Increased seed production and cover of annual non-native species. Threshold: Increased, continuous fine fuels modify the fire regime by changing intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture and impact the nutrient cycling and distribution.

Additional community tables

Table 6. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Primary Perennial Grasses**			219–364	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	112–168	–
	needle and thread	HECO26	*Hesperostipa comata*	84–140	–
	James' galleta	PLJA	*Pleuraphis jamesii*	11–28	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	11–28	–
2	**Secondary Perennial Grasses**			11–45	
	threeawn	ARIST	*Aristida*	3–17	–
	King's eyelashgrass	BLKI	*Blepharidachne kingii*	3–17	–
	blue grama	BOGR2	*Bouteloua gracilis*	3–17	–
	squirreltail	ELEL5	*Elymus elymoides*	3–17	–
	bluegrass	POA	*Poa*	3–17	–
Forb					
3	**Perennial**			22–73	
	globemallow	SPHAE	*Sphaeralcea*	11–28	–
	aster	ASTER	*Aster*	3–17	–
	milkvetch	ASTRA	*Astragalus*	3–17	–
	buckwheat	ERIOG	*Eriogonum*	3–17	–
	phlox	PHLOX	*Phlox*	3–17	–
Shrub/Vine					
4	**Primary Shrubs**			123–269	
	black sagebrush	ARNO4	*Artemisia nova*	112–196	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	11–45	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–28	–
5	**Secondary Shrubs**			8–73	
	shadscale saltbush	ATCO	*Atriplex confertifolia*	6–17	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	6–17	–
	Nevada jointfir	EPNE	*Ephedra nevadensis*	6–17	–
	spiny hopsage	GRSP	*Grayia spinosa*	6–17	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	6–17	–
	bud sagebrush	PIDE4	*Picrothamnus desertorum*	6–17	–
	horsebrush	TETRA3	*Tetradymia*	6–17	–
Tree					
6	**Evergreen**			3–11	
	Utah juniper	JUOS	*Juniperus osteosperma*	3–11	–

Animal community

Livestock/Wildlife Grazing Interpretations:
This site is suitable for livestock grazing. Considerations for grazing management include timing, intensity and duration of grazing. Targeting grazing can be used to reduce the density of non-natives.

Black sagebrush palatability has been rated as moderate to high depending on the ungulate and the season of use (Horton 1989, Wambolt 1996). The palatability of black sagebrush increases the potential negative impacts on remaining black sagebrush plants from grazing or browsing pressure following fire (Wambolt 1996). Pronghorn utilize black sagebrush heavily (Beale and Smith 1970). On the Desert Experiment Range, black sagebrush was found to comprise 68% of pronghorn diet even though it was only the third most common plant. Fawns were found to prefer black sagebrush utilizing it more than all other forage species combined (Beale and Smith 1970). Domestic livestock will also utilize black sagebrush. The domestic sheep industry that emerged in the Great Basin in the early 1900s was largely based on wintering domestic sheep in black sagebrush communities (Mozingo 1987). Domestic sheep will browse black sagebrush during all seasons of the year depending on the availability of other forage species, with greater amounts being consumed in fall and winter. Black sagebrush is generally less palatable to cattle than to domestic sheep and wild ungulates (McArthur et al. 1979); however, cattle use of black sagebrush has also been shown to be greatest in fall and winter (Schultz and McAdoo 2002), with only trace amounts being consumed in summer (Van Vuren 1984). Dormant season use of black sagebrush can reduce sagebrush density and increase the density of bunchgrasses such as Indian ricegrass.

Inappropriate grazing management during the growing season will cause a decline in understory plants such as needleandthread and Indian ricegrass. Growing season grazing by cattle may initially cause a decrease in the bunchgrass component and give a competitive advantage to shrub species including black sagebrush (Eckert et al. 1972).

Specifically, needleandthread grass is most commonly found on warm/dry soils (Miller et al. 2013) and is not grazing tolerant and will be one of the first grasses to decrease under heavy grazing pressure (Smoliak et al. 1972, Tueller and Blackburn 1974). Heavy grazing is likely to reduce basal area of these plants (Smoliak et al. 1972). With the reduction in competition from deep rooted perennial bunchgrasses, the rhizomatous galleta grass and short-statured Sandberg bluegrass will likely increase (Jameson 1962, Smoliak et al. 1972)

Indian ricegrass is a deep-rooted, cool season perennial bunchgrass that is adapted primarily to coarse textured soils. Indian ricegrass is a preferred forage species for livestock and wildlife (Cook 1962, Booth et al. 2006). This species is often heavily utilized in winter because it cures well (Booth et al. 2006). It is also readily utilized in early spring, being a source of green feed before most other perennial grasses have produced new growth (Quinones 1981). Booth et al. (2006) note that the plant does well when utilized in winter and spring. Cook and Child (1971), however, found that repeated heavy grazing reduced crown cover, which may reduce seed production, density, and basal area of these plants. Additionally, heavy early spring grazing reduces plant vigor and stand density (Stubbendieck et al. 1985). In eastern Idaho, productivity of Indian ricegrass was at least 10 times greater in undisturbed plots than in heavily grazed ones (Pearson 1976). Cook and Child (1971) found significant reduction in plant cover after seven years of rest from heavy (90%) and moderate (60%) spring use. The seed crop may be reduced where grazing is heavy (Bich et al. 1995). Tolerance to grazing increases after May, thus spring deferment may be necessary for stand enhancement (Pearson 1964, Cook and Child 1971); however, utilization of less than 60% is recommended. In summary, adaptive management is required to manage this bunchgrass well.

Reduced bunchgrass vigor or density provides an opportunity for galleta and/or Sandberg bluegrass expansion and/or cheatgrass and other invasive species such as halogeton to occupy interspaces. Increased cheatgrass cover leads to increased fire frequency and potentially an annual plant community. Galleta and/or Sandberg bluegrass increases under grazing pressure (Jameson 1962, Tisdale and Hironaka 1981) and is capable of co-existing with cheatgrass. Depending on the season of use, the type of grazing animal, and site conditions, either galleta or Sandberg bluegrass or cheatgrass may become the dominant understory with inappropriate grazing management.
Black sagebrush are desirable forage plants and also act as good cover for wildlife (Blaisdell et al. 1982). Pronghorn do best where shrub cover is moderate to low, therefore, low sagebrush varieties may be preferred in some areas over big sagebrush varieties (Blaisdell et al. 1982). Furthermore, a review identified black sagebrush as the most important source of winter browse for pronghorn in Utah (Allen et al. 1984). In winter, it was reported by Clary and Beale (1983) that pronghorn preferred black sagebrush habitat.
In a study by Behan and Welch (1985) black sagebrush accessions were preferred over six other big sagebrush accessions for winter habitat by mule deer. Black sagebrush (and other sagebrush communities) are less attractive to elk and moose. In southwestern Wyoming comparing winter habitat use by wild ungulates, elk and moose used Wyoming big sagebrush and black sagebrush community less than expected, while mule deer used it almost exclusively (Oedekoven et al. 1987).
Bird species use black sagebrush habitat. Sage thrashers and most passerines prefer areas with black sagebrush and other dwarf shrubs over areas with taller shrubs (Medin et al. 2000). Gunnison sage-grouse, Columbian sharp-tailed grouse, Brewer's sparrow, sage sparrow, sage thrasher, also use black sagebrush communities for cover and feed (Paige and Ritter 1999). Greater Sage grouse are known obligates in black sagebrush and other sagebrush habitats and will use black sagebrush sites as winter grounds (Connelly et al. 2000). For example: sage-grouse on

the Snake River Plains of Idaho use black sagebrush-big sagebrush communities as winter range, and in Nevada, sage-grouse select wind-swept ridges with short, scattered black sagebrush plants as winter feeding areas (Clements and Young 1997). In fact, throughout the west, greater sage grouse use mixed sagebrush habitats of big sagebrush and black sagebrush stands.

Black sagebrush, is often a component of low sagebrush communities and is an important shrub for pygmy rabbits and other sagebrush obligate species (Oregon Conservation Strategy, 2006).
Rodents also use black sagebrush habitats. A study in northeastern Nevada showed deer mice, Great Basin pocket mice, and Ord's kangaroo rats used gray low sagebrush-black sagebrush communities on dry ridge tops in late spring and summer (McAdoo et al. 2006). Rodents on cold-desert warm-desert ecotones within the Nevada Test Site preferred cold-desert communities over transition and warm-desert communities in which black sagebrush communities were more abundant (Hansen et al. 1999). Black sagebrush communities also support predators. According to study by MacLaren et al. (1988) greater sage-grouse are the primary avian prey of golden eagles in a mixed big sagebrush-black sagebrush shrubland in southeastern Wyoming.
Threats and Management
Changes in plant community composition caused by fire frequency, and other threats associated with this ecological site could affect the distribution and presence of wildlife species.

Hydrological functions

Runoff is high to very high. Permeability is slow to moderately rapid. A few rills and waterflow patterns may occur on steeper slopes after summer convection storms. Perennial herbaceous plants (especially deep-rooted bunchgrasses [i.e., Indian ricegrass, needleandthread]) slow runoff and increase infiltration. Shrub canopy and associated litter break raindrop impact.

Recreational uses

Aesthetic value is derived from the diverse floral and faunal composition and the colorful flowering of wild flowers and shrubs during the spring and early summer. This site offers rewarding opportunities to photographers and for nature study. This site is used for camping and hiking and has potential for upland and big game hunting.

Other products

Fourwing saltbush is traditionally important to Native Americans. They ground the seeds for flour. The leaves, placed on coals, impart a salty flavor to corn and other roasted food. Top-growth produces a yellow dye. Young leaves and shoots were used to dye wool and other materials. The roots and flowers were ground to soothe insect bites. Sand dropseed is an edible grass used by Native Americans.

Other information

Black sagebrush is an excellent species to establish on sites where management objectives include restoration or improvement of domestic sheep, pronghorn, or mule deer winter range. Fourwing saltbush is widely used in rangeland and riparian improvement and reclamation projects, including burned area recovery. It is probably the most widely used shrub for restoration of winter ranges and mined land reclamation. Winterfat adapts well to most site conditions, and its extensive root system stabilizes soil. However, winterfat is intolerant of flooding, excess water, and acidic soils. Indian ricegrass was traditionally eaten by some Native Americans. The Paiutes used seed as a reserve food source. Needleandthread grass is useful for stabilizing eroded or degraded sites. Sand dropseed is recommended as a component of grass seed mixtures for sandy and heavy to semi-sandy soils. Good results are seen reseeding dry low lands receiving less than 9 inches (230mm) of precipitation within rangelands of Nevada.

Type locality

Location 1: Elko County, NV	
Township/Range/Section	T35N R70E S6
Latitude	40° 56′ 43″
Longitude	114° 6′ 5″

General legal description	NW¼NW¼, Section 6, T35N. R70E. MDBM. About 18 miles north of Wendover, Pilot Creek Valley area, Elko County, Nevada. This site also found in White Pine County NV.

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Rangeland health reference sheet

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

Author(s)/participant(s)	GK BRACKLEY/P.NOVAK-ECHENIQUE
Contact for lead author	State Rangeland Management Specialist
Date	06/22/2006
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rills are none to rare. A few can be expected on steeper slopes in areas subjected to summer convection storms or rapid spring snowmelt. These will heal during the following growing season.

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2. **Presence of water flow patterns:** Water flow patterns are none to rare. A few (short <1m and disconnected) can be expected in areas subjected to summer convection storms or rapid snowmelt.If present, they will meander and are interruped by plants and rock fragments.

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3. **Number and height of erosional pedestals or terracettes:** Pedestals are none to rare. Occurrence is usually limited to areas of water flow patterns and may occur on shallow-rooted plants. Terracettes are typically not present.

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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 5 to 25% depending on amount of surface rock fragments. Bare ground will increase under extreme drought conditions as perennial forbs and grasses may decrease in cover.

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5. **Number of gullies and erosion associated with gullies:** None

6. **Extent of wind scoured, blowouts and/or depositional areas:** Wind scoured areas are none to rare. Surface rock fragments protect the soil surface.

7. **Amount of litter movement (describe size and distance expected to travel):** Fine litter (foliage from grasses and annual & perennial forbs) expected to move distance of slope length during intense summer convection storms or rapid snowmelt events. Persistent litter (large woody material) will remain in place except during large rainfall events.

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil stability values should be 3 to 4 with no cover and 4 to 6 with canopy cover. Areas of this site occurring on soils that have a physical crust will probably have stability values less than 3.

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Surface structure is typically thin platy, medium granular or subangular blocky. Soil surface colors are light browns or grays and soils are typified by an ochric epipedon. Organic matter of the surface 2 to 3 inches is typically 1 to 1.5 percent dropping off quickly below. Organic matter content can be more or less depending on micro-topography.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Perennial herbaceous plants (especially deep-rooted bunchgrasses [i.e., Indian ricegrass, needleandthread]) slow runoff and increase infiltration. Shrub canopy and associated litter break raindrop impact and will add in increasing infiltration and reducing runoff. With extended drought conditions plant cover may decrease and runoff will increase.

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** Compacted layers are none. Massive sub-surface horizons or subsoil duripans or petrocalcic horizons are not to be interpreted as compacted layers.

12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

    Dominant: Reference State: Deep-rooted, cool season, perennial bunchgrasses >

    Sub-dominant: low shrubs (black sagebrush) >> associated shrubs > shallow-rooted, cool season, bunchgrasses = warm season grasses = deep-rooted, cool season, perennial forbs > annual forbs.

    Other: Evergreen trees, succulents, biological crusts

    Additional: With an extended fire return interval the shrub component increases and the herbaceous component decreases.

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Dead branches within individual shrubs common and standing dead shrub canopy material may be as much as 25% of total woody canopy; some of the mature bunchgrasses (<20%) have dead centers.

14. **Average percent litter cover (%) and depth (in):** Within plant interspaces 15-30% and depth of litter is <¼ inch

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** For normal or average growing season (end of May) ± 500 lbs/ac; Favorable years ± 700 lbs/ac and unfavorable years ± 300 lbs/ac

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:** Potential invaders include cheatgrass, halogeton, Russian thistle and annual mustards. Utah juniper will increase and eventually dominate on this site with an extended fire interval. After wildfire cheatgrass will most likely invade and dominate.

17. **Perennial plant reproductive capability:** All functional groups should reproduce in average (or normal) and above average growing season years. Reduced growth and reproduction occurs during extreme or extended drought periods.