USDA Natural Resources Conservation Service

Ecological site R028BY017NV
LOAMY 5-8 P.Z.

Accessed: 05/03/2024

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.

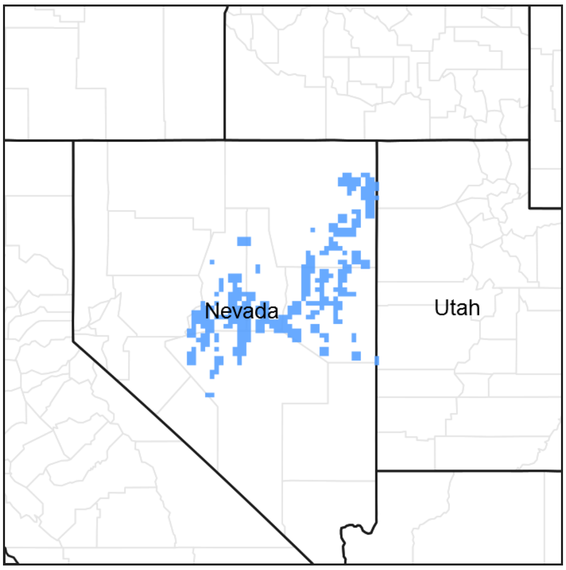

Figure 1. Mapped extent

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): 028B–Central Nevada Basin and Range

MLRA 28B occurs entirely in Nevada and comprises about 23,555 square miles (61,035 square kilometers). More than nine-tenths of this MLRA is federally owned. This area is in the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. It is an area of nearly level, aggraded desert basins and valleys between a series of mountain ranges trending north to south. The basins are bordered by long, gently sloping to strongly sloping alluvial fans. The mountains are uplifted fault blocks with steep sideslopes. Many of the valleys are closed basins containing sinks or playas. Elevation ranges from 4,900 to 6,550 feet (1,495 to 1,995 meters) in the valleys and basins and from 6,550 to 11,900 feet (1,995 to 3,630 meters) in the mountains.
The mountains in the southern half are dominated by andesite and basalt rocks that were formed in the Miocene and Oligocene. Paleozoic and older carbonate rocks are prominent in the mountains to the north. Scattered outcrops of older Tertiary intrusives and very young tuffaceous sediments are throughout this area. The valleys consist mostly of alluvial fill, but lake deposits are at the lowest elevations in the closed basins. The alluvial valley fill consists of cobbles, gravel, and coarse sand near the mountains in the apex of the alluvial fans. Sands, silts, and clays are on the distal ends of the fans.
The average annual precipitation ranges from 4 to 12 inches (100 to 305 millimeters) in most areas on the valley floors. Average annual precipitation in the mountains ranges from 8 to 36 inches (205 to 915 millimeters) depending on elevation. The driest period is from midsummer to midautumn. The average annual temperature is 34 to 52 degrees F (1 to 11 degrees C). The freeze-free period averages 125 days and ranges from 80 to 170 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 soil temperature regime, an aridic or xeric soil moisture regime, and mixed or carbonatic mineralogy. They generally are well drained, loamy or loamyskeletal, and shallow to very deep.
Nevada's climate is predominantly arid, with large daily ranges of temperature, infrequent severe storms and heavy snowfall in the higher mountains. Three basic geographical factors largely influence Nevada's climate: continentality, latitude, and elevation. 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, as a result 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 midlatitude 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 occasional thundershowers. The eastern portion of the state receives noteworthy 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).

Ecological site concept

This site occurs on fan skirts. Slopes gradients of 2 to 8 percent are typical. Elevations range from 5000 to 6500 feet.
The soils associated with this site are very deep, well drained, and formed in alluvium derived from mixed rocks. Soils are alkaline throughout and characterized by an ochric epipedon. Soil surface structure is typically platy with vesicular pores. The soil moisture regime is typic aridic and the soil temperature regime is mesic.
The reference state is dominated by Indian ricegrass, bottlebrush squirreltail, and shadscale. Production ranges from 200 to 400 pounds per acre.

Associated sites

R028BY018NV	**SILTY 5-8 P.Z.**
R028BY073NV	**SHALLOW SILTY 5-8 P.Z.**
R028BY075NV	**COARSE GRAVELLY LOAM 6-8 P.Z.**

Similar sites

R028BY019NV	**LOAMY SLOPE 5-8 P.Z.** Less productive site; typically on steep slopes.
R028BY009NV	**SHALLOW SILTY 8-10 P.Z.** More ACHY and ATCO; less PIDE4; more productive site.
R028BY073NV	**SHALLOW SILTY 5-8 P.Z.** Nearly homogeneous community of ATCO.
R028BY075NV	**COARSE GRAVELLY LOAM 6-8 P.Z.** Greater herbaceous composition; more productive site.

Table 1. Dominant plant species

Tree	Not specified

Shrub	(1) *Atriplex confertifolia*
Herbaceous	(1) *Achnatherum hymenoides* (2) *Elymus elymoides*

Physiographic features

This site is found on fan skirts. Slopes range from 2 to 15 percent, but gradients of 2 to 8 percent are typical. Elevations range from 4500 to 6500 feet, but are typically between 5000 to 6500 feet.

Table 2. Representative physiographic features

Landforms	(1) Fan skirt
Flooding frequency	None
Ponding frequency	None
Elevation	1,524–1,981 m
Slope	2–8%
Water table depth	0 cm
Aspect	Aspect is not a significant factor

Climatic features

The climate associated with this site is semiarid, characterized by cold, moist winters and warm, dry summers.

The average annual precipitation ranges from 5 to 8 inches. Mean annual air temperature is about 45 to 50 degrees F. The average growing season is 100 to 120 days.

Mean annual precipitation across the range in which this ES occurs is 7.83".
Monthly mean precipitation: January 0.685; February 0.61; March 0.70; April 0.845; May .97; June 0.68; July 0.50; August 0.395; September 0.50; October 0.745; November 0.60; December 0.60.
*The above data is averaged from the Beowawe and Lages WRCC climate stations.

Table 3. Representative climatic features

Frost-free period (average)	120 days
Freeze-free period (average)	160 days
Precipitation total (average)	203 mm

Climate stations used

- (1) LAGES [USC00264341], Ely, NV
- (2) BEOWAWE 49S U OF N RCH [USC00260800], Eureka, NV

Influencing water features

Influencing water features are not associated with this site.

Soil features

The soils associated with this site are very deep, well drained, and formed in mixed alluvium with a component of loess. Soils are alkaline throughout and characterized by an ochric epipedon. Soil surface texture is variable, but the soil structure is commonly platy, and may have vesicular pores, in the surface horizon. The soil moisture regime is typic aridic and the soil temperature regime is mesic. Soil series associated with this site include: Broyles, Caphor, Fenster, Hessing, Lopwash, Loray, Luap, Maghills, Mcconnel, Mcvegas, Nadra, Oxcorel, Piltdown, Raph, Ricert, Rotinom, Sodhouse, Spanel, Stingdorn, Tenabo, Unsel, Zerk, and Wintermute.

The representative soil series for this site include Loray and Broyles. Loray is classified as a sandy-skeletal, mixed, mesic Typic Haplocalcids. An ochric epipedon occurs from the soil surface to 18cm and a calcic horizon occurs from 30 to 58cm. Clay content in the particle size control section averages 0 to 8 percent and rock fragments range from 60 to 80 percent, made up of mainly gravel with <10 percent cobbles. Soils are alkaline and effervescent throughout. Parent material consists of mixed rocks with a component of loess.
Broyles is classified as an Ashy over loamy, glassy over mixed, superactive, mesic Durinodic Haplocambids. Diagnostic horizons include an ochric epipedon from the soil surface to 18cm and durinodes and identifiable secondary carbonates from 56 to 142cm. Soils are alkaline throughout, effervescent in the lower profile and derived from mixed alluvium, loess and volcanic ash.

This site may also occur on soils shallow to a duripan. This correlation is the result of low precipitation and low available water holding capacity in the root zone. Soil series include McVegas, Nadra, Sodhouse, Spanel, Stingdorn and Tenabo. These soils are also well drained, formed in alluvium derived from mixed a component of loess and/or volcanic ash, and are characterized by an ochric epipedon. Soil surface structure is platy and commonly has vesicular pores. Soil characterized by a duripan are representative of older geologic formations when compared to soils without a duripan.

Table 4. Representative soil features

Surface texture	(1) Gravelly loam (2) Ashy silt loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Very slow to moderately rapid
Soil depth	152–213 cm
Surface fragment cover <=3"	15–35%
Surface fragment cover >3"	0–2%
Available water capacity (0-101.6cm)	7.62–10.16 cm
Calcium carbonate equivalent (0-101.6cm)	0–20%
Electrical conductivity (0-101.6cm)	0–16 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	1–25
Soil reaction (1:1 water) (0-101.6cm)	7.9–9
Subsurface fragment volume <=3" (Depth not specified)	10–70%
Subsurface fragment volume >3" (Depth not specified)	0–5%

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.) (Caudle 2013). Biotic factors that influence resilience include site productivity, species composition and structure, and population regulation and regeneration (Chambers et al. 2013).
The ecological site is dominated by deep-rooted cool season, perennial bunchgrasses and drought tolerant shrubs with high root to shoot ratios. The dominant shrubs usually root to the full depth of the winter-spring soil moisture

recharge, which Fernandez and Caldwell (1975) reported as between 80 and 110 cm for shadscale and winterfat. Shadscale and winterfat both initiate root growth, in early April, a few days to a week prior to aerial plant parts and shadscale in particular exhibits active root growth for several weeks after termination of shoot growth (Fernandez and Caldwell 1975). Continued root growth, even for established plants that are not exploring new areas of the soil, facilitates water absorption particularly in low soil moisture conditions (Gardner 1960). Fernandez and Caldwell (1975) concluded that the ability of shadscale to explore the soil volume at greater depths with a more profuse system of small branching lateral roots than winterfat or sagebrush may play a role in its ability to remain photosynthetically active longer into the summer season. Although shadscale exhibits the ability to withstand drought conditions on a short-term basis the forty year photographic record (1951-1990) from the Raft River Valley of south-central Idaho visually demonstrates the impact of multiple years of drought on shadscale communities (Sharp et al. 1990). Scale insects have also been implicated in the death of shadscale (Sharp et al. 1990) however the data on this subject remains inconclusive (Nelson et al. 1990). Interestingly, periods of above normal springtime precipitation are also linked to shadscale die-off. Nelson et al. (1990) investigated areas of severe shadscale die-off that were, for the most part, located in low areas in valley bottoms or upland depressions that apparently incurred prolonged high soil moisture during a wet period. The high soil moisture appeared to be correlated with increased pythiaceous fungi leading to rootlet mortality and plant stress (Nelson et al. 1990). The authors suggest that depending on the degree and duration of plant stress, injury could range from a sustained disease to rapid death.

Shadscale is a densely clumped, rounded, compact native shrub. It generally attains heights of 8 to 32 inches and widths of 12 to 68 inches (Blaisdell and Holmgren 1984). Shadscale is considered an evergreen to partially deciduous shrub, since a small percentage of leaves are dropped in the winter (Smith and Nobel 1986). Shadscale possesses wider ecological amplitude than most Atriplex species (Crofts and Van Epps 1975), and shows ploidy levels from diploid (2x) to decaploid (10x). The extensive polyploidy of shadscale is an important consideration when implementing revegetation projects because ploidy levels are usually associated with distinct habitats (Sanderson et al. 1990). Diploid individuals are unlikely to perform as well in areas where tetraploids are more common. Diploid individuals generally occur above Pleistocene lake levels, whereas lake floors are usually occupied by autotetraploids. Overall, tetraploids are the most widespread throughout its range (Carlson 1984). Bud sagebrush, a common shrub to this ecological site, is a native, summer-deciduous shrub. It is low growing, spinescent, aromatic shrub with a height of 4 to 10 inches and a spread of 8 to 12 inches (Chambers and Norton 1993).

The perennial bunchgrasses that are sub-dominant with the shrubs include Indian ricegrass and bottlebrush squirreltail. The dominant grass within this site, is Indian ricegrass a hardy, cool-season, densely tufted, native perennial bunchgrass that grows from 4 to 24 inches in height (Blaisdell and Holmgren 1984). Squirreltail is a competitive, short-lived, perennial grass that readily establishes from seed. These species generally have somewhat shallower root systems than the shrubs, but root densities are often as high or higher than those of the shrubs in the upper 0.5m of the soil profile. General differences in root depth distributions between grasses and shrubs results in resource partitioning these shrub – grass systems.

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. Historically, shadscale dominant salt-desert shrub communities were free of exotic invaders; however, excessive grazing pressure during settlement and into the 20th century has increased the overall presence of cheatgrass, halogeton, Russian thistle and weedy mustard species (Peters and Bunting 1994). The presence of exotic annual plants within these ecosystems decreases ecosystem resilience and resistance to disturbance through competition for limited resources. Dobrowolski et al. (1990) cite multiple authors on the extent of the soil profile exploited by the competitive exotic annual cheatgrass. Specifically, the depth of rooting is dependent on the size the plant achieves and in competitive environments cheatgrass roots were found to penetrate only 15 cm whereas isolated plants and pure stands were found to root at least 1 m in depth with some plants rooting as deep as 1.5 to 1.7 m.
The ecological site has low resilience to disturbance and resistance to invasion. Increased resilience increases with elevation, aspect, increased precipitation and increased nutrient availability. Four possible stable states have been identified for this site.

Fire Ecology:
The lack of continuous fuels to carry fires made fire rare to nonexistent in shadscale communities (Young and Tipton 1990), thus it is not surprising that shadscale and bud sagebrush are both fire intolerant (Banner 1992, West 1994). Shadscale does not readily recover from fire, except for establishment through seed (West 1994). The slow

reestablishment allows for easy invasion by cheatgrass and other non-native weedy species (Sanderson et al. 1990). The increased presence of exotic annual grasses has greatly altered fire regimes in areas of the Intermountain West where shadscale is a major vegetational component. Exotic annuals increase fire frequency under wet to near-normal summer moisture conditions and repeated, frequent fire has converted large expanses of shadscale rangeland to annual non-native plant communities (Knapp 1998).

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. For most forbs and grasses the growing points are located at or below the soil surface providing relative protection from disturbances which decrease above ground biomass, such as grazing or fire. Thus, fire mortality is more correlated to duration and intensity of heat which is related to culm density, culm-leaf morphology, size of plant and abundance of old growth (Wright 1971, Young 1983). However, season and severity of the fire and post-fire soil moisture availability will influence plant response.
Indian ricegrass is a deep-rooted, cool season perennial bunchgrass that is adapted primarily to sandy soils. A prominent grass on this site, it is fairly fire tolerant (Wright 1985), which is likely due to its low culm density and below ground plant crowns. Vallentine (1989) cites several studies in the sagebrush zone that classified Indian ricegrass as being slightly damaged from late summer burning. Indian ricegrass has also 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 facilitates the reestablishment of Indian ricegrass. Grazing management following fire to promote seed production and establishment of seedlings is important.

Bottlebrush squirreltail is considered one of the most fire resistant bunchgrasses due to its small size, coarse stems, and sparse leafy material (Britton et al. 1990). Postfire regeneration occurs from surviving root crowns and from on- and off-site seed sources. Bottlebrush squirreltail has the ability to produce large numbers of highly germinable seeds, with relatively rapid germination (Young and Evans 1977) when exposed to the correct environmental cues. It exhibits the ability to germinate in the late fall and very early spring at a wide range of temperatures making it a strong competitor with cheatgrass (USDA NRCS Plant Fact Sheet). Early spring growth and ability to grow at low temperatures contribute to the persistence of bottlebrush squirreltail among cheatgrass dominated ranges (Hironaka and Tisdale 1973).

Needleandthread a minor component on this site is a fine leaf grass and is considered sensitive to fire (Akinsoji 1988, Bradley et al. 1992, Miller et al. 2013). 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 seen to kill the plants while August burning had no effect. Thus, under wildfire scenarios needle and thread is often present in the post-burn community.

Sandberg’s bluegrass also a minor component on this ecological site, has been found to increase following fire likely due to its low stature and productivity (Daubenmire 1975). Sandberg bluegrass may retard reestablishment of deeper rooted bunchgrass.

Rehabilitation following fire will have limited success. Observations from one hundred and seven separate plantings within the shadscale zone in Utah and Nevada indicate a very low success rate (Bleak et al. 1965). Seed from 148 native and non-native grasses, forbs and shrubs were planted from 1937 to 1962 across ten locations. Good seedling stands were obtained with introduced wheatgrasses, but most perished during the first summer. A few plantings of crested, fairway and Siberian wheatgrass along with Russian wildrye maintained stands for 10 or more years but eventually declined to a very few plants (Bleak et al. 1965). The primary cause of seeding failures appeared to be the arid climate.

State and transition model

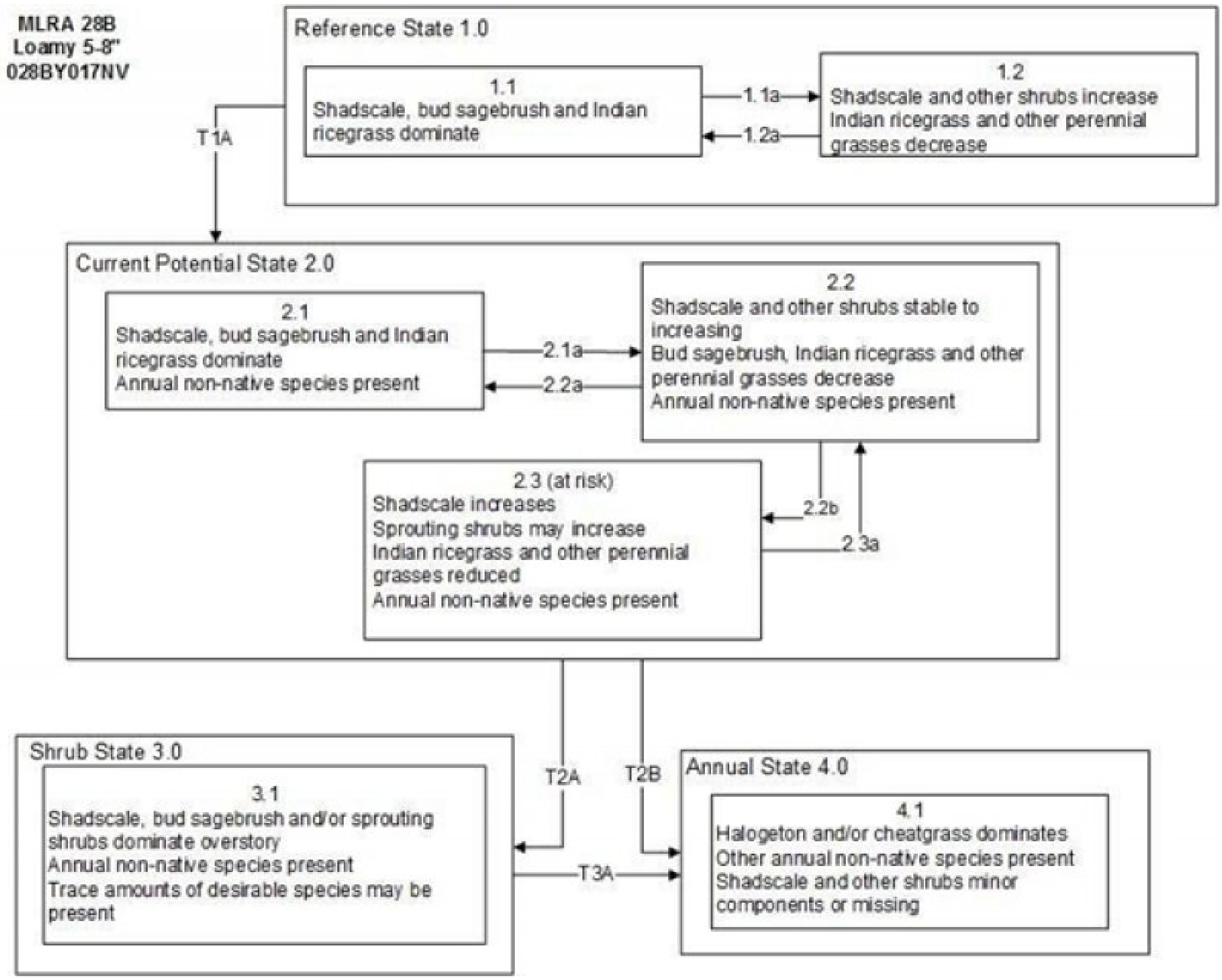

Figure 6. State and Transition Model

MLRA 28B
Loamy 5-8"
028BY017NV

Reference State 1.0 Community Phase Pathways
1.1a: Long-term drought and/or herbivory
1.2a: Release from drought and/or herbivory. Extreme growing season moisture may reduce shadscale.

Transition T1A: Introduction of non-native annual species such as halogeton.

Current Potential State 2.0 Community Phase Pathways
2.1a: Long-term drought and/or inappropriate grazing management
2.2a: Release from drought and/or appropriate grazing management that allows for an increase in bud sagebrush, winterfat and perennial grasses. Extreme growing season moisture may reduce shadscale.
2.2b: Inappropriate grazing and/or drought
2.3a: Release from drought and/or inappropriate grazing management allows for an increase in bud sagebrush and perennial grasses. Extreme growing season moisture may reduce shadscale.

Transition T2A: Long-term inappropriate grazing management and/or long-term drought.

Transition T2B: Soil disturbing treatments (drill seeding, roller chopper, Lawson aerator etc.), fire, and/or unusually wet spring.

Transition T3A: Soil disturbing treatments (drill seeding, roller chopper, Lawson aerator etc.), fire, and/or unusually wet spring.

Figure 7. Legend

State 1
Reference State

The Reference State 1.0 is a representative of the natural range of variability under pristine conditions. The Reference State has two general community phases: a shrub-grass dominated phase and a shrub dominant 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. This site is very stable, with little variation in plant community composition. Plant community changes would be reflected in production response to drought or herbivory. Wet years will increase grass production, while drought years will reduce production. Shrub production will also increase during wet years; however, extreme growing season wet periods has been shown to cause shadscale death.

Community 1.1
Community Phase

This community is dominated by shadscale, bud sagebrush and Indian ricegrass and bottlebrush squirreltail. Winterfat, spiny hopsage and needleandthread grass are also important specie but are minor components in the community. Community phase changes are primarily a function of chronic drought. Drought will favor shrubs over perennial bunchgrasses. However, long-term drought will result in an overall decline in plant community production, regardless of functional group. Extreme growing season wet periods may reduce the shadscale component. Fire is very infrequent to non-existent. Potential vegetative composition is about 30% grasses, 5% forbs, and 65% shrubs. Approximate ground cover (basal and crown) is 5 to 15 percent.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	146	219	291
Grass/Grasslike	67	101	135
Forb	11	17	22
Total	**224**	**337**	**448**

Community 1.2
Community Phase

Shrubs such as shadscale and bud sagebrush increase in the community. Perennial bunchgrasses decrease with drought and may become a minor component.

Pathway a
Community 1.1 to 1.2

Long-term drought and/or herbivory. Drought will favor shrubs over perennial bunchgrasses.

Pathway a
Community 1.2 to 1.1

Release from drought and/or herbivory would allow the vegetation to increase and bare ground would eventually decrease. Extreme growing season wet period may reduce shadscale.

State 2
Current Potential State

This state is similar to the Reference State 1.0. with the addition of a shadscale and sprouting shrub dominated phase. Ecological function has not changed, however the resiliency of the state has been reduced by the presence of invasive weeds. Non-natives may increase in abundance but will not become dominant within this State. These non-natives can be highly flammable and can promote fire where historically fire had been infrequent. Negative feedbacks enhance ecosystem resilience and contribute to the stability of the state. These feedbacks 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 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 shadscale and Indian ricegrass. Bottlebrush squirreltail and bud sagebrush are also important species on this site. Community phase changes are primarily a function of chronic drought. Fire is infrequent and patchy due to low fuel loads. Non-native annual species are present.

Community 2.2
Community Phase

Figure 9. Loamy 5-8", T. Stringham September 2012, NV780 MU170

Shadscale and rabbitbrush increase while Indian ricegrass and bud sagebrush decline. Bare ground increases along with annual weeds. Prolonged drought may lead to an overall decline in the plant community. Sandberg's bluegrass grass may increase.

Community 2.3
Community Phase (At Risk)

Shadscale and rabbitbrush dominates the overstory and perennial bunchgrasses, winterfat and bud sagebrush are reduced, either from competition with shrubs or from inappropriate grazing, chronic drought or both. Sandberg's bluegrass may increase. Annual non-native species may be stable or increasing due to a lack of completion with perennial bunchgrasses. Bare ground may be significant. This community is at risk of crossing a threshold to either State 3.0 (shrub) or State 4.0 (annual).

Pathway a
Community 2.1 to 2.2

Inappropriate growing season grazing favors unpalatable shrubs over bunchgrasses, winterfat and bud sagebrush. Prolonged drought will also decrease the perennial bunchgrasses in the understory.

Pathway a
Community 2.2 to 2.1

Release from drought and/or appropriate grazing management that facilitates an increase in perennial grasses, winterfat and bud sage. Periods of above-average precipitation during the growing season may reduce shadscale.

Pathway b
Community 2.2 to 2.3

Chronic drought and/or inappropriate grazing will significantly reduce perennial grasses, winterfat and bud sage in favor of shadscale and rabbitbrush.

Pathway a
Community 2.3 to 2.2

Release from drought and/or inappropriate grazing allows for bud sagebrush, winterfat and perennial grasses to increase. Extreme growing season wet period may reduce shadscale.

State 3
Shrub State

This state has one community phase that is characterized by shadscale, bud sagebrush or a sprouting shrub overstory with very little to no understory. The site has crossed a biotic threshold and site processes are being controlled by shrubs. Shrub cover exceeds the site concept and may be decadent, reflecting stand maturity and lack of seedling establishment due to competition with mature plants. The shrub overstory dominates site resources such that soil water, nutrient capture, nutrient cycling and soil organic matter are temporally and spatially redistributed. Bareground has increased.

Community 3.1
Community Phase

Decadent shadscale and bud sagebrush dominate the overstory. Rabbitbrush and/or other sprouting shrubs may be a significant component or dominant shrub. Deep-rooted perennial bunchgrasses may be present in trace amounts or absent from the community. Annual non-native species increase. Bare ground is significant.

State 4
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 plant community which is perpetuated by a shortened fire return interval. The herbaceous understory is dominated by annual non-native species such as cheatgrass and halogeton. Bare ground may be abundant. Resiliency has declined and further degradation from fire facilitates a cheatgrass and sprouting shrub plant community. The fire return interval has shortened due to the dominance of cheatgrass in the understory and is a driver in site dynamics.

Community 4.1
Community Phase

This community is dominated by annual non-native species. Halogeton and cheatgrass most commonly invade these sites. Trace amounts of shadscale and other shrubs may be present, but are not contributing to site function. Bare ground may be abundant, especially during low precipitation years. Soil erosion, soil temperature and wind are driving factors in site function.

Transition A
State 1 to 2

Trigger: This transition is caused by the introduction of non-native annual plants, such as halogeton and cheatgrass. Slow variables: Over time the annual non-native species will increase within the community. Threshold: Any amount of introduced non-native species causes an immediate decrease in the resilience of the site. Annual non-native species cannot be easily removed from the system and have the potential to significantly alter disturbance regimes from their historic range of variation.

Transition A
State 2 to 3

Trigger: Long-term inappropriate grazing and/or long-term chronic drought will decrease or eliminate deep rooted perennial bunchgrasses and favor shrub growth and establishment. Slow variables: Long term decrease in deep-rooted perennial grass density. Threshold: Loss of deep-rooted perennial bunchgrasses changes nutrient cycling, nutrient redistribution, and reduces soil organic matter.

Transition B
State 2 to 4

Trigger: Fire and/or soil disturbing treatments such as drill seeding and plowing. An unusually wet spring may facilitate the increased germination and production of cheatgrass leading to its dominance within the community. Slow variables: Increased production and cover of non-native annual species. Threshold: Loss of deep-rooted perennial bunchgrasses and shrubs truncates, spatially and temporally, nutrient capture and cycling within the community. Increased, continuous fine fuels from annual non-native plants modify the fire regime by changing intensity, size and spatial variability of fires.

Transition A
State 3 to 4

Trigger: Fire and/or soil disturbing treatments such as drill seeding and plowing. Slow variables: Increased production and cover of non-native annual 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 spatially and temporally thus impacting 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**			50–118	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	34–67	–
	squirreltail	ELEL5	*Elymus elymoides*	17–50	–
2	**Secondary Perennial Grasses**			7–17	
	needle and thread	HECO26	*Hesperostipa comata*	2–7	–
	Sandberg bluegrass	POSE	*Poa secunda*	2–7	–
Forb					
3	**Perennial**			7–34	
	milkvetch	ASTRA	*Astragalus*	2–10	–
	globemallow	SPHAE	*Sphaeralcea*	2–10	–
Shrub/Vine					
4	**Primary Shrubs**			168–252	
	shadscale saltbush	ATCO	*Atriplex confertifolia*	135–168	–
	bud sagebrush	PIDE4	*Picrothamnus desertorum*	34–84	–
5	**Secondary Shrubs**			7–27	
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	2–10	–
	spiny hopsage	GRSP	*Grayia spinosa*	2–10	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	2–10	–

Animal community

Livestock Interpretations:
This site is suitable for livestock grazing. Grazing considerations include timing, duration, frequency, and intensity of grazing.
Traditionally, shadscale plant communities provided good winter forage for the expanding sheep and cattle industry in the arid West. This site continues to provide valuable forage for livestock operations. Grazing management considerations including timing, intensity and duration of grazing. Indian ricegrass is highly palatable to all classes of livestock in both green and cured condition. It supplies a source of green feed before most other native grasses have produced much new growth. 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 1985). In eastern Idaho, productivity of Indian ricegrass was at least 10 times greater in undisturbed plots than in heavily grazed ones (Pearson 1965). Cook and Child (1971) found significant reduction in plant cover even after 7 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.
Bottlebrush squirreltail a minor component on this site, generally increases in abundance when moderately grazed or protected (Hutchings and Stewart 1953). In addition, moderate trampling by livestock in big sagebrush rangelands of central Nevada enhanced bottlebrush squirreltail seedling emergence compared to un-trampled conditions. Heavy trampling however was found to significantly reduce germination sites (Eckert et al. 1987). Squirreltail is more tolerant of grazing than Indian ricegrass but all bunchgrasses are sensitive to over utilization within the growing season.
Needleandthread 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 will likely increase (Smoliak et al. 1972).
Shadscale is a valuable browse species, providing a source of palatable, nutritious forage for a wide variety of livestock. Shadscale is a valuable browse species for a wide variety of wildlife and livestock (Blaisdell and Holmgren 1984). The spinescent growth habit of shadscale lends to its browsing tolerance with no more than 15 to 20% utilization by sheep being reported (Blaisdell and Holmgren 1984) and significantly less utilization by cattle. Increased presence of shadscale within grazed versus ungrazed areas is generally a result of the decreased competition from more heavily browsed associates (Cibils et al. 1998). Reduced competition from more palatable species in heavily grazed areas may increase shadscale germination and establishment. Chambers and Norton (1993) found shadscale establishment higher under spring than winter browsing as well as heavy compared to light browsing. During years of below average precipitation, shadscale has been found very susceptible to grazing pressure regardless of season (Chambers and Norton 1993). Following fire, grazing exclusion for 2 or more years is beneficial for revegetation of shadscale communities as first year shadscale seedlings lack spines and are highly susceptible to browsing. Spines develop in the second year (Zielinski 1994).
Budsage is palatable and nutritious forage for domestic sheep in the winter and spring although it is known to cause mouth sores in lambs. Bud sage can be poisonous or fatal to calves when eaten in quantity (Stubbendieck et al. 1992). Bud sagebrush is highly susceptible to effects of browsing. It decreases under browsing due to year-long palatability of its buds and is particularly susceptible to browsing in the spring when it is physiologically most active (Chambers and Norton 1993, Harper et al. 1990). Heavy browsing (>50%) may kill bud sagebrush rapidly (Wood and Brotherson 1986). Budsage, while desired by cattle in spring, is poisonous to cattle when consumed alone.
Winterfat is an important forage plant for livestock, especially during winter when forage is scarce. Abusive grazing practices have reduced or eliminated winterfat on some areas even though it is fairly resistant to browsing. Effects depend on severity and season of grazing. Winterfat, a highly nutritious winter feed shows similar results to bud sagebrush with significant declines in density with late winter or early spring grazing (Harper et al. 1990). Interestingly the same 54 year study also showed winterfat density decreasing in the ungrazed plots. Greenmolly provides excellent forage for sheep and cattle, and is often used as a winter forage, when it is high in protein.
In summary, overgrazing causes a decrease in Indian ricegrass along with bud sagebrush, while shadscale may

initially increase. Spring grazing year after year can be detrimental to bud sagebrush and bunchgrasses. Continued abusive grazing leads to increased bare ground and invasion by annual weeds (e.g., cheatgrass, halogeton, and tansy mustard). Shadscale may become dominant with an annual understory. With further deterioration, shadscale declines, bare ground increases, soil redistribution accelerates and site productivity decreases. On some soils, erosion can result in increased surface salts and development of desert pavement. Reestablishment of perennials is limited in areas of extensive desert pavement. Fire is a very infrequent and patchy event in these salt desert shrub communities; however, where it has occurred the shrub community is greatly reduced and annual exotic weeds will increase if present. Repeated fire within a 10 to 20 year timeframe has the potential to convert this site to an annual weed dominated system. Knowledge of successful rehabilitation strategies in these droughty plant communities is limited grass was at least 10 times greater in undisturbed plots than in heavily grazed ones (Pearson 1965). Cook and Child (1971) found significant reduction in plant cover even after 7 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. Adaptive management is required to manage this bunchgrass well.
Stocking rates vary over time depending upon season of use, climate variations, site, and previous and current management goals. A safe starting stocking rate is an estimated stocking rate that is fine-tuned by the client by adaptive management through the year and from year to year.

Wildlife Interpretations:
This site provides valuable habitat for several species of wildlife. Shadscale is a valuable browse species, providing a source of palatable, nutritious forage for a wide variety of wildlife particularly during spring and summer before the hardening of spiny twigs. (Jameson 1952, Welch et al. 1987). Shadscale provides feed for wild ungulates: mule deer (Odocoileus hemionus) browse shadscale, especially during winter (Bartmann 1983). Although it is not preferred, shadscale is also browsed in winter by pronghorn (Antilocapra americana) (Beal and Smith 1970). Shadscale habitats throughout northeastern Nevada are important home ranges for small mammals. The chisel-toothed kangaroo rat (Dipodomys microps) feed on shadscale foliage and use shadscale habitats during the spring, summer, and fall. Deer mice (Peromyscus maniculatus) use shadscale habitats all year (O'farrell and Clark 1986). Shadscale leaves and seeds are preferred forage for jackrabbits (Lepus californicus) (Currie and Goodwin 1966). The Great Basin kangaroo rat (Dipodomys ordii) also feeds on shadscale foliage (Kenagy 1973).
Several bird species will eat the fruit and use shadscale habitats for cover and nesting sites. The horned lark (Eremophila alpestris) occurs throughout shadscale communities. Although less commonly apparent the Brewer's sparrow (Spizella breweri) and sage thrasher (Oreoscoptes montanus) also occur in shadscale habitat. Other species, observed occasionally throughout breeding season in shadscale habitat include: northern harrier (Circus cyaneus), red-tailed hawk (Buteo jamaicensis) , ferruginos hawk (Buteo regalis), golden eagle (Aquila chrysaetos), American kestrel (Falco sparverius) , prairie falcon (Falco mexicanus), mourning dove (Zenaida macroura), burrowing owl (Athene cunicularia), short-eared owl (Asio flammeus), violet-green swallow (Tachycineta thalassina), cliff swallow (Petrochelidon), bam swallow (Hirundo rustica), common raven (Corvus corax), loggerhead shrike (Lanius ludovicianus), vesper sparrow (Pooecetes gramineus), black-throated sparrow (Amphispiza bilineata), and western meadowlark (Sternella neglecta) (Medin 1990).
It should be noted the loss of shadscale and associated shrubs has a negative effect on golden eagle habitat. The golden eagle is listed as a threatened species throughout the United States. Areas of shadscale shrub-steppe provide cover and forage for black-tailed jackrabbits, which are a major food source of golden eagles. Shadscale should be maintained within 1.9 miles of golden eagle nests in order to maintain the species (Kochert et al. 1999). Reptile and amphibian distribution is not widely studied throughout the intermountain cold desert shrub region; however, several reptiles and amphibians are recorded to occur throughout Nevada, where shadscale, budsage, winterfat and other desert shrubs are known to grow (Bernard and Brown 1977). In shadscale habitat specifically, western rattle snakes (Crotalus viridis) and gopher snakes (Pituophis catenifer catenifer) were recorded in a study by Diller and Johnson (1988). Amphibians such as: western toads, Woodhouse's toads (Anaxyrus woodhousii), northern leopard frogs (Lithobates pipiens), Columbia spotted frogs (Rana luteiventris), bullfrogs (Lithobates catesbeianus), and Great Basin spadefoots (Spea intermontana), California toads (Anaxyrus boreas halophilus), Amargosa toads (Anaxyrus nelsoni), Sonoran toads (Anaxyrus alvarius), red-spotted toads (Bufo punctatus) and mountain toad (Bufo cavifrons), also occur throughout the Great Basin in areas saltbush and black greasewood species are dominant (Hamilton 2004).
Budsage is palatable, nutritious forage for upland game birds, small game and big game in winter. Budsage is rated as "regularly, frequently, or moderately taken" by mule deer in Nevada in winter and is utilized by bighorn sheep in summer, but the importance of budsage in the diet of bighorns is not known. Budsage comprises 18 – 35% of a pronghorn's diet during the spring where it is available. Chukar will utilize the leaves and seeds of bud sage.

Winterfat is an important forage plant for wildlife, especially during winter when forage is scarce. Winterfat seeds are eaten by rodents. Winterfat is a staple food for black-tailed jackrabbit. Mule deer and pronghorn antelope browse winterfat. Winterfat is used for cover by rodents. It is potential nesting cover for upland game birds, especially when grasses grow up through its crown.
Indian ricegrass is eaten by pronghorn in "moderate" amounts whenever available. A number of heteromyid rodents inhabiting desert rangelands show preference for seed of Indian ricegrass. Indian ricegrass is an important component of jackrabbit diets in spring and summer. In Nevada, Indian ricegrass may even dominate jackrabbit diets during the spring through early summer months. Indian ricegrass seed provides food for many species of birds. Doves, for example, eat large amounts of shattered Indian ricegrass seed lying on the ground.
Changes in plant community composition could affect the distribution and presence of wildlife species and proper management is important to maintain healthy shadscale communities.

Hydrological functions

Runoff is slow to moderate and ponding will occur on some soils following intense storms. Potential for sheet and rill erosion is slight to moderate depending on slope and presence of rock fragments on the soil surface. Rills are rare. A few can be expected on steeper slopes in areas subjected to summer convection storms or rapid spring snowmelt. Water flow patterns are often numerous in areas subjected to summer convection storms. Flow patterns short and stable. Pedestals are rare with occurrence typically limited to areas within water flow patterns. Frost heaving of shallow rooted plants is not considered a "normal" condition. Sparse shrub canopy and associated litter break raindrop impact.

Recreational uses

Aesthetic value is derived from the diverse floral and faunal composition. This site offers rewarding opportunities to photographers and for nature study. This site has potential for upland and big game hunting.

Other products

Shadscale was a food source for Native Americans. Seeds were used by Native Americans in Nevada for bread and mush. Indian ricegrass was traditionally eaten by some Native Americans. The Paiutes used seed as a reserve food source. The large-seeded panicle is often used in dry floral arrangements.

Other information

Indian ricegrass is well-suited for surface erosion control and desert revegetation although it is not highly effective in controlling sand movement. Certain native ecotypes exhibit desirable characteristics such as drought and salinity tolerance, low seed dormancy, and good nutritional qualities. Indian ricegrass can be useful in the reclamation of many arid and semiarid areas in the western United States. Typical sites include those in which vegetation has been removed due to surface mining, construction activity, brush control, heavy grazing, or fire. Indian ricegrass can be used for revegetating degraded rangelands in areas of low precipitation and has naturally revegetated overgrazed ranges.

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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	06/20/2006
Approved by	P.Novak-Echenique
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 are short (<5 ft) and stable.

2. **Presence of water flow patterns:** Water flow patterns are often numerous in areas subjected to summer convection storms. Flow patterns relatively short (<10 ft.) and stable.

3. **Number and height of erosional pedestals or terracettes:** Pedestals are none to rare with occurrence typically limited to areas within water flow patterns. Frost heaving of shallow rooted plants is not considered a "normal" condition.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare Ground ±50-70% depending on amount of surface rock fragments.

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

6. **Extent of wind scoured, blowouts and/or depositional areas:** None - wind scouring would occur after a severe wildfire.

7. **Amount of litter movement (describe size and distance expected to travel):** Fine litter (foliage from grasses and annual & perennial forbs) is expected to move the 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 2 to 4 on most soil textures found on this site.

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Surface structure is typically fine to medium platy or prismatic. Soil surface colors are light grays and soils are typified by an ochric epipedon. Surface textures are loams, silt loams and very fine sandy loams. Organic carbon of the surface 2 to 3 inches is less than 1 percent.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Sparse shrub canopy and associated litter provide some protection from raindrop impact and opportunity for snow capture.

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. Platy or massive structure or duripans 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: Salt desert shrubs (shadscale & bud sagebrush) >> deep-rooted, cool season, perennial bunchgrasses. (By above ground production)

    Sub-dominant: Shallow-rooted, cool season, perennial bunchgrasses > associated shrubs > deep-rooted, cool season, perennial forbs = fibrous, shallow-rooted, cool season, perennial forbs = annual forbs. (By above ground production)

    Other: succulents, microbiotic crusts

    Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Dead branches within individual shrubs are common and standing dead shrub canopy material may be as much as 35% of total woody canopy; mature bunchgrasses commonly (±25%) have dead centers.

14. **Average percent litter cover (%) and depth (in):** Between plant interspaces 5 to 15% and depth (± ¼ in.)

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** For normal or average growing season (thru May) ± 300 lbs/ac; Spring moisture significantly affects total production. Favorable years ± 400 lbs/ac and unfavorable years ± 200 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 halogeton, Russian thistle, annual mustards, bur buttercup, and cheatgrass.

17. **Perennial plant reproductive capability:** All functional groups should reproduce in average and above average growing season years. Little growth or reproduction occurs in extreme drought years.