Ecological site R028AY003NV
LOAMY SLOPE 5-8 P.Z.

Accessed: 05/12/2025

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.

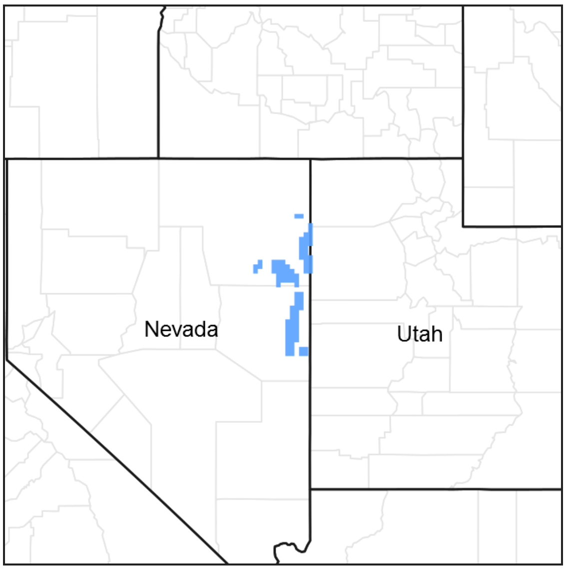

Figure 1. Mapped extent

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 fan skirts, hills and pediments on all exposures. Slopes range from 2 to 50 percent, but slope gradients of 15 to 30 percent are typical. Elevations are 4400 to 6200 feet.
The climate associated with this site is semiarid, characterized by cool, moist winters and warm, dry summers. Average annual precipitation is 5 to 8 inches. Mean annual air temperature is 47 to 54 degrees F. The average growing season is about 110 to 170 days.
The soils associated with this site are very shallow to shallow and well drained. The soils are high in sodium and carbonates with pH ranges of 8.6 to 9.2 within the main plant rooting zone. Surface textures are loams to sandy loams and are typically very gravelly, cobbly, or stony. Water intake rates are moderate to moderately rapid, available water holding capacity is very low, runoff is medium to high.
The reference state is dominated by shadscale, and Indian ricegrass. Needle and thread, bud sagebrush, and galleta are other important species associated with this site. Production ranges from 150 to 450 pounds per acre.

Associated sites

R028AY004NV	**SHALLOW CALCAREOUS SLOPE 8-10 P.Z.**
R028AY012NV	**LOAMY 5-8 P.Z.**
R028AY014NV	**GRAVELLY SANDY LOAM 5-8 P.Z.**

Similar sites

R028AY018NV	**COARSE GRAVELLY LOAM 5-8 P.Z.** ACHY-PLJA codominant grasses; more productive site
R028AY012NV	**LOAMY 5-8 P.Z.** More productive site
R028AY016NV	**GRAVELLY LOAM 5-8 P.Z.** ACHY-PLJA codominant grasses

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Atriplex confertifolia*
Herbaceous	(1) *Achnatherum hymenoides* (2) *Hesperostipa comata*

Physiographic features

This site occurs on fan skirts, hills and pediments on all exposures. Slopes range from 2 to 50 percent, but slope gradients of 15 to 30 percent are typical. Elevations are 4400 to 6200 feet.

Table 2. Representative physiographic features

Landforms	(1) Fan skirt (2) Hill (3) Pediment
Elevation	1,341–1,890 m
Slope	2–50%
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 5 to 8 inches. Mean annual air temperature is 47 to 54 degrees F. The average growing season is about 110 to 170 days.
The Mean annual precipitation at the Wendover airport (429832) is 4.59 inches.

Monthly mean precipitation is:
January .28; February .28; March .37; April .48; May .72; June .51; July .25; August .34; September .34; October .47, November .29; December .25.

Table 3. Representative climatic features

Frost-free period (average)	103 days
Freeze-free period (average)	124 days
Precipitation total (average)	127 mm

Climate stations used

- (1) WENDOVER AP AWOS [USW00024193], Wendover, UT

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 shallow and well drained. They are formed in residuum and colluvium derived from limestone and dolomite. The soils are high in sodium and carbonates with pH ranges of 8.6 to 9.2 within the main plant rooting zone. Surface textures are loams to sandy loams and are typically very gravelly, cobbly, or stony. Water intake rates are moderate to moderately rapid, available water holding capacity is very low, runoff is low to very high. Soil series associated with this site include: Izamatch and Theriot.

The representative soil component is Theriot, classified as a Loamy-skeletal, carbonatic, mesic Lithic Torriorthents. Diagnostic horizons include an ochric epipedon from the soil surface to 7 inches. Clay content in the particle control section averages 6 to 14 percent. Rock fragments range from 50 to 80 percent, dominantly cobbles and stones with less than 50 percent gravel. Reaction is moderately alkaline through very strongly alkaline. Effervescence is violently effervescent. Lithology consists of residuum and colluvium derived from limestone and dolomite.

Table 4. Representative soil features

Parent material	(1) Residuum–limestone (2) Colluvium–dolomite
Surface texture	(1) Very gravelly loam (2) Very cobbly fine sandy loam (3) Extremely gravelly sandy loam
Family particle size	(1) Sandy
Drainage class	Well drained
Permeability class	Moderate to moderately rapid
Soil depth	10–51 cm
Surface fragment cover <=3"	20–30%
Surface fragment cover >3"	20–35%
Available water capacity (0-101.6cm)	4.32–7.11 cm
Calcium carbonate equivalent (0-101.6cm)	15–60%
Electrical conductivity (0-101.6cm)	0–8 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–30
Soil reaction (1:1 water) (0-101.6cm)	8.6–9.2
Subsurface fragment volume <=3" (Depth not specified)	5–25%
Subsurface fragment volume >3" (Depth not specified)	10–55%

Ecological dynamics

An ecological site is the product of all the environmental factors responsible for its development and 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 et al 2013). 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 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. 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), though 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, as 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). Thus, the diploid most associated with this site is a tetraploid. 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).
Drought will initially cause a decline in bunchgrasses. Prolonged drought will cause a decline in shrubs, including shadscale and black greasewood, while annual weedy species and bare ground will increase. Shadscale is less adapted to drought than many of its common associates (Vest 1962, Holmgren and Hutchings 1972), showing high mortality during periods of prolonged drought (Schultz and Ostler 1995). Tolerance to drought is achieved through partial shedding of leaves; this reduces water loss during severe moisture stress (Lei 1999).

Winterfat is a long-lived, drought tolerant, native shrub typically about 30 cm tall (Mozingo 1987). It has a woody base from which annual branchlets grow (Welsh et al. 1987). The most common variety is a low growing dwarf form (less than 38.1 cm), which is most often found on desert valley floors (Stevens et al. 1977). Total winter precipitation is a primary growth driver and lower than average spring precipitation can reverse the impact of plentiful winter precipitation. While summer rainfall has a limited impact, heavy August-September rain can cause a second flowering in winterfat (West and Gasto 1978).
Winterfat reproduces from seed and primarily pollinates via wind (Stevens et al. 1977). Seed production, especially in desert regions, is dependent on precipitation (West and Gasto 1978) with good seed years occurring when there is appreciable summer precipitation and little browsing (Stevens et al. 1977). Winterfat has multiple dispersal mechanisms: diaspores are shed in the fall or winter, dispersed by wind, rodent-cached, or carried on animals (Majerus 2003). Diaspores take advantage of available moisture, tolerating freezing conditions as they progress from imbibed seeds to germinants to nonwoody seedlings (Booth 1989). Under some circumstances, the degree of reproduction may be dependent on mature plant density (Freeman and Emlen 1995).
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.

This ecological site has low resilience to disturbance and resistance to invasion. Annual non-native species such as halogeton and cheatgrass invade these sites where competition from perennial species is decreased. Four possible stable states have been identified for this site.

Fire Ecology:
Historically, 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). 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 vegetation 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).
Winterfat tolerates environmental stress, extremes of temperature and precipitation, and competition from other perennials but not the disturbance of fire or overgrazing (Ogle et al. 2001). Winterfat is able to sprout from buds near the base of the plant. However, if these buds are destroyed, winterfat will not sprout. Research has shown that winterfat seedling growth is depressed in growth by at least 90% when growing in the presence of cheatgrass (Hild et al. 2007). Repeated, frequent fires will increase the likelihood of conversion to a non-native, annual plant community with trace amounts of winterfat.
Bud sagebrush, a minor 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). Bud sagebrush is fire intolerant and must reestablish from seed (Banner 1992, West 1994).

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 growing points for most forbs and grasses 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. 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); therefore, 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.

Needle and thread, also 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 needle-and-thread grass. Early spring season burning was seen to kill the plants while August burning had no effect. Under wildfire scenarios, needle-and-thread is often present in the post-burn community.

State and transition model

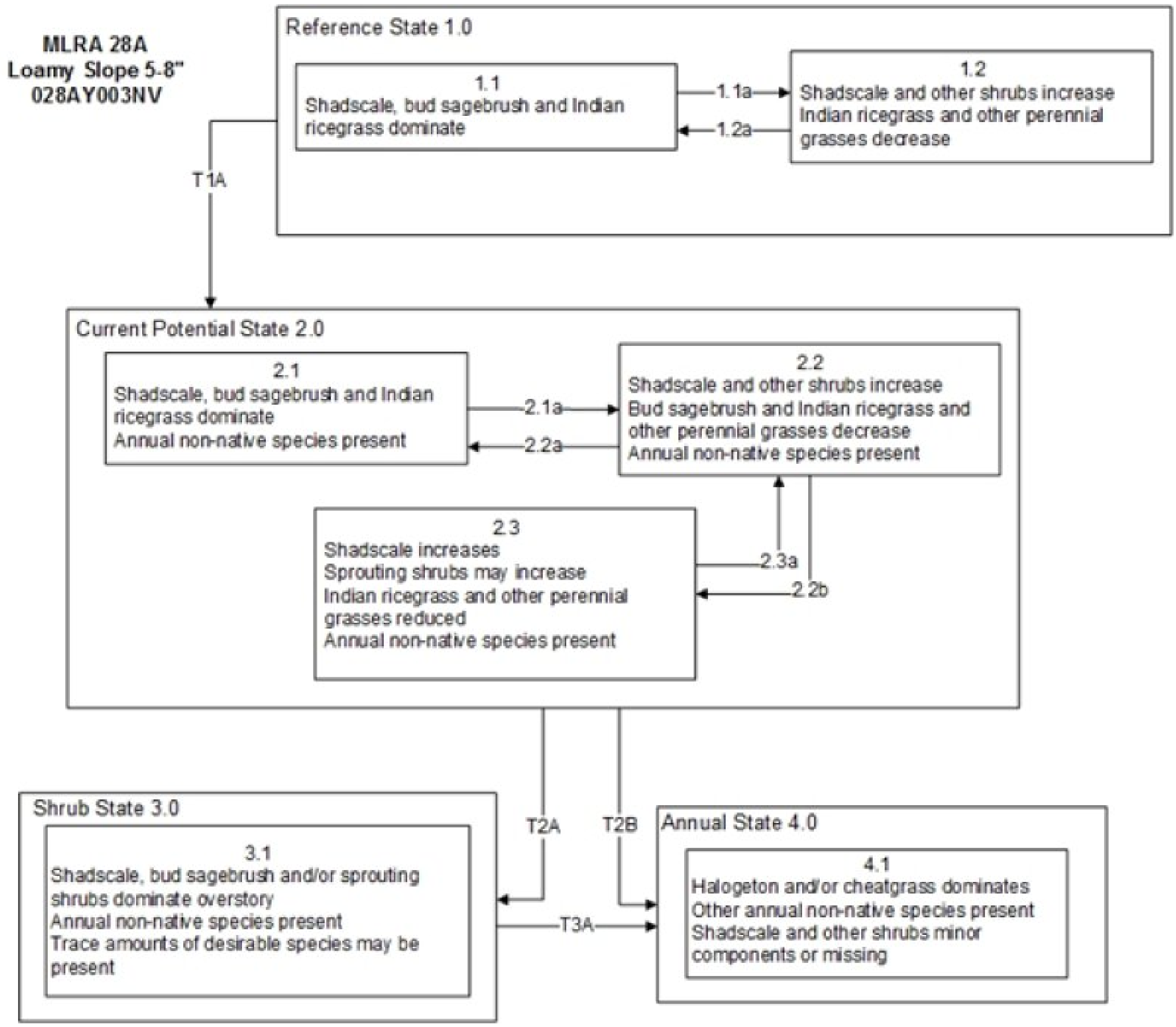

Figure 6. T. Stringham, 12/2014

MLRA 28A
Loamy Slope 5-8"
028AY003NV

Reference State 1.0 Community Phase Pathways
1.1a: Long-term drought and/or herbivory
1.2a: Release from drought and/or herbivory

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 dominate 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. Galleta grass and needle and thread are minor components along with winterfat and bud sagebrush. Community phase changes are primarily a function of chronic drought or insect damage. 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. Periods of above-average precipitation may also reduce the shadscale component. Fire is very infrequent to non-existent. Potential vegetative composition is approximately 30% grasses, 10% forbs and 60% shrubs. Approximate ground cover (basal and canopy) is 10 to 20 percent.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	101	219	303
Grass/Grasslike	50	110	151
Forb	17	36	50
Total	**168**	**365**	**504**

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, extreme wet periods, insect damage, and/or herbivory. Drought will favor shrubs over perennial bunchgrasses. Periods of above-average precipitation will reduce the shadscale component.

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. Periods of above-average precipitation 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 community phase. Ecological function has not changed, however the resiliency of the state has been reduced 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 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 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. Management would be to maintain high diversity of desired species to promote organic matter inputs and prevent the dispersal and seed production of the non-native invasive species.

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 minor amounts (<5 percent). This community is dominated by shadscale and Indian ricegrass. Needle and thread, galleta grass, bud sagebrush and winterfat are also important species on this site. Community phase changes are primarily a function of chronic drought, insect damage or periods of above-average precipitation. Fire is infrequent and patchy due to low fuel loads. Potential vegetative composition is about 30% grasses, 10% forbs and 60% shrubs. Ground cover (basal and crown) is 5 to 15 percent.

Community 2.2
Community Phase

Shadscale and rabbitbrush increase while Indian ricegrass, needle and thread and bud sagebrush decline. Bare ground increases along with annual weeds. Prolonged drought may lead to an overall decline in the plant community. Galleta grass may increase. Periods of above-average precipitation will decrease the shadscale component.

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. Galleta 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 sagebrush. Periods of above-average precipitation may reduce shadscale.

Pathway b
Community 2.2 to 2.3

Chronic drought and/or inappropriate grazing management will significantly reduce perennial grasses, winterfat and bud sagebrush 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 most commonly invades 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 from wind and soil temperature 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, mustards 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 management 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**			27–82	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	17–43	–
	needle and thread	HECO26	*Hesperostipa comata*	3–17	–
	James' galleta	PLJA	*Pleuraphis jamesii*	3–13	–
	squirreltail	ELEL5	*Elymus elymoides*	3–9	–
2	**Secondary Perennial Grasses**			3–9	
	threeawn	ARIST	*Aristida*	2–11	–
Forb					
3	**Perennial**			3–13	
	globemallow	SPHAE	*Sphaeralcea*	2–8	–
Shrub/Vine					
4	**Primary Shrubs**			33–68	
	shadscale saltbush	ATCO	*Atriplex confertifolia*	26–43	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	3–9	–
5	**Secondary Shrubs**			3–26	
	sickle saltbush	ATFA	*Atriplex falcata*	3–18	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	3–18	–
	spiny hopsage	GRSP	*Grayia spinosa*	3–18	–

Animal community

Livestock Interpretations:
This site is suitable for livestock grazing. Grazing management 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. Indian ricegrass is the dominant grass on this site and is a preferred forage species for livestock and wildlife (Cook 1962, Booth et al. 2006). Indian ricegrass is highly palatable to all classes of livestock in both green and cured condition. It supplies a source of green forage before most other native grasses have produced much new growth. 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, but all bunchgrasses are sensitive to over utilization within the growing season.
When actively growing, galleta provides good to excellent forage for cattle and horses and fair forage for domestic sheep. Although not preferred, all classes of livestock may use galleta when it is dry. Domestic sheep show greater use in winter than summer months and typically feed upon central portions of galleta tufts, leaving coarser growth around the edges. Galleta may prove somewhat coarse to domestic sheep.
Shadscale is a valuable browse species for a wide variety of wildlife and livestock (Blaisdell and Holmgren 1984). Shadscale provides good browse for domestic sheep. Shadscale leaves and seeds are an important component of domestic sheep and cattle winter diets. 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).
Bud sagebrush is palatable and nutritious forage for domestic sheep in the winter and spring although it is known to cause mouth sores in lambs. Bud sagebrush can be poisonous or fatal to calves when eaten in quantity. Bud sagebrush 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).
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.
Needle and thread also a minor component on these sites, is most commonly found on warm/dry soils (Miller et al. 2013). It 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 bluegrass will likely increase (Smoliak et al. 1972).
In summary, overgrazing causes a decrease in Indian ricegrass along with winterfat and bud sagebrush, while shadscale may initially increase. Spring grazing year after year can be detrimental to bud sagebrush and the perennial 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. 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:
Salt-desert shrub communities provide valuable habitat for a number of species.
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). It supplies browse, seed, and cover for birds, small mammals, rabbits, deer, and pronghorn antelope. Shadscale also 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 shadscale seeds 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), barn 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).

Hydrological functions

Runoff is medium to high. Permeability is moderate to moderately rapid. Rills and water flow patterns are none to rare. A few may occur after summer convection storms or rapid snowmelt. If present they are short (<3m) and not connected. Perennial herbaceous plants slow runoff and increase infiltration. Shrub canopy and associated litter provide some protection from raindrop impact and provide opportunity for snow catch and accumulation on site.

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

Seeds of shadscale were used by Native Americans of Arizona, Utah and Nevada for bread and mush. Indian ricegrass was traditionally eaten by some Native Americans. The Paiutes used seed as a reserve food source.

Other information

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. Needleandthread grass is useful for stabilizing eroded or degraded sites. Bottlebrush squirreltail is tolerant of disturbance and is a suitable species for revegetation.

Type locality

Location 1: White Pine County, NV	
Township/Range/Section	T28N R64E S27
Latitude	40° 16′ 34″
Longitude	144° 44′ 24″
General legal description	NE¼NE¼, Approximately one mile north of Currie, Goshute Valley area, Elko County, Nevada.

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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)	PATTI NOVAK-ECHENIQUE
Contact for lead author	State Rangeland Management Specialist
Date	05/02/2013

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. Surface rock fragments armor the soil surface.

2. **Presence of water flow patterns:** Water flow patterns are none to rare. A few may occur after summer convection storms or rapid snowmelt. If present they are short (<3m) and not connected.

3. **Number and height of erosional pedestals or terracettes:** Pedestals are none to rare. Occurrence is usually limited to areas of water flow paths.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground is ~20-30% 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

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 6 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 very fine to thick platy. Soil surface colors are browns and soils are typified by an ochric epipedon. Surface textures are loams or sandy loams. Organic matter of the surface 2 to 3 inches is typically 0.1 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 slow runoff and increase infiltration. Shrub canopy and associated litter provide some protection from raindrop impact and provide opportunity for snow catch and accumulation on site.

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. Subangular blocky, platy, or massive sub-surface horizons or subsoil argillic horizons are not to be interpreted as compacted layers.

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

    Dominant: Reference State: Short statured shrubs (i.e., shadscale)

    Sub-dominant: deep-rooted, cool season, perennial bunchgrasses > associated shrubs > shallow-rooted, cool season, perennial bunchgrasses > deep-rooted, cool season, perennial forbs = fibrous, shallow-rooted, cool season, perennial and annual forbs.

    Other:

    Additional:

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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.

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14. **Average percent litter cover (%) and depth (in):** Within plant interspaces (± 20%) and depth of litter is <1/4 inch.

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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) ± 325 lbs/ac; Favorable years ± 450 lbs/ac and unfavorable years ± 150 lbs/ac

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16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:** Potential invaders include halogeton, Russian thistle, bassia, annual mustards, and cheatgrass. Cheatgrass is most likely to invade after wildfire.

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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 extended or extreme drought years.
