USDA Natural Resources Conservation Service

Ecological site R028BY021NV SODIC DUNE

Accessed: 05/19/2024

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.

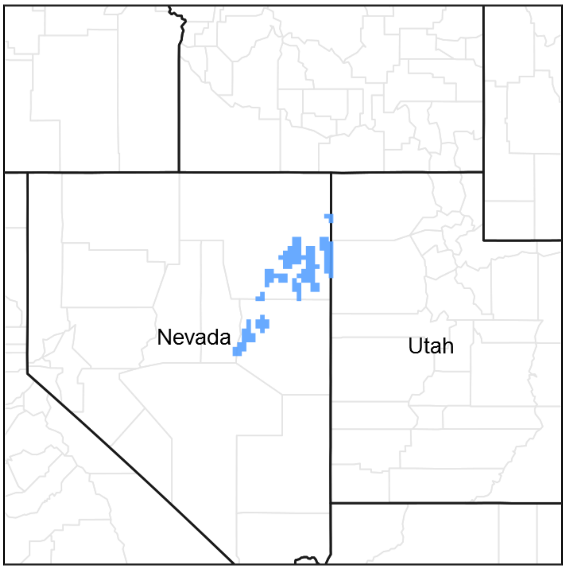

Figure 1. Mapped extent

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 dunes on basin floors. Slopes gradients of 4 to 15 percent are typical. Elevations range from 4500 to 5800 feet. Soils associated with this site are very deep, excessively drained, and exhibit minimal characteristics associated with soil development. They are coarse textured throughout, have an ochric epipedon, and are salt effected at depth. Soils are characterized by very low water holding capacity and rapid infiltration. Almost all the precipitation that falls upon this site is available for plant use. Deep rooted plants are particularly suited to this site as they can take advantage of the rapid infiltration and deep percolation of water through the sandy soils. Runoff is very low. The extremely loose and unstable surface soils and droughty conditions are generally not favorable to sustain a high yielding, uniform stand of grasses. Plant cover is usually patchy and areas of bare and drifting sand are common. These soils are extremely susceptible to wind erosion. The reference state is dominated by black greasewood. Production ranges from 200 to 400 pounds per acre.

Associated sites

R028BY005NV	**SANDY 8-10 P.Z.**
R028BY028NV	**SODIC TERRACE 8-10 P.Z.**
R028BY074NV	**SODIC TERRACE 5-8 P.Z.**

Similar sites

R028BY005NV	**SANDY 8-10 P.Z.** ARTR2 dominant shrub; more productive site; not on dune landforms.
R028BY068NV	**DUNE 8-10 P.Z.** ARTRT dominant shrub; SAVE4 rare to absent; more productive site.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Sarcobatus vermiculatus*
Herbaceous	(1) *Achnatherum hymenoides*

Physiographic features

This site is found on dunes on basin floors. Slopes range from 2 to 30 percent, but slope gradients of 4 to 15 percent are most typical. Elevations are 4500 to 5800 feet.

Table 2. Representative physiographic features

Landforms	(1) Dune
Flooding frequency	None
Ponding frequency	None
Elevation	1,372–1,768 m
Slope	4–15%
Ponding depth	0 cm
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.

Average annual precipitation ranges from 6 to 10 inches. The mean annual air temperature is 45 to 50 degrees F. The average growing season is 120 to 160 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) BEOWAWE 49S U OF N RCH [USC00260800], Eureka, NV
- (2) LAGES [USC00264341], Ely, NV

Influencing water features

This site is associated with the presence of ground water, which occurs below 150cm.

Soil features

The soils associated with this site are very deep, excessively drained, and exhibit minimal characteristics associated with soil development. These soils formed in eolian sands derived from mixed parent material. The soil profile is characterized by an ochric epipedon, coarse texture, and very low available water holding capacity. Soils are salt effected at depth. Runoff is negligible to very low. Soil moisture regime is typic aridic and the soil temperature regime is mesic.
Areas of bare and drifting sand are common. These soils are extremely susceptible to wind erosion. The soils series associated with this site is Kawich.

The representative soil component is Kawich (NV766, MU1412), classified as a mixed, mesic Typic Torripsamments. Diagnostic horizons include an ochric epipedon from the surface to 18cm. Soil reaction is slightly alkaline through very strongly alkaline increasing with depth. The profile is violently effervescent throughout.

Table 4. Representative soil features

Surface texture	(1) Fine sand (2) Sandy loam
Family particle size	(1) Sandy
Drainage class	Excessively drained
Permeability class	Very rapid
Soil depth	183–213 cm
Surface fragment cover <=3"	0–10%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	6.1–6.35 cm
Calcium carbonate equivalent (0-101.6cm)	0%
Electrical conductivity (0-101.6cm)	0–5 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0–5
Soil reaction (1:1 water) (0-101.6cm)	8.4–8.9
Subsurface fragment volume <=3" (Depth not specified)	0–10%
Subsurface fragment volume >3" (Depth not specified)	0%

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).

The Great Basin shrub communities have high spatial and temporal variability in precipitation, both among years and within growing seasons. Nutrient availability is typically low but increases with elevation and closely follows moisture availability. The moisture resource supporting the greatest amount of plant growth is usually the water stored in the soil profile during the winter. 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.

Aeolian processes, which are presumably the dominant mechanism of soil detachment and transport on this ecological site, are largely responsible for the removal of nutrient-rich soil particles from the intercanopy areas and the deposition onto shrub patches. This sediment redistribution leads to the accumulation of nutrients under the shrub canopies, a process known as "islands of fertility" (Schlesinger et al. 1990). Thus, the landscape exhibits a mosaic of sources and sinks, with bare soil interspaces acting as sources and vegetated patches as sinks of nutrients and sediments (Puigdefabregas 2005). Hydrological processes, such as infiltration and runoff, determine the conditions favorable for the establishment and survival of different vegetation functional groups with a consequent impact on the structure and function of these systems. Sand dunes have high rates of infiltration because of the soils large pore spaces and low field capacity. These soils also have very high rates of saturated hydraulic conductivity allowing for deep percolation of moisture protected from evaporation. Moisture retention occurs below the upper 30 to 60 cm (Saltz et al 1999).

Black greasewood is classified as a phreatophyte (Eddleman 2002), and its distribution is well-correlated with the distribution of groundwater (Mozingo 1987). Meinzer (1927) discovered that the taproots of black greasewood can penetrate from 20 to 57 feet below the surface. Romo (1984) found water tables ranging from 3.5-15 m under black greasewood dominated communities in Oregon. Black greasewood stands develop best where moisture is readily available, either from surface or subsurface runoff (Brown 1965). It is commonly found on floodplains that are either subject to periodic flooding, have a high water table at least part of the year, or have a water table less than 34 feet deep (Harr and Price 1972, Blauer et al. 1976, Branson et al. 1976, Blaisdell and Holmgren 1984, Eddleman 2002). Black greasewood is usually a deep-rooted shrub but has some shallow roots near the soil surface; the maximum rooting depth can be determined by the depth to a saturated zone (Harr and Price 1972). Ganskopp (1986) reported that water tables within 9.8 to 11.8 inches of the surface had no effect on black greasewood in Oregon. However, a study conducted in California found that black greasewood did not survive six months of continuous flooding (Groeneveld and Crowley 1988, Groeneveld 1990).
Fourwing saltbush is a native, long-lived woody shrub that grows on a variety of soils, landforms, and climatic conditions from sand dunes, sand sheets, alluvial fans and plains, hills and mountains and washes. It tolerates salinity but is not restricted to saline soils (Howard 2003). It is a polymorphic species and is evergreen or deciduous depending on climate (Ogle 2012). Fourwing saltbush has a long taproot of depths of 5 to 15 m. and many small lateral roots (Barrow 1997, Van Dersal 1938). Wallace et al. (1974) found that the roots compose 40 percent of the total mass of adult plants. Fourwing saltbush is classified as a phreatophyte and has been documented at water tables occurring from 8 to 62 feet in New Mexico (Meinzer 1927). Atriplex species are considered medium to short-lived shrubs and possess a number of morphological and physiological traits that enable them to cope with drought. Some of these traits include: a) photosynthesis through the C4 carboxylation pathway; b) production of leaf trichomes and accumulation of salt crystals on the leaf surface to increase reflectance; c) accumulation and synthesis of inorganic and organic solutes to maintain turgor; and d) root association with endomycorrhizae that allows absorption of soil moisture at very low water potentials (Cibils, et al. 1998, Dobrowolski 1990, Newton and Goodin 1989).

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).

Perennial bunchgrasses generally have somewhat shallower root systems than shrubs in these systems, but root densities are often as high as or higher than those of shrubs in the upper 0.5 m but taper off more rapidly than shrubs. General differences in root depth distributions between grasses and shrubs result in resource partitioning in these shrub/grass systems. The perennial bunchgrasses that are sub-dominant with the shrubs include Indian ricegrass and thickspike wheatgrass. Indian ricegrass is a hardy, cool-season, densely tufted, native perennial bunchgrass that grows from 4 to 24 inches in height (Blaisdell and Holmgren 1984).

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). These species generally have somewhat shallower root systems than the shrubs, but root densities are often as high as 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.

Basin wildrye, a minor species on this site, may reach up to six feet in height (Ogle et al 2012a). Basin wildrye does not tolerate long periods of inundation; it prefers cycles of wet winters and dry summers and is most commonly found in deep soils with high water holding capacities or seasonally high water tables (Ogle et al 2012a, Perryman and Skinner 2007).

Alkali sacaton, also a minor component of this site, is considered a facultative wet species in this region; therefore it is not drought tolerant. A lowering of the water table can occur with groundwater pumping and this may contribute to the loss of deep-rooted species such as black greasewood and an increase in rabbitbrush, shadscale and other species that are not groundwater dependent.
The ecological site may experience high wind erosion, especially with a decrease in vegetative cover. This can be caused by inappropriate grazing practices, drought, off-road vehicle use and/or fire. As ecological condition declines, the dunes become mobile and recruitment and establishment of perennial grasses is reduced. This can cause an increase in sprouting shrubs such as rabbitbrush and horsebrush which are better adapted to disturbed sites. Annual non-native species such as Russian thistle and cheatgrass invade these sites where competition from perennial species is decreased.

This ecological site has low resilience to disturbance and resistance to invasion. Increased resilience increases with elevation, aspect, increased precipitation and increased nutrient availability. Three possible stable states have been identified for this site though an additional Annual State has been noted in other MLRAs.

Fire Ecology:
Fire is a rare disturbance in these salt-desert shrub communities and likely occurs in years with above average production and corresponding biomass. Historically, salt-desert shrub communities had sparse understories and bare soil in intershrub spaces, making these communities somewhat resistant to fire (Young 1983, Paysen et al. 2000). They may burn only during high fire hazard conditions; for example, years with high precipitation can result in almost continuous fine fuels, increasing fire hazard (West et al. 1994, Paysen et al. 2000).

Black greasewood may be killed by severe fires but usually sprouts vigorously after low to moderate severity fire (Young 1983, Rickard and McShane 1984, West 1994). Grazing and other disturbance may result in increased biomass production due to sprouting and increased seed production, also leading to greater fuel loads (Sanderson and Stutz 1994). Higher production sites would have experienced fire more frequently than lower production sites. Bentz et al. (2008) reported that following a Nevada wildfire, black greasewood sprouts reached approximately 2.5 feet within 3 years. In a study by Rickard and McShane (1983), black greasewood canopy cover was measured at 47 percent of pre-burn levels two years following fire. They also counted 185 shrubs before wildfire and 210 shrubs two years following fire.

Fourwing saltbush is highly variable and its ability to sprout following fire may depend on the population and fire severity. A study by Parmenter (2008) showed 58% mortality rate of fourwing saltbush following fire in New Mexico; the surviving shrubs produced sprouts shortly after fire. Fourwing saltbush readily reestablishes from seed (Howard 2003).

Shadscale is intolerant of fire and can only regenerate through seed (Zielinski 1994). Increases in the fire return interval leads to increases in the shrub component of the plant community, potentially facilitating increases in bare ground, inland salt grass and invasive weeds. Lack of fire combined with excessive herbivory decreases or eliminates the herbaceous understory, favoring black greasewood and annual species. Therefore, fire can be detrimental to these communities, especially in the presence of fire tolerant, annual non-native species.

The effect of fire on bunchgrasses relates to culm density, culm-leaf morphology, and the size of the plant. The initial condition of bunchgrasses within the site along with seasonality and intensity of the fire factor into individual species' responses. 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 will influence plant response. Plant response will also vary depending on post-fire soil moisture availability.

Indian ricegrass 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.

Basin wildrye is relatively resistant to fire, particularly dormant season fire, as plants sprout from surviving root crowns and rhizomes (Zschaechner 1985). Fire maintained the grass dominance of these ecosystems, therefore increases in the fire return interval favors increases in the shrub component of the plant community. The reduction of grasses potentially facilitates increases in bare ground and the invasion of non-native species.

Bottlebrush squirreltail, a minor component on this site, is considered more fire tolerant than Indian ricegrass 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. 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).

Alkali sacaton can tolerate fire but is not resistant to it. Recovery of alkali sacaton after fire has been reported as two to four years (Bock and Bock 1978).

State and transition model

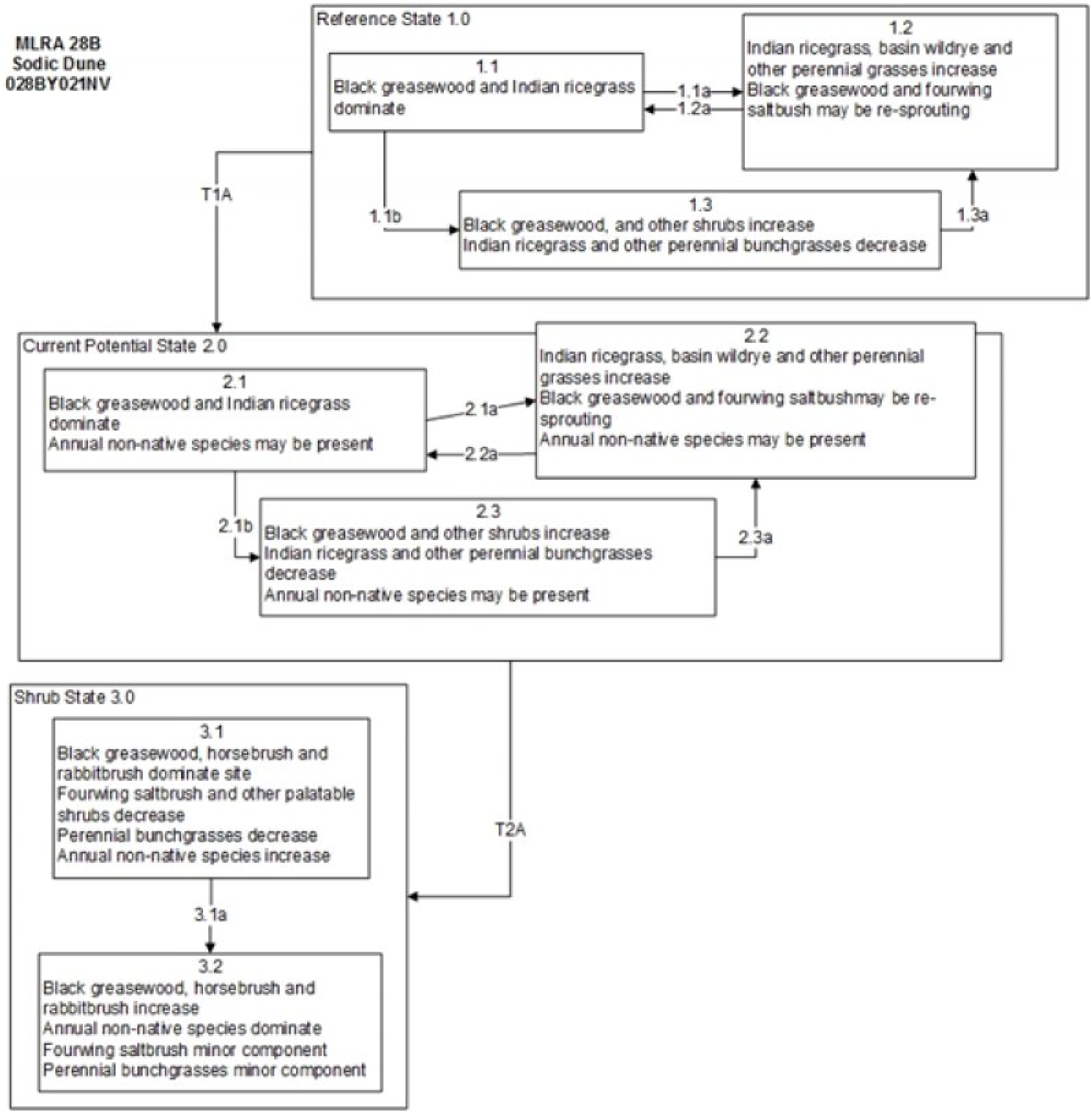

Figure 6. T. Stringham 2/2015

MLRA 28B
Sodic Dune
028BY021NV

Reference State 1.0 Community Phase Pathways
1.1a: Low severity fire creates grass/shrub mosaic
1.1b: Time and lack of disturbance such as fire. Excessive herbivory or long-term drought may also decrease perennial understory.
1.2a: Time and lack of disturbance allows for shrub regeneration.
1.3a: Low severity fire or herbivory resulting in a mosaic pattern.

Transition T1A: Introduction of non-native species such as halogeton, bur buttercup, cheatgrass and mustards.

Current Potential State 2.0 Community Phase Pathways
2.1a: Low severity fire creates grass/shrub mosaic; non-native annual species present
2.1b: Time and lack of disturbance such as fire. Inappropriate grazing management and/or long-term drought may also reduce perennial understory.
2.2a: Time and lack of disturbance allows for shrub regeneration
2.3a: Low severity fire creates shrub/grass mosaic. Brush management with minimal soil disturbance(aerial herbicide application); late-fall/winter grazing causing mechanical damage to shrubs

Transition T2A: Inappropriate grazing management favoring shrub dominance and reducing perennial bunchgrasses and/or long-term drought.

Shrub State 3.0
3.1a: Inappropriate grazing management in the presence of annual non-native species

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 three general community phases; a shrub-grass dominant phase, a perennial grass dominant 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. Plant community phase changes are primarily driven by fire, periodic drought and/or insect or disease attack.

Community 1.1
Community Phase

Black greasewood dominates this community phase. Shadscale, fourwing saltbush and other shrubs are also common. Indian ricegrass, thickspike wheatgrass, basin wildrye and other perennial grasses are common in the understory. Forbs are present but not abundant. Potential vegetative composition is about 25% grasses, 5% forbs, and 70% shrubs. Approximate ground cover (basal and crown) is less than 10 percent.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	157	235	314
Grass/Grasslike	56	84	112
Forb	11	17	22
Total	**224**	**336**	**448**

Community 1.2
Community Phase

This community phase is characteristic of a post-disturbance, early-seral community phase. Indian ricegrass, and other perennial bunchgrasses dominate. Black greasewood, fourwing saltbush, rabbitbrush and horsebrush may re-sprout after fire.

Community 1.3
Community Phase

Figure 9. Sodic Dune, T.Stringham 8/8/2013; SS NV779, MU4121

Black greasewood and other shrubs increase in the absence of disturbance. Deep-rooted perennial bunchgrasses in the understory are reduced either from competition with shrubs and/or from herbivory.

Pathway a
Community 1.1 to 1.2

Fire will decrease the shrub overstory and allow for the perennial bunchgrasses to dominate the site. Fires will typically be low severity due to dispersed fuel loads. A fire following an unusually wet spring facilitating an increase in fine fuels may be more severe and reduce shrub cover to trace amounts.

Pathway b
Community 1.1 to 1.3

Time and lack of disturbance such as fire allows for shrubs to increase. Resprouting shrubs, such as rabbitbrush and horsebrush are common. Chronic drought will cause a decline in perennial bunchgrasses allowing shrubs to increase. Herbivory may cause a decrease in perennial bunchgrasses and fourwing saltbush allowing other shrubs such as black greasewood and shadscale to increase.

Pathway a
Community 1.2 to 1.1

Absence of disturbance over time allows shrubs to recover.

Pathway a
Community 1.3 to 1.2

A low severity fire, herbivory or combinations will reduce the shrub overstory. Perennial grasses will increase.

State 2
Current Potential State

This state is similar to the Reference State 1.0. This state has the same three general community phases. 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

Black greasewood and Indian ricegrass dominate the site. Shadscale, fourwing saltbush and other shrubs are also common. Thickspike wheatgrass, basin wildrye and other perennial grasses are present in the understory. Forbs are present but not abundant. Non-native annual species are present in minor amounts (<5%). Potential vegetative composition is approximately 30% grasses, 5% forbs and 65% shrubs.

Community 2.2
Community Phase

This community phase is characteristic of a post-disturbance, early seral community phase. Indian ricegrass and other perennial grasses dominate. Fourwing saltbush may be killed by fire depending on ecotype, therefore it may decrease in the burned community. Depending on fire severity patches of intact fourwing saltbush may remain. Sprouting shrubs such as black greasewood and rabbitbrush may dominate the aspect for a number of years following fire. Annual non-native species generally respond well after fire and may be stable to increasing within the community.

Community 2.3
Community Phase

Shrubs, such as black greasewood, shadscale and fourwing saltbush, increase in the community and may become the dominant with lack of disturbance. Inappropriate grazing management may cause a decrease in fourwing saltbush and allow other shrubs such as black greasewood and shadscale to increase.

Pathway a
Community 2.1 to 2.2

Fire would decrease or eliminate the shrub overstory and allow for the perennial bunchgrasses to dominate the site. Fires would typically be small and patchy due to low fuel loads. A fire following an unusually wet spring or a change in management facilitating an increase in fuel loads may be more severe and reduce shrub cover to trace amounts. Annual non-native species generally respond well after fire and may be stable or increasing in within the community.

Pathway b
Community 2.1 to 2.3

Time and lack of disturbance and/or chronic drought allows for shrubs to increase and dominate the site, causing a reduction in the perennial bunchgrasses. Inappropriate grazing may cause a decrease in perennial bunchgrasses and fourwing saltbush allowing other shrubs such as black greasewood and rabbitbrush to increase. Bottlebrush squirreltail and thickspike wheatgrass may also increase depending on the grazing management.

Pathway a
Community 2.2 to 2.1

Time and lack of disturbance may allow for fourwing saltbush and other shrubs to establish and increase in community.

Pathway a
Community 2.3 to 2.2

Low severity fire, inappropriate grazing management or combinations may decrease palatable shrub cover allowing for the perennial understory to increase. Late fall/winter grazing may cause mechanical damage to shrubs promoting the perennial bunchgrass understory.

State 3
Shrub State

This state has two community phases and is a product of many years of heavy grazing during time periods harmful to perennial bunchgrasses. Black greasewood, horsebrush, and rabbitbrush dominate the overstory. Shrub cover exceeds 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. With a decrease in understory species the soils on these sites may become unstable and wind erosion may increase.

Community 3.1
Community Phase

Black greasewood dominates the overstory. Rabbitbrush and horsebrush may be significant components. Fourwing saltbush is still present but declining. Deep-rooted perennial bunchgrasses may be present in trace amounts or absent from the community. Annual non-native species increase. Bare ground is significant.

Community 3.2
Community Phase

Black greasewood, horsebrush, and rabbitbrush dominate the site. Fourwing saltbush may be found in trace amounts or may be absent from the site. Annual non-native species dominate the understory. Perennial bunchgrasses make up a minor component.

Pathway a
Community 3.1 to 3.2

Heavy grazing in winter and early spring decreases fourwing saltbush and perennial bunchgrasses, and may promote other shrubs such as rabbitbrush, horsebrush, and black greasewood.

Transition A
State 1 to 2

Trigger: This transition is caused by the introduction of non-native annual weeds, such as cheatgrass, mustards, and Russian thistle. 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: To Community Phase 3.1: Inappropriate cattle/horse grazing management will decrease or eliminate deep rooted perennial bunchgrasses and palatable shrubs and favor non-palatable shrub growth and establishment. Soil disturbing brush treatments will reduce non-sprouting shrubs and possibly increase non-native annual species and sprouting shrubs. 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. Loss of long-lived shrubs changes the temporal and depending on the replacement shrub, the spatial distribution of nutrient cycling.

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**			30–67	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	17–34	–
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	7–17	–
	basin wildrye	LECI4	*Leymus cinereus*	7–17	–
2	**Secondary Perennial Grasses**			17–34	
	squirreltail	ELEL5	*Elymus elymoides*	2–10	–
	needle and thread	HECO26	*Hesperostipa comata*	2–10	–
	alkali sacaton	SPAI	*Sporobolus airoides*	2–10	–
Forb					
3	**Perennial**			7–27	
	basin wildrye	LECI4	*Leymus cinereus*	7–17	–
	buckwheat	ERIOG	*Eriogonum*	2–7	–
	globemallow	SPHAE	*Sphaeralcea*	2–7	–
	princesplume	STANL	*Stanleya*	2–7	–
Shrub/Vine					
4	**Primary Shrubs**			168–269	
	greasewood	SAVE4	*Sarcobatus vermiculatus*	135–202	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	17–34	–
	shadscale saltbush	ATCO	*Atriplex confertifolia*	17–34	–
	alkali sacaton	SPAI	*Sporobolus airoides*	6–11	–
5	**Secondary Shrubs**			17–34	
	basin big sagebrush	ARTRT	*Artemisia tridentata ssp. tridentata*	3–7	–
	rubber rabbitbrush	ERNAN5	*Ericameria nauseosa ssp. nauseosa var. nauseosa*	3–7	–
	horsebrush	TETRA3	*Tetradymia*	3–7	–

Animal community

Livestock Interpretations:
This site is suitable for livestock grazing. Grazing management considerations include timing, intensity, frequency, and duration of grazing.

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 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. Thickspike wheatgrass, a minor component on this site, is a rhizomatous perennial with extensively creeping underground rootstocks. This characteristic enables the plant to withstand heavy grazing and considerable trampling. It prefers sandy soils where mature plants have been found to have average maximum root depths of about 15 inches. It is considered fair forage for all classes of livestock (Dayton 1937). Thickspike wheatgrass is palatable to all classes of livestock and wildlife. It is a preferred feed for cattle, sheep, horses, and elk in spring and is considered a desirable feed for deer and antelope in spring. It is considered a desirable feed for cattle, sheep, and horses in summer, fall, and winter.

The early growth and abundant production of basin wildrye make it a valuable source of forage for livestock. It is important forage for cattle and is readily grazed by cattle and horses in early spring and fall. Though coarse-textured during the winter, basin wildrye may be utilized more frequently by livestock and wildlife when snow has covered low shrubs and other grasses.

Alkali sacaton, a sub-dominant plant on this site, has been found to be sensitive to early growing season defoliation whereas late growing season and/or dormant season use allowed recovery of depleted stands (Hickey and Springfield 1966).

Bottlebrush squirreltail 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 untrampled conditions. Heavy trampling however was found to significantly reduce germination sites (Eckert et al. 1987). Bottlebrush squirreltail is more tolerant of grazing than Indian ricegrass but all bunchgrasses are sensitive to over utilization within the growing season.

Fourwing saltbush is one of the most palatable shrubs in the West. Its protein, fat, and carbohydrate levels are comparable to alfalfa. It provides nutritious forage for all classes of livestock. Palatability is rated as good for domestic sheep and domestic goats; fair for cattle; fair to good for horses in winter, poor for horses in other seasons. Fourwing saltbush is one of the most important forage shrubs in arid sites. Its importance is due to its abundance, accessibility, size, large volume of forage, evergreen habit, high palatability and nutritive value (Dayton 1937, Gordon 1975). The palatability rates from fairly good to good for cattle, and as good for sheep and goats, deer usually consume it as a winter browse (Dayton 1937). It has similar protein, fat, and carbohydrate levels as alfalfa (Medicago sativa)(Catlin 1925). Fourwing saltbush is especially valuable as winter forage. It was noted in a study by Otsyina et al. (1982) that sheep readily grazed fourwing saltbush when introduced into a new pasture.

Black greasewood is an important winter browse plant for domestic sheep and cattle. It also receives light to moderate use by domestic sheep and cattle during spring and summer months. In a study by Smith et al. (1992), utilization of new growth on greasewood shrubs by cattle was 77 percent in summer, and greasewood was found to have the highest amounts of crude protein when compared to perennial and annual grasses. Black greasewood plants have been found to contain high amounts of sodium and potassium oxalates which are toxic to livestock and caution should be taken when grazing these communities. These shrubs can be used lightly in the spring as long as there is a substantial amount of other preferable forage available (Benson et al. 2011).

Fourwing saltbush is especially valuable as winter forage. It was noted in a study by Otsyina et al. (1982) that sheep readily grazed fourwing saltbush when introduced into a new pasture.

Shadscale is a valuable browse species, providing a source of palatable, nutritious forage for a wide variety of livestock. Shadscale provides good browse for domestic sheep. Shadscale leaves and seeds are an important component of domestic sheep and cattle winter diets.

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.

Black greasewood is an important winter browse plant for big game animals and a food source for many other wildlife species. (Nevada Wildlife Action Plan 2012, Dayton 1931, Austin and Hash 1988, Johnson 1979). Black greasewood also provides good cover for wildlife species (Benson et al. 2011). Ungulates, such as pronghorns (Antilocapra americana), browse black greasewood. It also receives light to moderate use by mule deer (Odocoileus hemionus) during spring and summer months. Trace amounts of black greasewood were identified in the feces of pronghorn (seasonal preference was not determined) in a microhistology study by Johnson (1979). Furthermore, pronghorn and mule deer that occurred in greasewood habitat, utilized greasewood for cover, although the study did not determine if black greasewood was a desirable forage (Hanley and Hanley 1982). Other studies indicated that although mule deer and pronghorn do not prefer black greasewood as forage, the ungulates use black greasewood habitat as cover (Oedekoven and Lindzey 1987). Small mammals will also utilize black greasewood. For example, trace amounts of black greasewood were identified in the feces of black-tailed jack rabbits (Lepus californicus), seasonal preference was not determined (Johnson 1979). A study in the Great Basin

by Feldhamer (1979) found that pocket mice (Chaetodipus pencillatus) and chipmunk (Neotamias quadrimaculatus) populations were restricted to plant communities dominated by black greasewood. Black greasewood habitat is documented as used in minor amounts by other small mammals including voles, chipmunks, porcupines (Hystricomorph hystricidae), and raccoons (Anderson 2004). Soils of this habitat tend to be loose and either sandy or gravelly and are often easy to dig making them attractive to species such as the pale kangaroo mouse (Microdipodops pallidus) (Nevada Wildlife Action Plan 2012). This habitat is also an important feeding ground for pallid bats (Antrozous pallidus), which eat scorpions and other large invertebrates off its exposed desert flats (Nevada Wildlife Action Plan 2012). Black greasewood provides cover and nest sites for birds including lark buntings (Calamospiza melanocorys). Bird species, such as the sage sparrow (Artemisiospiza nevadensis) and lark buntings, are known to utilize black grease wood habitat (Wiens and Rotenberry 1981). The loggerhead shrike (Lanius ludovicianus) will use black greasewood for nesting and cover. Burrowing owls (Athene cunicularia) will use the loose soils for burrowing. Bald eagles (Haliaeetus leucocephalus) and prairie falcons (Falco mexicanus) winter in the valley bottoms where black greasewood occurs, preying on jack rabbits, and other rodents Nevada Wildlife Action Plan 2012).
Wildlife including rodents, and lagomorphs readily consume all aboveground portions of fourwing saltbush(Booth 1985). In a study in Wyoming, both deer (Odocoileus hemionus) and pronghorn (Antilocapra americana) consumed a large amount of fourwing saltbush, especially in winter months (Medcraft and Clark 1986). Fourwing saltbush also provides important habitat for mammals such as coyotes (Canis latrans) and rodents in areas where it dominates the landscape (Hafner 1977, Gese et al 1988). Additionally, the browse provides a source of water for black-tailed jackrabbits in arid environments (Hunter 1985). Birds and other small mammals will feed on the seeds and foliage. The plant acts as important cover for game-birds such as quail (Callipepla californica), and doves (Zenaida macroura), as well as passerines such as, towhees (Pipilo macualtus) and finches, that occur on arid range lands in the West (Dobbs et al. 2012, Booth 1985).

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 fourwing saltbush and black greasewood are known to grow (Bernard and Brown 1977). In black greasewood habitat specifically, western rattle snakes (Crotalus viridis) and gopher snakes (Pituophis catenifer catenifer) were recorded in a study by Diller and Johnson (1988). Reptile species including: eastern racer (Coluber constrictor), ringneck snake (Diadophis punctatus), night snakes (Hypsiglena torquata), Sonoran mountain kingsnakes (Lampropeltis pyromelana), striped whipsnakes (Masticophis taeniatus), gopher snakes (Pituophis catenifer), long-nosed snakes (Rhinocheilus lecontei), wandering gartersnakes (Thamnophis elegans vagrans), sidewinders (Crotalus cerastes), Great Basin rattlesnakes (Crotalus oreganus lutosus), Great Basin collared lizard (Crotaphytus bicinctores), long-nosed leopard lizard (Gamelia copeii), short-horned lizard (Phrynosoma douglasii), desert-horned lizard (Phrynosoma platyrhinos), western fence lizards (Sceloporus occidentalis), northern side-blotched lizards (Uta stansburiana stansburiana), banded gecko (Coleonyx variegatus), desert iguana (Diposaurus dorsalis), chuckwalla (Sauromalus ater), zebra-tailed lizard (Callisaurus draconoides), pigmy horned-lizard (Phrynosoma douglasii), desert night lizard (Xantusia vigilis), whip-tailed lizard (Aspidoscelis tigris tigris) and western skinks (Plestiodon skiltonianus) occur in areas where sagebrush is dominant. Similarly, 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). Studies have not determined if all species of reptiles and amphibians prefer certain species of saltbush or greasewood; however, researchers agree that maintaining habitat where saltbush and greasewood and reptiles and amphibians occur is important; however, there has been no research regarding the effect of saltbush and greasewood on reptile and amphibian habitat and distribution (Linsdale 1938,West 1999 and ref. therein). It should be noted that habitats within the Great Basin, intermountain cold desert shrub, such as black greasewood/fourwing saltbush/winterfat dominated communities are also the primary habitat of the long-nosed leopard lizard (Nevada Wildlife Action Plan 2012). Furthermore, fourwing saltbush provides excellent habitat for at-risk species such as the desert tortoise (Gopherus agassizii). The desert tortoise will browse fourwing saltbush and use it for cover (Durant et al. 1994).

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. 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. In the spring, it is a preferred feed for elk and is considered desirable feed for deer and antelope. It is desirable feed for elk during

summer, fall, and winter.
Thickspike wheatgrass is also a component of black-tailed jackrabbit diets. Thickspike wheatgrass provides some cover for small mammals and birds.
Basin wildrye provides winter forage for mule deer, though use is often low compared to other native grasses. Basin wildrye provides summer forage for black-tailed jackrabbits. Because basin wildrye remains green throughout early summer, it remains available for small mammal forage for longer time than other grasses.
Bottlebrush squirreltail is a dietary component of several wildlife species. Bottlebrush squirreltail may provide forage for mule deer and pronghorn.

Hydrological functions

Runoff is negligible to very low. Permeability is very rapid. A few small water flow paths (<2m) may occur after summer convection storms or rapid snowmelt. Perennial herbaceous plants (especially deep-rooted bunchgrasses [i.e., Indian ricegrass, basin wildrye] slow runoff and increase infiltration. Shrub canopy and associated litter break raindrop impact and provide some opportunity for snow catch and accumulation on site.

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

The leaves, seeds and stems of black greasewood are edible. Seeds of shadscale were used by Native Americans of Arizona, Utah, and Nevada for bread and mush. Fourwing saltbush is traditionally important to Native Americans. They ground the seeds for flour. The leaves, placed on coals, impart a salty flavor to corn and other roasted food. Top-growth produces a yellow dye. Young leaves and shoots were used to dye wool and other materials. The roots and flowers were ground to soothe insect bites. Indian ricegrass was traditionally eaten by some Native Americans. The Paiutes used the seeds as a reserve food source. Basin wildrye was used as bedding for various Native American ceremonies, providing a cool place for dancers to stand.

Other information

Black greasewood is useful for stabilizing soil on wind-blown areas. It successfully revegetates processed oil shale and is commonly found on eroded areas and sites too saline for most plant species. Fourwing saltbush is widely used in rangeland and riparian improvement and reclamation projects, including burned area recovery. It is probably the most widely used shrub for restoration of winter ranges and mined land reclamation. Thickspike is a good revegetation species because it forms tight sod under dry rangeland conditions, has good seedling strength, and performs well in low fertility or eroded sites. It does not compete well with aggressive introduced grasses during the establishment period, but are very compatible with slower developing natives, bluebunch wheatgrass (Pseudoroegneria spicata), western wheatgrass (Pascopyrum smithii), and needlegrass (Achnatherum spp.) species. It’s drought tolerance combined with rhizomes, fibrous root systems, and good seedling vigor make these species ideal for reclamation in areas receiving 8 to 20 inches annual precipitation. Thickspike wheatgrass can be used for hay production and will make nutritious feed, but is more suited to pasture use. Basin wildrye is useful in mine reclamation, fire rehabilitation and stabilizing disturbed areas. Its usefulness in range seeding, however, may be limited by initially weak stand establishment.

Type locality

Location 1: Elko County, NV	
Township/Range/Section	T35 N R63 E S34
Latitude	40° 52′ 21″
Longitude	114° 50′ 50″
General legal description	SE ¼, About 2 miles west of Ventosa, along south side of road leading to Tobar, Elko County, Nevada. This site also occurs in Churchill, Eureka, and White Pine Counties, 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	07/12/2012
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rills are non-existent.

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2. **Presence of water flow patterns:** A few small water flow paths (<2m) may occur after summer convection storms or rapid snowmelt.

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3. **Number and height of erosional pedestals or terracettes:** Pedestals are few to common with occurrence due to wind scouring.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare Ground 70-80%.

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

6. **Extent of wind scoured, blowouts and/or depositional areas:** Slight to moderate wind scouring may occur especially during wind events prior to summer convection storms or winter storms.

7. **Amount of litter movement (describe size and distance expected to travel):** Fine litter (foliage from grasses and annual & perennial forbs) expected to move unsheltered distance during heavy wind. Persistent litter (large woody material) expected to remain in place.

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 1 to 4 on the sandy soil textures found on this site. (To be field tested.)

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Surface structure is typically loose and single grained. Soil surface colors are pale browns and soils are typified by an ochric epipedon. Surface textures are typically fine sands and sandy loams. Organic matter of the surface 2 to 3 inches is typically less than 1 percent. Organic matter content can be more or less depending on micro-topography.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Perennial herbaceous plants (especially deep-rooted bunchgrasses [i.e., Indian ricegrass] slow runoff and increase infiltration. Shrub canopy and associated litter break raindrop impact and provide some 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. Massive sub-surface horizons are not to be interpreted as compaction.

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: Tall shrubs (black greasewood) > deep-rooted, cool season, perennial bunchgrasses

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

    Other: warm season perennial bunchgrasses

    Additional:

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 30% of total woody canopy; some of the mature bunchgrasses (±20%) have dead centers.

14. **Average percent litter cover (%) and depth (in):** Between plant interspaces (± 10-15%) and depth of litter is ± ¼ inch

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** For normal or average growing season (thru June) ± 300 lbs/ac; 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 cheatgrass, halogeton, Russian thistle, annual mustards, and annual kochia.

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