Ecological site R028BY005NV
SANDY 8-10 P.Z.

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General information

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

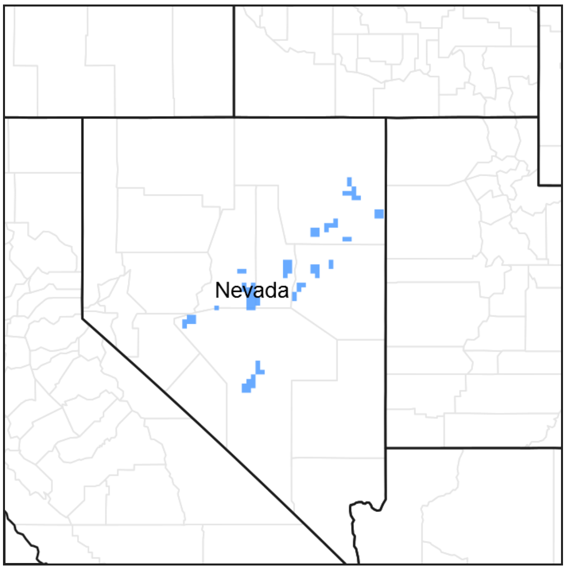

Figure 1. Mapped extent

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

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

The central concept for this ecological site occurs on sand sheets. Slopes gradients of 2 to 8 percent are typical and elevations range from 5300 to 6200 feet.
The soils associated with this site are very deep and excessively drained. These soils are sandy throughout and formed in eolian sands. They are characterized by low available water holding capacity and wind erosion is a problem under poor vegetative cover conditions.
The reference plant community is dominated by big sagebrush, needle and thread, and Indian ricegrass. Production ranges from 400 to 800 pounds per acre.

Associated sites

R028BY010NV	**LOAMY 8-10 P.Z.**
R028BY011NV	**SHALLOW CALCAREOUS LOAM 8-10 P.Z.**
R028BY021NV	**SODIC DUNE**

Similar sites

R028BY052NV	**DROUGHTY LOAM 8-10 P.Z.** ACHY dominant grass; ARTRW-GRSP codominant shrubs.
R028BY080NV	**SHALLOW LOAM 8-10 P.Z.** Less shrub diversity; less productive.
R028BY068NV	**DUNE 8-10 P.Z.** ACHY-ELMA7 codominant grasses; dune landscape position.
R028BY010NV	**LOAMY 8-10 P.Z.** ELMA7 not codominant grass; less shrub diversity.

Table 1. Dominant plant species

Tree	Not specified

Shrub	(1) *Artemisia tridentata*
Herbaceous	(1) *Achnatherum hymenoides* (2) *Hesperostipa comata*

Physiographic features

This site occurs on sand sheets and occasionally on partially stabilized dunes. Slopes range from 0 to 15 percent, but slope gradients of 2 to 8 percent are most typical. Elevations are typically 5700 to 6200 feet, but may occur as low as 5300 in some areas.

Table 2. Representative physiographic features

Landforms	(1) Sand sheet
Ponding frequency	None
Elevation	1,737–1,890 m
Slope	2–8%
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.

Mean annual air temperature ranges 45 to 50 degrees F. The average growing season is 100 to 120 days.

Mean annual precipitation across the range in which this ES occurs is 9.01". Monthly mean precipitation:
January 0.69; February 0.65; March 0.87; April 0.88; May 1.14; June 0.73; July 0.65; August 0.77; September 0.66; October 0.79; November 0.62; December 0.60.
*The above data is averaged from the Diamond Valley- Eureka and McGill WRCC climate stations.

Table 3. Representative climatic features

Frost-free period (average)	90 days
Freeze-free period (average)	120 days
Precipitation total (average)	229 mm

Climate stations used

- (1) DIAMOND VALLEY - EUREKA 14NNW [USC00262296], Eureka, NV
- (2) MCGILL [USC00264950], Ely, NV

Influencing water features

Influencing water features are not associated with this site.

Soil features

The soils associated with this site are very deep, excessively drained, and formed in eolian sand derived from mixed parent material. These soils are sandy throughout and have an ochric epipedon. The soils have low runoff, low water holding capacity and wind erosion is a problem under poor vegetative cover conditions.
Soil series associated with this site include: Hamacer and Zorravista.

The representative soil component is Zorravista (NV766 MU1650) a mixed, mesic Xeric Torripsamments.

Diagnostic horizons include: an ochric epipedon from the soil surface to 18cm. Effervescence decreases with depth and soil profile is moderately alkaline throughout. Clay content is less than 5 percent in the particle size control section.

Table 4. Representative soil features

Surface texture	(1) Sand (2) Fine sand
Family particle size	(1) Sandy
Drainage class	Somewhat excessively drained to excessively drained
Permeability class	Moderate to moderately rapid
Soil depth	152–213 cm
Surface fragment cover <=3"	0–10%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	5.08–8.89 cm
Calcium carbonate equivalent (0-101.6cm)	0–10%
Electrical conductivity (0-101.6cm)	0 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	7.4–9
Subsurface fragment volume <=3" (Depth not specified)	0–5%
Subsurface fragment volume >3" (Depth not specified)	0%

Ecological dynamics

Important abiotic factors contributing to the presence of this ecological site include the sandy, or coarse, soil texture. In semi-arid systems, like the Great Basin, coarse textured soils have higher annual biomass production when compared to fine-textured soils in the same precipitation zone. In sandy soils more of the moisture found in the soil profile is available for immediate uptake by plant roots, instead of being held by the smaller soil particles (silt & clay).
An ecological site is the product of all the environmental factors responsible for its development and it has a set of key characteristics that influence a site's resilience to disturbance and resistance to invasives. Key characteristics include 1) climate (precipitation, temperature), 2) topography (aspect, slope, elevation, and landform), 3) hydrology (infiltration, runoff), 4) soils (depth, texture, structure, organic matter), 5) plant communities (functional groups, productivity), and 6) natural disturbance regime (fire, herbivory, etc.) (Caudle et al. 2013). Biotic factors that that influence resilience include site productivity, species composition and structure, and population regulation and regeneration (Chambers et al. 2013).
This ecological site is dominated by deep-rooted cool season, perennial bunchgrasses and long-lived shrubs (50+ years) with high root to shoot ratios. The dominant shrubs usually root to the full depth of the winter-spring soil moisture recharge, which ranges from 1.0 to over 3.0 m. (Comstock and Ehleringer 1992). Root length of mature sagebrush plants was measured to a depth of 2 meters in alluvial soils in Utah (Richards and Caldwell 1987). These shrubs have a flexible generalized root system with development of both deep taproots and laterals near the surface (Dobrowolski et al. 1990)
In the Great Basin, the majority of annual precipitation is received during the winter and early spring. This continental semiarid climate regime favors growth and development of deep-rooted shrubs and herbaceous cool season plants using the C3 photosynthetic pathway (Comstock and Ehleringer 1992).

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

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

Native insect outbreaks are also important drivers of ecosystem dynamics in sagebrush communities. Climate is generally believed to influence the timing of insect outbreaks especially a sagebrush defoliator, Aroga moth (Aroga websteri). Aroga moth infestations have occurred in the Great Basin in the 1960s, early 1970s, and is ongoing in Nevada since 2004 (Bentz, et al 2008). Thousands of acres of big sagebrush have been impacted, with partial to complete die-off observed. Aroga moth can partially or entirely kill individual plants or entire stands of big sagebrush (Furniss and Barr 1975).

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 needle and thread. 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 in these shrub/grass systems.

The Great Basin sagebrush communities have high spatial and temporal variability in precipitation, both among years and within growing seasons. Nutrient availability is typically low but increases with elevation and closely follows moisture availability. The 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. The invasion of sagebrush communities by cheatgrass (*Bromus tectorum*) has been linked to disturbances (fire, abusive grazing) that have resulted in fluctuations in resources (Chambers et al. 2007). The introduction of annual weedy species, like cheatgrass, may cause an increase in fire frequency. Conversely, as fire frequency decreases, sagebrush will increase and with inappropriate grazing management the perennial bunchgrasses and forbs may be reduced.

This site may experience high wind erosion, especially with a decrease in vegetative cover. This can be caused by inappropriate grazing practices, drought, Aroga moth infestation, off-road vehicle use and/or fire. As ecological condition declines the dunes become mobile, and recruitment and establishment of sagebrush and perennial grasses is reduced. This can cause an increase in sprouting shrubs such as rabbitbrush and horsebrush which are more adapted to disturbed sites. Annual non-native species invade these sites where competition from perennial species is decreased.

This site has low resilience to disturbance and resistance to invasion. Increased resilience increases with elevation, aspect, increased precipitation and increased nutrient availability. Three alternative states have been identified for this ecological site but an annual state has been noted in other MLRA's and may be possible for this site.

Fire Ecology:

In many big sagebrush communities, changes in fire frequency occurred along with fire suppression, livestock grazing and OHV use. Few if any fire history studies have been conducted on basin big sagebrush; however, Sapsis and Kauffman (1991) suggest that fire return intervals in basin big sagebrush are intermediate between mountain big sagebrush (15 to 25 years) and Wyoming big sagebrush (50 to 100 years). Fire severity in big sagebrush communities is described as "variable" depending on weather, fuels, and topography. However, fire in basin big sagebrush communities are typically stand replacing (Sapsis and Kauffman 1991). Basin big sagebrush and Wyoming big sagebrush are killed by fire. Because of the time needed to produce seed, they are eliminated by frequent fires (Bunting et al. 1987). Basin big sagebrush and Wyoming big sagebrush reinvade a site primarily by off-site seed or seed from plants that survive in unburned patches. Approximately 90% of big sagebrush seed is dispersed within 30 feet (9 m) of the parent shrub (Goodrich et al. 1985) with maximum seed dispersal at approximately 108 feet (33 m) from the parent shrub (Shumar and Anderson 1986). Therefore regeneration of big sagebrush after stand replacing fires is difficult and dependent upon proximity of residual mature plants and favorable moisture conditions (Johnson and Payne 1968, Humphrey 1984). Reestablishment after fire may require 50-120 or more years (Baker 2006). However, the introduction and expansion of cheatgrass has dramatically altered the fire regime (Balch et al. 2013), therefore altering restoration potential of big sagebrush communities (Evans and Young 1978). Sites with low abundances of native perennial grasses and forbs typically have reduced resiliency following disturbance and are less resistant to invasion or increases in cheatgrass (Miller et al 2013).

The effect of fire on bunchgrasses relates to culm density, culm-leaf morphology, and the size of the plant. The initial condition of bunchgrasses within the site along with seasonality and intensity of the fire all factor into the individual species response. For most forbs and grasses the growing points are located at or below the soil surface providing relative protection from disturbances which decrease above ground biomass, such as grazing or fire. Thus, fire mortality is more correlated to duration and intensity of heat which is related to culm density, culm-leaf morphology, size of plant and abundance of old growth (Wright 1971, Young 1983).
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.
Needle and thread 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 burning was found to kill the plants while August burning had no effect. Thus, under wildfire scenarios needle-and-thread is often present in the post-burn community.
Spiny hopsage is generally top-killed by fire (Daubenmire 1970), but often sprouts after plants are damaged by fire or mechanical injury (Shaw 1992). Fires in spiny hopsage sites generally occur in late summer when plants are dormant, and sprouting generally does not occur until the following spring (Daubenmire 1970). Spiny hopsage is reported to be least susceptible to fire during summer dormancy (Rickard and McShane 1984). Plants often survive fires that kill adjacent sagebrush (Blauer et al. 1976).
Depending on fire severity, rabbitbrush may increase after fire. Rubber rabbitbrush is top-killed by fire, but can sprout after fire and can also establish from seed (Young 1983).
Invasion of cheatgrass, mustards and other annual weeds decreases site resilience, increases the risk of stand replacing fire and decreases the potential for sagebrush and Indian ricegrass reestablishment. Soil movement associated with fire and other activities such as OHV use or brush treatment has been observed. Twelve years after stand replacing fires near Winnemucca, NV reestablishment of sagebrush stands has not occurred. Spiny hopsage, a minor component in the reference community, has increased on burned areas due to the ability to resprout. Repeated fire within a 10 to 20 year timeframe has the potential to convert this site to an annual weed dominated system which was observed in MLRA 24 but not in MLRA 28A or 28B. See (024XY001NV).

State and transition model

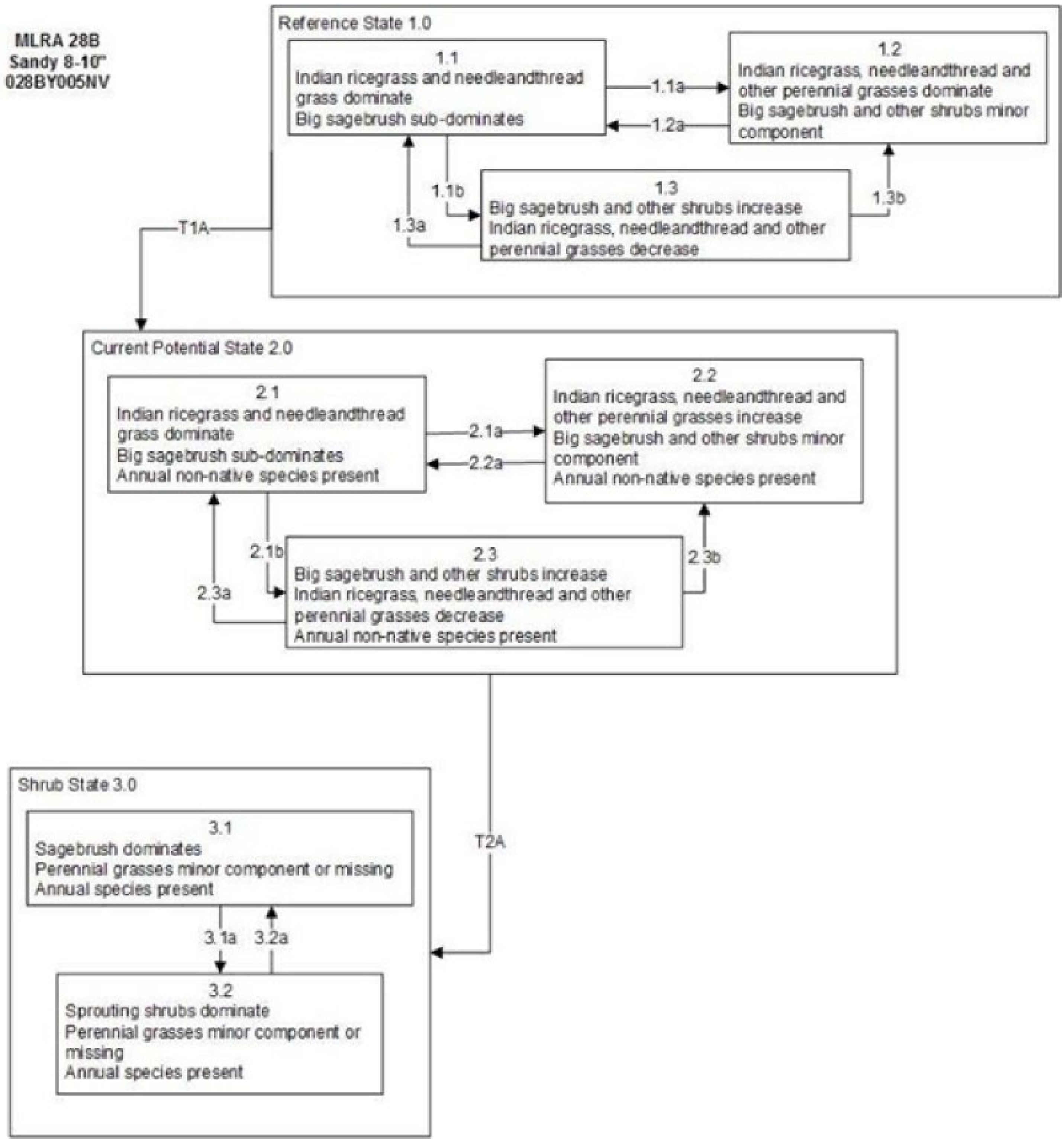

Figure 6. State and Transition Model

MLRA 28B
Sandy 8-10"
028BY005NV

Reference State 1.0 Community Phase Pathways
1.1a: Low severity fire and/or Aroga moth infestation creates grass/sagebrush mosaic.
1.1b: Time and lack of disturbance such as fire. Excessive herbivory and/or drought will reduce perennial bunchgrasses.
1.2a: Time and lack of disturbance allows for sagebrush regeneration.
1.3a: Low severity fire or Aroga moth infestation resulting in a mosaic pattern.
1.3b: High severity fire and/or severe Aroga moth infestation significantly reduces sagebrush cover leading to early/mid-seral community.

Transition T1A: Introduction of non-native species such as cheatgrass, mustards and Russian thistle.

Current Potential State 2.0 Community Phase Pathways
2.1a: Low severity fire and/or Aroga moth infestation creates grass/sagebrush mosaic; non-native annual species present
2.1b: Time and lack of disturbance such as fire. Inappropriate grazing and/or drought will reduce perennial bunchgrasses.
2.2a: Time and lack of disturbance allows for regeneration of sagebrush
2.3a: Low severity fire or Aroga moth infestation creates sagebrush/grass mosaic. Brush management (aerial herbicide application), late-fall/winter grazing causing mechanical damage to sagebrush.
2.3b: High severity fire and/or severe Aroga moth infestation significantly reduces sagebrush cover leading to early mid-seral community

Transition T2A: Inappropriate grazing management favoring shrub dominance and reducing perennial bunchgrasses and/or drought (3.1) Fire (3.2)

Shrub State 3.0 Community Phase Pathways
3.1a: Fire, Aroga moth, brush management (aerial herbicide application), and/or late-fall/winter grazing causing mechanical damage to sagebrush.
3.2a: Time and lack of disturbance (an unlikely/slow transition)

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

Big sagebrush, Indian ricegrass and needleandthread dominate the site. Fourwing saltbush, spiny hopsage and other shrubs are also common. Thickspike wheatgrass and other perennial grasses are also present in the understory. Forbs are present but not abundant.Potential vegetative composition is about 55% grasses, 10% forbs, and 35% shrubs. Approximate ground cover (basal and crown) is 15 to 25 percent.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	247	370	493
Shrub/Vine	157	235	314
Forb	45	67	90
Total	**449**	**672**	**897**

Community 1.2
Community Phase

This community phase is characteristic of a post-disturbance, early seral community phase. Indian ricegrass, thickspike wheatgrass, needleandthread grass, and other perennial grasses dominate. Wyoming and basin big sagebrush are killed by fire, therefore decreasing within the burned community. Sagebrush could still be present in unburned patches. Forbs may increase post-fire but will likely return to pre-burn levels within a few years.

Community 1.3
Community Phase

Wyoming and basin big sagebrush increase in the absence of disturbance or with herbivory that favors shrubs. Decadent sagebrush dominates the overstory and the deep-rooted perennial bunchgrasses in the understory are reduced either from competition with shrubs or from herbivory.

Pathway a
Community 1.1 to 1.2

Fire would decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses to dominate the site. Fires would typically be small and patchy due to dispersed fuel loads. A fire following an unusually wet spring or a change in management may be more severe and reduce sagebrush cover to trace amounts. A severe infestation of Aroga moth could also cause a large decrease in sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs.

Pathway b
Community 1.1 to 1.3

Chronic drought, time and/or herbivory favor an increase in Wyoming and basin big sagebrush over deep-rooted perennial bunchgrasses. Combinations of these would allow the sagebrush overstory to increase and dominate the site, causing a reduction in the perennial bunchgrasses. Bottlebrush squirreltail and thickspike wheatgrass may increase in density depending on herbivory impacts.

Pathway a
Community 1.2 to 1.1

Absence of disturbance over time allows for the sagebrush to recover.

Pathway a
Community 1.3 to 1.1

A low severity fire and/or a moderate Aroga moth infestation may reduce sagebrush overstory and allow perennial bunchgrasses to increase.

Pathway b
Community 1.3 to 1.2

Severe fire would decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses to dominate the site. A severe infestation of Aroga moth could also cause a large decrease in sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs.

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. 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

Big sagebrush, Indian ricegrass and needleandthread dominate the site. Thickspike wheatgrass may be a significant component; other shrubs such as fourwing saltbush and spiny hopsage are also present. Forbs make up smaller percentages by weight of the understory. Non-native annual species are present.

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. Wyoming and basin big sagebrush are killed by fire, therefore decreasing within the burned community. Sagebrush could still be present in unburned patches. Forbs may increase post-fire but will likely return to pre-burn levels within a few years. Annual non-native species generally respond well after fire and may be stable or increasing within the community. Rabbitbrush and other sprouting shrubs may dominate the aspect for a number of years following fire.

Community 2.3
Community Phase

Wyoming and basin big sagebrush increase and the perennial understory are reduced. Decadent sagebrush dominates the overstory and the deep-rooted perennial bunchgrasses in the understory are reduced either from competition with shrubs or from grazing management. Other shrubs such as spiny hopsage and rabbitbrush may also increase in the overstory. Annual non-natives are present.

Pathway a
Community 2.1 to 2.2

Fire would decrease or eliminate the overstory of sagebrush 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 may be more severe and reduce sagebrush cover to trace amounts. A severe infestation of Aroga moth could also cause a large decrease in sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs. Annual non-native species generally respond well after fire and may be stable or increasing within the community.

Pathway b
Community 2.1 to 2.3

Time, chronic drought, grazing management that favors shrubs or combinations of these would allow the sagebrush overstory to increase and dominate the site, causing a reduction in the perennial bunchgrasses. However thickspike wheatgrass may increase in the understory depending on the grazing management. Heavy spring grazing will favor an increase in sagebrush. Annual non-native species may be stable or increasing within the understory.

Pathway a
Community 2.2 to 2.1

Absence of disturbance over time allows for the sagebrush to recover.

Pathway a

Community 2.3 to 2.1

Low severity fire or Aroga moth infestation creates sagebrush/grass mosaic. Brush management with minimal soil disturbance; late-fall/winter grazing causing mechanical damage to sagebrush can also reduce sagebrush overstory and allow an increase in perennial bunchgrasses or thickspike wheatgrass.

Pathway b
Community 2.3 to 2.2

High severity fire would decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses to dominate the site. A severe infestation of Aroga moth could also cause a large decrease in sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs.

State 3
Shrub State

This state consists of two community phases one which is dominated by big sagebrush and one that is dominated by sprouting shrubs such as rabbitbrush and horsebrush. This site has crossed a biotic threshold and site processes are being controlled by shrubs. Bare ground has increased and dunes may become active.

Community 3.1
Community Phase

Perennial bunchgrasses are reduced and the site is dominated by big sagebrush. Thickspike wheatgrass may be present. Bare ground and wind erosion has increased. Annual non-native species are present.

Community 3.2
Community Phase

Figure 9. Sandy 8-10" (R028BY005NV) P. Novak-Echenique NV780 MU 253 9/17/2012

Figure 10. Sandy 8-10" (R028BY005NV) P. Novak-Echenique Eureka County 2011

Sprouting shrubs such as rabbitbrush or spiny hopsage may dominate aspect following disturbance for a number of years. Wind erosion may be significant and lead to soil redistribution and potential dune flattening, significantly reducing safe sites for sagebrush reestablishment. Trace amounts of sagebrush may be present. Annual non-native species are present.

Pathway a
Community 3.1 to 3.2

Fire, Aroga moth, late-fall/winter grazing or brush management would decrease or eliminate the overstory of sagebrush. A severe infestation of Aroga moth could also cause a large decrease in sagebrush within the community, giving a competitive advantage to forbs and sprouting shrubs.

Pathway a
Community 3.2 to 3.1

Time and lack of disturbance allows for regeneration of sagebrush. This may take many years.

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 plants 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: Inappropriate, long-term grazing of perennial bunchgrasses during the growing season, and/or long term drought would favor shrubs and initiate transition to Community Phase 3.1. Fire would cause a transition to Community Phase 3.2. Slow variables: Long term decrease in deep-rooted perennial grass density. Threshold: Loss of deep-rooted perennial bunchgrasses changes spatial and temporal nutrient cycling and nutrient redistribution, and reduces soil organic matter.

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**			235–437	
	needle and thread	HECO26	*Hesperostipa comata*	101–168	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	101–168	–
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	34–101	–
2	**Secondary Perennial Grasses**			13–54	
	squirreltail	ELEL5	*Elymus elymoides*	3–13	–
	basin wildrye	LECI4	*Leymus cinereus*	3–13	–
Forb					
3	**Perennial**			34–101	
	basin wildrye	LECI4	*Leymus cinereus*	7–27	–
	milkvetch	ASTRA	*Astragalus*	3–13	–
	buckwheat	ERIOG	*Eriogonum*	3–13	–
	phlox	PHLOX	*Phlox*	3–13	–
	globemallow	SPHAE	*Sphaeralcea*	3–13	–
	princesplume	STANL	*Stanleya*	3–13	–
Shrub/Vine					
4	**Primary Shrubs**			128–256	
	basin big sagebrush	ARTRT	*Artemisia tridentata ssp. tridentata*	50–84	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	13–54	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	13–34	–
5	**Secondary Shrubs**			34–67	
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	7–20	–
	jointfir	EPHED	*Ephedra*	7–20	–
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	7–20	–
	spiny hopsage	GRSP	*Grayia spinosa*	7–20	–
	horsebrush	TETRA3	*Tetradymia*	7–20	–

Animal community

Livestock Interpretations:
This site is suitable for livestock grazing. Grazing management considerations include timing, frequency, intensity 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 in the desert ranges of Utah. 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 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. Thickspike wheatgrass's extensive rhizome system allows established stands to withstand heavy grazing and trampling. Thickspike wheatgrass is a rhizomatous perennial grass 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 (USDA 1937).

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.

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.

Livestock browse Wyoming big sagebrush, but may use it only lightly when palatable herbaceous species are available. Basin big sagebrush may serve as emergency food during severe winter weather, but it is not usually sought out by livestock.

Inappropriate grazing leads to an increase in sagebrush and a decline in understory plants like Indian ricegrass and needleandthread grass. Invasion of annual weedy forbs and cheatgrass could occur with further grazing degradation, leading to an increase in bare ground. A combination of overgrazing and prolonged drought leads to soil erosion, increased bare ground and a loss in plant production. Without management cheatgrass and annual forbs are likely to invade and dominate the site, especially after fire.

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:

Wyoming big sagebrush is preferred browse for wild ungulates. Pronghorn usually browse Wyoming big sagebrush heavily. Basin big sagebrush is the least palatable of all the subspecies of big sagebrush. Basin big sagebrush is browsed by mule deer from fall to early spring, but is not preferred. Sagebrush-grassland communities provide critical sage-grouse breeding and nesting habitats. Meadows surrounded by sagebrush may be used as feeding and strutting grounds. Sagebrush is a crucial component of their diet year-round, and sage-grouse select sagebrush almost exclusively for cover. Sage-grouse prefer mountain big sagebrush and Wyoming big sagebrush communities to basin big sagebrush communities.

Wild ungulates use basin big sagebrush for cover and feed. Mule deer (Odocoileus hemionus), pronghorn antelope (Antilocapra americana) and elk (Alces alces) will browse basin big sagebrush from autumn through early spring (Wambolt et al. 1994). Early and midseral basin big sagebrush provide forage and protection from predators for mule deer (Nevada Wildlife Action Plan 2012). Further use of basin big sagebrush by mule deer varies between local populations: in Utah mule deer prefer basin big sage less than populations in Oregon. Also, mule deer preference for the shrub varies seasonally. Basin big sagebrush was used more by mule deer populations in Oregon and Utah in winter than by the same populations in fall. (Sheehy and Winward 1981, Welch et al. 1981) This could be because basin big sagebrush is consumed as a last resort plant and browsed when plants considered more palatable were no longer available (Welch et al. 1981). Elk and pronghorn antelope will browse basin big sagebrush in areas where mountain and Wyoming sagebrush are unavailable (Beale and Smith 1970, Wambolt 1996). A study by Brown (1977) determined that desert bighorn sheep (Ovis candensis nelsoni) preferred big sagebrush over other shrub types; however, the variety was not noted.

Basin big sagebrush communities also serve as cover and food for smaller desert wildlife such as lagomorphs and rodents. Pygmy rabbits (Brachylagus idahoensis) rely on tall basin big sagebrush in deep soil for shelter and food throughout the year (Green and Flinders 1980, White et al. 1991, Nevada Wildlife Action Plan 2012). A study by Larrison and Johnson (1973) captured deer mice (Peromyscus maniculatus) in big sagebrush communities more than any other plant community, suggesting the mice prefer these plant communities for cover over other plant communities. No specific variety of big sagebrush was mentioned in the study.

Basin big sagebrush serves as valuable habitat for native birds. Studies have suggested that sage grouse use basin big sagebrush for cover and food where mountain and Wyoming big sagebrush are absent (Welch et al. 1991). Birds such as Brewer’s sparrows (Spizella breweri) are considered dependent on sagebrush communities for cover and will nest in basin big sagebrush. Thus when basin big sagebrush communities are converted to agriculture fields, Brewer’s sparrow populations can decline due to loss of habitat (Knick et al. 2003). In fact, mature basin big sagebrush act as nesting structures, protection from predators and thermal cover for sage grouse (Centrocercus minimus), the loggerhead shrike (Lanius ludovicianus), the sage sparrow (Amphispiza belli), Brewer’s sparrow and

sage thrasher (Oreoscoptes montanus) (Nevada Wildlife Action Plan 2012). The plant also acts as important cover for game-birds such as the gray partridge (Perdix perdix), quail (Callipepla californica), and doves (Zenaida macroura), as well as passerines such as, towhees (Pipilo maculatus) and finches, that occur on arid range lands in the West (Dobbs et al. 2012, Booth 1985).
Several reptiles and amphibians are distributed throughout the sagebrush steppe in the west in Nevada, where basin big sagebrush is known to grow (Bernard and Brown 1977). Reptile species including: eastern racers (Coluber constrictor), ringneck snakes (Diadophis punctatus), night snakes (Hypsiglena torquata), Sonoran mountain kingsnakes (Lampropeltis pyromelana), striped whipsnakes (Masticophis taeniatus), gopher snakes (Pituophis catenifer), long-nosed snakes (Rhinoceheilus lecontei), wandering garter snakes (Thamnophis elegans vagrans), Great Basin rattlesnakes (Crotalus oreganus lutosus), Great Basin collared lizard (Crotaphytus bicinctores), long-nosed leopard lizard (Gambelia wislizenii), short-horned lizard (Phrynosoma douglassi), desert-horned lizard (Phrynosoma platyrhinos), sagebrush lizards (Sceloporus graciosus), western fence lizards (Sceloporus occidentalis), northern side-blotched lizards (Uta uta stansburiana), western skinks (Plestiodon skiltonianus), and Great Basin whiptails (Aspidoscelis tigris) occur in areas where sagebrush is dominant. Similarly, amphibians such as: western toads (Anaxyrus boreas), Woodhouse's toads (Anaxyrus woodhousii), northern leopard frogs (Lithobates pipiens), Columbia spotted frogs (Rana luteiventris), bullfrogs (Lithobates catesbeianus), and Great Basin spadefoots (Spea intermontana) also occur throughout the Great Basin in areas sagebrush species are dominant (Hamilton 2004). Studies have not determined if reptiles and amphibians prefer certain species of sagebrush; however, researchers agree that maintaining habitat where basin big sagebrush and reptiles and amphibians occur is important. In fact, wildlife biologists have noticed declines in reptiles where sagebrush steppe habitat has been seeded with introduced grasses (West 1999 and ref. therein).
Furthermore, wildlife use a variety of associated understory plants and soils that occur in basin big sagebrush habitat. For example: sage grouse (Centrocercus urophasianus), sagebrush vole (Lemmiscus curtatus), Merriam's shrew (Sorex merriami) and Preble's shrew (Sorex preblei) use the grasses that occur with basin big sagebrush for nesting, cover and forage. Basin big sagebrush sandy soil sites provide burrowing opportunities and protection from predators for burrowing owls (Athene cunicularia), dark and pale kangaroo mice (Microdipodops megacephalus and Microdipodops pallidus, respectively). Basin big sagebrush that occur on woodland and rock ecotnes provides nesting and foraging habitat for the ferruginous hawk (Buteo regalis) (Nevada Wildlife Action Plan 2012).
Other animals such as the ferruginous hawk, bald eagle (Haliaeetus leucocephalus), prairie flacon (Falco mexicanus), desert-horned lizard, greater and pygmy short-horned lizard feed on animals that inhabit basin big sagebrush habitat types (Nevada Wildlife Action Plan 2012).
Fourwing saltbush provides valuable habitat and year-round browse for wildlife. Fourwing saltbush also provides browse and shelter for small mammals. Additionally, the browse provides a source of water for black-tailed jackrabbits in arid environments. Granivorous birds consume the fruits. Wild ungulates, rodent and lagomorphs readily consume all aboveground portions of the plant. Palatability is rated good for deer, elk, pronghorn and bighorn sheep.
Winterfat is an important forage plant for wildlife, especially during winter when forage is scarce. Winterfat seeds are eaten by rodents. Winterfat is a staple food for black-tailed jackrabbit. Mule deer and pronghorn antelope browse winterfat. Winterfat is used for cover by rodents. It is potential nesting cover for upland game birds, especially when grasses grow up through its crown.
Indian ricegrass is eaten by pronghorn in moderate amounts whenever available. In Nevada, Indian ricegrass is a highly valued fall elk food. Thickspike wheatgrass is palatable to some extent to all classes of wildlife. In the spring thickspike wheatgrass 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.

Needleandthread is widespread throughout the West and can be important to wildlife, especially early in the spring. Needleandthread is moderately palatable to wildlife. Throughout the West, needleandthread is moderately important spring forage for mule deer, but use declines considerably as more preferred forages become available in summer. Thickspike wheatgrass is also a component of black-tailed jackrabbit diets. Thickspike wheatgrass provides some cover for small mammals and birds.
Sand dropseed provides poor forage for wildlife. Large mammals in general show little use of sand dropseed. Sand dropseed is not preferred by pronghorn, elk, and deer. Small mammals and birds utilize sand dropseed to a greater extent than large mammals.
Galleta provides moderately palatable forage when actively growing and relatively unpalatable forage during dormant periods. Galleta provides poor cover for most wildlife species.
Changes in plant community composition caused by fire frequency associated with this ecological site could affect the distribution and presence of wildlife species. (USDA Ecological Site Description 2014).

Hydrological functions

Runoff is very low to very high. Permeability is slow to rapid. Rills are rare. A few can be expected on steeper slopes in areas subjected to summer convection storms or rapid spring snowmelt. Water flow patterns are none to rare. Pedestals are rare with occurrence typically limited to areas affected by wind scouring. 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 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

Native Americans made tea from big sagebrush leaves. They used the tea as a tonic, an antiseptic, for treating colds, diarrhea, and sore eyes and as a rinse to ward off ticks. Big sagebrush seeds were eaten raw or made into meal. Some Native American peoples used the bark of big sagebrush to make rope and baskets. 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.

Other information

Wyoming big sagebrush is used for stabilizing slopes and gullies and for restoring degraded wildlife habitat, rangelands, mine spoils and other disturbed sites. It is particularly recommended on dry upland sites where other shrubs are difficult to establish. Basin big sagebrush shows high potential for range restoration and soil stabilization. Basin big sagebrush grows rapidly and spreads readily from seed. Fourwing saltbush is widely used in rangeland and riparian improvement and reclamation projects, including burned area recovery. It is probably the most widely used shrub for restoration of winter ranges and mined land reclamation. Winterfat adapts well to most site conditions, and its extensive root system stabilizes soil. However, winterfat is intolerant of flooding, excess water, and acidic soils. Needleandthread is useful for stabilizing eroded or degraded sites. 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.

Type locality

Location 1: White Pine County, NV	
Township/Range/Section	T19 N R55 E S36
Latitude	39° 28′ 36″
Longitude	115° 43′ 49″
General legal description	Newark Valley area, White Pine County, Nevada. This site is also found in Elko and Eureka Counties, Nevada.

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Contributors

CP/HA/RK
P. NovakEchenique
T. Stringham

Rangeland health reference sheet

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

Author(s)/participant(s)	GK Brackley/P.Novak-Echenique
Contact for lead author	State Rangeland Management Specialist
Date	06/01/2006
Approved by	P. Novak-Echenique
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

2. **Presence of water flow patterns:** Water flow patterns none to rare. A few may occur on steeper slopes after summer convection storms or rapid snowmelt. These will be short (<1m) and not connected.

3. **Number and height of erosional pedestals or terracettes:** Pedestals are rare with occurrence typically limited to areas affected by wind scouring. This site may experience severe wind scouring after a severe wildfire where all vegetative cover is removed.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not**

bare ground): Bare Ground 50-60%

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

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6. **Extent of wind scoured, blowouts and/or depositional areas:** None to slight. Wind scouring would be common after severe wildfire or extended drought periods.

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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.

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil stability values should be 2 to 5 on the sandy soil textures found on this site. (To be field tested)

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Surface structure is typically single grained or platy. Soil surface colors are light brownish grays and soils are typified by an ochric epipedon. Surface textures are wind blown clay loams or sands. Organic matter of the surface 2 to 3 inches is typically 1 to 1.5 percent dropping off quickly below. Organic matter content can be more or less depending on micro-topography.

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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 opportunity for snow catch and accumulation on site.

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11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** Compacted layers do not occur. Platy or massive sub-surface horizons, subsoil calcic 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: Deep-rooted, cool season, perennial bunchgrasses

    Sub-dominant: tall shrubs (big sagebrush, fourwing saltbush) >> medium to low-stature shrubs (winterfat, spiny hopsage, ephedra) = shallow-rooted or rhizomatous, cool season, perennial grasses = deep-rooted, cool season, perennial forbs = fibrous, shallow-rooted, cool season, perennial forbs

    Other:

    Additional: With an extended fire return interval, the shrub component will increase at the expense of the herbaceous component.

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 (<25%) have dead centers.

14. **Average percent litter cover (%) and depth (in):** Between plant interspaces (15-25%) and depth (< ¼ in.)

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** For normal or average growing season (through June) ± 600 lbs/ac; Spring moisture significantly affects total production. Favorable years ± 800 lbs/ac and unfavorable years ± 400 lbs/ac.

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

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