Ecological site R028AY025NV
DRY FLOODPLAIN

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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.

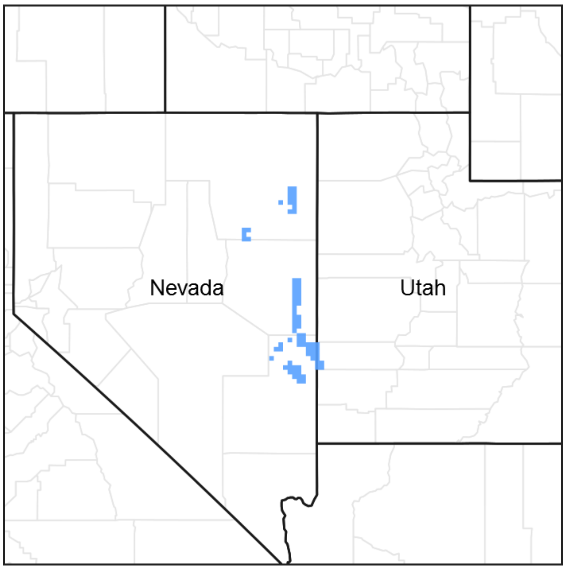

Figure 1. Mapped extent

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): 028A–Ancient Lake Bonneville

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

Ecological site concept

This site occurs on inset fans, lake plains and drainageways. Slopes range from 0 to 4 percent. Elevations are 5500 to 5800 feet.
The climate associated with this site is semiarid, characterized by cool, moist winters and warm, dry summers. Average annual precipitation is 8 to about 12 inches. Mean annual air temperature is 45 to 50 degrees F. The average growing season is about 100 to 140 days.
Soils associated with this site are derived from alluvium of mixed rock sources. These soils have low to moderate salt accumulations. Surface soil textures vary from loam to sandy loam. Runoff is very low to very high. Water intake rates are very slow to to moderately rapid, and the available water holding capacity is moderate to high. Soils are well to moderately well drained.
The reference state is dominated by basin wildrye, creeping wildrye and basin big sagebrush. Production ranges from 1100 to 1800 pounds per acre.

Associated sites

F028AY074NV	**PIMO JUOS/ARNO4/PSSP-ACHY**
R028AY028NV	**DROUGHTY LOAM 8-10 P.Z.**
R028AY068NV	**LOAMY SLOPE 16+ P.Z.**

Similar sites

R028AY054NV	**COARSE LOAMY FAN 8-10 P.Z.** Less productive site; LECI4-ACHY codominant with HECO26
R028AY106NV	**SALINE BOTTOM** LECI4-SPAI codominant; SAVE4 dominant shrub; ARTR2 absent to rare
R028BY041NV	**DRY FLOODPLAIN** Dry Floodplain. ELTR5 rare to absent.
R028AY107NV	**SALINE FLOODPLAIN** ATCA2 dominant shrub; ARTR2 absent to rare
R028AY031NV	**LOAMY FAN 8-10 P.Z.** Less productive site; LECI4-ELLAL codominant with ACHY

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Artemisia tridentata*
Herbaceous	(1) *Leymus cinereus*

Physiographic features

This site occurs on inset fans, lake plains and drainageways. Slopes range from 0 to 4 percent. Elevations are 5500 to 5800 feet.

Table 2. Representative physiographic features

Landforms	(1) Inset fan (2) Drainageway (3) Lake plain
Flooding duration	Very brief (4 to 48 hours)
Flooding frequency	Rare
Ponding frequency	None
Elevation	5,500–5,800 ft

Slope	0–4%
Aspect	Aspect is not a significant factor

Climatic features

Nevada's climate is predominantly arid, with large daily ranges of temperature, infrequent severe storms, heavy snowfall in the higher mountains, and great location variations with elevation. Three basic geographical factors largely influence Nevada's climate: continentality, latitude, and elevation. Continentality is the most important factor. The strong continental effect is expressed in the form of both dryness and large temperature variations. Nevada lies on the eastern, lee side of the Sierra Nevada Range, a massive mountain barrier that markedly influences the climate of the State. The prevailing winds are from the west, and as the warm moist air from the Pacific Ocean ascend the western slopes of the Sierra Range, the air cools, condensation occurs and most of the moisture falls as precipitation. As the air descends the eastern slope, it is warmed by compression, and very little precipitation occurs. The effects of this mountain barrier are felt not only in the West but throughout the state, with the result that the lowlands of Nevada are largely desert or steppes. The temperature regime is also affected by the blocking of the inland-moving maritime air. Nevada sheltered from maritime winds, has a continental climate with well-developed seasons and the terrain responds quickly to changes in solar heating.
Nevada lies within the mid-latitude belt of prevailing westerly winds which occur most of the year. These winds bring frequent changes in weather during the late fall, winter and spring months, when most of the precipitation occurs. To the south of the mid-latitude westerlies, lies a zone of high pressure in subtropical latitudes, with a center over the Pacific Ocean. In the summer, this high-pressure belt shifts northward over the latitudes of Nevada, blocking storms from the ocean. The resulting weather is mostly clear and dry during the summer and early fall, with scattered thundershowers. The eastern portion of the state receives significant summer thunderstorms generated from monsoonal moisture pushed up from the Gulf of California, known as the North American monsoon. The monsoon system peaks in August and by October the monsoon high over the Western U.S. begins to weaken and the precipitation retreats southward towards the tropics (NOAA 2004).
The climate associated with this site is semiarid, characterized by cool, moist winters and warm, dry summers. Average annual precipitation is 8 to about 12 inches. Mean annual air temperature is 45 to 50 degrees F. The average growing season is about 100 to 140 days.

Mean annual precipitation at LAGES, NEVADA Station is 8.13 inches.

Monthly mean precipitaion is:
January 0.59; February 0.6; March 0.76; April 0.92;
May 0.92; June 0.65; July 0.71; August 0.46;
September 0.63; October 0.94; November 0.5;
December 0.46.

Table 3. Representative climatic features

Frost-free period (average)	0 days
Freeze-free period (average)	120 days
Precipitation total (average)	10 in

Influencing water features

This site may receive run-in from adjacent landforms.

Soil features

Soils associated with this site are very deep and derived from alluvium of mixed rock sources or lacustrine deposits. Soils are moderately drained to well drained. These soils have low to moderate salt accumulations. Surface soil textures vary from silt loams to fine sandy loams. Runoff is low to high. Water intake rates are very slow to moderately rapid, and the available water holding capacity is moderate to high. Increased soil moisture in these soils is a result of low runoff and rapid infiltration of the precipitation received from summer convection storms. They have a typic-aridic soil moisture regime and a mesic soil temperature regime. Soil series associated with this site include: Ravendog, Sevenmile, Sheffit, and Toopits.

The representative soil series is Toopits, a fine-loamy, mixed, superactive, calcareous, mesic Xeric Torriorthents. Diagnostic horizons include an ochric epipedon from the soil surface to 18 cm. Clay content in the particle control section averages 27 to 35 percent. Reaction is moderately alkaline or strongly alkaline. Effervescence is violently effervescent. Lithology consists of mixed rocks.

Table 4. Representative soil features

Parent material	(1) Alluvium–welded tuff
Surface texture	(1) Fine sandy loam (2) Fine sandy loam (3) Silt loam
Family particle size	(1) Loamy
Drainage class	Well drained to moderately well drained
Permeability class	Moderate to slow
Soil depth	60–84 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-40in)	5.1–7.4 in
Calcium carbonate equivalent (0-40in)	5–15%
Electrical conductivity (0-40in)	0 mmhos/cm
Sodium adsorption ratio (0-40in)	0
Soil reaction (1:1 water) (0-40in)	8.8–9
Subsurface fragment volume <=3" (Depth not specified)	0%
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 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 influence resilience include site productivity, species composition and structure, and population regulation and regeneration (Chambers et al. 2013).
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 has been linked to disturbances (fire, abusive grazing) that have resulted in fluctuations in resources (Chambers et al 2007).

The ecological sites in this DRG are dominated by the deep-rooted cool season, perennial bunchgrasses such as basin wildrye and long-lived shrubs (50+ years) such as basin big sagebrush and Wyoming big sagebrush. These shrubs have high root to shoot ratios. Root length of mature big sagebrush plants was measured to a depth of 2 meters in alluvial soils in Utah (Richards and Caldwell 1987). These shrubs have a flexible generalized root system with development of both deep taproots and laterals near the surface (Comstock and Ehleringer 1992). Differences in root depth distribution between grasses and shrubs result in resource partitioning in this system.

The perennial bunchgrasses generally have somewhat shallower root systems than the shrubs, but root densities are often as high as or higher than those of shrubs in the upper 0.5 m but taper off more rapidly than shrubs. However, basin wildrye is weakly rhizomatous and has been found to root to depths of up to 2 meters and to exhibit greater lateral root spread than many other grass species (Abbott et al. 1991, Reynolds and Fraley 1989).

Basin wildrye is a large, cool-season perennial bunchgrass with an extensive deep coarse fibrous root system (Reynolds and Fraley 1989). Clumps 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).

Beardless wildrye, also known as creeping wildrye, is a subdominant grass on this site. It is a cool-season perennial sod-forming grass that is strongly rhizomatous (Young-Mathews and Winslow 2010). In a study of native California grasses, beardless wildrye performed the best in terms of above-ground biomass and high resistance to invasion by non-native annuals (Lulow 2006).

Millions of acres in the arid and semi-arid West have been brush-beaten and planted with crested wheatgrass in order to benefit both livestock and wildlife and to increase range production (Zlatnik 1999). Crested wheatgrass is a cool-season, medium height, exotic perennial bunchgrass. As a native of Russia, it is adapted to very cold and very dry climates which made it the common choice for range rehabilitation. Sites within this DRG may exhibit an understory of crested wheatgrass in areas where historical seedings have been allowed to return to sagebrush.

Seasonally high water tables have been found to be necessary for maintenance of site productivity and reestablishment of basin wildrye stands following disturbances such as fire, drought or excessive herbivory (Eckert et al. 1973). The sensitivity of basin wildrye seedling establishment to reduced soil water availability is increased as soil pH increases (Stuart et al. 1971). Lowering of the water table through extended drought, channel incision or water pumping will decrease basin wildrye production and establishment, while sagebrush, black greasewood, rabbitbrush, and invasive weeds increase. Farming and abandonment may facilitate the creation of surface vesicular crust, increased surface ponding, and decreased infiltration; which leads to dominance by sprouting shrubs and an annual understory.

The ecological sites in this DRG have moderate resilience to disturbance and resistance to invasion. A primary disturbance on these ecological sites is drought, fire, flooding, Aroga infestation (Aroga websteri), and channel incision or other disturbance leading to a lowered seasonal water table. This facilitates an increase in shrubs and a decrease in basin wildrye. The introduction of annual weedy species, like cheatgrass (*Bromus tectorum*), may cause an increase in fire frequency and eventually lead to an annual state or a state dominated by rabbitbrush. Other troublesome non-native weeds such as broadleaved pepperweed or tall whitetop (*Lepidium latifolium*), hoary cress or whitetop (*Cardaria draba*), scotch cottonthistle (*Onopordum acanthium*) or bull thistle (*Cirsium vulgare*) are potential invaders on this site. Four possible alternative stable states have been identified for this DRG.

Fire Ecology:

Natural fire return intervals are estimated to vary between less than 35 years up to 100 years in sagebrush ecosystems with basin wildrye (Paysen et al. 2000). Higher production sites would have experienced fire more frequently than lower production sites. 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). In many Great Basin plant communities, changes in fire frequency occurred along with fire suppression, livestock grazing, and OHV use. Fire severity is described as "variable" depending on weather, fuels, and topography and is typically stand replacing (Sapsis and Kauffman 1991). The introduction and expansion of cheatgrass has dramatically altered the fire regime (Balch et al. 2013), therefore altering restoration potential of big sagebrush/basin wildrye plant communities (Evans and Young 1978).

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). Season and severity of the fire will influence plant response as will. post-fire soil moisture availability.

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, inland salt grass, and invasive weeds. Lack of fire combined with excessive herbivory converts these sites to sagebrush, black greasewood, and rabbitbrush dominance.
Basin big sagebrush and Wyoming big sagebrush are easily killed by fire and do not sprout after fire. Repeated fires may eliminate the onsite seed source; reinvasion into these areas may be extremely slow (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 to 120 or more years (Baker 2006).
Rubber rabbitbrush is top-killed by fire, but can resprout after fire and can also establish from seed (Young 1983). Shortened fire intervals within this ecological site favor a beardless wildrye understory with varying amounts of rabbitbrush dominated overstory.

State and transition model

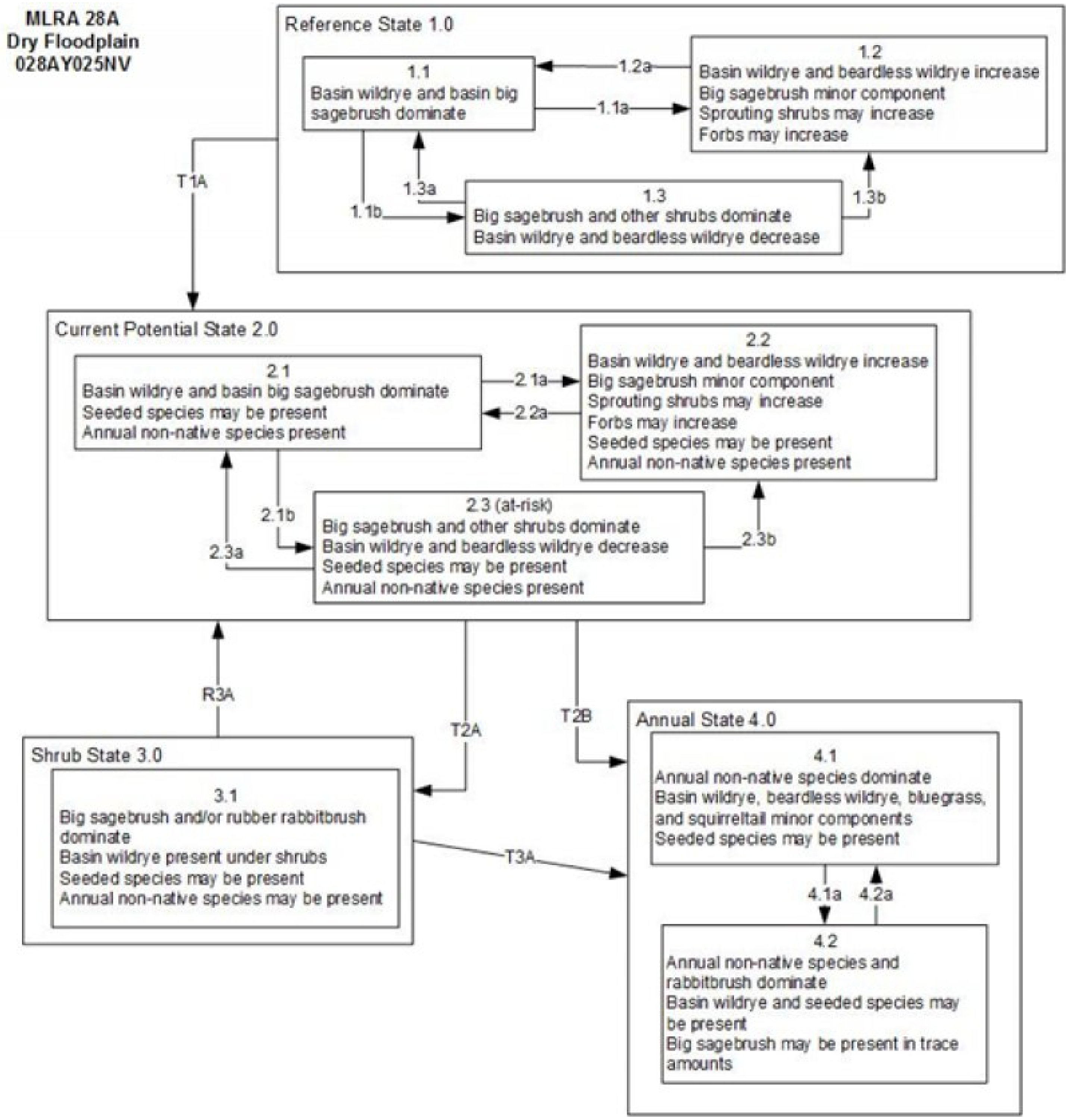

Figure 6. State and Transition Model

MLRA 28A
Dry Floodplain
028AY025NV

Reference State 1.0 Community Phase Pathways
1.1a: Low severity fire creates grass/sagebrush mosaic; high severity fire significantly reduces sagebrush cover and leads to early/mid-seral community dominated by grasses and forbs.
1.1b: Time and lack of disturbance such as fire or long-term drought. Excessive herbivory may also decrease perennial understory.
1.2a: Time and lack of disturbance allows for shrub regeneration.
1.3a: A low severity fire, Aroga moth, or combinations will reduce some of the sagebrush overstory and allow grass species to increase.
1.3b: High severity fire significantly reduces sagebrush cover and allows grass species to dominate.

Transition T1A: Introduction of annual non-native species.

Current Potential State 2.0 Community Phase Pathways
2.1a: Low severity fire creates grass/sagebrush mosaic; high severity fire significantly reduces sagebrush cover and leads to early/mid-seral community dominated by grasses and forbs. Non-native annual species present.
2.1b: Time and lack of disturbance such as fire or long-term drought. Inappropriate grazing management may also reduce perennial understory.
2.2a: Time and lack of disturbance allows for regeneration of sagebrush.
2.3a: A low severity fire, Aroga moth, or combinations will reduce some of the sagebrush overstory and allow grass species to increase. May also be caused by brush management with minimal soil disturbance or late-fall/winter grazing that causes mechanical damage to sagebrush.
2.3b: High severity fire significantly reduces sagebrush cover and allows grass species to dominate.

Transition T2A: Time and lack of disturbance, may be coupled with grazing management and/or hydrologic changes that favor shrubs over perennial grasses.
Transition T2B: Severe fire.

Shrub State 3.0 Community Phase Pathways
None.

Transition T3A: Severe fire.
Restoration Pathway R3A: Mechanical/chemical brush treatment coupled with herbicide. Seeding of perennial bunchgrasses may be necessary.

Annual State 4.0 Community Phase Pathways
4.1a: Time and lack of disturbance
4.2a: Fire

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

This community is dominated by basin wildrye, creeping wildrye, basin big sagebrush. Forbs and other grasses make up smaller components. Wyoming big sagebrush may also be present. Potential vegetative composition is about 80% grasses, 5% forbs and 15% shrubs. Approximate ground cover (basal and crown) is 30 to 50 percent.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	880	1200	1440
Shrub/Vine	165	225	270
Forb	55	75	90
Total	**1100**	**1500**	**1800**

Community 1.2
Community Phase

Figure 9. Dry Floodplain (028AY025NV) T.K. Stringham, August 2013

This community phase is characteristic of a post-disturbance, early-seral community. Basin wildrye and other perennial bunchgrasses dominate. Rubber rabbitbrush may be sprouting. Depending on fire severity or intensity of Aroga moth infestations, patches of intact big sagebrush may remain.

Community 1.3
Community Phase

Figure 10. Dry Floodplain (028AY025NV) T.K. Stringham, May 2012

Wyoming big sagebrush, basin big sagebrush and rubber rabbitbrush dominate the shrub layer. Deep-rooted perennial bunchgrasses are dominated by basin wildrye. Other common grasses and grass-likes include Indian ricegrass, creeping wildrye, Sandberg's bluegrass, Baltic rush and sedge. Common forbs include bird's-beak, desert princesplume and thelypody. Composition by weight is approximately 60% shrubs, 40% grasses and a trace of forbs. Basin big sagebrush increases in the absence of disturbance. Decadent big sagebrush and/or rubber rabbitbrush dominates the overstory and the deep-rooted perennial bunchgrasses in the understory are reduced either from competition with shrubs and/or from herbivory. Wyoming big sagebrush and black greasewood may also be present.

Pathway a
Community 1.1 to 1.2

Fire will decrease or eliminate the overstory of big sagebrush and allow for the perennial bunchgrasses to dominate the site. Fires will typically be low severity, resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring may be more severe and reduce sagebrush cover to trace amounts. A severe infestation of Aroga moth or prolonged flooding could also cause a large decrease in big sagebrush giving a competitive advantage to the perennial grasses and forbs.

Pathway b
Community 1.1 to 1.3

Time and lack of disturbance such as fire allows for sagebrush to increase and become decadent. Chronic drought, herbivory, or combinations of these will cause a decline in perennial bunchgrasses and fine fuels, leading to a reduced fire frequency and allowing big sagebrush to dominate the site.

Pathway a
Community 1.2 to 1.1

Time and lack of disturbance will allow basin big sagebrush to increase.

Pathway a
Community 1.3 to 1.1

A low severity fire, Aroga moth, prolonged flooding or combinations will reduce some of the big sagebrush overstory and allow grass species to increase.

Pathway b
Community 1.3 to 1.2

Community Phase

Community Phase

Fire will decrease or eliminate the overstory of big sagebrush and allow for the perennial bunchgrasses to dominate the site. Fires will typically be low severity resulting in a mosaic pattern due to low fine fuel loads. A fire following an unusually wet spring or a change in management favoring an increase in fine fuels may be more severe and reduce sagebrush cover to trace amounts. A severe infestation of Aroga moth or prolonged flooding could also cause a large decrease in big 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 with three similar 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. A site may be considered to be in the Current Potential State if the non-native seeded species crested wheatgrass is present.

Community 2.1
Community Phase

This community phase is similar to the Reference State Community Phase 1.1, but non-native species are present in trace amounts. Basin wildrye and basin big sagebrush dominate the site. Wyoming big sagebrush may also be present. Seeded species such as crested wheatgrass may be present and/or dominate the understory. Forbs and other shrubs and grasses make up smaller components of this site.

Community 2.2
Community Phase

This community phase is characteristic of a post-disturbance, early seral community where annual non-native species are present. Sagebrush is present in trace amounts; perennial bunchgrasses dominate the site. Depending on fire severity or intensity of Aroga moth infestations, patches of intact sagebrush may remain. Rabbitbrush may be sprouting. Seeded species such as crested wheatgrass may be present and/or dominate the understory. Perennial forbs may be a significant component after fire for several years. Annual non-native species are stable or increasing within the community.

Community 2.3
Community Phase (At Risk)

This community is at risk of crossing a threshold to another state. Basin big sagebrush dominates the overstory and perennial bunchgrasses in the understory are reduced, either from competition with shrubs or from inappropriate grazing, or from both. Wyoming big sagebrush and black greasewood may also be present. Rabbitbrush may be a significant component. Inland saltgrass may increase and become co-dominate with deep rooted bunchgrasses. Annual non-natives species may be stable or increasing due to lack of competition with perennial bunchgrasses. Seeded species such as crested wheatgrass (*Agropyron cristatum*) may be present. This site is susceptible to further degradation from grazing, drought, and fire.

Pathway a
Community 2.1 to 2.2

Fire reduces the shrub overstory and allows for perennial bunchgrasses to dominate the site. Fires are typically low severity resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring or a change in management favoring an increase in fine fuels may be more severe and reduce sagebrush cover to trace amounts. A severe infestation of Aroga moth or prolonged flooding 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 are likely to increase after fire.

Pathway b
Community 2.1 to 2.3

Time and lack of disturbance allows for sagebrush to increase and become decadent. Chronic drought reduces fine fuels and leads to a reduced fire frequency, allowing big sagebrush to dominate the site. Inappropriate grazing management reduces the perennial bunchgrass understory; conversely Sandberg bluegrass may increase in the understory depending on grazing management.

Pathway a
Community 2.2 to 2.1

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

Pathway a
Community 2.3 to 2.1

Heavy late-fall or winter grazing may cause mechanical damage and subsequent death to big sagebrush, facilitating an increase in the herbaceous understory. An infestation of Aroga moth will reduce some big sagebrush overstory and allow perennial grasses to increase in the community. Brush treatments with minimal soil disturbance will also decrease sagebrush and release the perennial understory. Annual non-native species are present and may increase in the community.

Pathway b
Community 2.3 to 2.2

Fire eliminates/reduces the overstory of sagebrush and allows for the understory perennial grasses to increase. Fires will typically be low severity resulting in a mosaic pattern due to low fine fuel loads. A fire that follows an unusually wet spring or change in management favoring an increase in fine fuels may be more severe and reduce the shrub component to trace amounts. A severe infestation of Aroga moth will also cause a large decrease in sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs. Annual non-native species respond well to fire and may increase post-burn.

State 3
Shrub State

This state is a product of many years of heavy grazing during time periods harmful to perennial bunchgrasses. Sites within this DRG with high water tables may transition to a shrub state if the hydrology of the area is affected. In both cases, basin wildrye is significantly reduced and other perennial grasses will increase. Big sagebrush dominates the overstory and rabbitbrush may be a significant component. Big sagebrush 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 and shallower rooted grasses dominate site resources such that soil water, nutrient capture, nutrient cycling and soil organic matter are temporally and spatially redistributed.

Community 3.1
Community Phase

Figure 11. Dry Floodplain (028AY025NV) T.K. Stringham, May 2012.

Decadent big sagebrush dominates the overstory. Rabbitbrush and black greasewood may be significant components. Deep-rooted perennial bunchgrasses may be present in trace amounts or absent from the community. Creeping wildrye is present but may be found only in patches. Annual non-native species increase. Crested wheatgrass may be a significant component in this phase if the site has a history of seeding treatments. Bare ground is significant.

State 4
Annual State

This state has two community phases. One community phase is characterized by the dominance of annual non-native species such as cheatgrass and tansy mustard in the understory. The other community phase is dominated by rabbitbrush with an understory of cheatgrass and mustards. Big sagebrush and/or rabbitbrush may dominate the overstory.

Community 4.1
Community Phase

Annual non-native plants such as tansy mustard (*Descurainia pinnata*) and cheatgrass dominate this site. Crested wheatgrass may be a significant component in this phase if the site has a history of seeding treatments.

Community 4.2
Community Phase

Annual non-native plants such as tansy mustard (*Descurainia pinnata*) and cheatgrass dominate the understory while sprouting shrubs such as rabbitbrush dominate the overstory. Big sagebrush may be present in trace amounts. Crested wheatgrass may be a significant component in this phase if the site has a history of seeding treatments.

Pathway a
Community 4.1 to 4.2

Time and lack of disturbance allow sprouting shrubs to recover and mature. Sagebrush may re-establish in a limited extent.

Pathway a
Community 4.2 to 4.1

Fire

Transition A
State 1 to 2

Trigger: This transition is caused by the introduction of non-native annual plants, such as cheatgrass and mustards. 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: Repeated, heavy, growing season grazing will decrease or eliminate basin wildrye and favor shrub growth and establishment. To Community Phase 3.2: Severe fire in the depleted state 2.3 will remove sagebrush overstory and allow beardless wildrye to dominate the understory. Grazing and/or fire may couple with hydrologic changes and accelerate the transition to state 3.0. Slow variables: Long term decrease in basin wildrye density due to grazing or lowering water table. Threshold: Loss of the large, deep-rooted basin wildrye changes nutrient cycling, nutrient redistribution, and reduces soil organic matter.

Transition B
State 2 to 4

Trigger: Severe fire. Slow variables: Increased production and cover of non-native annual species. Threshold: Loss of deep-rooted perennial bunchgrasses and shrubs truncates, spatially and temporally, nutrient capture and cycling within the community. Increased, continuous fine fuels from annual non-native plants modify the fire regime by changing intensity, size and spatial variability of fires.

Restoration pathway A
State 3 to 2

Restoration of this state would require mechanical or chemical brush treatment and control of annual invasive weed species. Seeding of grasses may be necessary if basin wildrye is severely reduced or no longer present in the community. Prescribed burning is not recommended if there is a significant component of cheatgrass or other non-native weeds in the understory. If channel incision has lowered the water table or altered spring soil moisture the probability of establishment of a basin wildrye seeding will be significantly reduced.

Transition A
State 3 to 4

Trigger: Severe fire. Slow variables: Increased production and cover of non-native annual species. Threshold: Increased, continuous fine fuels modify the fire regime by changing intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture spatially and temporally thus impacting nutrient cycling and distribution.

Additional community tables

Table 6. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Primary Perennial Grasses**			925–1125	
	basin wildrye	LECI4	*Leymus cinereus*	750–900	–
	beardless wildrye	LETR5	*Leymus triticoides*	75–225	–
2	**Secondary Perennial Grasses**			75–150	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	8–45	–
	sedge	CAREX	*Carex*	8–45	–
	saltgrass	DISP	*Distichlis spicata*	8–45	–
	squirreltail	ELEL5	*Elymus elymoides*	8–45	–
	mat muhly	MURI	*Muhlenbergia richardsonis*	8–45	–
	western wheatgrass	PASM	*Pascopyrum smithii*	8–45	–
	bluegrass	POA	*Poa*	8–45	–
	alkali sacaton	SPAI	*Sporobolus airoides*	8–45	–
Forb					
3	**Perennial**			30–150	
	milkvetch	ASTRA	*Astragalus*	8–75	–
	povertyweed	IVAX	*Iva axillaris*	8–75	–
Shrub/Vine					
4	**Primary Shrubs**			75–225	
	basin big sagebrush	ARTRT	*Artemisia tridentata ssp. tridentata*	38–113	–
5	**Secondary Shrubs**			30–150	
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	15–45	–
	spiny hopsage	GRSP	*Grayia spinosa*	15–45	–
	greasewood	SAVE4	*Sarcobatus vermiculatus*	15–45	–

Animal community

Livestock Interpretations:
This site is suitable for livestock grazing. Grazing management considerations include timing, intensity, frequency, and duration of grazing. Grazing management should be keyed to basin wildrye and other perennial grass production.

During settlement, many of the cattle in the Great Basin were wintered on extensive basin wildrye stands, however due to sensitivity to spring use many stands were decimated by early in the 20th century (Young et al. 1976). Less palatable species such as black greasewood, rabbitbrush and inland salt grass (Distichlis spicata) increased in dominance along with invasive non-native species such as Russian thistle (Salsola tragus), mustards, and cheatgrass (Roundy 1985). Spring defoliation of basin wildrye and/or consistent, heavy grazing during the growing season has been found to significantly reduce basin wildrye production and density (Krall et al. 1971). Thus, inadequate rest and recovery from defoliation can cause a decrease in basin wildrye and an increase in rabbitbrush, black greasewood, beardless wildrye, inland saltgrass, and non-native weeds (Young et al. 1976, Roundy 1985). Additionally, native basin wildrye seed viability has been found to be low and seedlings lack vigor (Young and Evans 1981). Roundy (1985) found that although basin wildrye is adapted to seasonally dry saline soils, high and frequent spring precipitation is necessary to establish it from seed. This suggests that establishment of native basin wildrye seedlings occurs only during years of unusually high precipitation. Therefore, reestablishment of a stand that has been decimated by grazing may be episodic.
Basin wildrye is valuable forage for livestock (Ganskopp et al. 2007) and wildlife, but is intolerant of heavy, repeated, or spring grazing (Krall et al. 1971). 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. Basin wildrye is used often as a winter feed for livestock and wildlife; not only providing roughage above the snow but also cover in the early spring months (Majerus 1992). Inadequate rest and recovery from defoliation causes a decrease in basin wildrye and an increase in basin big sagebrush and rubber rabbitbrush along with western wheatgrass (Pascopyrum smithii) and beardless wildrye. Further deterioration of the sites promotes shrub dominance, increased bare ground and the invasion of annual weeds, primarily cheatgrass and Russian thistle.
Beardless wildrye tolerates tramping and recovers well following grazing (Young-Mathews 2010). Because if it’s grazing tolerance, with continued heavy grazing beardless wildrye may become the dominant grass on this site. Once established it is very rhizomatous and maintains stands for many years. Basin big sagebrush may serve as emergency food during severe winter weather, but it is not usually sought out by livestock. Livestock browse Wyoming big sagebrush, but may use it only lightly when palatable herbaceous species are available.
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:
Basin big sagebrush/basin wildrye communities provide cover and food for large ungulates, upland game birds, and smaller wildlife. Because of its tall, heavy growth, basin wildrye provides forage for elk (Cervus canadensis) and other big game in the winter when snow cover is more than two feet (Plummer et al 1968).
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. Wyoming big sagebrush is preferred browse for wild ungulates. Pronghorn usually browse Wyoming big sagebrush heavily. 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. 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. Creeping wildrye is used for forage for many wildlife species and is often used for cover.
Wild ungulates use basin big sagebrush for cover and feed. Mule deer, pronghorn (Antilocarpra americana) and elk 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 (Wildlife Action Plan Team 2012). 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 preferred big sagebrush over other shrub types; however, the variety was not noted.
These plants communities provide cover and food for smaller desert wildlife such as lagomorphs and rodents. Pygmy rabbits (Brachylagus idahoensis) rely on tall basin big sagebrush for shelter and food throughout the year

(Green and Flinders 1980, White et al. 1982, Wildlife Action Plan Team 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.
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 Greater sage grouse (Centrocercus urophasianus), the loggerhead shrike (Lanius ludovicianus), the sage sparrow (Artemisiospiza nevadensis), Brewer's sparrow and sage thrasher (Oreoscoptes montanus) (Wildlife Action Plan Team 2012). The plant also acts as important cover for game-birds such as the gray partridge (Perdix perdix), mountain quail (Oreotyx pictus), and mourning doves (Zenaida macroura), as well as passerines such as, towhees (Pipilo spp.) and finches (Haemorhous spp.), that occur on arid range lands in the West (Dobbs et al. 2012, Booth 1985).
Changes in plant community composition caused by, human activity, invasive weeds, fire frequency associated with this ecological site could affect the distribution and presence of wildlife species.

Hydrological functions

This site in nearly level, thus typically there are no rills present. This site is subject to rare flooding and rill development may occur where run-in occurs from adjacent sites. These are widely spaced and not connected. Waterflow patterns may be common after spring runoff and summer convection storms. They may be long (10-15 ft), less than 6 inches wide and widely spaced (5-10 ft apart). Deep-rooted perennial herbaceous bunchgrasses (basin wildrye) slow runoff and increase infiltration. Tall stature and relatively coarse foliage of basin wildrye and associated litter break raindrop impact and provide opportunity for snow catch and moisture 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

Some Native American peoples used the bark of big sagebrush to make rope and baskets. 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. Basin wildrye was used as bedding for various Native American ceremonies, providing a cool place for dancers to stand.

Other information

Basin big sagebrush shows high potential for range restoration and soil stabilization. Basin big sagebrush grows rapidly and spreads readily from seed. 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 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. Creeping wildrye is primarily used for reclamation of wet, saline soils.

Type locality

Location 1: Elko County, NV	
Township/Range/Section	T32N R66E S21
General legal description	SE¼SE¼ Section 21, R66E. T32N. MDBM. About 7 miles south of Flowery Lake, Goshute Valley area, Elko County, Nevada.

Other references

Abbott, M. L., L. Fraley Jr., and T. D. Reynolds. 1991. Root profiles of selected cold desert shrubs and grasses in disturbed and undisturbed soils. Environmental and Experimental Botany 31(2): 165-178.

Akinsoji, A. 1988. Postfire vegetation dynamics in a sagebrush steppe in southeastern Idaho, USA. Vegetatio 78:151-155.

Baker, W. L. 2006. Fire and restoration of sagebrush ecosystems. Wildlife Society Bulletin 34:177-185.

Baker, W. L. 2011. Pre-euro-american and recent fire in sagebrush ecosystems. Pp 185-201 In S. T. Knick and J. W. Connelly, editors. Greater Sage-grouse: Ecology and Conservation of a Landscape Species and its Habitats. University of California Press, Berkeley, California.

Balch, J. K., B. A. Bradley, C. M. D'Antonio, and J. Gómez-Dans. 2013. Introduced annual grass increases regional fire activity across the arid western USA (1980–2009). Global Change Biology 19:173-183.

Beale, D. M. and A.D. Smith. 1970. Forage use, water consumption, and productivity of pronghorn antelope in western Utah. The Journal of Wildlife Management. 34: 570-582.

Blaisdell, J. P. 1953. Ecological effects of planned burning of sagebrush-grass range on the upper Snake River Plains. US Dept. of Agriculture.

Booth, DT. 1985. The role of fourwing saltbush in mined land reclamation: A viewpoint. Journal of Range Management. 28:562-565.

Bradley, A. F., N. V. Noste, and W. C. Fischer. 1992. Gen. Tech. Rep. INT-287: Fire Ecology of Forests and Woodlands in Utah. . U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT.

Brown, K.W. 1977. Food habits of desert bighorn sheep in Nevada, 1956–1976. Desert Bighorn Council Transactions, 21: 32–60.

Bunting, S. C., B. M. Kilgore, and C. L. Bushey. 1987. Guidelines for Prescribed Burning Sagebrush-grass Rangelands in the Northern Great Basin. US Department of Agriculture, Forest Service, Intermountain Research Station Ogden, UT, USA.

Caudle, D., J. DiBenedetto, M. Karl, H. Sanchez, and C. Talbot. 2013. Interagency Ecological Site Handbook for Rangelands. Available at: http://jornada.nmsu.edu/sites/jornada.nmsu.edu/files/InteragencyEcolSiteHandbook.pdf. Accessed 4 October 2013.

Chambers, J., B. Bradley, C. Brown, C. D'Antonio, M. Germino, J. Grace, S. Hardegree, R. Miller, and D. Pyke. 2013. Resilience to stress and disturbance, and resistance to *Bromus tectorum* L. invasion in cold desert shrublands of western North America. Ecosystems:1-16.

Chambers, J.C., B.A. Roundy, R.R. Blank, S.E. Meyer, and A. Whittaker. 2007. What makes Great Basin sagebrush ecosystems invasible by *Bromus tectorum*? Ecological Monographs 77:117-145.

Comstock, J. P. and J. R. Ehleringer. 1992. Plant adaptation in the Great Basin and Colorado plateau. Western North American Naturalist 52:195-215.

Dobbs, R. C., P. R. Martin and T. E. Martin. 2012. Green-tailed Towhee (Pipilo chlorurus), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: < http://bna.birds.cornell.edu/bna/species/368 doi:10.2173/ bna.368>

Eckert, R. E., Jr., A. D. Bruner, and G. J. Klomp. 1973. Productivity of tall wheatgrass and Great Basin wildrye under irrigation on a greasewood-rabbitbrush range site. Journal of Range Management 26:286-288.

Evans, R. A. and J. A. Young. 1978. Effectiveness of rehabilitation practices following wildfire in a degraded big sagebrush-downy brome community. Journal of Range Management 31:185-188.

Fire Effects Information System (Online; http://www.fs.fed.us/database/feis/plants/).

Ganskopp, D., L. Aguilera, and M. Vavra. 2007. Livestock forage conditioning among six northern Great Basin grasses. Rangeland Ecology & Management 60:71-78.

Goodrich, S., E. D. McArthur, and A. H. Winward. 1985. A new combination and a new variety in Artemisia tridentata. The Great Basin Naturalist 45:99-104.

Green, J.S. and J.T. Flinders. 1980. Habitat and dietary relationships of the pygmy rabbit. J. Range Manage. 33:136-142.

Hickey, Jr., W.C. and H.W. Springfield. 1966. Alkali sacaton: its merits for forage and cover. Journal of Range Management 19(2):71-74.

Houghton, J.G., C.M. Sakamoto, and R.O. Gifford. 1975. Nevada's Weather and Climate, Special Publication 2. Nevada Bureau of Mines and Geology, Mackay School of Mines, University of Nevada, Reno, NV.

Humphrey, L. D. 1984. Patterns and mechanisms of plant succession after fire on Artemisia-grass sites in southeastern Idaho. Vegetatio 57:91-101.

Johnson, J. R. and G. F. Payne. 1968. Sagebrush reinvasion as affected by some environmental influences. Journal of Range Management 21:209-213.

Knick, S.T., D.S. Dobkin, J.T. Rotenberry, M.A. Schroeder, W.M.V. Haegen, and C. Van Riper III. 2003. Teetering on the edge or too late? Conservation and research issues for avifauna of sagebrush habitats. The Condor. 105:611-634.

Krall, J. L., J. R. Stroh, C. S. Cooper, and S. R. Chapman. 1971. Effect of time and extent of harvesting basin wildrye. Journal of Range Management 24:414-418.

Larrison, C.J. and D.R. Johnson 1973. Density changes and habitat affinities of rodents of shadscale and sagebrush associations. Great Basin Naturalist. 33:255-264.

Lulow, M. E. 2006. Invasion by non-native annual grasses: The importance of species biomass, composition, and time among California native grasses of the Central Valley. Restoration Ecology, 14(4), 616-626.

Majerus, M. E. 1992. High-stature grasses for winter grazing. Journal of soil and water conservation 47:224-225.

Marcum, K.B. and D.H. Kopec. 1997. Salinity tolerance of turfgrasses and alternative species in the subfamily Chloridoideae (Poaceae). International Turfgrass Society Research Journal 8:735-742.

McKell, C. M. and W. W. Chilcote. 1957. Response of Rabbitbrush Following Removal of Competing Vegetation. Journal of Range Management Archives 10:228-229.

Miller, R. F., J. C. Chambers, D. A. Pyke, F. B. Pierson, and C. J. Williams. 2013. A review of fire effects on vegetation and soils in the Great Basin Region: response and ecological site characteristics.

National Oceanic and Atmospheric Administration. 2004. The North American Monsoon. Reports to the Nation. National Weather Service, Climate Prediction Center. Available online: http://www.weather.gov/.

Ogle, D.G., St. John, L., and D. Tilley. 2012b. Plant Guide for Fourwing Saltbush (Atriplex canescens). USDA Natural Resources Conservation Service, Aberdeen, ID Plant Materials Center. 83210-0296.

Ogle, D.G., Tilley, D., and L. St. John. 2012a. Plant Guide for basin wildrye (Leymus cinereus). USDA-Natural Resources Conservation Service, Aberdeen Plant Materials Center. Aberdeen, Idaho.

Paysen, T. E., R. J. Ansley, J. K. Brown, G. J. Gottfried, S. M. Haase, M. G. Harrington, M. G. Narog, S. S. Sackett, and R. C. Wilson. 2000. Fire in Western Shrubland, Woodland, and Grassland Ecosystems. Wildland Fire in Ecosystems: Effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-vol 2:121-159.

Perryman, B.L. and Q.D. Skinner. 2007. A Field Guide to Nevada Grasses. Indigenous Rangeland Management Press, Lander, Wyoming. 256 p.

Plummer, A.P., D.R. Christensen, and S.B. Monsen. 1968. Restoring big-game range in Utah. Utah Division of Fish and Game Publication No. 683.

Reynolds, T.D., and L. Fraley Jr. 1989. Root profiles of some native and exotic plant species in southeastern Idaho. Environmental and Experimental Botany. 29(2): 241-248.

Richards, J. H. and M. M. Caldwell. 1987. Hydraulic lift: Substantial nocturnal water transport between soil layers by Artemisia tridentata roots. Oecologia 73:486-489.

Robberecht, R. and G. Defossé. 1995. The relative sensitivity of two bunchgrass species to fire. International Journal of Wildland Fire 5:127-134.

Roundy, B. A. 1985. Emergence and establishment of basin wildrye and tall wheatgrass in relation to moisture and salinity. Journal of Range Management 38:126-131.

Sapsis, D. B. and J. B. Kauffman. 1991. Fuel consumption and fire behavior associated with prescribed fires in sagebrush ecosystems. Northwest Science 65:173-179.

Sheehy, P.D. and A.H. Winward. 1981. Relative palatability of seven Artemisia taxa to mule deer and sheep. J. Range Manage. 34:397-399.

Shumar, M. L. and J. E. Anderson. 1986. Water relations of two subspecies of big sagebrush on sand dunes in southeastern Idaho. Northwest Science 60:179-185.

Smoliak, S., J. F. Dormaar, and A. Johnston. 1972. Long-term grazing effects on Stipa-Bouteloua prairie soils. Journal of Range Management 25:246-250.

Stringham, T.K., P. Novak-Echenique, P. Blackburn, C. Coombs, D. Snyder and A. Wartgow. 2015. Final Report for USDA Ecological Site Description State-and-Transition Models, Major Land Resource Area 28A and 28B Nevada. University of Nevada Reno, Nevada Agricultural Experiment Station Research Report 2015-01. p. 1524.

Stuart, D. M., G. E. Schuman, and A. S. Dylla. 1971. Chemical characteristics of the coppice dune soils in Paradise Valley, Nevada. Soil Sci. Soc. Am. J. 35:607-611.

Tueller, P. T. and W. H. Blackburn. 1974. Condition and trend of the big sagebrush/needleandthread habitat type in Nevada. Journal of Range Management 27:36-40.

USDA-NRCS Plants Database (Online; http://www.plants.usda.gov).

Wambolt, C.L. 1996. Mule deer and elk foraging preference for 4 sagebrush taxa. J. Range Manage. 49:499-503.

Wambolt, C.L., W.H. Creamer, and R.J. Rossi. 1994. Predicting big sagebrush winter forage by sub-species and browse form class. J. Range Manage. 47:231-234.

Welch B.L., E. D. McArthur, and J.N. Davis. 1981. Differential preference of wintering mule deer for accessions of big sagebrush and for black sagebrush. J. Range Manage. 34:409-411

White, S. M., J.T. Flinders, and B.S. Welch. 1982. Preference of pygmy rabbits (Brachylagus idahoensis) for various populations of big sagebrush (Artemisia tridentata). Journal of Range Management. 35: 724-726.

Wildlife Action Plan Team. 2012. Nevada Wildlife Action Plan. Nevada Department of Wildlife. Reno, Nevada.

Wright, H. A. 1971. Why squirreltail Is more tolerant to burning than needle-and-thread. Journal of Range Management 24:277-284.
Wright, H. A. and A. W. Bailey. 1982. Fire ecology: United States and southern Canada. Wiley & Sons.

Wright, H. A. and J. O. Klemmedson. 1965. Effect of fire on bunchgrasses of the sagebrush-grass region in southern Idaho. Ecology 46:680-688.

Young, J. A. and R. A. Evans. 1981. Germination of Great Basin wildrye seeds collected from native stands. Agron. J. 73:917-920.

Young, J. A., R. A. Evans, and P. T. Tueller. 1976. Great Basin plant communities-pristine and grazed. Holocene environmental change in the Great Basin. Nevada Archeological Survey Research Paper 6:186-215.

Young, R. P. 1983. Fire as a vegetation management tool in rangelands of the intermountain region. Pp.18-31 In Managing Intermountain Rangelands - Improvement of Range and Wildlife Habitats. USDA, Forest Service.

Young-Mathews, A. and S.R. Winslow. 2010. Plant guide for beardless wildrye (Leymus triticoides). USDA-Natural Resources Conservation Service, Plant Materials Center. Lockeford, CA.

Zlatnik, Elena. 1999. *Agropyron cristatum*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/

Zschaechner, G. A. 1985. Studying rangeland fire effects: a case study in Nevada. Pp. 66-84 in Rangeland Fire Effects, A Symposium. Bureau of Land Management, Boise, Idaho.

Contributors

RK
T.Stringham/P.Novak-Echenique

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)	P NOVAK-ECHENIQUE
Contact for lead author	State Rangeland Management Specialist
Date	05/14/2013
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** This site in nearly level, thus typically there are no rills present. This site is subject to rare flooding and rill development may occur where run-in occurs from adjacent sites. These are widely spaced and not connected.

2. **Presence of water flow patterns:** Waterflow patterns may be common after spring runoff and summer convection storms. They may be long (10-15 ft), less than 6 inches wide and widely spaced (5-10 ft apart).

3. **Number and height of erosional pedestals or terracettes:** A few plants may be pedestalled adjacent to flow paths. Terracettes are small and stable.

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare Ground up to 30%

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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

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7. **Amount of litter movement (describe size and distance expected to travel):** Fine litter (foliage of grasses and annual & perennial forbs) only expected to move during periods of flooding by adjacent streams. Persistent litter (large woody material) will remain in place except during major flooding 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 will range from 5 to 6 under cover and 4 to 5 in the interspaces.

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil surface structure is thick or thin platy. Soil surface colors are grays and browns and soils have a mollic epipedon. Surface textures are fine sandy loams and silt loams. Organic matter can range from 2 to 3.5 percent in the upper 3 to 5 inches.

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Deep-rooted perennial herbaceous bunchgrasses (basin wildrye) slow runoff and increase infiltration. Tall stature and relatively coarse foliage of basin wildrye and associated litter break raindrop impact and provide opportunity for snow catch and moisture 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):** None – Subangular blocky or massive structure is not to be interpreted as compaction.

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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: Tall-statured, deep-rooted, cool season, perennial bunchgrasses

    Sub-dominant: Rhizomatous grasses = tall shrubs > deep-rooted, cool season, perennial forbs > shallow-rooted, cool season, perennial grasses > fibrous, shallow-rooted, cool season, perennial forbs.

    Other: Grass-like plants, warm season bunchgrasses

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

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

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14. **Average percent litter cover (%) and depth (in):** Between plant interspaces (25-35%) and depth of litter ±½-inch

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** For normal or average growing season (thru June) ± 1500 lbs/ac; Favorable years ± 1800 lbs/ac and unfavorable years ± 1100 lbs/ac

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

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