Ecological site R028AY090NV
LOAMY BOTTOM 10-14 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.

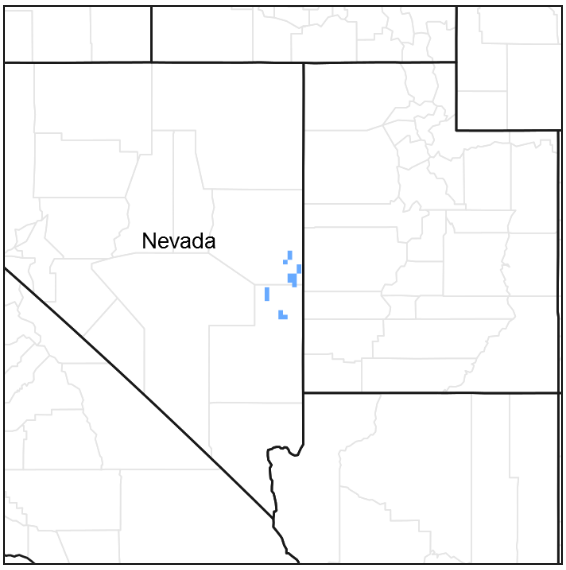

Figure 1. Mapped extent

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): 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 drainageways in mountains. Slope gradients of 0 to 8 percent are typical. Elevations are 7400 to 9200 feet.
The climate associated with this site is semiarid, characterized by cool, moist winters and warm, dry summers. Average annual precipitation is 10 to about 14 inches. Mean annual air temperature is 43 to 47 degrees F. The average growing season is 80 to about 120 days.
Soils associated with this site are very deep and well drained. They are formed in limestone and minor amounts of quartzite. Surface and subsurface textures are loams. The available water capacity is high. Additional moisture is received on this site as overflow from adjacent streams or as run-in from higher landscapes. These soils are susceptible to gully formation which will intercept natural overland flow patterns causing site degradation. The soil moisture regime is xeric and the soil temperature regime is frigid.
The reference state is dominated by basin wildrye and basin big sagebrush. Production ranges from 2500 to 6000 pounds per acre.

Associated sites

R028AY031NV	**LOAMY FAN 8-10 P.Z.**
R028AY091NV	**LOAMY FAN 10-14 P.Z.**
R028AY095NV	**LOAMY 10-12 P.Z.**

Similar sites

R028AY055NV	**LOAMY BOTTOM 14+ P.Z.** ARTRV dominant shrub, less productive site; ELTR7 major grass spp.
R028AY091NV	**LOAMY FAN 10-14 P.Z.** Less productive site; HECO26 & ELLAL major grasses
R028AY031NV	**LOAMY FAN 8-10 P.Z.** Less productive site; ACHY & ELLAL codominant grasses
R028AY025NV	**DRY FLOODPLAIN** Less productive site; DISP & SAVE4 commonly occur
R028AY121NV	**DEEP LOAMY 8-10 P.Z.** Less productive site; soils without a mollic epipedon
R028AY122NV	**DEEP SODIC LOAM 8-10 P.Z.** Less productive site; SAVE4 important shrub

Table 1. Dominant plant species

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

Physiographic features

This site occurs on drainageways in mountains. Slope gradients of 0 to 8 percent are typical. Elevations are 7400 to 9200 feet.

Table 2. Representative physiographic features

Landforms	(1) Drainageway
Flooding duration	Very brief (4 to 48 hours) to brief (2 to 7 days)
Flooding frequency	Very rare to occasional
Ponding frequency	None

Elevation	2,256–2,804 m
Slope	0–8%
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 10 to about 14 inches. Mean annual air temperature is 43 to 47 degrees F. The average growing season is 80 to about 120 days.

Mean annual precipitation at ELY WBO, NEVADA
climate station (262631)is 9.72 inches.

Monthly mean precipitation is:
January 0.77; February 0.78; March 1.01;
April 1.03; May 1.1; June 0.65; July 0.64;
August 0.81; September 0.75; October 0.82;
November 0.68; December 0.68.

Table 3. Representative climatic features

Frost-free period (average)	0 days
Freeze-free period (average)	100 days
Precipitation total (average)	305 mm

Influencing water features

Additional moisture is received on this site as overflow from adjacent streams or as run-in from higher landscapes.

Soil features

Soils associated with this site are very deep and well drained. They are formed in limestone and minor amounts of quartzite. Surface and subsurface textures are loams. The available water capacity is high. Additional moisture is received on this site as overflow from adjacent streams or as run-in from higher landscapes. These soils are susceptible to gully formation which will intercept natural overland flow patterns causing site degradation. The soil moisture regime is xeric and the soil temperature regime is frigid. The soil series associated with this site include: Bigwash and Sevenmile.

The representative soil series is Bigwash, classified as a Coarse-loamy, mixed, superactive, frigid Cumulic Haploxerolls. Diagnostic horizons include a mollic epipedon from the soil surface to 60 inches. Clay content in the particle control section averages 12 to 18 percent. Rock fragments range from 5 to 15 percent, consisting mainly of limestone. Reaction is slightly alkaline to strongly alkaline. Effervescence is strongly to violently effervescent. Lithology consists of alluvium derived mainly from limestone and minor amounts of quartzite.

Table 4. Representative soil features

Parent material	(1) Alluvium–limestone
Surface texture	(1) Loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Moderately rapid
Soil depth	191–203 cm
Surface fragment cover <=3"	0–5%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	14.73–18.8 cm
Calcium carbonate equivalent (0-101.6cm)	0–5%
Electrical conductivity (0-101.6cm)	0 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	7.8–8.7
Subsurface fragment volume <=3" (Depth not specified)	5–10%
Subsurface fragment volume >3" (Depth not specified)	0%

Ecological dynamics

An ecological site is the product of all the environmental factors responsible for its development and it has a set of key characteristics that influence a site’s resilience to disturbance and resistance to invasives. Key characteristics include 1) climate (precipitation, temperature), 2) topography (aspect, slope, elevation, and landform), 3) hydrology (infiltration, runoff), 4) soils (depth, texture, structure, organic matter), 5) plant communities (functional groups, productivity), and 6) natural disturbance regime (fire, herbivory, etc.) (Caudle 2013). Biotic factors that influence resilience include site productivity, species composition and structure, and population regulation and regeneration (Chambers et al 2013).

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 (Comstock and Ehleringer 1992).
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 1m or more and to exhibit greater lateral root spread than many other grass species (Abbott et al. 1991). 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 has been linked to disturbances (fire, abusive grazing) that have resulted in fluctuations in resources (Chambers et al 2007). A primary disturbance on these ecological sites is channel incision leading to a lowered seasonal water table which facilitates an increase in shrubs and a decrease in perennial bunchgrasses (Chambers and Miller 2004). With continued site degradation, rubber rabbitbrush becomes the dominant plant. There is some evidence that many Loamy Bottom ecological sites are degraded Wet Meadow ecological sites created through channel incision processes. Additionally, the encroachment of Singleleaf pinyon and Utah juniper into associated upland sites has the potential to modify the hydrology of this site through changes to the watersheds overall water budget. Research indicates pinyon and juniper canopies intercept, on average, 44% of incoming rainfall (Lossing 2012) and a 10 to 12 inch dbh tree consumes approximately 10 to 68 liters per day (Snyder et al. 2013). Further investigation and updating of ecological site concepts for this site is warranted.
The introduction of annual weedy species, like cheatgrass, 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 tall whitetop, scotch thistle or bull thistle are potential invaders on this site.

This ecological site has moderate resilience to disturbance and resistance to invasion. A primary disturbance on these ecological sites is 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, 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 whitetop, tall whitetop, scotch thistle or bull thistle are potential invaders on this site. Four possible alternative stable states have been identified for this site.

Fire Ecology:
In many basin 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 does not sprout after fire. Because of the time needed to produce seed, it is eliminated by frequent fires (Bunting et al. 1987). Basin big sagebrush reinvades 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 basin 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).

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). In addition, 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). Miller et al. (2013) reported increased total shoot and reproductive shoot densities in the first year following fire, although by year two there was little difference between burned and control treatments.

The majority of research concerning rabbitbrush has been conducted on green rabbitbrush. Green rabbitbrush has a large taproot and is known to be shorter-lived and less competitive than sagebrush. Seedling density, flower production, and shoot growth decline as competition from other species increases (McKell and Chilcote 1957, Miller et al. 2013, Young and Evans 1974). Depending on fire severity, rabbitbrush may increase after fire. 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 creeping wildrye understory with varying amounts of rabbitbrush dominated overstory.

Hydrologic modification of this site may occur through channel incision or gully formation with post-fire rain events. Channel incision or gully formation has the potential to lower the site water table, drying out the site and favoring the dominance of sagebrush and rabbitbrush over the herbaceous component.

State and transition model

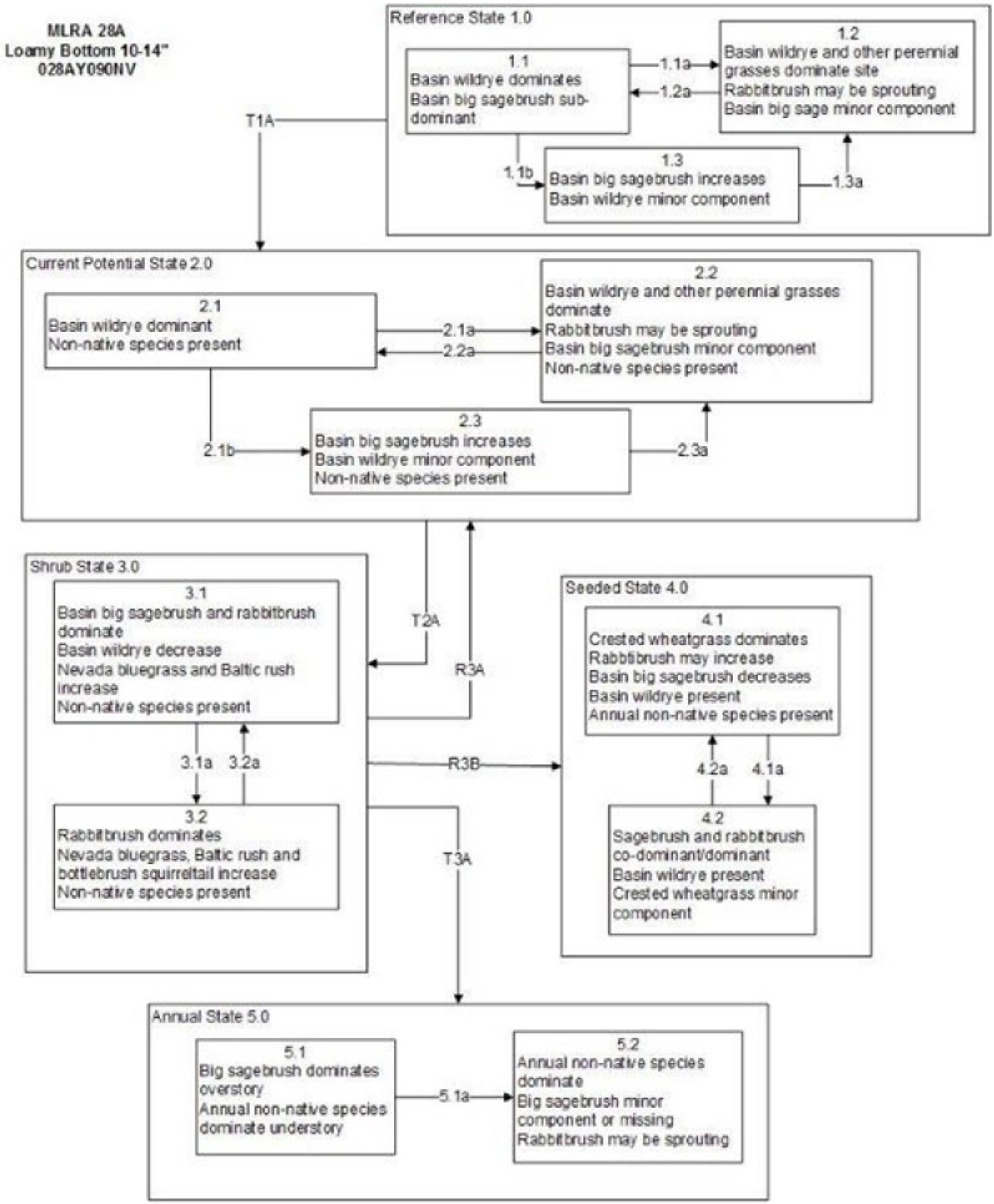

Figure 5. State and Transition Model

MLRA 28A
Loamy Bottom 10-14"
028AY090NV

Reference State 1.0 Community Phase Pathways
1.1a: Fire significantly reduces sagebrush cover and leads to early/mid-seral community, dominated by grasses and forbs. Aroga moth may cause a large die-off in sagebrush resulting in a mosaic of grass and sagebrush.
1.1b: Time and lack of disturbance such as fire. Excessive herbivory, long-term drought or combinations may also decrease perennial understory.
1.2a: Time and lack of disturbance allows for shrub regeneration.
1.3a: Fire significantly reduces sagebrush cover and leads to early/mid-seral community, dominated by grasses and forbs. Aroga moth may cause a large die-off in sagebrush resulting in a mosaic of grass and sagebrush.

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

Current Potential State 2.0 Community Phase Pathways
2.1a: Fire creates grass/sagebrush mosaic. Aroga moth may also cause a large die-off in sagebrush; non-native annual species present.
2.1b: Time and lack of disturbance such as fire. Inappropriate grazing management, long-term drought or combinations may also reduce perennial understory.
2.2a: Time and lack of disturbance allows for regeneration of sagebrush
2.3a: Fire reduces sagebrush. Aroga moth infestation may create a sagebrush/grass mosaic. Brush management with minimal soil disturbance; late-fall/winter grazing causing mechanical damage to sagebrush.

Transition T2A: Hydrologic alteration (lowering of water table i.e. gullying of associated channel), inappropriate grazing management or combinations (3.1). Fire (3.2)

Shrub State 3.0 Community Phase Pathways
3.1a: Fire and/or brush management with minimal soil disturbance
3.2a: Time and lack of disturbance (not likely to occur)

Transition T3A: Continual inappropriate grazing management and/or hydrologic alteration (i.e. gullying of associated channel) (5.1). Severe fire, and/or failed brush management and seeding (5.2)

Restoration R3A: Brush management and seeding of native species, may be coupled with restoration of channel (2.2)
Restoration R3B: Brush management with minimal soil disturbance coupled with seeding of desired species (4.1)

Seeded State 4.0 Community Phase Pathways
4.1a: Time and lack of disturbance; inappropriate grazing management may also reduce perennial understory
4.2a: Fire, brush management, and/or Aroga moth infestation.

Annual State 5.0 Community Phase Pathways
5.1a: Severe fire or failed brush treatment and seeding.

Figure 6. 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. Management should focus on maintaining high species diversity to promote site resiliency and a healthy watershed.

Community 1.1
Community Phase

This community is dominated by basin wildrye, western wheatgrass, Nevada bluegrass and basin big sagebrush. Other shrubs, forbs and other perennial grasses and grass-likes makeup smaller components. Potential vegetative composition is about 75% grasses, 5% forbs and 20% shrubs. Approximate ground cover (basal and crown) is 60 to 70 percent.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	2102	3363	5044
Shrub/Vine	560	897	1345
Forb	140	224	336
Total	**2802**	**4484**	**6725**

Community 1.2
Community Phase

This community phase is characteristic of a post-disturbance, early-seral community. Basin wildrye, Nevada bluegrass and other perennial grasses and grass-likes dominate. Rabbitbrush is present in minor amounts. Depending on fire severity or intensity of Aroga moth infestations, patches of intact sagebrush may remain.

Community 1.3
Community Phase

Sagebrush increases in the absence of disturbance. Decadent sagebrush dominates the overstory and the deep-rooted perennial bunchgrasses in the understory are reduced either from competition with shrubs and/or from herbivory.

Pathway a
Community 1.1 to 1.2

Fire will decrease or eliminate the sparse stand of sagebrush and bunchgrasses and grass-likes will remain dominant. A severe infestation of Aroga moth could also cause a large decrease in sagebrush giving a competitive advantage to the perennial grasses and forbs. Rabbitbrush will likely resprout.

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 sagebrush to increase.

Pathway a
Community 1.3 to 1.2

Fire will decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses to dominate the site. Fire will typically remove most of the sagebrush overstory. 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 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. Management would be to maintain high diversity of desired species to promote organic matter inputs and prevent the dispersal and seed production of the non-native invasive species.

Community 2.1
Community Phase

This community phase is similar to the Reference State Community Phase 1.1, with the presence of non-native species in trace amounts. Basin wildrye, western wheatgrass and Nevada bluegrass dominate the site. Forbs and other shrubs and grasses make up smaller components of this site. Potential vegetative composition is about 75% grasses, 5% forbs and 20% shrubs. Approximate ground cover (basal and crown) is 60 to 70 percent.

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 and grass-likes dominate the site. Depending on fire severity or intensity of Aroga moth infestations, patches of intact sagebrush may remain. Rabbitbrush may be sprouting. Non-native species are stable or increasing within the community.

Community 2.3
Community Phase

This community phase is at risk of crossing a threshold to another state. Sagebrush dominates the overstory and perennial bunchgrasses in the understory are reduced, either from competition with shrubs, inappropriate grazing, lowered water table or a combination of the three. Rabbitbrush may be a significant component. Nevada bluegrass may increase and become co-dominate with deep rooted bunchgrasses. Non-native species may be stable or increasing due to lack of competition with perennial bunchgrasses. This site is susceptible to further degradation from grazing, drought, and fire.

Pathway a
Community 2.1 to 2.2

Fire will decrease or eliminate the sparse stand of sagebrush and perennial bunchgrasses and grass-likes remain dominant on the site. Fire will typically remove most of the sagebrush overstory and rabbitbrush will likely resprout. A severe infestation of Aroga moth could also cause a large decrease in sagebrush giving a competitive advantage to the perennial grasses and forbs. Non-native species are likely to increase after fire.

Pathway b
Community 2.1 to 2.3

Time and lack of disturbance such as fire allows for sagebrush and rabbitbrush 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 and rabbitbrush to dominate the site. Inappropriate grazing management reduces the perennial bunchgrass understory; conversely beardless (creeping) wildrye and/or mat muhly 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 and rabbitbrush allows the shrub component to recover. The establishment of big sagebrush can take many years.

Pathway a
Community 2.3 to 2.2

Fire will decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses to dominate the site. Fire will typically remove most of the sagebrush overstory. 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. Non-native species respond well to fire and may increase post-burn.

State 3
Shrub State

This state has two community phases a decadent shrub phase and a sprouting shrub phase. This state is a product of many years of heavy grazing during time periods harmful to perennial bunchgrasses and/or hydrologic modification resulting in a lowered water table. Nevada bluegrass may become the dominant grass. Sagebrush dominates the overstory and rabbitbrush may be a significant component. Sagebrush cover exceeds site concept and may be decadent, reflecting stand maturity. The shrub overstory 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

Decadent sagebrush dominates the overstory. Rabbitbrush may be a significant component. Deep-rooted perennial bunchgrasses may be present in trace amounts or absent from the community. Nevada bluegrass and annual non-native species increase. Bare ground is significant.

Community 3.2
Community Phase

Nevada bluegrass and/or rabbitbrush dominates the site; annual non-native species may be present but are not dominant. Trace amounts of sagebrush may be present.

Pathway a
Community 3.1 to 3.2

Fire, heavy fall grazing causing mechanical damage to shrubs, and/or brush treatments with minimal soil disturbance, will greatly reduce the overstory shrubs to trace amounts and allow for creeping wildrye, mat muhly or Sandberg bluegrass to dominate the site.

Pathway a
Community 3.2 to 3.1

Time and lack of disturbance may allow sagebrush to recover.

State 4
Seeded State

This state has two community phases one that is characterized by the dominance of seeded introduced species and the other with shrubs dominating the overstory. Forage kochia and other desired seeded species including basin big sagebrush and native and non-native forbs may be present.

Community 4.1
Community Phase

Introduced bunchgrass species and other non-native species such as forage kochia dominate the community. Native and non-native seeded forbs may be present. Trace amounts of basin big sagebrush may be present, especially if seeded. Annual non-native species present.

Community 4.2
Community Phase

Basin big sagebrush and seeded wheatgrass species co-dominate. Annual non-native species stable to increasing.

Pathway a
Community 4.1 to 4.2

Inappropriate grazing management particularly during the growing season reduces perennial bunchgrass vigor and density and facilitates shrub establishment.

Pathway a
Community 4.2 to 4.1

Low severity fire, brush management, and/or Aroga moth infestation will reduce the sagebrush overstory and allow seeded wheatgrass species to become dominant.

State 5
Annual State

The Annual State is likely possible on this site, however it was not observed during field work. Johanson (2011) documented the presence of an Annual State within the Utah portion of MLRA 28A for the Loamy Bottom ecological site (R028AY006UT). Cheatgrass was found to be the dominant species along with a diverse selection of invasive forbs including Russian thistle, knapweed and various non-native thistles. State resiliency is maintained through increased fire frequency and efficient utilization of soil nitrogen (Johanson 2011). This state has two plant community phases one that is characterized by an overstory of big sagebrush and an understory dominated by cheatgrass and the other a post-fire community dominated by cheatgrass with a trace amount of shrubs. Targeted grazing could be used to reduce the annual grasses species. Range seeding may also be needed.

Community 5.1
Community Phase

Big sagebrush dominates the overstory and cheatgrass dominates the understory. Various non-native, invasive forbs may be sub-dominate.

Community 5.2
Community Phase

Cheatgrass dominates and various non-native, invasive forbs may be co-dominante. Rabbitbrush may be sprouting. Nevada bluegrass and/or rabbitbrush dominates the site; annual non-native species may be present but are not dominant. Trace amounts of sagebrush may be present.

Pathway a
Community 5.1 to 5.2

Severe fire or failed brush treatment and seeding will greatly reduce the overstory of sagebrush to trace amounts and facilitate the dominance of cheatgrass and non-native forbs.

Transition A
State 1 to 2

Trigger: This transition is caused by the introduction of non-native annual and perennial plants, such as cheatgrass, mustards, and whitetop (*Cardaria draba*). Slow variables: Over time the 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. 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 deep rooted perennial bunchgrasses, increase Sandberg bluegrass and favor shrub growth and establishment. Alteration in the hydrology of the site may also cause an increase in sagebrush; with gullying of associated channel the water table is dropped and may cause a decrease in perennial bunchgrasses. To Community Phase 3.2: Severe fire will remove sagebrush overstory, decrease perennial bunchgrasses and enhance Sandberg bluegrass. Slow variables: Long term decrease in deep-rooted perennial grass density. Threshold: Loss of deep-rooted perennial bunchgrasses changes nutrient cycling, nutrient redistribution, and reduces soil organic matter.

Restoration pathway A
State 3 to 2

Brush management such as mowing, coupled with seeding of basin wildrye. May be coupled with restoration of the water table where channel incision has occurred. Engineered structures are recommended. See USDA, NRCS National Engineering Handbook (2008).

Conservation practices

Brush Management
Range Planting

Restoration pathway B
State 3 to 4

Brush management such as mowing, coupled with seeding of deep rooted non-native bunchgrasses.

Transition A
State 3 to 5

Trigger: To Community Phase 5.1: Repeated, heavy, growing season grazing will decrease or eliminate deep rooted perennial bunchgrasses, increase cheatgrass and non-native forbs and favor shrub growth and establishment. Alteration in the hydrology of the site may also cause an increase in sagebrush; with gullying of associated channel the water table is dropped and may cause a decrease in perennial bunchgrasses. To Community Phase 5.2: Severe fire will remove sagebrush overstory and cheatgrass will be the dominate plant species. Rabbitbrush may be present. Failed brush management and seeding will also result in Community Phase 5.2. Slow variables: Long term decrease in deep-rooted perennial grass density and increase in shrub overstory. Channel incisement may be occurring. Threshold: Loss of deep-rooted perennial bunchgrasses changes nutrient cycling, 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**			3452–4439	
	basin wildrye	LECI4	*Leymus cinereus*	3138–3587	–
	western wheatgrass	PASM	*Pascopyrum smithii*	224–448	–
2	**Secondary Perennial Grasses**			90–224	
	blue grama	BOGR2	*Bouteloua gracilis*	22–90	–
	sedge	CAREX	*Carex*	22–90	–
	squirreltail	ELEL5	*Elymus elymoides*	22–90	–
	bluebunch wheatgrass	PSSPS	*Pseudoroegneria spicata ssp. spicata*	22–90	–
Forb					
3	**Perennial**			90–404	
	aster	ASTER	*Aster*	22–90	–
	lupine	LUPIN	*Lupinus*	22–90	–
	ragwort	SENEC	*Senecio*	22–90	–
Shrub/Vine					
4	**Primary Shrubs**			224–448	
	basin big sagebrush	ARTRT	*Artemisia tridentata ssp. tridentata*	224–448	–
5	**Secondary Shrubs**			56–224	
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	45–135	–
	currant	RIBES	*Ribes*	45–135	–
	Woods' rose	ROWO	*Rosa woodsii*	45–135	–
	willow	SALIX	*Salix*	45–135	–

Animal community

Livestock Interpretations:
This site is suitable for livestock grazing. Grazing management considerations include duration, intensity, frequency, and timing of grazing. If the site is dependent upon a water table supported by an associated stream channel, excessive livestock or wildlife trampling of the streamside vegetation could lead to channel morphology changes and eventual headcutting, incision or other channel instability processes. Any lowering of the water table associated with channel degradation has potential negative impacts on the associated loamy bottom plant community. 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). 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). Overgrazing leads to an increase in big sagebrush and a decline in understory plants like basin wildrye and Nevada bluegrass. 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.
Reduced bunchgrass vigor or density provides an opportunity for creeping wildrye or mat muhly expansion and/or cheatgrass and other invasive species to occupy interspaces. Creeping wildrye, so named due to its rhizomatous rooting characteristic, is tolerant of grazing and increases under grazing pressure (USDA 1937).
Western wheatgrass provides important forage for domestic sheep. Fall regrowth cures well on the stem, so western wheatgrass is good winter forage for domestic livestock.
Bluegrass is a widespread forage grass. It is one of the earliest grasses in the spring and is sought by domestic livestock and several wildlife species. Nevada bluegrass is a palatable species, but its production is closely tied to weather conditions. It produces little forage in drought years, making it a less dependable food source than other

perennial bunchgrasses.
The sagebrush / rabbitbrush component will expand with a lowering of the seasonal water table. The root length of mature sagebrush was measured to a depth of 2 meters in alluvial soils in Utah (Richards and Caldwell 1987).
Basin big sagebrush may serve as emergency food during severe winter weather, but it is not usually sought out by livestock.
Stocking rates vary over time depending upon season of use, climate variations, site, and previous and current management goals. A safe starting stocking rate is an estimated stocking rate that is fine-tuned by the client by adaptive management through the year and from year to year.

Wildlife Interpretations:
This site provides valuable wildlife habitat for a variety of species. Mountain big sagebrush occurs, often as a dominant species in shrublands or codominant species, over a range of habitats in Nevada (Tueller et al. 1979). Mountain big sagebrush is important to livestock and many wild animals for both food and cover. Mountain big sagebrush is highly preferred and nutritious winter forage for mule deer, elk and pronghorn. Elk (Alces alces) and pronghorn antelope (Antilocapra americana) prefer mountain big sagebrush over basin and Wyoming sagebrush (Beale and Smith 1970, Wambolt 1996). A study by Brown (1977) determined that desert bighorn sheep (Ovis canadensis nelisoni) preferred big sagebrush over other shrub types; however, the variety was not noted. Welch and Wagstaff (1992) noted in a study near Provo, Utah, mountain big sagebrush was highly preferred winter forage of mule deer (Odocoileus hemionus) over other available forage. Other studies have determined, in the same study area, that mountain big sagebrush is preferred by both wintering domestic sheep as well as mule deer (Welch et al. 1986).
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 mountain big sagebrush for nesting, cover and forage. Mountain 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)(Nevada Wildlife Action Plan 2012).
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).
Sagebrush communities are important for maintaining lagomorph and rodent populations. Pygmy rabbits, sagebrush obligates, use sites with big sagebrush at a higher intensity than low sagebrush sites (Heady and Laundre 2005). A study by Larrison and Johnson (1973) captured more deer mice in big sagebrush communities than in any other plant community. Although specific varieties of big sagebrush are not mentioned in these studies, thus, suggests that deer mice prefer big sagebrush plant communities where mountain big sagebrush are present, for cover over other plant communities.
It should be noted that sagebrush-grassland communities provide critical sage-grouse (Centrocercus urophaianus) 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 (Lepus californicus). Because basin wildrye remains green throughout early summer, it remains available for small mammal forage for longer time than other grasses.

Western wheatgrass and Nevada bluegrass are important forages for several wildlife species.

Hydrological functions

The typical seasonally high water table occurs at depths of 30 to 60 inches which allows for significant production of basin wildrye. In many areas, this site occurs where a channel has become entrenched lowering the water table required to support a meadow plant community. However, with further channel incisement and associated water table lowering site degradation occurs. Most Great Basin streams have been prone to incision for the past two thousand years, thus separating changes attributable to ongoing stream incision from those caused by human impact can be difficult (Chambers et al. 2004). The most direct evidence that anthropogenic disturbance has attributed to stream incision in the central Great Basin is derived from research on the effects of roads on riparian areas (Forman and Deblinger 2000; Trombulak and Frissel 2000). Assigning cause and effect to more diffuse disturbances such as livestock grazing is more difficult. In general, overuse of the riparian area by livestock can negatively affect stream bank and channel stability, and localized changes in stream morphology have been associated with heavy livestock use in the western United States (see reviews in Trimble and Mendle 1995; Belsky et al. 1999). However, data that clearly demonstrate the relationship between regional stream incision and overuse by livestock have not been collected for the Great Basin (Chambers et al. 2004). The impact of feral horse use on riparian systems is also in need of documentation. In regards to restoration and management it is important to recognize that particular streams have a greater sensitivity to both natural and management disturbances. For further guidance see Chambers et al. (2004), Rosgen (2006), or USDA, NRCS Stream Visual Assessment Protocol (1998).

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 Americans used the bark of big sagebrush to make rope and baskets. 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. 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. Western wheatgrass is a good soil binder and is well suited for reclamation of disturbed sites such as erosion control and soil stabilization.

Type locality

Location 1: White Pine County, NV	
Township/Range/Section	T21N R68E S13
Latitude	39° 41′ 46″
Longitude	114° 14′ 17″
General legal description	SE¼ Grass Valley Canyon area, southeast Antelope Valley, White Pine County, Nevada.

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Rangeland health reference sheet

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

Author(s)/participant(s)	P.Novak-Echenique
Contact for lead author	State Rangeland Management Specialist
Date	05/22/2015
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rills are not present. This site is nearly level and rills typically do not form.

2. **Presence of water flow patterns:** Water flow patterns are few and will typically occur after the site has been flooded during spring runoff or summer convection storms. Flow patterns are meandering and may be fairly long (up to 20 ft), but are less than 6 inches wide and are widely spaced (5-10 ft).

3. **Number and height of erosional pedestals or terracettes:** Pedestals are few and typically occur in flow paths. Terracettes are none to rare and would be small and stable.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare Ground ± 10-20%.

5. **Number of gullies and erosion associated with gullies:** Gullies may be present but are rare. They would occur on the lowest part of the site where flows concentrate. There may be active erosion on the side walls, but the bottoms would be stabilized with perennial vegetation.

6. **Extent of wind scoured, blowouts and/or depositional areas:** None

7. **Amount of litter movement (describe size and distance expected to travel):** Fine litter (foliage 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 large 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 4 to 6, with higher numbers under canopy.

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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 moderate to weak subangular blocky. Soil surface colors are dark grayish browns and the soils have thick mollic epipedons. Surface textures are loams. Organic matter can range from 2 to 4 percent for much of the upper 20 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 grasses 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 snow 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 – Subsurface subangular blocky 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: Tall-statured, deep-rooted, cool season, perennial bunchgrasses >>

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

    Other:

    Additional: With an extended fire return interval or water table drawdown 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; dead grass material may be as much as 25% of total canopy.

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14. **Average percent litter cover (%) and depth (in):** Between plant interspaces (± 50%) and litter depth is ±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 (through June) ± 4000 lbs/ac; Favorable years ±6000 lbs/ac and

unfavorable years ±2500 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 cheatgrass, Russian thistle, whitetop, saltcedar, and thistles.

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17. **Perennial plant reproductive capability:** All functional groups should reproduce in most years. Reduced growth and reproduction occur during extreme or extended drought periods.
