# Ecological site R028AY120NV
# CLAY HUMMOCKS

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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.

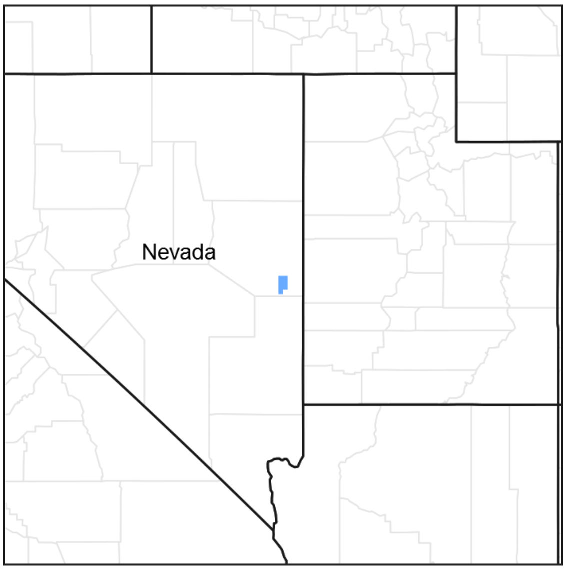


**Figure 1. Mapped extent**

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 is located in areas of mounded, or "hummocky", micro-relief on lakeplain terraces. Hummocks, or mounds, occupy about 75% of the total area and occur in a random association with the inter-mound, flat to concave, portions of the site. Slopes range from 0 to 4 percent. Elevations are from 5,400 feet to about 6,000 feet.

The climate associated with this site is semiarid, characterized by cool, moist winters and warm, dry summers. Average annual precipitation is 5 to 8 inches. Mean annual air temperature ranges from 45 to 50 degrees F. The average growing season is about 100 to 120 days.

The soils of this site are very deep and moderately well drained. Capillary rise of moisture fed by a ground water table fluctuates between 3 feet (inter-mound) and 5 feet (hummocks) of the soil surface. Surface soils are silty clay loams and have a strong granular structure. Infiltration of water is rapid when the surface soils are dry. Once the surface soils are wetted, intake rates slow and run-off from the hummock areas is rapid. Inter-mound positions receive additional moisture as run-in from the surrounding mounded areas and may be ponded for short periods in the late winter and spring. The fine textured subsoils have formed in lacustrine sediments. Soil reaction is moderately to strongly alkaline. The soils have a relatively high amount of gypsum which tends to reduce soil salinity.

The reference state is dominated by basin wildrye and black greasewood. Shadscale is an important shrub associated with this ecological site. Production ranges from 600 to 1600 pounds per acre.

## Associated sites

| | |
|---|---|
| R028BY004NV | **SALINE BOTTOM**<br>Saline Bottom |
| R028BY020NV | **SODIC FLAT 5-8 P.Z.**<br>Sodic Flat 5-8" PZ |
| R028BY074NV | **SODIC TERRACE 5-8 P.Z.**<br>Sodic Terrace 5-8" PZ |

## Similar sites

| | |
|---|---|
| R028AY024NV | **SODIC TERRACE 5-8 P.Z.**<br>Sodic Terrace 5-8" PZ. Less productive site; SPAI dominant grass. |
| R028AY103NV | **SHALLOW SODIC TERRACE 5-8 P.Z.**<br>Shallow Sodic Terrace 5-8" PZ. Less productive site; SAVE4 dominant plant. |
| R028BY101NV | **CLAY DUNE**<br>Clay Dune. SPAI & DISP codominant grasses; occurs on dune landform. |
| R028BY020NV | **SODIC FLAT 5-8 P.Z.**<br>Sodic Flat 5-8" PZ. Less productive site. |
| R028AY106NV | **SALINE BOTTOM**<br>Saline Bottom. More productive site; DISP & SPAI important grasses. |

**Table 1. Dominant plant species**

| | |
|---|---|
| Tree | Not specified |
| Shrub | (1) *Sarcobatus vermiculatus* |
| Herbaceous | (1) *Leymus cinereus* |

## Physiographic features

This site is located in areas of mounded, or "hummocky", micro-relief on lake plains, basin floors and alluvial flats. Hummocks, or mounds, occupy about 75% of the total area and occur in a random association with the inter-mound, flat to concave, portions of the site. Slopes range from 0 to 4 percent. Elevations are from 5400 feet to about 6000 feet.

**Table 2. Representative physiographic features**

| | |
|---|---|
| Landforms | (1) Lake plain<br>(2) Basin floor<br>(3) Alluvial flat |
| Ponding duration | Very brief (4 to 48 hours) to long (7 to 30 days) |
| Ponding frequency | None to occasional |
| Elevation | 1,646–1,829 m |
| Slope | 0–4% |
| Ponding depth | 0–15 cm |
| Water table depth | 107–152 cm |
| Aspect | Aspect is not a significant factor |

## Climatic features

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

The climate associated with this site is semiarid, characterized by cool, moist winters and warm, dry summers. Average annual precipitation is 5 to 8 inches. Mean annual air temperature is 45 to 50 degrees F. The average growing season is about 100 to 120 days.

Mean annual precipitaion at the LUND, NEVADA climate station (264745) is 10.04 inches.

January 0.78; February 0.85; March 1; April 0.98:
May 0.95; June 0.82; July 0.69; August 0.87;
September 0.77; October 0.92;
November 0.69; December 0.73.

**Table 3. Representative climatic features**

| | |
|---|---|
| Frost-free period (average) | 0 days |
| Freeze-free period (average) | 110 days |
| Precipitation total (average) | 178 mm |

## Influencing water features

This site receives additional moisture as run-in from adjacent landscapes.

## Soil features

The soils of this site are very deep and moderately well drained. Capillary rise of moisture fed by a ground water table fluctuates between 3 feet (inter-mound) and 5 feet (hummocks) of the soil surface. Surface soils are silty clay loams and have a strong granular structure. Infiltration of water is rapid when the surface soils are dry. Once the surface soils are wetted, intake rates slow and run-off from the hummock areas is rapid. Inter-mound positions receive additional moisture as run-in from the surrounding mounded areas and may be ponded for short periods in the late winter and spring. The fine textured subsoils have formed in lacustrine sediments. Soil reaction is strongly alkaline to very strongly alkaline. The soils have a relatively high amount of gypsum which tends to reduce soil salinity. The soil series associated with this site include: Ewelac.

The representative soil component is Ewelac (SS NV779 MU 3500), classified as a fine, smectitic, mesic Vertic Haplocambid. Diagnostic horizons include an ochric epipedon from the soil surface to 7 inches, and a cambic horizon from 5 to 28 inches. Soil texture is silty clay throughout the profile. Clay content in the particle control section averages 35 to 50 percent. Reaction is strongly alkaline or very strongly alkaline. Effervescence is violently effervescent. Lithology consists of lacustrine deposits.

**Table 4. Representative soil features**

| | |
|---|---|
| Surface texture | (1) Silty clay<br>(2) Silt loam |
| Family particle size | (1) Clayey |
| Drainage class | Moderately well drained |
| Permeability class | Slow |
| Soil depth | 152–213 cm |
| Surface fragment cover <=3" | 0% |
| Surface fragment cover >3" | 0% |
| Available water capacity (0-101.6cm) | 15.75–16 cm |
| Calcium carbonate equivalent (0-101.6cm) | 25–35% |
| Electrical conductivity (0-101.6cm) | 0–16 mmhos/cm |
| Sodium adsorption ratio (0-101.6cm) | 46–90 |
| Soil reaction (1:1 water) (0-101.6cm) | 8.8–9.6 |
| 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 has a set of key characteristics that influence a site's resilience to disturbance and resistance to invasives. Key characteristics include 1) climate (precipitation, temperature), 2) topography (aspect, slope, elevation, and landform), 3) hydrology (infiltration, runoff), 4) soils (depth, texture, structure, organic matter), 5) plant communities (functional groups, productivity), and 6) natural disturbance regime (fire, herbivory, etc.) (Caudle et al 2013). Biotic factors that influence resilience include site productivity, species composition and structure, and population regulation and regeneration (Chambers et al. 2013).
This ecological site is dominated by basin wildrye, a cool-season perennial grass. Black greasewood dominates the overstory.
Black greasewood is classified as a phreatophyte (Eddleman 2002), and its distribution is well correlated with the distribution of groundwater (Mozingo 1987). Meinzer (1927) discovered that the taproots of black greasewood could penetrate from 20 to 57 feet below the surface. Romo (1984) found water tables ranging from 3.5 to 15 m under black greasewood dominated communities in Oregon. Black greasewood stands develop best where moisture is readily available, either from surface or subsurface runoff (Brown 1965). It is commonly found on floodplains that are either subject to periodic flooding, have a high water table at least part of the year, or have a water table less than 34 feet deep (Harr and Price 1972, Blauer et al. 1976, Branson et al. 1976, Blaisdell and Holmgren 1984, Eddleman 2002). Ganskopp (1986) reported that water tables within 9.8 to 11.8 inches of the surface had no effect on black greasewood in Oregon. However, a study, conducted in California, found that black greasewood did not survive six months of continuous flooding (Groeneveld and Crowley 1988, Groeneveld 1990). Black greasewood is a deep-rooted shrub with lateral roots near the soil surface; the maximum rooting depth can be determined by the depth to a saturated zone (Harr and Price 1972).

Seasonally high water tables have been found necessary for maintenance of productivity and reestablishment of basin wildrye 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 or water pumping will decrease basin wildrye production and establishment while black greasewood, rabbitbrush, inland saltgrass and invasive weeds will increase. Drought will initially cause a decline in bunchgrasses. Prolonged drought will cause a decline in shrubs, including shadscale and black greasewood, while annual weedy species and bare ground will increase. Shadscale is less adapted to drought than many of its common associates (Vest 1962, Holmgren and Hutchings 1972), showing high mortality during periods of prolonged drought (Schultz and Ostler 1995). Tolerance to drought is achieved through partial shedding of leaves; this reduces water loss during severe moisture stress (Lei 1999).

As site condition deteriorates, this site may become a pure stand of black greasewood or a pure stand with an annual understory. A lowering of the water table can occur with groundwater pumping and this may contribute to the loss of deep-rooted species such as greasewood and basin wildrye and an increase in rabbitbrush, shadscale and other species that are not groundwater dependent.

This ecological site has moderate resilience to disturbance and resistance to invasion. The primary disturbance is extended drought or other disturbance leading to lowering of the 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 black greasewood and rabbitbrush. Three possible stable states have been identified for this site.

Fire Ecology:
Fire was a rare disturbance in salt-desert shrub communities and likely occurred in years with above average production. Natural fire return intervals are estimated to vary between less than 35 to 100+ years in salt-desert ecosystems with basin wildrye (Paysen et al. 2000). Historically, black greasewood-saltbush communities had sparse understories and bare soil in intershrub spaces, making these communities somewhat resistant to fire (Young 1983, Paysen et al. 2000). They may burn only during high fire hazard conditions; for example, years with high precipitation can result in almost continuous fine fuels, increasing fire hazard (West 1994, Paysen et al. 2000).

Black greasewood may be killed by severe fires, but can resprout after low to moderate severity fires (Robertson 1983, West 1994). Sheeter (1969) reported that following a Nevada wildfire, black greasewood sprouts reached approximately 2.5 feet within three years. Grazing and other disturbances may result in increased biomass production due to sprouting and increased seed production, which may also lead to greater fuel loads (Sanderson and Stutz 1994). Higher production sites will experience fire more frequently than lower production sites.

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) reports fall and spring burning increased total shoot and reproductive shoot densities in the first year, although live basal areas were similar between burn and unburned plants. By year two, there was little difference between burned and control treatments.

Indian ricegrass is a deep-rooted, cool season perennial bunchgrass that is adapted primarily to sandy soils. It is fairly fire tolerant (Wright 1985), likely due to its low culm density and below ground plant crowns. Vallentine (1989) cites several studies in the sagebrush zone that classified Indian ricegrass as being slightly damaged from late summer burning. Indian ricegrass has also been found to reestablish on burned sites through seed dispersed from adjacent unburned areas (Young 1983, West 1994). Thus the presence of surviving, seed producing plants facilitates the reestablishment of Indian ricegrass. Grazing management following fire to promote seed production and establishment of seedlings is important.

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

## State and transition model

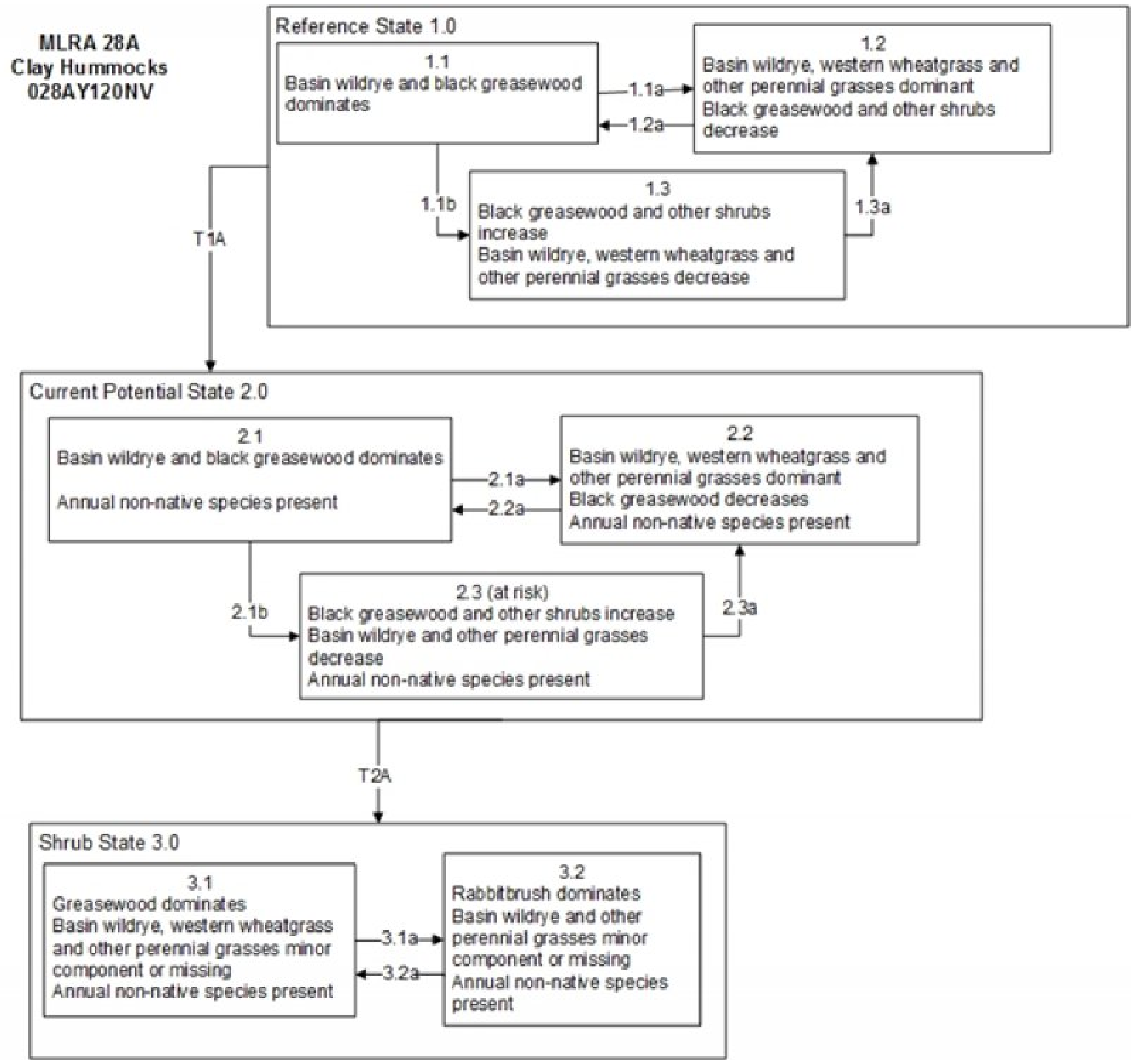


**Figure 5. T. Stringham 2/2015**

MLRA 28A
Clay Hummocks
028AY120NV

Reference State 1.0 Community Pathways
1.1a: Low severity fire resulting in a mosaic pattern.
1.1b: Time and lack of disturbance such as fire, long-term drought, herbivory, or combinations of these.
1.2a: Time and lack of disturbance such as fire, long-term drought, herbivory, or combinations of these.
1.3a: Fire significantly reduces shrub cover.

Transition T1A: Introduction of non-native plants.

Current Potential State 2.0 Community Pathways:
2.1a: Fire or brush treatments (i.e. mowing) with minimal soil disturbance.
2.1b: Time and lack of disturbance such as fire, long-term drought, inappropriate grazing management, or combinations of these.
2.2a: Time and lack of disturbance such as fire, long-term drought, inappropriate grazing management, or combinations of these.
2.3a: Heavy late fall/winter grazing causing mechanical damage to shrubs and/or brush treatment with minimal soil disturbance and/or fire.

Transition T2A: Time and lack of disturbance and/or inappropriate grazing management would reduce the perennial understory(3.1). Severe fire, lowering of water table from groundwater pumping and/or soil disturbing brush treatments (3.2)

Shrub State 3.0 Community Phase Pathways
3.1a: Long-term drought and/or lowering of the water table due to groundwater pumping and/or severe fire.
3.2a: Release of drought and/or grazing pressure may allow for black greasewood and perennial bunchgrasses to increase

**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.

## Community 1.1
## Community Phase

This community is dominated by basin wildrye and black greasewood. Shadscale, rubber rabbitbrush and other shrubs make up minor components. Potential vegetative composition is about 75% grasses, 20% shrubs, and up to 5% forbs. Approximate ground cover (basal and crown) is 15 to 30 percent.

**Table 5. Annual production by plant type**

| Plant Type | Low (Kg/Hectare) | Representative Value (Kg/Hectare) | High (Kg/Hectare) |
|---|---|---|---|
| Grass/Grasslike | 504 | 757 | 1345 |
| Shrub/Vine | 135 | 202 | 359 |
| Forb | 34 | 50 | 90 |
| **Total** | **673** | **1009** | **1794** |

## Community 1.2
## Community Phase

This community phase is characteristic of a post-disturbance, early-seral community phase. Basin wildrye dominates the community. Black greasewood will decrease but will likely sprout and return to pre-burn levels within a few years. Early colonizers such as rabbitbrush and shadscale may increase.

### Community 1.3
### Community Phase

Black greasewood and shadscale increase in the absence of disturbance. Decadent shrubs dominate the overstory and deep-rooted perennial bunchgrasses in the understory are reduced either from competition with shrubs, herbivory, drought or combinations of these.

### Pathway a
### Community 1.1 to 1.2

A low severity fire would decrease the overstory of black greasewood and allow for the understory perennial grasses to increase. Fires are typically low severity resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring facilitating an increase in fine fuels may be more severe and reduce black greasewood cover to trace amounts.

### Pathway b
### Community 1.1 to 1.3

Absence of disturbance over time, significant herbivory, chronic drought or combinations of these would allow the black greasewood overstory to increase and dominate the site. This will generally cause a reduction in perennial bunch grasses; however inland saltgrass may increase in the understory depending on the timing and intensity of herbivory. Heavy spring utilization will favor an increase in black greasewood.

### Pathway a
### Community 1.3 to 1.2

Fire will decrease the overstory of black greasewood and allow for the perennial bunchgrasses to dominate the site. Fires are typically high severity in this phase due to the dominance of black greasewood resulting in removal of the overstory shrub community.

### 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.

### Community 2.1
### Community Phase

This community phase is compositionally similar to the Reference State Community Phase 1.1 with the presence of non-native species in trace amounts. This community is dominated by basin wildrye and black greasewood. Shadscale, rubber rabbitbrush and other shrubs comprise the minor components. Non-native annual species such as halogeton and cheatgrass are present in minor amounts. Potential vegetative composition is approximately 75% grasses, 5% forbs and 20% shrubs.

### Community 2.2

### Community Phase

This community phase is characteristic of a post-disturbance, early-seral community where annual non-native species are present. Basin wildrye dominates the site. Depending on fire severity patches of intact shrubs may remain. Black greasewood and rabbitbrush may be sprouting. Annual non-native species are stable to increasing in the community.

### Community 2.3
### Community Phase (at risk)

Black greasewood dominates the overstory and perennial bunchgrasses in the understory are reduced, either from competition with shrubs or from inappropriate grazing, or from both. Rabbitbrush may be a significant component. Annual non-native species are stable or increasing. This community is at risk of crossing a threshold to State 3.0 (grazing or fire).

### Pathway a
### Community 2.1 to 2.2

A low severity fire would decrease the overstory of black greasewood and allow for the understory perennial grasses to increase. 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 black sagebrush cover to trace amounts. Brush treatments with minimal soil disturbance may also reduce black greasewood and allow for perennial bunchgrasses to increase. Annual non-native species are likely to increase after fire.

### Pathway b
### Community 2.1 to 2.3

Absence of disturbance over time, chronic drought, inappropriate grazing management or combinations of these would allow the black greasewood overstory to increase and dominate the site. Inappropriate grazing management reduces the perennial bunchgrass understory; conversely inland saltgrass may increase in the understory.

### Pathway a
### Community 2.2 to 2.1

Absence of disturbance over time, drought and/or grazing management that favors the establishment and growth of black greasewood allows the shrub component to recover.

### Pathway a
### Community 2.3 to 2.2

Grazing management that reduces shrubs will allow for the perennial bunchgrasses in the understory to increase. Heavy late-fall/winter grazing may cause mechanical damage to black greasewood promoting the perennial bunchgrass understory. Brush treatments with minimal soil disturbance will also decrease greasewood and release the perennial understory. Fires may be high severity due to the dominance of black greasewood in this community phase; a fire would decrease the shrub overstory and may allow for an increase in perennial bunchgrasses. Annual non-native species are present and may increase in the community.

### State 3
### Shrub State

This state has two community phases, one that is characterized by a dominance of black greasewood overstory and the other with a rabbitbrush overstory. This site has crossed a biotic and abiotic threshold and site processes are being controlled by shrubs. Bare ground has increased.

### Community 3.1
### Community Phase

Black greasewood dominates the overstory. Rabbitbrush may be a significant component. Deep-rooted perennial bunchgrasses such as basin wildrye have significantly declined. Annual non-native species increase. Bare ground is significant.

### Community 3.2
### Community Phase

**Figure 8. T. Stringham 4/2013, NV779 MU3509**

Rabbitbrush dominates the site. Perennial bunchgrasses are present but a minor component. Annual non-native species are present and may be increasing in the understory.

### Pathway a
### Community 3.1 to 3.2

Drought and/or lowering of water table by groundwater pumping would reduce black greasewood and allow for rabbitbrush and other shrubs on the site to dominate. Severe fire would also reduce black greasewood overstory and allow for an increase rabbitbrush.

### Pathway a
### Community 3.2 to 3.1

Release from drought and/or grazing pressure may allow for black greasewood, basin wildrye and other perennial bunchgrasses to increase.

### Transition A
### State 1 to 2

Trigger: Introduction of non-native annual plants. Slow variables: Over time the annual non-native plants will increase within the community. Threshold: Any amount of introduced non-native species causes an immediate decrease in the resilience of the site. Annual non-native species cannot be easily removed from the system and have the potential to significantly alter disturbance regimes from their historic range of variation.

### Transition A
### State 2 to 3

Trigger: To Community Phase 3.1: Inappropriate cattle/horse grazing will decrease or eliminate deep rooted perennial bunchgrasses and favor shrub growth and establishment. To Community Phase 3.2: Severe fire will reduce and/or eliminate black greasewood overstory and decrease perennial bunchgrasses. Soil disturbing brush treatments will reduce black greasewood and possibly increase non-native annual species. Lowering of the water table due to groundwater pumping will also decrease black greasewood and allow for rabbitbrush and other shrubs to increase. Slow variables: Long term decrease in deep-rooted perennial grass density and/or black greasewood. Threshold: Loss of deep-rooted perennial bunchgrasses changes nutrient cycling, nutrient redistribution, and reduces soil organic matter. Loss of long-lived, black greasewood changes the temporal and depending on the replacement shrub, the spatial distribution of nutrient cycling. Slow variables: Long term decrease in deep-rooted perennial grass density and/or black greasewood. Threshold: Loss of deep-rooted perennial bunchgrasses changes nutrient cycling, nutrient redistribution, and reduces soil organic matter. Loss of long-lived, black greasewood changes the temporal and depending on the replacement shrub, the spatial distribution of nutrient cycling.

## Additional community tables

**Table 6. Community 1.1 plant community composition**

| Group | Common Name | Symbol | Scientific Name | Annual Production (Kg/Hectare) | Foliar Cover (%) |
|---|---|---|---|---|---|
| **Grass/Grasslike** | | | | | |
| 1 | **Primary Perennial Grasses** | | | 706–857 | |
| | basin wildrye | LECI4 | *Leymus cinereus* | 706–857 | – |
| 2 | **Secondary Perennial Grasses** | | | 20–81 | |
| | Indian ricegrass | ACHY | *Achnatherum hymenoides* | 6–30 | – |
| | squirreltail | ELEL5 | *Elymus elymoides* | 6–30 | – |
| | western wheatgrass | PASM | *Pascopyrum smithii* | 6–30 | – |
| **Forb** | | | | | |
| 3 | **Perennial Forbs** | | | 1–50 | |
| | milkvetch | ASTRA | *Astragalus* | 6–20 | – |
| 4 | **Annual Forbs** | | | 1–20 | |
| | bird's-beak | CORDY | *Cordylanthus* | 1–10 | – |
| **Shrub/Vine** | | | | | |
| 5 | **Primary Perennial Shrubs** | | | 121–282 | |
| | greasewood | SAVE4 | *Sarcobatus vermiculatus* | 101–202 | – |
| | shadscale saltbush | ATCO | *Atriplex confertifolia* | 20–81 | – |
| 6 | **Secondary Perennial Shrubs** | | | 1–50 | |
| | big sagebrush | ARTR2 | *Artemisia tridentata* | 11–30 | – |
| | rubber rabbitbrush | ERNA10 | *Ericameria nauseosa* | 11–30 | – |

## Animal community

Livestock Interpretations:
This site is suited for livestock grazing. Grazing management considerations include timing, intensity, frequency, and duration of grazing.
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). Basin wildrye is intolerant of heavy or repeated grazing, especially if grazed before reaching maturity. 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. Less palatable species such as black greasewood, rabbitbrush and inland salt grass increased in dominance along with invasive non-native species such as povertyweed, Russian thistle, 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 and black greasewood, along with inland saltgrass and non-native weeds (Young et al. 1976, Roundy 1985). Additionally, natural 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 suggesting that establishment of natural 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.
Black greasewood is an important winter browse plant for domestic sheep and cattle. Black greasewood may

increase in response to grazing. Removal of competition can dramatically increase growth rates and total leader length of black greasewood. Black greasewood is considered an important browse species for wildlife and livestock. In a study by Smith et al. (1992), utilization of new growth on greasewood shrubs by cattle was 77 percent in summer, and greasewood was found to have the highest amounts of crude protein when compared to perennial and annual grasses. Black greasewood plants have been found to contain high amounts of sodium and potassium oxalates which are toxic to livestock and caution should be taken when grazing these communities. These shrubs can be used lightly in the spring as long as there is a substantial amount of other preferable forage available (Benson et al. 2011).

Shadscale is a valuable browse species for a wide variety of wildlife and livestock (Blaisdell and Holmgren 1984). The spinescent growth habit of shadscale lends to its browsing tolerance with no more than 15 to 20% utilization by sheep being reported (Blaisdell and Holmgren 1984) and significantly less utilization by cattle. Increased presence of shadscale within grazed versus ungrazed areas is generally a result of the decreased competition from more heavily browsed associates (Cibils et al. 1998). Reduced competition from more palatable species in heavily grazed areas may increase shadscale germination and establishment. Chambers and Norton (1993) found shadscale establishment higher under spring than winter browsing as well as heavy compared to light browsing ($p<0.01$). During years of below average precipitation, shadscale has been found very susceptible to grazing pressure regardless of season (Chambers and Norton 1993).

Bottlebrush squirreltail is very palatable winter forage for domestic sheep of Intermountain ranges. Domestic sheep relish the green foliage. Overall, bottlebrush squirreltail is considered moderately palatable to livestock. Shadscale is a valuable browse species, providing a source of palatable, nutritious forage for a wide variety of 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:

Salt-desert shrub communities provide valuable habitat for a number of species. Black greasewood also provides good cover for wildlife species (Benson et al. 2011).

Black greasewood dominates the salt desert shrub-type habitat, generally bordering areas that are dominated by sagebrush species. Black greasewood is an important winter cover and browse plant for wildlife. (Nevada Wildlife Action Plan 2012, Dayton 1931, Austin and Hash 1988, Johnson 1979).

Ungulates, such as pronghorns (Antilocapra americana), browse black greasewood. Trace amounts of black greasewood were identified in the feces of pronghorn (seasonal preference was not determined) in a microhistology study by Johnson (1979). Furthermore, pronghorn and mule deer that occurred in greasewood habitat, utilized greasewood for cover, although the study did not determine if black greasewood was a desirable forage (Hanley and Hanley 1982). Other studies indicated that although mule deer (Odocoileus hemionus) and pronghorn do not prefer black greasewood as forage, the ungulates use black greasewood habitat as cover (Oedekoven and Lindzey 1987). Small mammals will also utilize black greasewood. For example, trace amounts of black greasewood were identified in the feces of black-tailed jack rabbits (Lepus californicus), seasonal preference was not determined (Johnson 1979). A study in the Great Basin by Feldhamer (1979) found that pocket mice (Perognathus parvus) and chipmunk (Tamius spp.) populations were restricted to plant communities dominated by black greasewood. Furthermore, black greasewood habitat is documented as used in minor amounts by other small mammals including voles, chipmunks, porcupines (Erethizon dorsatum), and raccoons (Procyon lotor) (Anderson 2004) Soils of this habitat tend to be loose and either sandy or gravelly and are often easy to dig making them attractive to species such as the pale kangaroo mouse (Microdipodops pallidus) (Nevada Wildlife Action Plan 2012). This habitat is also an important feeding ground for pallid bats (Antrozous pallidus), which eat scorpions and other large invertebrates off its exposed desert flats (Nevada Wildlife Action Plan 2012).

Black greasewood provides cover and nest sites for several species of birds. Bird species, such as the sage sparrow (Amphispiza belli) and lark buntings (Calamospiza melanocorys), are known to utilize black grease wood habitat (Wiens and Rotenberry 1981). The loggerhead shrike (Lanius ludovicianus) will use black greasewood for nesting and cover. Burrowing owls (Athene cunicularia) will use the loose soils for burrowing. Bald eagles (Haliaeetus leucocephalus) and prairie falcons (Falco mexicanus) winter in the valley bottoms where black greasewood occurs, preying on jack rabbits, and other rodents Nevada Wildlife Action Plan 2012).

Reptiles and amphibians also occur in black greasewood habitats. Western rattle snakes (Crotalus viridis) and gopher snakes (Pituophis catenifer) were recorded in greasewood habitat in a study by Diller and Johnson (1988). Reptile species including: eastern racers (Coluber constrictor), ringneck snakes (Diadophis punctatus), night snakes (Hypsiglena torquata), Sonoran mountain kingsnakes (Lampropeltis pyromelana), striped whipsnakes (Masticophis taeniatus), long-nosed snakes (Rhinocheilus lecontei), wandering gartersnakes (Thamnophis elegans vagrans), sidewinders (Crotalus cerastes), Great Basin rattlesnakes (Crotalus oreganus), Great Basin collared lizard (Crotaphytus bicinctores), long-nosed leopard lizard (Gambelia wislizenii), short-horned lizard (Phrynosoma hernandesi), desert-horned lizard (Phrynosoma platyrhinos), western fence lizards (Sceloporus occidentalis), northern side-blotched lizards (Uta stansburiana nevadensis), banded gecko (Coleonyx variegatus), desert iguana (Dipsosaurus dorsalis), zebra-tailed lizard (Callisaurus draconoides), pigmy horned-lizard (Phrynosoma douglasii), desert night lizard (Xantusia vigilis), whip-tailed lizard (Aspidoscelis uniparens) and western skinks (Plestiodon skiltonianus) occur in areas where black greasewood habitat is prominent. 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), California toads (Anaxyrus boreas halophilus), Amargosa toads (Anaxyrus nelsoni), great plains toads (Anaxyrus cognatus), Sonoran toads (Anaxyrus alvarius), red-spotted toads (Anaxyrus punctatus) and mountain toad (Anaxyrus cavifrons), also occur throughout the Great Basin in areas where black greasewood is dominant (Hamilton 2004).

Shadscale is a valuable browse species, providing a source of palatable, nutritious forage for a wide variety of wildlife particularly during spring and summer before the hardening of spiny twigs. It supplies browse, seed, and cover for birds, small mammals, rabbits, deer, and pronghorn antelope. Black greasewood is an important winter browse plant for big game animals and a food source for many other wildlife species. It also receives light to moderate use by mule deer and pronghorn during spring and summer months. Budsage is palatable, nutritious forage for upland game birds, small game and big game in winter. Budsage is rated as "regularly, frequently, or moderately taken" by mule deer in Nevada in winter and is utilized by bighorn sheep in summer, but the importance of budsage in the diet of bighorns is not known. Bud sage comprises 18 – 35% of a pronghorn's diet during the spring where it is available. Chukar will utilize the leaves and seeds of bud sage. Budsage is highly susceptible to effects of browsing. It decreases under browsing due to year-long palatability of its buds and is particularly susceptible to browsing in the spring when it is physiologically most active.

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.

Indian ricegrass is eaten by pronghorn in "moderate" amounts whenever available. In Nevada it is consumed by desert bighorns. A number of heteromyid rodents inhabiting desert rangelands show preference for seed of Indian ricegrass. Indian ricegrass is an important component of jackrabbit diets in spring and summer. In Nevada, Indian ricegrass may even dominate jackrabbit diets during the spring through early summer months. Indian ricegrass seed provides food for many species of birds. Doves, for example, eat large amounts of shattered Indian ricegrass seed lying on the ground.

Bottlebrush squirreltail is a dietary component of several wildlife species. Bottlebrush squirreltail may provide forage for mule deer and pronghorn.

## Hydrological functions

Runoff is medium to high. Permeability is slow. Hydrologic soil group is D. Flow patterns are none to rare. A few may occur in the intermound areas after summer convection storms or rapid snowmelt. These are short (<1m), meandering and not connected. This site may be ponded for brief periods during the winter and after summer convection storms. Shrub canopy and associated litter break raindrop impact and provide opportunity for snow capture on this site. Deep-rooted, perennial grasses (basin wildrye) enhance infiltration and reduce runoff.

## 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 suitable for camping and hiking and has potential for upland and big game hunting.

## Other products

Basin wildrye was used as bedding for various Native American ceremonies, providing a cool place for dancers to stand. The leaves, seeds and stems of black greasewood are edible. Seeds of shadscale were used by Native Americans for bread and mush.

## Other information

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. Black greasewood is useful for stabilizing soil on wind-blown areas. It successfully revegetates eroded areas and sites too saline for most plant species.

## Type locality

| Location 1: White Pine County, NV | |
|---|---|
| Township/Range/Section | T11N R67E S29 |
| UTM zone | N |
| UTM northing | 4296858 |
| UTM easting | 0718839 |
| Latitude | 38° 47′ 36″ |
| Longitude | -114° 28′ 48″ |
| General legal description | About 5 miles southwest of Shoshone, east of Hwy 93, Spring Valley area, White Pine County, Nevada. |

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## Contributors

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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 | 12/08/2015 |
| Approved by | |
| Approval date | |
| Composition (Indicators 10 and 12) based on | Annual Production |

## Indicators

1. **Number and extent of rills:** This site is nearly level and rills are non-existent on this site.

2. **Presence of water flow patterns:** Flow patterns are none to rare. A few may occur in the intermound areas after summer convection storms or rapid snowmelt. These are short (<1m), meandering and not connected.

3. **Number and height of erosional pedestals or terracettes:** Pedestals are none to rare with occurrence typically limited to areas within water flow paths. Terracettes are non-existent.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground 40-50%

5. **Number of gullies and erosion associated with gullies:** Typically none. A few, small gullies may occur in intermound areas where run-in is received from adjacent landscapes.

6. **Extent of wind scoured, blowouts and/or depositional areas:** Slight wind-scouring occurs in the intermound areas which provides additional sediment to the mounded areas.

7. **Amount of litter movement (describe size and distance expected to travel):** Fine litter (foliage from grasses and annual & perennial forbs) expected to move distance of slope length during intense summer convection storms or rapid snowmelt events. Persistent litter (large woody material) will remain in place except during large rainfall events.

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil stability values should be 3 to 6 on most soil textures found on this site.

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Surface structure is typically fine to medium subangular blocky. Soil surface colors are dark grayish browns and soils are typified by an ochric epipedon. Surface textures are silt clays. Organic matter of the surface 2 to 3 inches is less than 5 percent. Where the soil surface in not vegetated, the surface is highly dispersed and contains powdery white crystalline salt accumulations at a depth of 8 to 13 cm below the surface.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Shrub canopy and associated litter break raindrop impact and provide opportunity for snow capture on this site. Deep-rooted, perennial grasses (basin wildrye) enhance infiltration and reduce runoff.

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** Compacted layers are none. Platy or massive sub-surface horizons are not to be interpreted as compacted layers.

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

    Dominant: Reference State: Deep-rooted, cool season perennial bunchgrasses (basin wildrye) >

    Sub-dominant: tall salt-desert shrubs (black greasewood)> associated shrubs > deep-rooted cool season perennial forbs

    Other: Others: cool season rhizomatous grasses and annual forbs.

    Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Dead branches within individual shrubs common and standing dead shrub canopy material may be as much as 35% of total woody canopy; mature bunchgrasses commonly (±25%) have dead centers.

14. **Average percent litter cover (%) and depth ( in):** Between plant interspaces (20-30%) and depth (< ¼ in.)

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** For normal or average growing season (thru June) ± 900 lbs/ac; Favorable years ±1600 lbs/ac and unfavorable years ±600 lbs/ac

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

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