

Ecological site R028AY062NV MOUNTAIN RIDGE

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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.

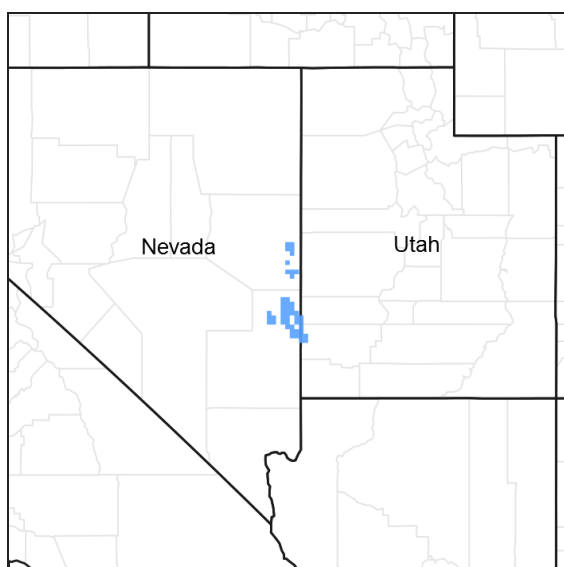


Figure 1. Mapped extent

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 high mountain ridges and shoulders on all aspects. Slopes range from 2 to 50 percent, but slopes of 4 to 15 percent are most typical. Elevations are 5700 to 9020 feet.

The climate associated with this site is semiarid, characterized by cold, moist winters and warm, dry summers. Average annual precipitation is 14 to 22 inches. Mean annual air temperature is 40 to 43 degrees F. The average growing season is about 60 to 90 days.

The soils associated with this site are mostly shallow to bedrock or an argillic horizon. Intense winds over this site inhibit snow accumulation and thus lower the effective precipitation. These soils have high amounts of gravels, cobbles, rock or stones on the surface which occupy plant growing space yet protect the soil from excessive erosion. The available water capacity is very low, but the surface cover of rock fragments helps to reduce evaporation and conserve soil moisture. Runoff is high to very high and potential for sheet and rill erosion is moderate to high depending on the slope. Pedestaling of some grass plants is common during the winter due to frost heaving. Because of high elevations where this site occurs, the soils are cool and plant growth is not initiated until mid- or late spring.

The reference state is dominated by low sagebrush, bluebunch wheatgrass, muttongrass and several mat-forming perennial forbs. Production ranges from 100 to 350 pounds per acre.

Associated sites

F028AY078NV	POTR5-PIEN WSG:1R1907
F028AY084NV	PIEN WSG:3R0907
R028AY061NV	CLAYPAN 14+ P.Z.
R028AY068NV	LOAMY SLOPE 16+ P.Z.

Similar sites

R028AY125NV	GRAVELLY CLAYPAN 14+ P.Z. PUTR2 codominant shrub; ACPI2 & ACLE9 minor species, if present
R028AY094NV	CLAYPAN 12-14 P.Z. More productive site; ACTH7 codominant grass
R028AY061NV	CLAYPAN 14+ P.Z. More productive site

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) <i>Artemisia arbuscula</i>
Herbaceous	(1) <i>Pseudoroegneria spicata</i> ssp. <i>spicata</i>

Physiographic features

This site occurs on high mountain ridges and shoulders on all aspects. Slopes range from 2 to 50 percent, but slopes of 4 to 15 percent are most typical. Elevations are approximately 8000 to 10,000 feet.

Table 2. Representative physiographic features

Landforms	(1) Mountain (2) Ridge
Elevation	2,438–3,048 m
Slope	2–50%
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 cold, moist winters and warm, dry summers. Average annual precipitation is 14 to 22 inches. Mean annual air temperature is 40 to 43 degrees F. The average growing season is about 60 to 90 days.

Mean annual precipitation at the Great Basin National Park climate station (263340) is 13.33 inches.

Monthly mean precipitation is:
January 1.05; February 1.18; March 1.37; April 1.21; May 1.24; June .87; July .97; August 1.18; September 1.08; October .96; December .96

Table 3. Representative climatic features

Frost-free period (average)	0 days
Freeze-free period (average)	75 days
Precipitation total (average)	457 mm

Influencing water features

There are no influencing water features associated with this site.

Soil features

The soils associated with this site are mostly shallow to bedrock or an argillic horizon. Intense winds over this site inhibit snow accumulation and thus lower the effective precipitation. These soils have high amounts of gravels, cobbles, rock or stones on the surface which occupy plant growing space yet protect the soil from excessive erosion. The available water capacity is very low, but the surface cover of rock fragments helps to reduce evaporation and conserve soil moisture. Runoff is high to very high and potential for sheet and rill erosion is moderate to high depending on the slope. Pedestaling of some grass plants is common during the winter due to frost heaving. Because of high elevations where this site occurs, the soils are cool and plant growth is not initiated until mid- or late spring. The soil moisture regime is xeric and the soil temperature regime is frigid or cryic. The soil series associated with this site include: Basinpeak, Schoolmarm, and Wiltop.

The representative soil series is Wiltop, classified as a clayey-skeletal, smectitic, frigid, Vitrandic Argixerolls . Diagnostic horizons include a mollic epipedon from the soil surface to 24 inches, an argillic horizon from 24 to 47 inches. Clay content in the particle control section averages 35 to 40 percent. Rock fragments range from 35 to 60 percent mainly gravel. Reaction is slightly acidic to neutral. Effervescence is none. Depth to bedrock is 40 to 60 inches. Lithology consists of fragments is welded tuff.

Table 4. Representative soil features

Parent material	(1) Colluvium–welded tuff (2) Residuuum–welded tuff
Surface texture	(1) Gravelly coarse sandy loam (2) Ashy sandy loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Moderate to moderately rapid
Soil depth	25–152 cm
Surface fragment cover <=3"	10–30%
Surface fragment cover >3"	10–20%
Available water capacity (0-101.6cm)	4.57–7.87 cm
Calcium carbonate equivalent (0-101.6cm)	0%
Electrical conductivity (0-101.6cm)	0 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	6.7–6.9
Subsurface fragment volume <=3" (Depth not specified)	35–60%
Subsurface fragment volume >3" (Depth not specified)	0%

Ecological dynamics

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

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 (Dobrowolski et al. 1990). Root length of mature sagebrush plants was measured to a depth of 2 meters in alluvial soils in Utah (Richards and Caldwell 1987). However, community types with low or black sagebrush as the dominant shrub were found to have soil depths and thus available rooting depths of 71 to 81 cm in a study in northeast Nevada (Jensen 1990). 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 that are co-dominant with the shrubs include bluebunch wheatgrass, muttongrass, needlegrasses, Sandberg bluegrass and squirreltail. These species 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. Differences in root depth distributions between grasses and shrubs result in resource partitioning in these shrub/grass systems.

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

Low sagebrush is fairly drought tolerant but also tolerates perched water tables during some portion of the growing season. Low and black sagebrush may also be susceptible to the sagebrush defoliator, Aroga moth. Aroga moth can partially or entirely kill individual plants or entire stands of big sagebrush (Furniss and Barr 1975), but the research is inconclusive of the damage sustained by low or black sagebrush populations. Low and black sagebrush are generally long-lived; therefore it is not necessary for new individuals to recruit every year for perpetuation of the stand. Infrequent large recruitment events and simultaneous low, continuous recruitment is the foundation of population maintenance (Noy-Meir 1973). Survival of the seedlings is dependent on adequate moisture conditions.

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 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).

This ecological site has moderate to high resilience to disturbance and resistance to invasion. Increased resilience increases with elevation, aspect, increased precipitation and increased nutrient availability. Four possible alternative stable states have been identified for this site.

Fire Ecology:

Fire is not a major ecological component of these community types (Winward 2001), and would be infrequent. Fire return intervals have been estimated at 100 to 200 years (Kitchen and McArthur 2007); however, fires were probably patchy and very infrequent due to the low productivity of these sites. Low sagebrush is killed by fire and does not sprout (Young 1983). Establishment after fire is from seed, generally blown in and not from the seed bank (Bradley et al. 1992). Fire risk is greatest following a wet, productive year when there is greater production of fine fuels (Beardall and Sylvester 1976). 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). However, season and severity of the fire will influence plant response. Plant response will vary depending on post-fire soil moisture availability.

Fire will remove aboveground biomass from bluebunch wheatgrass but plant mortality is generally low (Robberecht and Defossé 1995) because the buds are underground (Conrad and Poulton 1966) or protected by foliage. Uresk et al. (1976) reported burning increased vegetative and reproductive vigor of bluebunch wheatgrass. Thus, bluebunch wheatgrass is considered to experience slight damage to fire but is more susceptible in drought years (Young 1983). Plant response will vary depending on season, fire severity, fire intensity and post-fire soil moisture availability. The aboveground vegetation of needlegrass species is consumed by fire. When fire severity is high, heat may be transferred below the soil surface further damaging or killing the plant. Muttongrass is top killed by fire but will resprout after low to moderate severity fires. A study by Vose and White (1991) in an open sawtimber site, found minimal difference in overall effect of burning on muttongrass.

State and transition model

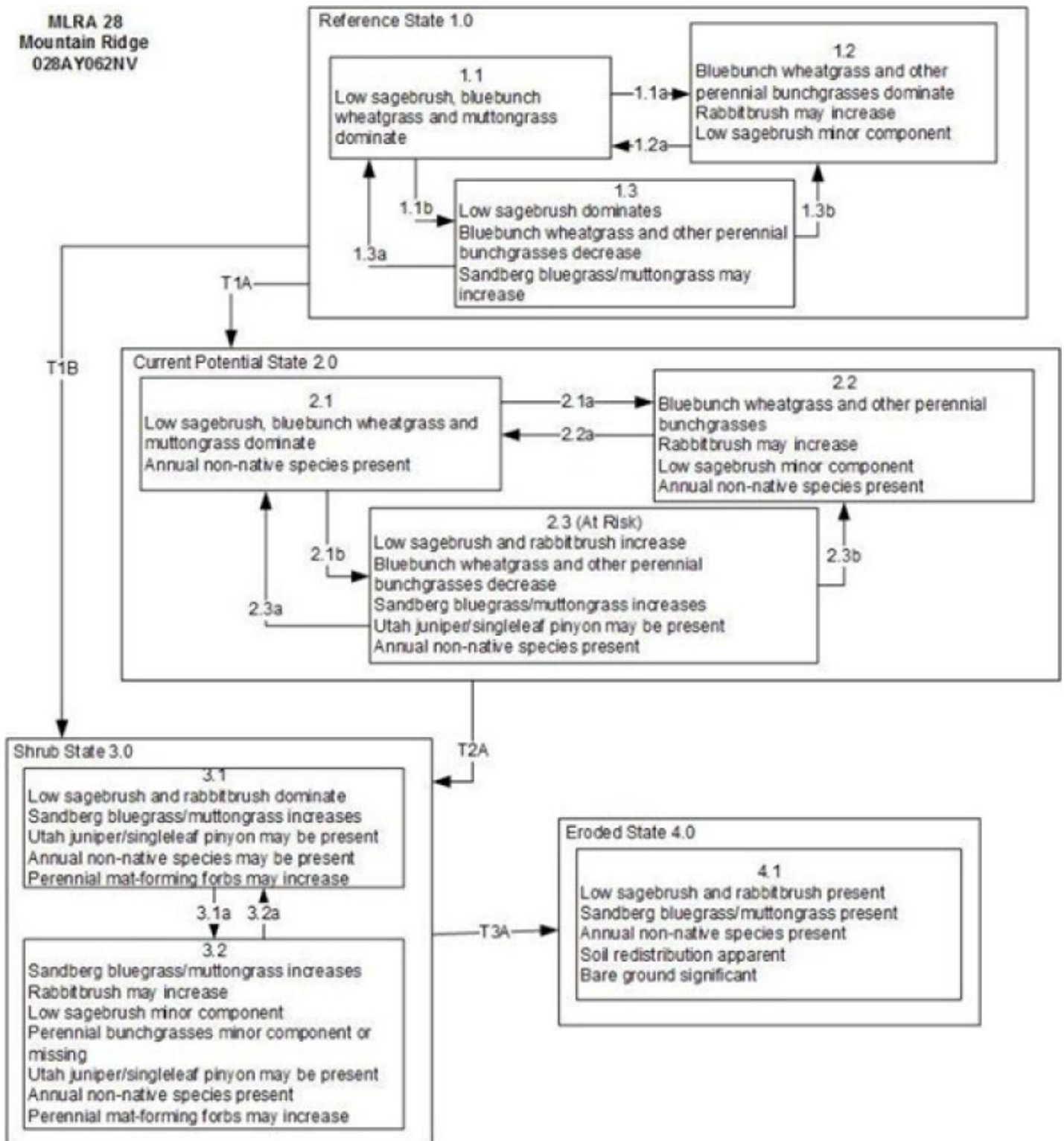


Figure 6. State and Transition Model

Reference State 1.0 Community Phase Pathways

- 1.1a: Low severity fire creates grass/sagebrush mosaic; high severity fire significantly reduces sagebrush cover and leads to early/mid-seral community, dominated by grasses and forbs.
- 1.1b: Time and lack of disturbance such as fire or drought. Excessive herbivory would also reduce perennial understory.
- 1.2a: Time and lack of disturbance allows for shrub regeneration.
- 1.3a: Low severity fire or late fall/winter herbivory causing mechanical damage to sagebrush would reduce sagebrush overstory.
- 1.3b: High severity fire significantly reduces sagebrush cover leading to early/mid-seral community.

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

Transition T1B: Inappropriate grazing management will reduce perennial understory (3.1). Fire (3.2).

Current Potential State 2.0 Community Phase Pathways

- 2.1a: Low severity fire creates grass/sagebrush mosaic; high severity fire significantly reduces sagebrush cover and leads to early/mid-seral community dominated by grasses and forbs; non-native annual species present.
- 2.1b: Time and lack of disturbance such fire or drought. Inappropriate grazing management may also reduce perennial understory.
- 2.2a: Time and lack of disturbance allows for shrub regeneration
- 2.3a: Low severity fire resulting in a mosaic pattern. Brush management with minimal soil disturbance; late-fall/winter grazing causing mechanical damage to sagebrush.
- 2.3b: High severity fire significantly reduces sagebrush cover leading to early/mid-seral community.

Transition T2A: Inappropriate grazing management (3.1). Fire or brush treatment; may be coupled with inappropriate grazing management (3.2).

Shrub State 3.0 Community Phase Pathways

- 3.1a: Fire, brush management (i.e. mowing) with minimal soil disturbance, and/or inappropriate sheep grazing.
- 3.2a: Time and lack of disturbance (unlikely to occur)

Transition T3A: Inappropriate grazing management, soil disturbing treatments, fire or multiple fires, and/or drought (4.1)

Figure 7. Legend

State 1

Reference State

The Reference State 1.0 is a representative of the natural range of variability under pristine conditions. The reference state has three general community phases; a shrub-grass dominant phase, a perennial grass dominant phase and a shrub dominant phase. State dynamics are maintained by interactions between climatic patterns and disturbance regimes. Negative feedbacks enhance ecosystem resilience and contribute to the stability of the state. These include the presence of all structural and functional groups, low fine fuel loads, and retention of organic matter and nutrients. Plant community phase changes are primarily driven by fire, periodic drought and/or insect or disease attack. Due to the nature and extent of disturbance in this site, all three plant community phases would likely occur in a mosaic across the landscape.

Community 1.1

Community Phase

This community is dominated by low sagebrush, bluebunch wheatgrass, needlegrass, and perennial forbs. Fringed sagebrush and Douglas rabbitbrush make up minor components. Perennial forbs comprise 10 to 15% of the plant community and other perennial grasses make up smaller components. Potential vegetative composition is approximately 45% grasses, 10% forbs, and 45% shrubs. Approximate ground cover (basal and crown) is 10 to 20 percent.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	50	126	177
Grass/Grasslike	50	127	176
Forb	11	28	39
Total	111	281	392

Community 1.2

Community Phase

This community phase is characteristic of a post-disturbance, early or mid-seral community. Bluebunch wheatgrass, muttongrass, and other perennial bunchgrasses dominate. Sprouting shrubs such as Douglas' rabbitbrush may increase. Depending on fire severity 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. Sandberg bluegrass may increase in the understory and become the dominant grass on the site.

Pathway a

Community 1.1 to 1.2

Fire reduces the shrub overstory and allows for perennial bunchgrasses to dominate the site. Fires are typically low severity resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring facilitating an increase in fine fuels may be more severe and reduce sagebrush cover to trace amounts.

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 generally cause a decline in perennial bunchgrasses and fine fuels leading to a reduced fire frequency and allowing 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 1.1

A low severity fire, or late fall/winter herbivory causing mechanical damage to sagebrush or combinations will reduce the sagebrush overstory and create a sagebrush/grass mosaic.

Pathway b

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. Fires will typically be high intensity due to the dominance of sagebrush in this community phase.

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 similar to the Reference State Community Phase 1.1, with the presence of non-native species in trace amounts. Low sagebrush, fringed sagebrush, bluebunch wheatgrass, needlegrass and perennial forbs dominate the site. Other shrubs and perennial grasses make up smaller components of this site.

Community 2.2

Community Phase

This community phase is characteristic of a post-disturbance, early to mid-seral community where annual non-native species are present. Sagebrush is present in trace amounts; perennial bunchgrasses dominate the site. Rabbitbrush may be sprouting or dominant in the community. Perennial forbs may be a significant component for a number of years and may dominant in the higher elevation sites. Annual non-native species are stable or increasing within the community.

Community 2.3

Community Phase (At Risk)

Low sagebrush 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. Sandberg bluegrass may increase and become co-dominate with deep rooted bunchgrasses. Utah juniper may be present and without management will likely increase. Annual non-natives 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. This community is at risk of crossing a threshold to state 3.0 (grazing or fire).

Pathway a

Community 2.1 to 2.2

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

Pathway b

Community 2.1 to 2.3

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

Pathway a

Community 2.2 to 2.1

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

Pathway a

Community 2.3 to 2.1

Grazing management that reduces shrubs will allow for the perennial bunchgrasses in the understory to increase. Heavy late-fall or winter grazing may cause mechanical damage and subsequent death to sagebrush, facilitating an increase in the herbaceous understory. Brush treatments with minimal soil disturbance will also decrease sagebrush and release the perennial understory. Annual non-native species are present and may increase in the community. A low severity fire would decrease the overstory of sagebrush and allow for the understory perennial grasses to increase. Due to low fuel loads in this State, fires will likely be small creating a mosaic pattern.

Pathway b

Community 2.3 to 2.2

Fires will decrease or eliminate the overstory of sagebrush and allows for perennial grasses to increase. Fires will typically be high intensity due to the dominance of sagebrush resulting in removal of the overstory shrub community. Annual non-native species respond well to fire and may increase post-burn. Brush treatment would reduce sagebrush overstory and allow for perennial bunchgrasses to increase.

State 3

Shrub State

This state has two community phases; one with a decadent low sagebrush overstory, and one with a post-fire rabbitbrush overstory, with a Sandberg bluegrass understory. Sagebrush cover exceeds site concept and may be decadent, reflecting stand maturity and lack of seedling establishment due to competition with mature plants. The shrub overstory and Sandberg bluegrass understory dominate site resources such that soil water, nutrient capture, nutrient cycling and soil organic matter are temporally and spatially redistributed. Bare ground and soil redistribution may be increasing.

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. Sandberg bluegrass and annual non-native species increase. Utah juniper and/or singleleaf pinyon may be present in sites which occur near woodlands. Bare ground is significant. Bare ground may be significant and soil redistribution may be occurring.

Community 3.2

Community Phase

Bluegrass dominates the site; annual non-native species may be present but are not dominant. Trace amounts of sagebrush may be present. Sprouting shrubs such as rabbitbrush may dominate the overstory. Annual non-native species may be increasing and bare ground is significant.

Pathway a

Community 3.1 to 3.2

Fire reduces sagebrush to trace amounts and allows for sprouting shrubs such as rabbitbrush to dominate. Inappropriate or excessive sheep grazing could also reduce cover of sagebrush and allow for sprouting shrubs to dominate the community. Brush treatments with minimal soil disturbance would facilitate sprouting shrubs and Sandberg's bluegrass.

Pathway a

Community 3.2 to 3.1

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

State 4

Eroded State

This state has one community phase. Abiotic factors including soil redistribution and erosion, soil temperature, soil crusting and sealing are primary drivers of ecological condition within this state. Soil moisture, soil nutrients and soil organic matter distribution and cycling are severely altered due to degraded soil surface conditions. Low sagebrush dominates the overstory and herbaceous species may be present in trace amounts. Regeneration of sagebrush or herbaceous species is not evident.

Community 4.1

Community Phase

Low sagebrush dominates the overstory and herbaceous species may be present in trace amount particularly under canopies. Dead sagebrush skeletons are prominent. Regeneration of sagebrush or herbaceous species is not evident. Annual non-native species present primarily under canopies.

Transition A

State 1 to 2

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

Transition B

State 1 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. From community phase 1.3 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.

Transition A

State 2 to 3

Trigger: To Community Phase 3.1: Inappropriate cattle/horse grazing will decrease or eliminate deep rooted perennial bunchgrasses, increase Sandberg bluegrass and favor shrub growth and establishment. To Community Phase 3.2: Severe fire will remove sagebrush overstory, decrease perennial bunchgrasses and enhance Sandberg bluegrass. Soil disturbing brush treatments and/or inappropriate sheep grazing will reduce sagebrush and potentially increase sprouting shrubs and Sandberg bluegrass. Slow variables: Long term decrease in deep-rooted perennial grass density and/or low sagebrush. Threshold: Loss of deep-rooted perennial bunchgrasses changes nutrient cycling, nutrient redistribution, and reduces soil organic matter. Loss of long-lived, black sagebrush changes the temporal and depending on the replacement shrub, the spatial distribution of nutrient cycling.

Transition A

State 3 to 4

Trigger: Inappropriate grazing management following fire, multiple fires, prolonged drought or any combination of these would increase soil erosion. Soil disturbing treatments such as a failed drill seeding could also increase erosion. Slow variable: Bare ground interspaces large and connected; water flow paths long and continuous, understory is sparse Threshold: Soil redistribution and erosion is significant and linked to vegetation mortality evidenced by pedestalling and burying of herbaceous species and / or lack of recruitment in the interspaces.

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			118–205	
	bluebunch wheatgrass	PSSPS	<i>Pseudoroegneria spicata</i> ssp. <i>spicata</i>	84–140	–
	muttongrass	POFE	<i>Poa fendleriana</i>	28–43	–
	Letterman's needlegrass	ACLE9	<i>Achnatherum lettermanii</i>	2–11	–
	pine needlegrass	ACPI2	<i>Achnatherum pinetorum</i>	3–11	–
2	Secondary Perennial Grasses			15–28	
	Indian ricegrass	ACHY	<i>Achnatherum hymenoides</i>	1–9	–
	blue grama	BOGR2	<i>Bouteloua gracilis</i>	1–9	–
	sedge	CAREX	<i>Carex</i>	1–9	–
	squirreltail	ELEL5	<i>Elymus elymoides</i>	1–9	–
	alpine fescue	FEBR	<i>Festuca brachyphylla</i>	1–9	–
	mat muhly	MURI	<i>Muhlenbergia richardsonis</i>	1–9	–
	Sandberg bluegrass	POSE	<i>Poa secunda</i>	1–9	–
Forb					
3	Perennial			15–56	
	pussytoes	ANTEN	<i>Antennaria</i>	1–15	–
	aster	ASTER	<i>Aster</i>	1–15	–
	buckwheat	ERIOG	<i>Eriogonum</i>	1–15	–
	phlox	PHLOX	<i>Phlox</i>	1–15	–
	goldenweed	PYRRO	<i>Pyrrocoma</i>	1–15	–
Shrub/Vine					
4	Primary Shrubs			110–141	
	little sagebrush	ARAR8	<i>Artemisia arbuscula</i>	99–112	–
	prairie sagewort	ARFR4	<i>Artemisia frigida</i>	6–15	–
	yellow rabbitbrush	CHVI8	<i>Chrysothamnus viscidiflorus</i>	6–15	–
5	Secondary Shrubs			6–28	
	Utah serviceberry	AMUT	<i>Amelanchier utahensis</i>	3–15	–
	whitestem goldenbush	ERDI14	<i>Ericameria discoidea</i>	3–15	–

Animal community

Livestock/Wildlife Grazing Interpretations:

This site is suitable for livestock grazing. Considerations for grazing management including timing, intensity and duration of grazing. Targeted grazing could be used to decrease the density of non-natives.

Bluebunch wheatgrass is considered one of the most important forage grass species on western rangelands for livestock. Although bluebunch wheatgrass can be a crucial source of forage, it is not necessarily the most highly preferred species. Muttongrass is excellent forage for domestic livestock especially in the early spring. Muttongrass begins growth in late winter and early spring, which makes it available before many other forage plants. Pine needlegrass provides a palatable and nutritious feed for livestock and wildlife during the spring and early summer. Bunchgrasses, in general, best tolerate light grazing after seed formation. Britton et al. (1990) observed the effects

of clipping rate on basal area of five bunchgrasses in eastern Oregon, and found grazing from August to October (after seed set) has the least impact. Heavy grazing during the growing season will reduce perennial bunchgrasses and increase sagebrush. Abusive grazing by cattle or horses will likely increase low sagebrush, rabbitbrush and some forbs such as arrowleaf balsamroot. Annual non-native weedy species such as cheatgrass and mustards may invade.

Bluebunch wheatgrass is moderately grazing tolerant and is very sensitive to defoliation during the active growth period (Blaisdell and Pechanec 1949, Laycock 1967, Anderson and Scherzinger 1975, Britton et al. 1990). Herbage and flower stalk production was reduced with clipping at all times during the growing season; however, clipping was most harmful during the boot stage (Blaisdell and Pechanec 1949). Tiller production and growth of bluebunch was greatly reduced when clipping was coupled with drought (Busso and Richards 1995). Mueggler (1975) estimated that low vigor bluebunch wheatgrass may need up to 8 years rest to recover. Although an important forage species, it is not always the preferred species by livestock and wildlife.

Thurber's needlegrass is an important forage source for livestock and wildlife in the arid regions of the West (Ganskopp 1988). Although the seeds are apparently not injurious, grazing animals avoid them when they begin to mature. Sheep, however, have been observed to graze the leaves closely, leaving stems untouched (Eckert and Spencer 1987). Heavy grazing during the growing season has been shown to reduce the basal area of Thurber's needlegrass (Eckert and Spencer 1987), suggesting that both seasonality and utilization are important factors in management of this plant. A single defoliation, particularly during the boot stage, was found to reduce herbage production and root mass thus potentially lowering the competitive ability of this needlegrass (Ganskopp 1988). Reduced bunchgrass vigor or density provides an opportunity for Sandberg bluegrass expansion and/or cheatgrass and other invasive species to occupy interspaces. Increased cheatgrass cover leads to increased fire frequency and potentially an annual plant community. Sandberg bluegrass increases under grazing pressure (Tisdale and Hironaka 1981) and is capable of co-existing with cheatgrass. Depending on the season of use, the type of grazing animal, and site conditions, Sandberg bluegrass or cheatgrass may become the dominant understory with inappropriate grazing management.

Domestic sheep and, to a much lesser degree, cattle consume low sagebrush, particularly during the spring, fall, and winter (Sheehy and Winward 1981). Letterman's needlegrass begins growth early in the year and remains green throughout the relatively long growing season, thus, making it valuable forage for livestock. Domestic sheep and to a much lesser degree cattle consume low sagebrush, particularly during the spring, fall and winter. Fringed sagebrush is an important forage species for domestic cattle, sheep, and goats. Douglas' rabbitbrush is tolerant of grazing and may be "rejuvenated" by foliage removal. In parts of the Great Basin, plants regrew rapidly after they were nearly completely consumed by spring-browsing black-tailed jackrabbits. Douglas' rabbitbrush commonly increases on degraded rangelands as more palatable species are removed.

Heavy dormant season grazing by sheep will reduce sagebrush cover and increase grass production (Laycock 1967). Severe trampling damage to supersaturated soils could occur if sites are used in early spring when there is abundant snowmelt. Trampling damage, particularly from cattle or horses, in low sagebrush habitat types is greatest when high clay content soils are wet. In drier areas with more gravelly soils, no serious trampling damage occurs, even when the soils are wet (Hironaka et al. 1983).

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:

Low sagebrush is considered a valuable browse plant during the spring, fall and winter months. In some areas it is of little value in winter due to heavy snow. Mule deer utilize and sometimes prefer low sagebrush, particularly in winter and early spring. Sagebrush-grassland communities provide critical sage-grouse breeding and nesting habitats. Sagebrush is a crucial component of their diet year-round, and sage-grouse select sagebrush almost exclusively for cover. Sage-grouse utilize low sagebrush primarily during the winter. Fringed sagebrush and Douglas' rabbitbrush are important forage species for many wildlife species. Bluebunch wheatgrass is considered one of the most important forage grass species on western rangelands for wildlife. Bluebunch wheatgrass does not generally provide sufficient cover for ungulates, however, mule deer are frequently found in bluebunch-dominated grasslands. Deer and elk make heavy use of muttongrass, especially in early spring when other green forage is scarce. Depending upon availability of other nutritious forage, deer may use mutton grass in all seasons.

Muttongrass cures well and is an important fall and winter deer food in some areas. Pine needlegrass and Letterman's needlegrass are important forage species for many wildlife species.

Pygmy rabbits, a threatened species of conservation concern throughout California, Oregon, Nevada, Idaho, Montana, Wyoming and Utah (endangered in Washington) often burrow where low sagebrush mixes with mountain big sagebrush. Low sagebrush is an important shrub for pygmy rabbits and other sagebrush obligate species

(Oregon Conservation Strategy, 2006). In southwest Idaho, Oregon, Montana and Nevada, pygmy will burrow where the big sagebrush form islands within the low sagebrush matrix (Keinath and McGee 2004). Sage grouse, another threatened species of conservation concern and sagebrush obligate species, feeds almost exclusively on leaves of sagebrush. Although big sagebrush dominates the diet in most portions of the range sage grouse inhabit low sagebrush varieties will be consumed depending on availability (Connelly et al. 2000). Other bird species, such as the Columbian sharp-tailed grouse, use low sagebrush, as it provides intermediate cover (Saab and Marks. 1992).

Several reptiles and amphibians are distributed throughout the sagebrush steppe in the west in Nevada, where low sagebrush is known to grow (Bernard and Brown 1977). Studies have not determined if reptiles and amphibians prefer certain species of sage; however, researchers agree that maintaining habitat where low 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).

Threats and Management

Changes in plant community composition caused by fire frequency, and other threats associated with this ecological site could affect the distribution and presence of wildlife species.

Hydrological functions

Permeability is moderate. Runoff is high to very high. Hydrologic soil groups are B and D.

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 hiking and has potential for upland and big game hunting.

Other information

Low sagebrush can be successfully transplanted or seeded in restoration. Letterman's needlegrass has been used successfully in revegetating mine spoils. This species also has good potential for erosion control.

Type locality

Location 1: White Pine County, NV	
Township/Range/Section	T13N R69E S6
Latitude	39° 1' 42"
Longitude	114° 16' 14"
General legal description	Timber Creek Trail to Johnson Lake, Great Basin National Park, Snake Range, 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	03/20/2015
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rills are none to rare. A few may occur on steeper slopes after summer convection storms or rapid snowmelt.

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

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3. **Number and height of erosional pedestals or terracettes:** Pedestals are none to rare. Frost heaving of shallow rooted plants should not be considered an indicator of soil erosion. A few short, terracettes may occur on steeper slopes.
-
4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare Ground \pm 5-20% depending on amount of surface rock fragments.
-
5. **Number of gullies and erosion associated with gullies:** None
-
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 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 4 to 6 on most soil textures found on this site. (To be field tested.)
-
9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Surface structure is very fine platy or very fine to fine granular. Soil surface colors are grayish browns or browns and soils have a mollic epipedon. Surface textures are loams or ashy loams. Organic matter of the surface 2 to 4 inches is typically 1.25 to 3 percent dropping off quickly below. Organic matter content can be more or less depending on micro-topography.
-
10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Perennial herbaceous plants (especially deep-rooted bunchgrasses) slow runoff and increase infiltration. Shrub canopy and associated litter break raindrop impact. High intense winds on this site limit the opportunity for snow catch and accumulation on site.
-
11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** Compacted layers are not typical. Subangular blocky or platy structure or subsoil argillic horizons are not to be interpreted as compacted.
-
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 Plant Community: Deep-rooted, cool season, perennial bunchgrasses >

Sub-dominant: low shrubs (low sagebrush) >> associated shrubs > shallow-rooted, cool season, perennial bunchgrasses > deep-rooted, cool season, perennial forbs > fibrous, shallow-rooted, cool season, perennial forbs = annual forbs.

Other:

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 20% of total woody canopy; some of the mature bunchgrasses (<10%) have dead centers.
-
14. **Average percent litter cover (%) and depth (in):** Between plant interspaces (15-25%) and litter depth is $\pm\frac{1}{4}$ inch.
-
15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** For normal or average growing season (through mid-June) \pm 250 lbs/ac; Favorable years + 350 lbs/ac and unfavorable years + 100 lbs/ac.
-
16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:** Potential invaders include cheatgrass.
-
17. **Perennial plant reproductive capability:** All functional groups should reproduce in average (or normal) and above average growing season years. Reduced growth and reproduction occur during drought years.
-