

Ecological site R028BY034NV MOUNTAIN RIDGE 12-14 P.Z.

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General information

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

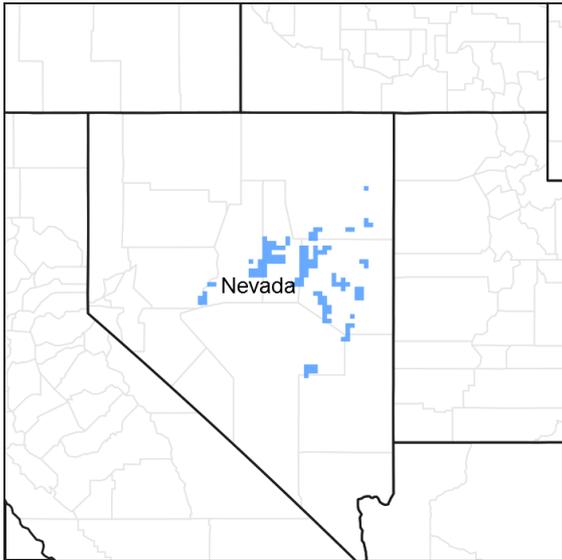


Figure 1. Mapped extent

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

MLRA notes

Major Land Resource Area (MLRA): 028B—Central Nevada Basin and Range

MLRA 28B occurs entirely in Nevada and comprises about 23,555 square miles (61,035 square kilometers). More than nine-tenths of this MLRA is federally owned. This area is in the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. It is an area of nearly level, aggraded desert basins and valleys between a series of mountain ranges trending north to south. The basins are bordered by long, gently sloping to strongly sloping alluvial fans. The mountains are uplifted fault blocks with steep sideslopes. Many of the valleys are closed basins containing sinks or playas. Elevation ranges from 4,900 to 6,550 feet (1,495 to 1,995 meters) in the valleys and basins and from 6,550 to 11,900 feet (1,995 to 3,630 meters) in the mountains.

The mountains in the southern half are dominated by andesite and basalt rocks that were formed in the Miocene and Oligocene. Paleozoic and older carbonate rocks are prominent in the mountains to the north. Scattered outcrops of older Tertiary intrusives and very young tuffaceous sediments are throughout this area. The valleys consist mostly of alluvial fill, but lake deposits are at the lowest elevations in the closed basins. The alluvial valley fill consists of cobbles, gravel, and coarse sand near the mountains in the apex of the alluvial fans. Sands, silts, and clays are on the distal ends of the fans.

The average annual precipitation ranges from 4 to 12 inches (100 to 305 millimeters) in most areas on the valley floors. Average annual precipitation in the mountains ranges from 8 to 36 inches (205 to 915 millimeters) depending on elevation. The driest period is from midsummer to midautumn. The average annual temperature is 34 to 52 degrees F (1 to 11 degrees C). The freeze-free period averages 125 days and ranges from 80 to 170 days, decreasing in length with elevation.

The dominant soil orders in this MLRA are Aridisols, Entisols, and Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an aridic or xeric soil moisture regime, and mixed or carbonatic mineralogy. They generally are well drained, loamy or loamyskeletal, and shallow to very deep.

Nevada's climate is predominantly arid, with large daily ranges of temperature, infrequent severe storms and heavy snowfall in the higher mountains. Three basic geographical factors largely influence Nevada's climate:

continentality, latitude, and elevation. The strong continental effect is expressed in the form of both dryness and large temperature variations. Nevada lies on the eastern, lee side of the Sierra Nevada Range, a massive mountain barrier that markedly influences the climate of the State. The prevailing winds are from the west, and as the warm moist air from the Pacific Ocean ascend the western slopes of the Sierra Range, the air cools, condensation occurs and most of the moisture falls as precipitation. As the air descends the eastern slope, it is warmed by compression, and very little precipitation occurs. The effects of this mountain barrier are felt not only in the West but throughout the state, as a result the lowlands of Nevada are largely desert or steppes.

The temperature regime is also affected by the blocking of the inland-moving maritime air. Nevada sheltered from maritime winds, has a continental climate with well-developed seasons and the terrain responds quickly to changes in solar heating. Nevada lies within the midlatitude belt of prevailing westerly winds which occur most of the year. These winds bring frequent changes in weather during the late fall, winter and spring months, when most of the precipitation occurs.

To the south of the mid-latitude westerlies, lies a zone of high pressure in subtropical latitudes, with a center over the Pacific Ocean. In the summer, this high-pressure belt shifts northward over the latitudes of Nevada, blocking storms from the ocean. The resulting weather is mostly clear and dry during the summer and early fall, with occasional thundershowers. The eastern portion of the state receives noteworthy summer thunderstorms generated from monsoonal moisture pushed up from the Gulf of California, known as the North American monsoon. The monsoon system peaks in August and by October the monsoon high over the Western U.S. begins to weaken and the precipitation retreats southward towards the tropics (NOAA 2004).

Ecological site concept

This site occurs on convex portions of mountains. Slopes gradients of 4 to 30 percent are typical. Elevations range from 6800 to 9000 feet.

Soils associated with this site are shallow, well drained, and formed in residuum and colluvium derived from mixed parent material. The soil profile has a mollic epipedon, an argillic and is skeletal with >35 percent rock fragments throughout. Soil moisture regime is xeric and the soil temperature regime is frigid.

The reference state is dominated by bluebunch wheatgrass, Thurber's needlegrass, low sagebrush and perennial mat-forming forbs. Black sagebrush may occur and is typically restricted to the ridge crest areas where soil depth is most limited. Production ranges from 100 to 350 pounds per acre.

Important abiotic factors contributing to the presence of this site include intense winds that inhibit snow accumulation and a convex landform shape, thus lowering the effective precipitation. The soils are shallow, have a high amount of gravels and cobbles armoring the surface and occupying plant growing space. The available water holding capacity is very low. Runoff is high to very high.

Associated sites

R028BY015NV	LOAMY SLOPE 12-16 P.Z.
R028BY030NV	LOAMY 12-16 P.Z.
R028BY046NV	GRAVELLY LOAM 12-14 P.Z.
R028BY087NV	GRAVELLY CLAY 12-14 P.Z.

Similar sites

R028BY048NV	CALCAREOUS MOUNTAIN RIDGE ARAR8 absent; soils from limestone parent material
R028BY027NV	SHALLOW CALCAREOUS SLOPE 14+ P.Z. PSSPS dominant grass; ACTH7 absent; ARAR8 absent

R028BY039NV	COBBLY CLAYPAN 12-14 P.Z. ARNO4 absent
R028BY037NV	CLAYPAN 12-14 P.Z. ARNO4 absent; more productive site
R028BY038NV	MOUNTAIN RIDGE 14+ P.Z. PSSPS dominant grass; POFE major grass; higher elevations

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) <i>Artemisia arbuscula</i>
Herbaceous	(1) <i>Pseudoroegneria spicata subsp. spicata</i> (2) <i>Achnatherum thurberianum</i>

Physiographic features

This site occurs on convex portions of mountains, including ridges, shoulders, and upper backslopes. Slopes range from 4 to 75 percent, but slope gradients of 4 to 30 percent are typical. Elevations range from 6500 to 9000 feet, but is typically found above 6800 feet.

Table 2. Representative physiographic features

Landforms	(1) Mountain (2) Ridge
Flooding frequency	None
Ponding frequency	None
Elevation	6,800–9,000 ft
Slope	4–30%
Aspect	Aspect is not a significant factor

Climatic features

The climate associated with this site is semiarid, characterized by cold, moist winters and warm, dry summers.

Average annual precipitation is estimated to range from 12 to 14 inches. Mean annual air temperature is about 44 to 47 degrees F. The average growing season is about 40 to 70 days. Weather stations with a long term data record are currently not available for this ecological site. Associated climate data will be updated when information becomes available.

Table 3. Representative climatic features

Frost-free period (average)	50 days
Freeze-free period (average)	70 days
Precipitation total (average)	13 in

Influencing water features

Influencing water features are not associated with this site.

Soil features

The soils associated with this site are shallow, well drained, and formed in residuum and colluvium derived from mixed parent material. Soils are skeletal with >35 percent rock fragments and are characterized by a mollic

epipedon and an argillic. The soil moisture regime is xeric and the soil temperature regime is frigid. The soil series associated with this site include Cleavage, Gando, Horsetrack, Aurum and Hutchley.

The representative soil series is Hutchley, a loamy-skeletal, mixed, superactive, frigid Lithic Argixeroll. A mollic epipedon occurs from the soil surface to 38cm and an argillic horizon occurs from 23 to 38cm. Clay content in the particle size control section averages 24 to 35 percent and rock fragments range from 35 to 60 percent. Parent material consists of volcanic and metasedimentary rocks.

Important abiotic factors include intense winds and convex landform shape that inhibit snow accumulation, thus lowering the effective precipitation. The available water holding capacity is very low. Runoff is very high.

Table 4. Representative soil features

Parent material	(1) Residuum–metasedimentary rock
Surface texture	(1) Gravelly loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Moderately slow to moderate
Soil depth	10–18 in
Surface fragment cover ≤3"	20–65%
Surface fragment cover >3"	0–10%
Available water capacity (0–40in)	0.8–1.9 in
Calcium carbonate equivalent (0–40in)	0%
Electrical conductivity (0–40in)	0 mmhos/cm
Sodium adsorption ratio (0–40in)	0
Soil reaction (1:1 water) (0–40in)	7.3–7.5
Subsurface fragment volume ≤3" (Depth not specified)	35–60%
Subsurface fragment volume >3" (Depth not specified)	0–5%

Ecological dynamics

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

The 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, Thurber needlegrass, bluegrass and pine needlegrass. 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 and black sagebrush are tolerant of droughty conditions. 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). Fire return intervals have been estimated at 100 to 200 years in black sagebrush dominated sites (Kitchen and McArthur 2007) and likely is similar in the low sagebrush ecosystem; however, historically fires were probably patchy due to the low productivity of these sites. Fine fuel loads generally average 100 to 400 pounds per acre (110- 450 kg/ha) but are occasionally as high as 600 pounds per acre (680 kg/ha) in low sagebrush habitat types (Bradley et al. 1992). Recovery time of low sagebrush following fire is variable (Young 1983). After fire, if regeneration conditions are favorable, low sagebrush recovers in 2 to 5 years, however on harsh sites where cover is low to begin with and/or erosion occurs after fire, recovery may require more than 10 years (Young 1983). Slow regeneration may subsequently worsen erosion (Blaisdell et al. 1982).

Black sagebrush plants have no morphological adaptations for surviving fire and must reestablish from seed following fire (Wright et al. 1979). The ability of black sagebrush to establish after fire is mostly dependent on the amount of seed deposited in the seed bank the year before the fire. Seeds typically do not persist in the soil for more than one growing season (Beetle 1960). A few seeds may remain viable in soil for two years (Meyer 2008); however, even in dry storage, black sagebrush seed viability has been found to drop rapidly over time, from 81% to 1% viability after two and ten years of storage, respectively (Stevens et al. 1981). Thus, repeated frequent fires can eliminate black sagebrush from a site, however black sagebrush in zones receiving 12 to 16 inches of annual precipitation have been found to have greater fire survival (Boltz 1994). In lower precipitation zones, rabbitbrush may become the dominant shrub species following fire, often with an understory of Sandberg bluegrass and/or cheatgrass and other weedy species.

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.

Burning has been found to decrease the vegetative and reproductive vigor of Thurber's needlegrass (Uresk et al. 1976). Fire can cause high mortality, in addition to reducing basal area and yield of Thurber's needlegrass (Britton et al. 1990). The fine leaves and densely tufted growth form make this grass susceptible to subsurface charring of the crowns (Wright and Klemmedson 1965). Although timing of fire highly influenced the response and mortality of Thurber's needlegrass, smaller bunch sizes were less likely to be damaged by fire (Wright and Klemmedson 1965). Thurber's needlegrass often survives fire and will continue growth or regenerate from tillers when conditions are favorable (Koniak 1985, Britton et al. 1990). Reestablishment on burned sites has been found to be relatively slow due to low germination and competitive ability (Koniak 1985). Cheatgrass has been found to be a highly successful competitor with seedlings of this needlegrass and may preclude reestablishment (Evans and Young 1978).

State and transition model

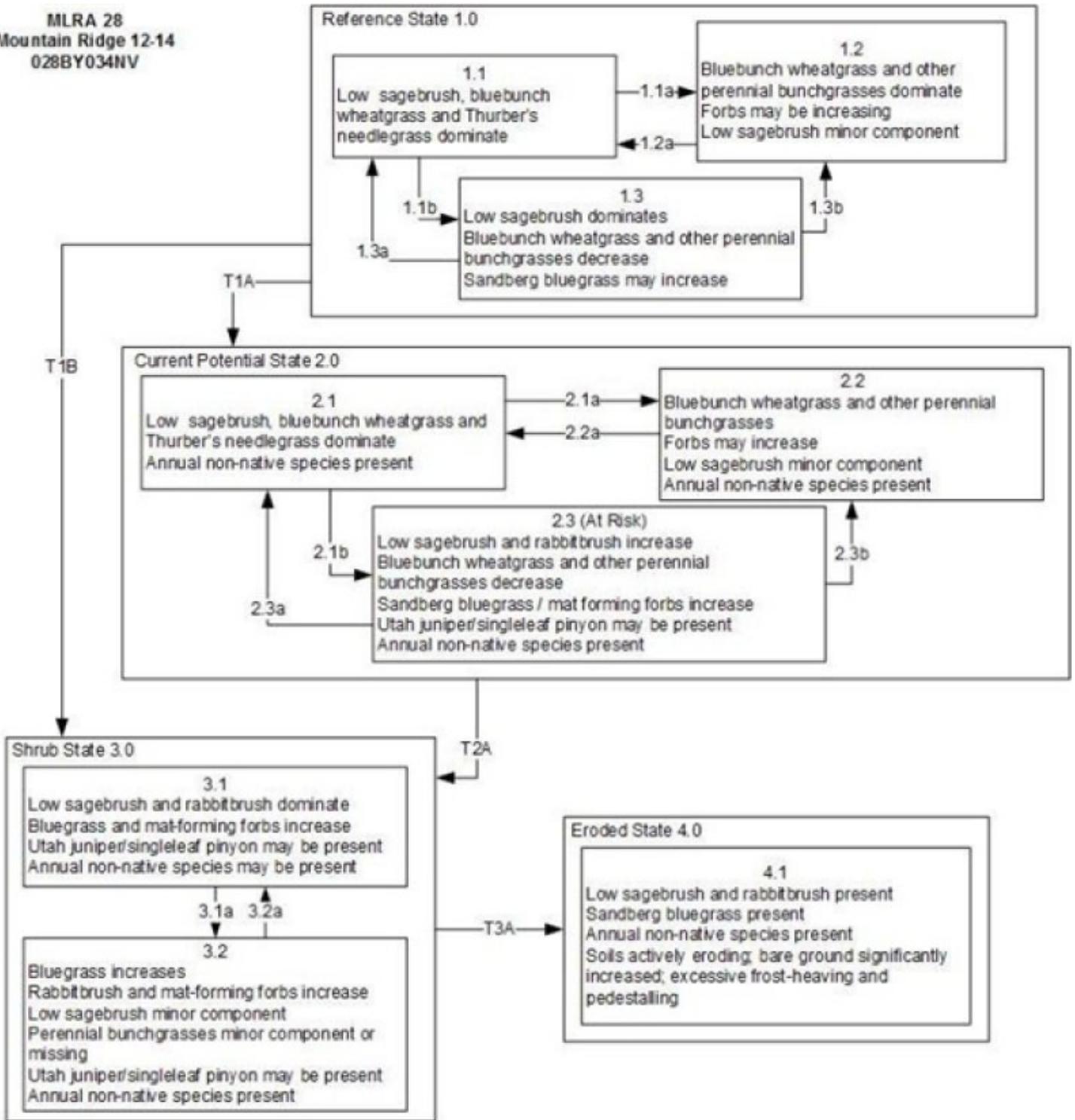


Figure 4. State and Transition Model

MLRA 28
Mountain Ridge 12-14
028BY034NV

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 5. 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



Figure 6. Mountain Ridge 12-14" (R028BY034). P. Novak-Echenique, July 2012

This community is dominated by low sagebrush, Thurber's needlegrass and bluebunch wheatgrass. Black sagebrush and bluegrasses 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 about 45% grasses, 10% forbs and 45% shrubs. Approximate ground cover (basal and crown) is 15 to 20 percent.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Shrub/Vine	45	90	158
Grass/Grasslike	45	90	157
Forb	10	20	35
Total	100	200	350

Community 1.2 Community Phase

This community phase is characteristic of a post-disturbance, early or mid-seral community. Bluebunch wheatgrass, Thurber's needlegrass 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, bluebunch wheatgrass, Thurber's 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-dominant 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



Figure 8. Mountain Ridge 12-14" (R028BY034NV). T.Stringham, June 2013

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 pinyon pine 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 (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	Primary Perennial Grasses			74–156	
	bluebunch wheatgrass	PSSPS	<i>Pseudoroegneria spicata ssp. spicata</i>	40–80	–
	Thurber's needlegrass	ACTH7	<i>Achnatherum thurberianum</i>	20–40	–
	pine needlegrass	ACPI2	<i>Achnatherum pinetorum</i>	4–16	–
	muttongrass	POFE	<i>Poa fendleriana</i>	5–10	–
	Sandberg bluegrass	POSE	<i>Poa secunda</i>	5–10	–
2	Secondary Perennial Grasses			10–20	
	Indian ricegrass	ACHY	<i>Achnatherum hymenoides</i>	1–6	–
	squirreltail	ELEL5	<i>Elymus elymoides</i>	1–6	–
	needle and thread	HECO26	<i>Hesperostipa comata</i>	1–6	–
Forb					
3	Perennial			14–30	
	goldenweed	PYRRO	<i>Pyrrcoma</i>	4–10	–
	buckwheat	ERIOG	<i>Eriogonum</i>	1–4	–
	lupine	LUPIN	<i>Lupinus</i>	1–4	–
	pricklypear	OPUNT	<i>Opuntia</i>	1–4	–
	phlox	PHLOX	<i>Phlox</i>	1–4	–
Shrub/Vine					
4	Primary Shrubs			70–90	
	little sagebrush	ARAR8	<i>Artemisia arbuscula</i>	55–70	–
	black sagebrush	ARNO4	<i>Artemisia nova</i>	10–20	–
5	Secondary Shrubs			10–20	
	yellow rabbitbrush	CHVI8	<i>Chrysothamnus viscidiflorus</i>	1–4	–
	winterfat	KRLA2	<i>Krascheninnikovia lanata</i>	1–4	–

Animal community

Livestock 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.

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 perennial forbs such as phlox and goldenweed. 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. Excessive sheep grazing favors Sandberg bluegrass; however, where cattle are the dominant grazers, cheatgrass often dominates (Daubenmire 1970). Thus, 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). 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). Domestic livestock will also utilize black sagebrush. The domestic sheep industry that emerged in the Great Basin in the early 1900s was largely based on wintering domestic sheep in black sagebrush communities (Mozingo 1987). Domestic sheep will browse black sagebrush during all seasons of the year depending on the availability of other forage species with greater amounts being consumed in fall and winter. Black sagebrush is generally less palatable to cattle than to domestic sheep and wild ungulates (McArthur et al. 1982); however, cattle use of black sagebrush has also been shown to be greatest in fall and winter (Schultz and McAdoo 2002), with only trace amounts being consumed in summer (Van Vuren 1984).

Wildlife Interpretations:

This ecological site provides valuable browse plants for wildlife (Clements and Young 1997, Sheehy and Winward 1981, Ngugi et al. 1992.). The ability of low sagebrush to grow on exposed sites provides important cover and feed for wintering animals. In other areas, low sagebrush may be used preferentially in winter when shorter grasses are buried by snow (Meuggler and Stewart 1980). Pronghorn utilize black sagebrush heavily (Beale and Smith 1970). On the Desert Experiment Range, black sagebrush was found to comprise 68% of pronghorn diet even though it was only the third most common plant. Fawns were found to prefer black sagebrush utilizing it more than all other forage species combined (Beale and Smith 1970).

Pygmy rabbits (*Brachylagus idahoensis*), a threatened species of conservation concern throughout Nevada 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 rabbits will burrow where the big sagebrush form islands within the low sagebrush matrix (Keinath and McGee 2004). Sage grouse (*Centrocercus urophasianus*), 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, gray flycatcher (*Empidonax wrightii*), horned lark (*Eremophila alpestris*), vesper sparrow (*Pooecetes gramineus*) and western meadowlark (*Sturnella neglecta*), use low sagebrush, as it provides intermediate cover (Holmes and Alman 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). Reptile species including: eastern racers (*Coluber constrictor*), ringneck snakes (*Diadophis punctatus*), night snakes (*Hypsiglena torquata*), Sonoran mountain kingsnakes (*Lampropeltis pyromelana*), striped whipsnakes (*Masticophis taeniatus*), gopher snakes (*Pituophis catenifer*), long-nosed snakes (*Rhinocheilus lecontei*), wandering gartersnakes (*Thamnophis elegans vagrans*), Great Basin rattlesnakes (*Crotalus oreganus lutosus*), Great Basin collared lizard (*Crotaphytus bicinctores*), long-nosed leopard lizard (*Gambelia wislizenii*), short-horned lizard (*Phrynosoma hernandesi*), desert-horned lizard (*Phrynosoma platyrhinos*), sagebrush lizards (*Sceloporus graciosus*), western fence lizards (*Sceloporus occidentalis*), northern side-blotched lizards (*Uta stansburiana nevadaensis*), western skinks (*Plestiodon skiltonianus*), and Great Basin whiptails (*Aspidoscelis tigris tigris*) occur in areas where sagebrush is dominant. Similarly, amphibians such as: western toads (*Anaxyrus boreas*), Woodhouse's toads (*Anaxyrus woodhousii*), northern leopard frogs (*Lithobates pipiens*), Columbia spotted frogs (*Rana luteiventris*), bullfrogs (*Lithobates catesbeianus*), and Great Basin spadefoots (*Spea intermontana*) also occur throughout the Great Basin in areas

sagebrush species are dominant (Hamilton 2004). Studies have not determined if reptiles and amphibians prefer certain species of sagebrush; however, researchers agree that maintaining habitat where basin big sagebrush and reptiles and amphibians occur is important. In fact, wildlife biologists have noticed declines in reptiles where sagebrush steppe habitat has been seeded with introduced grasses (West 1999 and ref. therein). 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.

Further threats to low sagebrush dominant habitats include the Aroga moth. The Aroga moth is a sagebrush defoliator that threatens to infest extensive sagebrush stands throughout Great Basin rangelands (Bentz et al. 2008). Climate is generally believed to play a key role in determining the timing of insect outbreaks on Great Basin rangelands, but the exact mechanisms are not well understood (Bentz et al. 2008). These factors make management difficult; therefore, additional knowledge is needed to identify the susceptibility of landscapes altered by climate change and humans, as well as optimal strategies for management of host plants and insects populations residing in these changed systems (Bentz et al. 2008). This information will help managers and land owners alike manage the range for optimal productivity.

Hydrological functions

Runoff is very high. Permeability is moderately slow to moderate. Rills are none. Gravels and cobbles armor the surface. Water flow patterns are none to rare. Pedestals are none to rare. Frost heaving of shallow rooted plants should not be considered an indicator of soil erosion. Gullies are none. Surface structure is very fine platy or very fine to fine granular. Soil surface colors are dark and soils have a mollic epipedon. Organic carbon of the surface 2 to 4 inches is typically 1 to 3 percent dropping off quickly below. Organic matter content can be more or less depending on micro-topography.

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 has potential for upland and big game hunting.

Other information

Low sagebrush can be successfully transplanted or seeded in restoration. Black sagebrush is an excellent species to establish on sites where management objectives include restoration or improvement of domestic sheep, pronghorn, or mule deer winter range.

Type locality

Location 1: White Pine County, NV	
Township/Range/Section	T17N R64E S25
Latitude	39° 18' 34"
Longitude	114° 43' 16"
General legal description	SW ¹ / ₄ SE ¹ / ₄ Section 25, T17N. R64E. MDBM. Duck Creek Basin, Duck Creek range, White Pine County, Nevada. This site also occurs in Eureka, Lander and White Pine Counties, Nevada.

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Rangeland health reference sheet

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

Author(s)/participant(s)	Patti Novak-Echenique
Contact for lead author	State Rangeland Management Specialist
Date	11/18/2009
Approved by	PNovak-Echenique
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rills are none. Gravels and cobbles armor the surface.

2. **Presence of water flow patterns:** Water flow patterns are none to rare.

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.

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 3 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 dark and soils have a mollic epipedon. Organic carbon 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 and provide 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 none. Subangular blocky or platy sub-surface horizons 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 State: Deep-rooted, cool season, perennial bunchgrasses > low shrubs (low sagebrush, black sagebrush)

Sub-dominant: 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 ($\pm 20\%$) 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) ± 200 lbs/ac; Spring moisture significantly affects total production. 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.
-