Ecological site R028BY039NV
COBBLY CLAYPAN 12-14 P.Z.

Accessed: 10/12/2024

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.

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 mountain shoulders and backslopes. Slopes range from 8 to 50 percent, but slope gradients of 15 to 50 percent are most typical. Elevations range from 8000 to 9500 feet.

The soils associated with this site are shallow, well drained, and formed in residuum and colluvium derived from volcanic parent material. Soils typically have a mollic epipedon and an argillic within 30cm of the soil surface. The soil surface is covered with >55% rock fragments that are greater than 3" in diameter (cobbles, stones and boulders). Available water holding capacity is very low. The soil moisture regime is xeric bordering on aridic and the soil temperature regime is frigid.

The reference state is dominated by low sagebrush, bluebunch wheatgrass and Thurber's needlegrass. Production ranges from 200 to 500 pounds per acre.

Important abiotic factors contributing to the presence of this site include the >55% rock fragments on the soil surface that occupy plant growing space and reduce infiltration resulting in lower annual production.

Associated sites

F028BY064NV	**Shallow Gravelly Mountains 12-16 P.Z**
R028BY015NV	**LOAMY SLOPE 12-16 P.Z.**
R028BY030NV	**LOAMY 12-16 P.Z.**
R028BY037NV	**CLAYPAN 12-14 P.Z.**
R028BY087NV	**GRAVELLY CLAY 12-14 P.Z.**

Similar sites

R028BY034NV	**MOUNTAIN RIDGE 12-14 P.Z.** ARNO4 may be codominant; soils typically without a thick argillic horizon
R028BY038NV	**MOUNTAIN RIDGE 14+ P.Z.** PSSPS dominant grass; higher elevations
R028BY037NV	**CLAYPAN 12-14 P.Z.** More productive site

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Artemisia arbuscula*
Herbaceous	(1) *Pseudoroegneria spicata subsp. spicata* (2) *Achnatherum thurberianum*

Physiographic features

This site typically occurs on shoulders and backslopes of mountains. Slopes range from 8 to 50 percent, but slope gradients of 15 to 50 percent are typical. Elevations range from 6500-9500, but this site is typically found above 8000 feet.

Table 2. Representative physiographic features

Landforms	(1) Mountain slope (2) Mountain

Flooding frequency	None
Ponding frequency	None
Elevation	8,000–9,500 ft
Slope	15–50%
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. The estimated average annual precipitation is greater than 12 inches. Mean annual air temperature is about 43 to 45 degrees F. The average growing season is about 70 to 100 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)	100 days
Freeze-free period (average)	70 days
Precipitation total (average)	12 in

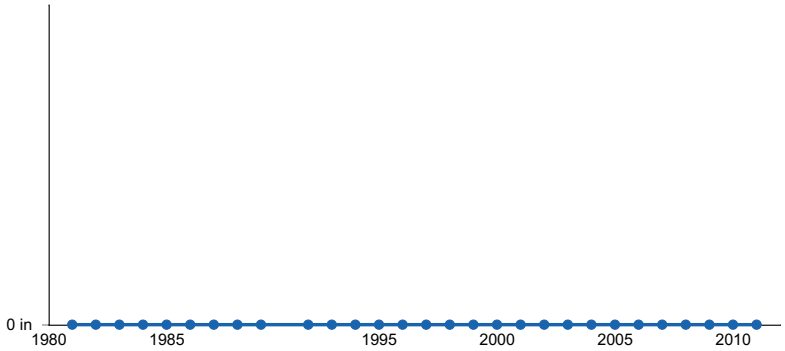

Figure 1. Annual precipitation pattern

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 volcanic rocks. Soils are characterized by a mollic epipedon and an argillic within 30cm of the surface. The surface is covered with >55 percent rock fragments >3 inches in diameter (cobbles, stones and boulders). Available water holding capacity is very low. The soil moisture regime is xeric bordering on aridic and the soil temperature regime is frigid. The soil series associated with this site include Chen, Garfan and Schoolmarm.

The representative soil series is Chen, a Clayey-skeletal, smectitic, frigid Aridic Lithic Argixerolls. Diagnostic horizons include a mollic epipedon from the soil surface to 33cm, argillic horizon from 20 to 43cm, and lithic contact at 43cm to underlying hard, unweathered andesite. Clay content in the particle size control section averages 38 to 55 percent. Rock fragments range from 35 to 65 percent, mainly gravel and cobbles. Reaction is slightly acid through slightly alkaline. Soils are not effervescent. Parent material consists of volcanic rocks, chert, sedimentary rocks, and loess.

Table 4. Representative soil features

Parent material	(1) Residuum–chert
Surface texture	(1) Cobbly loam
Family particle size	(1) Clayey
Drainage class	Well drained
Permeability class	Very slow
Soil depth	15–18 in
Surface fragment cover <=3"	5–10%
Surface fragment cover >3"	55–90%
Available water capacity (0-40in)	1–2.3 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)	6.6–6.8
Subsurface fragment volume <=3" (Depth not specified)	35–65%
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 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 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).
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 with the soil profile (Bates et al. 2006). Low sagebrush is fairly drought tolerant but also tolerates saturated soils during some portion of the growing season. Low sagebrush is 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 sagebrush populations.
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).
The range and density of singleleaf pinyon and Utah juniper has increased since the middle of the nineteenth century (Tausch 1999, Miller and Tausch 2000). Causes for expansion of trees into sagebrush ecosystems include wildfire suppression, historic livestock grazing, and climate change (Bunting 1994). Mean fire return intervals prior to European settlement in low sagebrush ecosystems were greater than 100 years, however frequent enough to inhibit the encroachment of singleleaf pinyon and Utah juniper into these low productive sagebrush cover types (Miller and Tausch 2000). Thus, trees were isolated to fire-safe areas such as rocky outcroppings and areas with low-productivity. An increase in crown density causes a decrease in understory perennial vegetation and an increase in bare ground. This allows for the invasion of non-native annual species such as cheatgrass. With annual species in the understory wildfire can become more frequent and increase in intensity.

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

Fire Ecology:
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).
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).

Muttongrass, a minor component on this site, 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 mutton grass.
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). Antelope bitterbrush is moderately fire tolerant (McConnell and Smith 1977). It regenerates by seed and resprouting (Blaisdell and Mueggler 1956, McArthur et al. 1982), however sprouting ability is highly variable and has been attributed to genetics, plant age, phenology, soil moisture and texture and fire severity (Blaisdell and Mueggler 1956, Blaisdell et al. 1982, Clark et al. 1982, Cook et al. 1994). Bitterbrush sprouts from a region on the stem approximately 1.5 inches above and below the soil surface; the plant rarely sprouts if the root crown is killed by fire (Blaisdell and Mueggler 1956). Low intensity fires may allow for bitterbrush to sprout; however, community response also depends on soil moisture levels at time of fire (Murray 1983). Lower soil moisture allows more charring of the stem below ground level

(Blaisdell and Mueggler 1956), thus sprouting will usually be more successful after a spring fire than after a fire in summer or fall (Murray 1983, Busse et al. 2000, Kerns et al. 2006). If cheatgrass is present, bitterbrush seedling success is much lower. The factor that most limits establishment of bitterbrush seedlings is competition for water resources with the invasive species cheatgrass (Clements and Young 2002).

Singleleaf pinyon and Utah juniper are usually killed by fire, and are most vulnerable to fire when they are under four feet tall (Bradley et al. 1992). Larger trees, because they have foliage farther from the ground and thicker bark, can survive low severity fires but mortality does occur when 60% or more of the crown is scorched. With the low production of the understory vegetation, high severity fires within this plant community were not likely and rarely became crown fires (Bradley et al. 1992, Miller and Tausch 2000). Tree density on this site increases with grazing management that favors the removal of fine fuels and management focused on fire suppression. With an increase of cheatgrass in the understory, fire severity is likely to increase. Singleleaf pinyon and Utah juniper reestablishes by seed from nearby seed source or surviving seeds. Utah juniper begins to produce seed at about 30 years old (Bradley et al. 1992). Seeds establish best through the use of a nurse plant such as sagebrush and rabbitbrush (Everett and Ward 1984, Tausch and West 1988, Bradley et al. 1992).

State and transition model

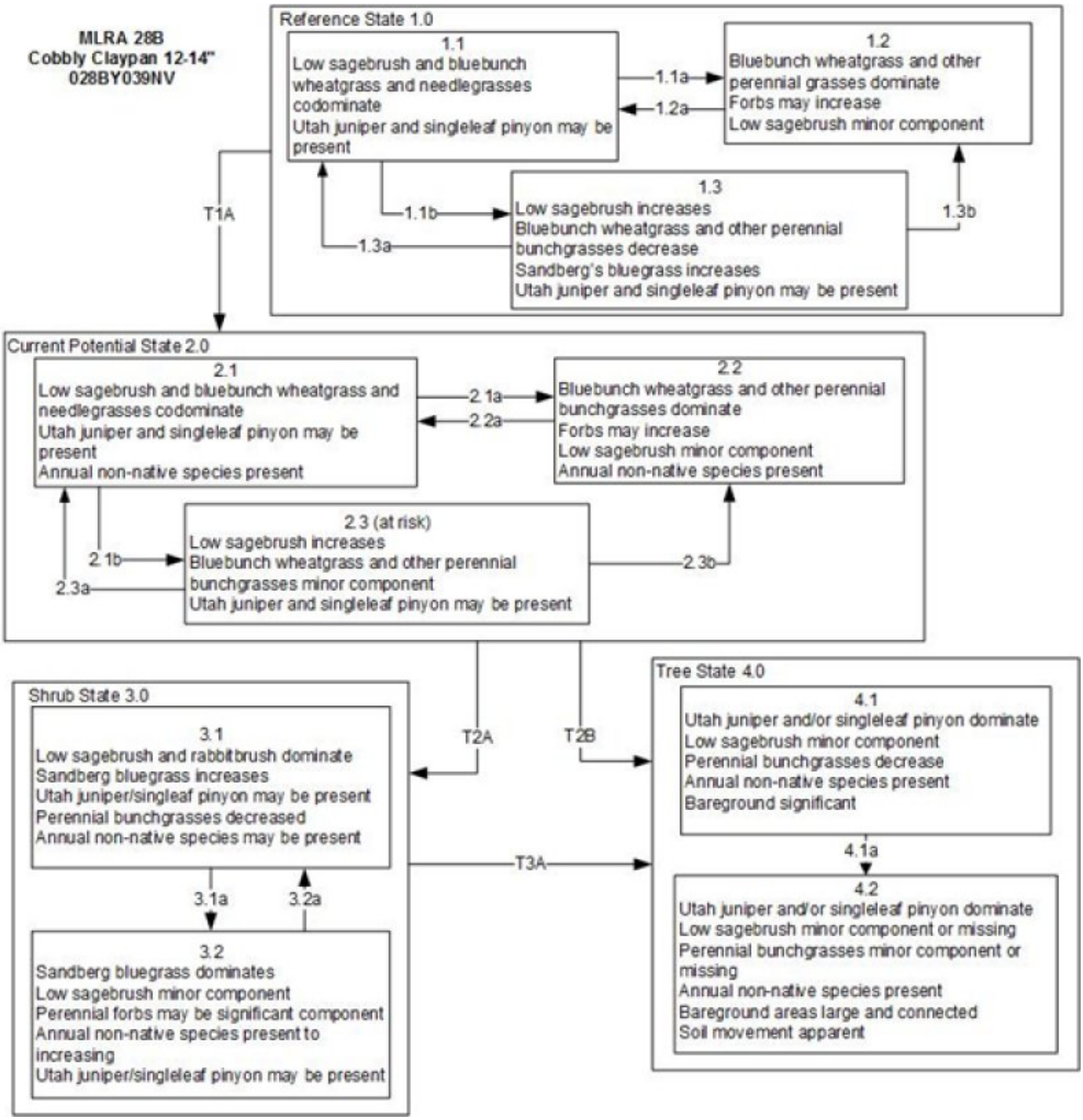

Figure 3. PNovakEchenique3_2017

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 3 general community phases; a shrub-grass dominant phase, a perennial grass dominant phase and a shrub dominant phase. State dynamics are maintained by interactions between climatic patterns and disturbance regimes. Negative feedbacks enhance ecosystem resilience and contribute to the stability of the state. These include the presence of all structural and functional groups, low fine fuel loads, and retention of organic matter and nutrients. Plant community phase changes are primarily driven by fire, periodic drought and/or insect or disease attack.

Community 1.1
Community Phase

This community is dominated by low sagebrush, antelope bitterbrush, bluebunch wheatgrass, Thurber's needlegrass and Sandberg's bluegrass. Forbs and other grasses make up smaller components. Utah juniper and singleleaf pinyon are described in the site concept and may or may not be present in low densities. Potential vegetative composition is about 40% grasses, 15% forbs and 45% shrubs and trees. Approximate ground cover (basal and crown) is 10 to 20 percent.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Shrub/Vine	36	148	211
Grass/Grasslike	80	140	200
Forb	30	52	75
Tree	4	9	14
Total	**150**	**349**	**500**

Community 1.2
Community Phase

This community phase is characteristic of a post-disturbance, early/mid-seral community. Bluebunch wheatgrass, needlegrasses and other perennial bunchgrasses dominate. Depending on fire severity patches of intact sagebrush may remain. Rabbitbrush and other sprouting shrubs may be present. Perennial forbs may be a significant component for a number of years following fire and may dominate in the higher elevation sites.

Community 1.3
Community Phase

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

Pathway a
Community 1.1 to 1.2

Fire will decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses to dominate the site. Fires will typically be low severity resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring may be more severe and reduce sagebrush cover to trace amounts.

Pathway b
Community 1.1 to 1.3

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

Pathway a
Community 1.2 to 1.1

Time and lack of disturbance will allow sagebrush to establish.

Pathway a
Community 1.3 to 1.1

A low severity fire, herbivory 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.

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, antelope bitterbrush, bluebunch wheatgrass, Thurber's needlegrass and Sandberg's bluegrass dominate the site. Forbs and other shrubs and grasses make up smaller components of this site. Utah juniper and singleleaf pinyon are described in the site concept and may or may not be present in low densities.

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. Depending on fire severity or intensity of Aroga moth infestations, patches of intact sagebrush may remain. Rabbitbrush may be sprouting or dominant in the community. Perennial forbs may be a significant component for a number of years and may dominate in the higher elevation sites. Annual non-native species are stable or increasing within the community.

Community 2.3
Community Phase (At Risk)

This community is at risk of crossing a threshold to another state. 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 and/or singleleaf pinyon may be present and without management will likely increase. Annual non-native species may be stable or increasing due to lack of competition with perennial bunchgrasses. This site is susceptible to further degradation from grazing, drought, and fire.

Pathway a
Community 2.1 to 2.2

Fire 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 sagebrush to dominate the site. Inappropriate grazing management reduces the perennial bunchgrass understory; conversely Sandberg bluegrass and muttongrass 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 sagebrush can take many years.

Pathway a
Community 2.3 to 2.1

A change in 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. 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. Annual non-native species are present and may increase in the community.

Pathway b
Community 2.3 to 2.2

Fire eliminates/reduces the overstory of sagebrush and allows for the understory perennial grasses to increase. Fires may be high severity in this community phase due to the dominance of sagebrush resulting in removal of overstory shrub community. Annual non-native species respond well to fire and may increase post burn.

State 3
Shrub State

This state is characterized by low sagebrush or a sprouting shrub overstory with a Sandberg bluegrass understory. The site has crossed a biotic threshold and site processes are being controlled by shrubs. Sagebrush cover exceeds site concept and may be decadent, reflecting stand maturity and lack of seedling establishment due to competition with mature plants. Bareground has increased and pedestalling of grasses may be excessive. Soil water, nutrient capture, nutrient cycling and soil organic matter are temporally and spatially redistributed.

Community 3.1
Community Phase

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

Community 3.2
Community Phase

Sandberg’s bluegrass dominates the site; annual non-native species may be present but are not dominant. Rabbitbrush may dominate overstory with trace amounts of sagebrush. Perennial forbs may be a significant component of the plant community.

Pathway a
Community 3.1 to 3.2

Fire reduces low sagebrush to trace amounts and allows for sprouting shrubs such as rabbitbrush to dominate. Excessive fall grazing causing mechanical damage to shrubs, and/or brush treatments with minimal soil disturbance would reduce sagebrush and facilitate sprouting shrubs and Sandberg 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 the shrub component to recover. The establishment of low sagebrush can take many years.

State 4
Tree State

This state is characterized by a dominance of Utah juniper and/or singleleaf pinyon in the overstory. Low sagebrush and perennial bunchgrasses may still be present, but they are no longer controlling site resources. Soil moisture, soi nutrients and soil organic matter distribution and cycling have been spatially and temporally altered.

Community 4.1
Community Phase

Utah juniper and/or singleleaf pinyon dominates the overstory and site resources. Trees are actively growing with noticeable leader growth. Trace amounts of bunchgrass may be found under tree canopies with trace amounts of Sandberg bluegrass and forbs in the interspaces. Sagebrush is stressed and dying. Annual non-native species are present under tree canopies. Bare ground interspaces are large and connected.

Community 4.2
Community Phase

Utah juniper and/or singleleaf pinyon dominate overstory. Low sagebrush is decadent and dying with numerous skeletons present or sagebrush may be missing from the system. Bunchgrasses present in trace amounts and annual non-native species may dominate understory. Herbaceous species may be located primarily under the canopy or near the drip line of trees. Bare ground interspaces are large and connected. Soil movement may be apparent.

Pathway a
Community 4.1 to 4.2

Time and lack of disturbance or management action allows for tree cover and density to further increase and trees to out-compete the herbaceous understory species for sunlight and water.

Transition A
State 1 to 2

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

Transition A
State 2 to 3

Trigger: To Community Phase 3.1: Inappropriate 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 in community phase 2.3 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 B
State 2 to 4

Trigger: Time and lack of disturbance or management action allows for Utah juniper and/or singleleaf pinyon to dominate. This may be coupled with grazing management that favors tree establishment by reducing understory herbaceous competition for site resources Feedbacks and ecological processes: Trees increasingly dominate use of soil water resulting in decreasing herbaceous and shrub production and decreasing organic matter inputs, contributing to reductions in soil water availability to grasses and shrubs and increased soil erodibility. Slow variables: Over time the abundance and size of trees will increase. Threshold: Trees dominate ecological processes and number of shrub skeletons exceed number of live shrubs. Minimal recruitment of new shrub cohorts.

Transition A
State 3 to 4

Trigger: Absence of disturbance over time allows for Utah juniper or singleleaf pinyon dominance. Feedbacks and ecological processes: Trees increasingly dominate use of soil water resulting in decreasing herbaceous and shrub production and decreasing organic matter inputs, contributing to reductions in soil water availability to grasses and shrubs and increased soil erodibility. Slow variables: Long-term increase in juniper and/or singleleaf pinyon density. Threshold: Trees overtop low sagebrush and out-compete shrubs for water and sunlight. Shrub skeletons exceed live shrubs in number. There is minimal recruitment of new shrub cohorts.

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**			60–176	
	bluebunch wheatgrass	PSSPS	*Pseudoroegneria spicata ssp. spicata*	35–88	–
	Thurber's needlegrass	ACTH7	*Achnatherum thurberianum*	18–53	–
	Sandberg bluegrass	POSE	*Poa secunda*	7–35	–
2	**Secondary Perennial Grasses**			7–35	
	Webber needlegrass	ACWE3	*Achnatherum webberi*	2–7	–
	squirreltail	ELEL5	*Elymus elymoides*	2–7	–
Forb					
3	**Perennial**			35–70	
	fleabane	ERIGE2	*Erigeron*	2–7	–
	buckwheat	ERIOG	*Eriogonum*	2–7	–
Shrub/Vine					
4	**Primary Shrubs**			88–158	
	little sagebrush	ARAR8	*Artemisia arbuscula*	88–123	–
	antelope bitterbrush	PUTR2	*Purshia tridentata*	0–35	–
5	**Secondary Shrubs**			7–35	
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	2–7	–
Tree					
6	**Evergreen**			4–14	
	Utah juniper	JUOS	*Juniperus osteosperma*	2–7	–
	singleleaf pinyon	PIMO	*Pinus monophylla*	2–7	–

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 5 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, and potentially medusahead, 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.
The Thurber's needlegrass component of this plant community 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. Sandberg bluegrass increases under grazing pressure (Tisdale and Hironaka 1981) and is capable of co-existing with cheatgrass or other weedy species. Depending on the season of use, the grazer and site conditions, either 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. However, trampling damage is likely to be localized in nature around areas where livestock or feral horses congregate. 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).
Antelope bitterbrush a minor component on this site is a critical browse species for mule deer, antelope and elk and is often utilized heavily by domestic livestock (Wood 1995). Grazing tolerance is dependent on site conditions (Garrison 1953) and the shrub can be severely hedged during the dormant season for grasses and forbs.
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).
Low sagebrush is considered valuable browse in the spring, fall and winter months for wildlife. In a study by Barnett and Crawford (1994), low sagebrush-bluebunch wheatgrass community was used during the pre-laying season of sagegrouse hens, sagebrush composed 50 to 80% of the diet by dry weight. Pronghorn antelope commonly use low sagebrush ranges throughout the summer months (Kindschy et al. 1982) and deer make heavy use of low sagebrush community types in early spring (Urness 1965).
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.

Hydrological functions

Runoff is high to very high. Permeability is moderate to very slow.

Recreational uses

Aesthetic value is derived from the diverse floral and faunal composition and the colorful flowering of wild flowers and shrubs during the spring and early summer. This site offers rewarding opportunities to photographers and for nature study. This site is used for camping and hiking and has potential for upland and big game hunting.

Other information

Low sagebrush can be successfully transplanted or seeded in restoration. Antelope bitterbrush enhances succession by retaining soil and depositing organic material and in some habitats and with some ecotypes, by fixing nitrogen.

Type locality

Location 1: White Pine County, NV	
Township/Range/Section	T25N R67E S32
Latitude	40° 0′ 1″
Longitude	114° 25′ 31″
General legal description	NE¼ SE¼, This site occurs along the Chin Creek drainage on the east side of the Antelope Mountains, White Pine County, Nevada.

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Rangeland health reference sheet

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

Author(s)/participant(s)	P. NOVAK-ECHENIQUE
Contact for lead author	State Rangeland Management Specialist
Date	04/02/2014
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rills are none. Rock fragments armor the surface.

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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. They are typically short (<1m) and not connected. They are meandering and are interrupted by plants and surface rocks.

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3. **Number and height of erosional pedestals or terracettes:** Pedestals are none to rare. Occurrence is usually limited to areas of water flow patterns. Frost heaving of shallow rooted plants should not be considered an indicator of soil erosion.

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare Ground ±15-25% depending on amount of surface rock fragments.

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5. **Number of gullies and erosion associated with gullies:** None

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6. **Extent of wind scoured, blowouts and/or depositional areas:** None. Rock fragments protect soil surface.

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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.

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

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Surface structure is typically weak thick platy. Soil surface colors are grayish brownw and soils have a mollic epipedon. Surface textures are loams. Organic matter 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

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Perennial herbaceous plants slow runoff and increase infiltration. Shrub canopy and associated litter break raindrop impact and provide opportunity for snow catch and accumulation on site.

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

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

    Dominant: Reference State: Evergreen low shrubs (low sagebrush) > deep-rooted, cool season, perennial bunchgrasses

    Sub-dominant: associated shrubs > deep-rooted, cool season, perennial forbs > fibrous, shallow-rooted, cool season, perennial forbs > annual forbs

    Other: evergreen trees

    Additional: With an extended fire return interval, the shrub and tree component will increase at the expense of the herbaceous component. Singleleaf pinyon and Utah juniper will eventually dominate the site and the understory will be greatly reduced.

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Dead branches within individual shrubs common and standing dead shrub canopy material may be as much as 20% of total woody canopy; some of the mature bunchgrasses (<10%) have dead centers.

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14. **Average percent litter cover (%) and depth (in):** Between plant interspaces (10-20%) and litter depth is <¼ inch.

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** For normal or average growing season (thruJune) ±350 lbs/ac; Favorable years ±500 lbs/ac and unfavorable years ±200 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 and annual mustards. With an extended fire return interval singleleaf pinyon and Utah juniper will increase and eventually dominate this site.

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 extended or extreme drought periods.