

## **Ecological site R025XY025NV CHALKY KNOLL**

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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.

### **MLRA notes**

Major Land Resource Area (MLRA): 025X—Owyhee High Plateau

#### **MLRA Notes 25—Owyhee High Plateau**

This area is in Nevada (56 percent), Idaho (30 percent), Oregon (12 percent), and Utah (2 percent). It makes up about 27,443 square miles. MLRA 25 is characteristically cooler and wetter than the neighboring MLRAs of the Great Basin. The western boundary is marked by a gradual transition to the lower and warmer basins of MLRA 24. The boundary to the south-southeast, with MLRA 28B, is marked by gradual changes in geology marked by an increased dominance of singleleaf pinyon and Utah juniper and a reduced presence of Idaho fescue. The boundary to the north, with MLRA 11, is a rapid transition from the lava plateau topography to the lower elevation Snake River Plain.

#### **Physiography:**

All of this area lies within the Intermontane Plateaus. The southern half is in the Great Basin section of the Basin and Range province. This part of the MLRA is characterized by isolated, uplifted fault-block mountain ranges separated by narrow, aggraded desert plains. This geologically older terrain has been dissected by numerous streams draining to the Humboldt River.

The northern half of the area lies within the Columbia Plateaus province. This part of the MLRA forms the southern boundary of the extensive Columbia Plateau basalt flows. Most of the northern half is in the Payette section, but the northeast corner is in the Snake River Plain section. Deep, narrow canyons draining into the Snake River have been incised into this broad basalt plain. Elevation ranges from 3,000 to 7,550 feet on rolling plateaus and in gently sloping basins. It is more than 9,840 feet on some steep mountains. The Humboldt River crosses the southern half of this area

#### **Geology:**

The dominant rock types in this MLRA are volcanic. They include andesite, basalt, tuff, and rhyolite. In the north and west parts of the area, Cretaceous granitic rocks are exposed among Miocene volcanic rocks in mountains. A Mesozoic igneous and metamorphic rock complex dominates the south and east parts of the area. Upper and Lower Paleozoic calcareous sediments, including oceanic deposits, are exposed with limited extent in the mountains. Alluvial fan and basin fill sediments occur in the valleys.

#### **Climate:**

The average annual precipitation in most of this area is typically 11 to 22 inches. It increases to as much as 49 inches at the higher elevations. Rainfall occurs in spring and sporadically in summer. Precipitation occurs mainly as snow in winter. The precipitation is distributed fairly evenly throughout fall, winter, and spring. The amount of precipitation is lowest from midsummer to early autumn. The average annual temperature is 33 to 51 degrees F. The freeze-free period averages 130 days and ranges from 65 to 190 days, decreasing in length with elevation. It is typically less than 70 days in the mountains.

#### **Water:**

The supply of water from precipitation and streamflow is small and unreliable, except along the Owyhee, Bruneau, and Humboldt Rivers. Streamflow depends largely on accumulated snow in the mountains. Surface water from mountain runoff is generally of excellent quality and suitable for all uses. The basin fill sediments in the narrow alluvial valleys between the mountain ranges provide some ground water for irrigation. The alluvial deposits along the large streams have the most ground water. Based on measurements of water quality in similar deposits in

adjacent areas, the basin fill deposits probably contain moderately hard water. The water is suitable for almost all uses. The carbonate rocks in this area are considered aquifers, but they are little used. Springs are common along the edges of the limestone outcrops.

#### Soils:

The dominant soil orders in this MLRA are Aridisols and Mollisols. The soils in the area dominantly have a mesic or frigid temperature regime and an aridic, aridic bordering on xeric, or xeric moisture regime. Soils with aquic moisture regimes are limited to drainage or spring areas, where moisture originates or runs on and through. These soils are of a very limited extent throughout the MLRA. They generally are well drained, clayey or loamy, and shallow or moderately deep. Most of the soils formed in mixed parent material. Volcanic ash and loess mantle the landscape. Surface soil textures are loam and silt loam with ashy texture modifiers in some areas. Argillic horizons occur on the more stable landforms. They are exposed nearer the soil surface on convex landforms, where ash and loess deposits are more likely to erode. Soils that formed in carbonatic parent material in areas that receive less than 12 inches of precipitation are characterized by calcic horizons throughout the profile, while soils in areas that receive more than 12 inches of precipitation do not have calcic horizons in the upper part of the profile. Soils that formed on stable landforms at the lower elevations are dominated by ochric horizons. Soils that formed at the middle and upper elevations are characterized by mollic epipedons. Soils in drainage areas at all elevations that receive moisture running on or through them are characterized by thicker mollic epipedons.

#### Biological Resources:

This MLRA supports shrub-grass vegetation. Lower elevations are characterized by Wyoming big sagebrush associated with bluebunch wheatgrass, western wheatgrass, and Thurber's needlegrass. Other important plants include bluegrass, squirreltail, penstemon, phlox, milkvetch, lupine, Indian paintbrush, aster, and rabbitbrush. Black sagebrush occurs but is less extensive. Singleleaf pinyon and Utah juniper occur in limited areas. With increasing elevation and precipitation, vast areas characterized by mountain big sagebrush or low sagebrush/early sagebrush in association with Idaho fescue, bluebunch wheatgrass, needlegrasses, and bluegrass become common. Snowberry, curl-leaf mountain mahogany, ceanothus, and juniper also occur. Mountains at the highest elevations support whitebark pine, Douglas-fir, limber pine, Engelmann spruce, subalpine fir, aspen, and curl-leaf mountain mahogany.

Major wildlife species include mule deer, bighorn sheep, pronghorn, mountain lion, coyote, bobcat, badger, river otter, mink, weasel, golden eagle, red-tailed hawk, ferruginous hawk, Swainson's hawk, northern harrier, prairie falcon, kestrel, great horned owl, short-eared owl, long-eared owl, burrowing owl, pheasant, sage grouse, chukar, gray partridge, and California quail. Reptiles and amphibians include western racer, gopher snake, western rattlesnake, side-blotched lizard, western toad, and spotted frog. Fish species include bull, red band, and rainbow trout.

## Ecological site concept

This site is on summits and side slopes of low hills on all exposures. Slopes range from 4 to 50 percent, but slope gradients of 8 to 30 percent are most typical. Elevations range from 4,500 to 5,500 feet (1,372 to 1,676 meters).

The soils associated with this site have a shallow effective rooting zone with depth to bedrock ranging from 8 to 20 inches (20 to 51cm). These soils are calcareous and may have a high percentage of gravel. The available water capacity is very low.

The representative plant community is Indian ricegrass, Wyoming big sagebrush and black sagebrush. Shrubs cover dominates the aspect of the site. Antelope bitterbrush, spiny hopsage and bottlebrush squirreltail are other important species associated with this site.

## Associated sites

R024XY030NV	<b>SHALLOW CALCAREOUS LOAM 8-10 P.Z.</b>
R025XY019NV	<b>LOAMY 8-10 P.Z.</b>
R025XY026NV	<b>CHANNERY HILL</b>

## Similar sites

R025XY019NV	<b>LOAMY 8-10 P.Z.</b> ARNO4 absent; more productive site; PSSPS-ACTH7 condominant grasses
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R025XY026NV	<b>CHANNERY HILL</b> ARTRW absent; ARNO4 dominant shrub; less productive site
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**Table 1. Dominant plant species**

Tree	Not specified
Shrub	(1) <i>Artemisia tridentata subsp. wyomingensis</i> (2) <i>Artemisia nova</i>
Herbaceous	(1) <i>Achnatherum hymenoides</i>

## Physiographic features

This site is on summits and side slopes of low hills slopes on all exposures. Slopes range from 4 to 50 percent, but slope gradients of 8 to 30 percent are most typical. Elevations range from 4,500 to 5,500 feet (1,372 to 1,676 meters).

**Table 2. Representative physiographic features**

Landforms	(1) Hill (2) Pediment (3) Plateau
Runoff class	High to very high
Flooding frequency	None
Ponding frequency	None
Elevation	4,500–5,500 ft
Slope	8–30%
Water table depth	48 in
Aspect	W, NW, N, NE, E, SE, S, SW

**Table 3. Representative physiographic features (actual ranges)**

Runoff class	Not specified
Flooding frequency	Not specified
Ponding frequency	Not specified
Elevation	Not specified
Slope	4–50%
Water table depth	Not specified

## Climatic features

The climate associated with this site is semiarid, characterized by cold, moist winters and warm, dry summers. The average annual precipitation ranges from 8 to 10 inches (20 to 25 cm). Mean annual air temperature is typically more than 45 to 50 degrees F. The average growing season is about 100 to 120 days.

Mean annual precipitation across the range of the ecological site is 9.56 inches (25 cm).

Monthly mean precipitation in inches: January 1.17 (2.9 cm); February 0.92 (2.3 cm); March 0.92 (2.3 cm); April 0.85 (2.2 cm); May 0.97 (2.5 cm); June 0.77 (2.0 cm); July 0.37 (0.9 cm); August 0.40 (1.0 cm); September 0.45 (1.1 cm); October 0.72 (1.8 cm); November 0.92 (2.3 cm); December 1.09 (2.8 cm).

\*The above data is averaged from the ELKO WB AIRPORT, NEVADA climate station (262573), NASIS and, Western Regional Climate Center.

Table 4. Representative climatic features

Frost-free period (characteristic range)	70-120 days
Freeze-free period (characteristic range)	91-130 days
Precipitation total (characteristic range)	7-13 in
Frost-free period (actual range)	50-120 days
Freeze-free period (actual range)	91-130 days
Precipitation total (actual range)	5-15 in
Frost-free period (average)	100 days
Freeze-free period (average)	110 days
Precipitation total (average)	10 in

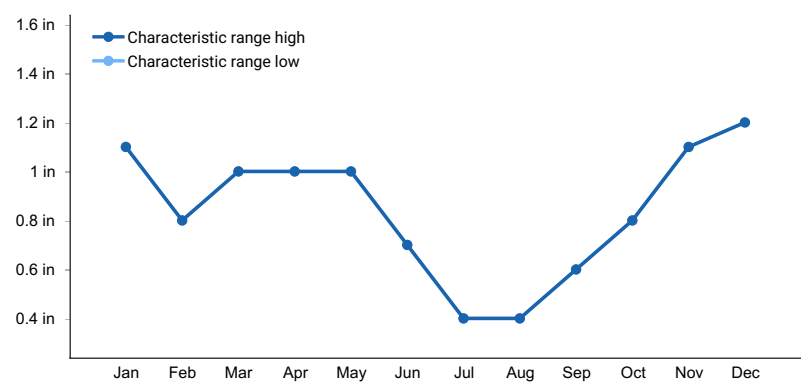


Figure 1. Monthly precipitation range

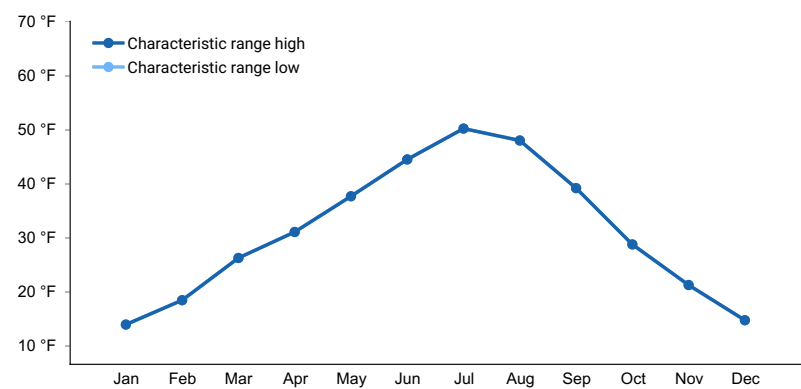


Figure 2. Monthly minimum temperature range

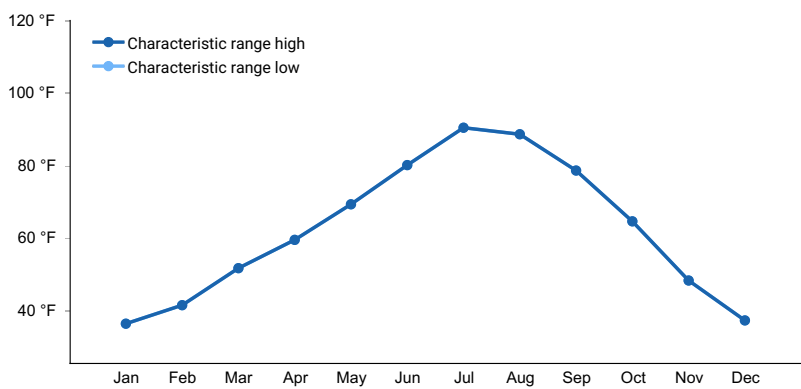
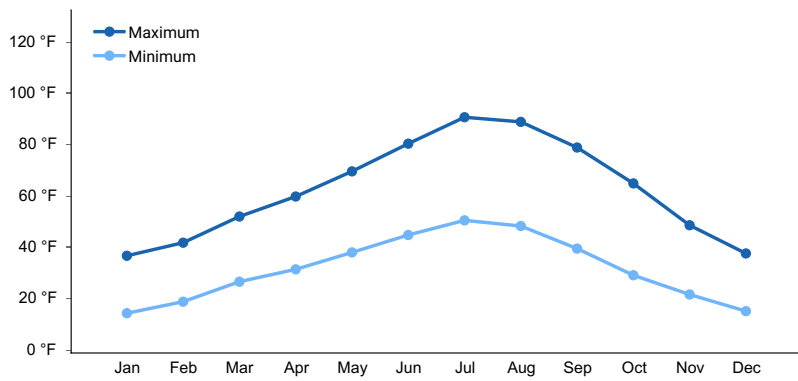
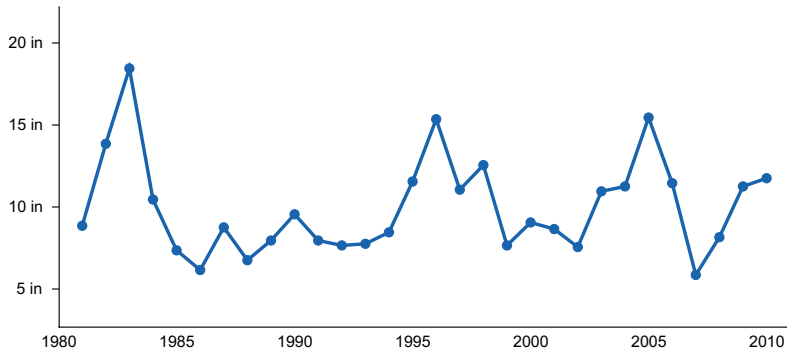


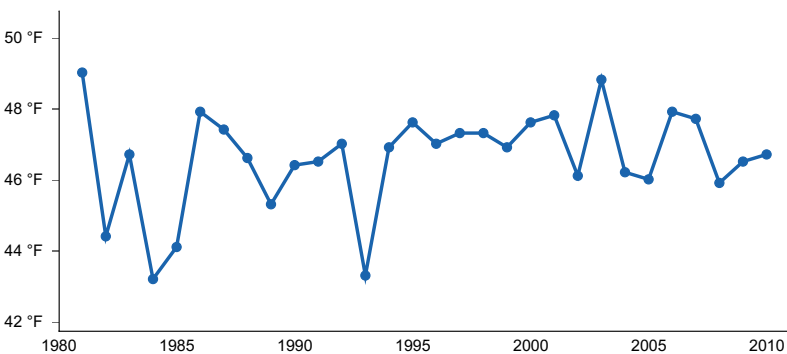
Figure 3. Monthly maximum temperature range



**Figure 4. Monthly average minimum and maximum temperature**



**Figure 5. Annual precipitation pattern**



**Figure 6. Annual average temperature pattern**

## Climate stations used

- (1) ELKO RGNL AP [USW00024121], Elko, NV

## Influencing water features

No influencing water features are associated with this site.

## Soil features

The soils associated with this site have a shallow effective rooting zone with depth to bedrock ranging from 8 to 40 inches (20 to 102cm). These soils are calcareous and may have a high percentage of gravel. The available water capacity is very low. Runoff is medium to very high and potential for surface erosion is moderate to severe depending on steepness of slope.

The soil series associated with this site include Perwick, Puett, and Shayla.

A representative soil series is Puett, classified as a loamy, mixed, superactive, calcareous, mesic, shallow Xeric Torriorthent. This soil is shallow, well drained and formed in residuum and colluvium derived from tuff and tuffaceous

sedimentary rocks. Reaction is moderately or strongly alkaline, and effervescence is strongly or violently effervescent. Diagnostic horizons include an ochric epipedon from the soil surface to 7 inches (18 cm). Clay content in the particle-size control section is between 5 to 10 percent. Rock fragments range from 0 to 35 percent gravel. Lithology of fragments are volcanic such as tuff or sedimentary such as tuffaceous sandstone and siltstone.

**Table 5. Representative soil features**

Parent material	(1) Colluvium–tuff (2) Residuum–tuff (3) Lacustrine deposits (4) Colluvium–sandstone and siltstone (5) Residuum–sandstone and siltstone
Surface texture	(1) Gravelly loam (2) Very gravelly silty clay loam
Family particle size	(1) Loamy (2) Coarse-loamy (3) Loamy-skeletal
Drainage class	Well drained
Permeability class	Moderate to moderately rapid
Depth to restrictive layer	8–40 in
Soil depth	8–40 in
Surface fragment cover ≤3"	10–40%
Surface fragment cover >3"	0–10%
Available water capacity (0–40in)	1–5 in
Calcium carbonate equivalent (0–40in)	1–30%
Electrical conductivity (0–40in)	0–4 mmhos/cm
Sodium adsorption ratio (0–40in)	0–12
Soil reaction (1:1 water) (0–40in)	7.9–9.6
Subsurface fragment volume ≤3" (Depth not specified)	15–25%
Subsurface fragment volume >3" (Depth not specified)	15–60%

## Ecological dynamics

An ecological site is the product of all the environmental factors responsible for its development and has a set of key characteristics that influence a site's resilience to disturbance and resistance to invasives. Key characteristics include 1) climate (precipitation and temperature), 2) topography (aspect, slope, elevation, and landform), 3) hydrology (infiltration and runoff), 4) soils (depth, texture, structure, and organic matter), 5) plant communities (functional groups and 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, as well as 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 meters (Comstock and Ehleringer 1992). Root length of mature sagebrush plants was measured to a depth of 2 meters in alluvial soils in Utah (Richards and Caldwell 1987). These shrubs have a flexible generalized root system with development of both deep taproots and laterals near the surface (Dobrowolski et al. 1990).

In the Great Basin, the majority of annual precipitation is received during the winter and early spring. This continental semiarid climate regime favors growth and development of deep-rooted shrubs and herbaceous cool season plants using the C3 photosynthetic pathway (Comstock and Ehleringer 1992). Winter precipitation and slow melting of snow results in deeper percolation of moisture into the soil profile. Herbaceous plants, more shallow-rooted than shrubs, grow earlier in the growing season and thrive on spring rains, while deeper-rooted shrubs lag in phenological development because they draw from deeply infiltrating moisture in snowmelt from the previous winter.

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).

Variability in plant community composition and production depends on soil surface texture and depth. For example, Thurber's needlegrass will increase on gravelly soils, whereas Indian ricegrass will increase with sandy soil surfaces, and bottlebrush squirreltail will increase with silty soil surfaces. A weak argillic horizon will promote production of bluebunch wheatgrass. Production generally increases with soil depth. The amount of sagebrush in the plant community is dependent upon disturbances such as fire, Aroga moth infestations, and grazing. Sandberg bluegrass more easily dominates sites where surface soils are gravelly loams or when there is an increase in ash in the upper soil profile.

Wyoming big sagebrush is the most drought tolerant of the big sagebrushes and is generally long-lived, deeming it unnecessary for new individuals to recruit every year for perpetuation of the stand. Simultaneous low, continuous recruitment and infrequent large recruitment events are the foundation of population maintenance (Noy-Meir 1973). Survival of the seedlings is dependent on adequate moisture conditions.

Native insect outbreaks are also important drivers of ecosystem dynamics in sagebrush communities. Climate is generally believed to influence the timing of insect outbreaks, especially with regard to Aroga moth (Aroga websteri), a sagebrush defoliator. Aroga moth infestations have occurred in the Great Basin in the 1960s, early 1970s, and have been ongoing in Nevada since 2004 (Bentz, et al 2008). Thousands of acres of big sagebrush have been impacted, with partial to complete die-off of plants or entire stands of big sagebrush observed (Furniss and Barr 1975).

The Great Basin sagebrush communities have high spatial and temporal variability in precipitation, both among years and within growing seasons. Nutrient availability is typically low but increases with elevation and closely follows moisture availability. The moisture resource supporting the greatest amount of plant growth is usually the water stored in the soil profile during winter. The invasibility of plant communities is often linked to resource availability. Disturbance can decrease resource uptake due to damage or mortality of the native species and depressed competition. It can also increase resource pools via the decomposition of dead plant material following disturbance. The invasion of sagebrush communities by cheatgrass (*Bromus tectorum*) has been linked to disturbances (fire, abusive grazing) that have resulted in fluctuations in resources (Chambers et al. 2007).

Perennial bunchgrasses generally have shallower root systems than shrubs in these systems, 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. General differences in root depth distributions between grasses and shrubs result in resource partitioning in these shrub/grass systems.

The introduction of annual weedy species, such as cheatgrass, may cause an increase in fire frequency and eventually lead to an annual state. Conversely, as fire frequency decreases, sagebrush will increase and with inappropriate grazing management, perennial bunchgrasses and forbs may be reduced.

At the upper range of this site's precipitation range, there is potential for infilling by Utah juniper (*Juniperus osteosperma*) and/or singleleaf pinyon (*Pinus monophylla*). Infilling may also occur if the site is adjacent to woodland sites or other ecological sites with juniper present. Without disturbance in these areas, Utah juniper will eventually dominate the site and outcompete sagebrush for water and sunlight, severely reducing both the shrub and herbaceous understory (Miller and Tausch 2000, Lett and Knapp 2005). The potential for soil erosion increases

as the woodland matures and the understory plant community cover declines (Pierson et al. 2010).

As ecological condition declines, rabbitbrush and littleleaf horsebrush increase in density while Indian ricegrass and other perennial grasses are reduced in the understory. Cheatgrass, annual mustards, Russian thistle, halogeton and Utah juniper are species likely to invade this site.

The range and density of Utah juniper and singleleaf pinyon 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).

This ecological site has low resilience to disturbance and low resistance to invasion. Increased resilience increases with elevation, aspect, increased precipitation and increased nutrient availability. Six possible stable states have been identified for the Chalky Knoll ecological site.

#### Fire Ecology:

Wyoming big sagebrush communities historically had low fuel loads and patchy fires that burned in a mosaic pattern were common at 10-70 year return intervals (Young et al. 1979, West and Hassan 1985, Bunting et al. 1987). Davies et al. (2006) suggest fire return intervals in Wyoming big sagebrush communities are around 50-100 years.

Wyoming big sagebrush is killed by fire and establishes after fire from a seedbank; from seed produced by remnant plants that escaped fire; and from plants adjacent to the burn that seed in. Black sagebrush is highly susceptible to fire-caused mortality; plants are readily killed by all fire intensities. Following burning, reestablishment occurs through off-site sources. Recovery time for Wyoming big sagebrush may require 50-120 or more years (Baker 2006). The introduction and expansion of cheatgrass, however, has dramatically altered the fire regime (Balch et al. 2013) and restoration potential of Wyoming big sagebrush communities.

Black sagebrush plants have no morphological adaptations for surviving fire and must reestablish from seed (Wright et al. 1979). The ability of black sagebrush to establish after fire is mostly dependent upon the amount of seed deposited in the seed bank the preceeding year. 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 2 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 2 and 10 years of storage respectively (Stevens et al. 1981). Thus, repeated frequent fires can eliminate black sagebrush from a site, though 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.

Antelope bitterbrush, a minor component on this site, is moderately fire tolerant (McConnell and Smith 1977). It regenerates by seed and resprouting (Blaisdell and Mueggler 1956, McArthur et al. 1982), though 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 cheatgrass, an invasive species (Clements and Young 2002).

Spiny hopsage is considered to be somewhat fire tolerant and often survives fires that kill sagebrush; it is reported to be least susceptible to fire during summer dormancy. Sprouting generally does not occur until the following spring.

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 are factors in individual species' responses. 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).

Indian ricegrass – the dominant grass on this site - is fairly fire tolerant (Wright 1985), which is likely due to its low culm density and below-ground plant crowns. Indian ricegrass has been found to reestablish on burned sites through seed dispersed from adjacent unburned areas (Young 1983, West 1994); thus, the presence of surviving, seed-producing plants is necessary for reestablishment of Indian ricegrass. Grazing management following fire to promote seed production and establishment of seedlings is important.

Sandberg bluegrass, a minor component of this ecological site, has been found to increase following fire likely due to its low stature and productivity (Daubenmire 1975). Sandberg bluegrass may retard reestablishment of deeper-rooted bunchgrasses. Reduced bunchgrass vigor or density provides an opportunity for Sandberg bluegrass expansion and/or cheatgrass and other invasive species to occupy interspaces, leading to increased fire frequency and potentially an annual plant community.

Depending on fire severity, rabbitbrush and horsebrush may increase after fire. Rubber rabbitbrush is top-killed by fire, but can resprout after fire and can also establish from seed (Young 1983). Yellow rabbitbrush is top-killed by fire, but sprouts vigorously after fire (Kuntz 1982, Akinsoji 1988). As cheatgrass increases, fire frequencies also increase to between 0.23 and 0.43 times a year; at this rate, even sprouting shrubs such as rabbitbrush will not survive (Whisenant 1990).

## **State and transition model**

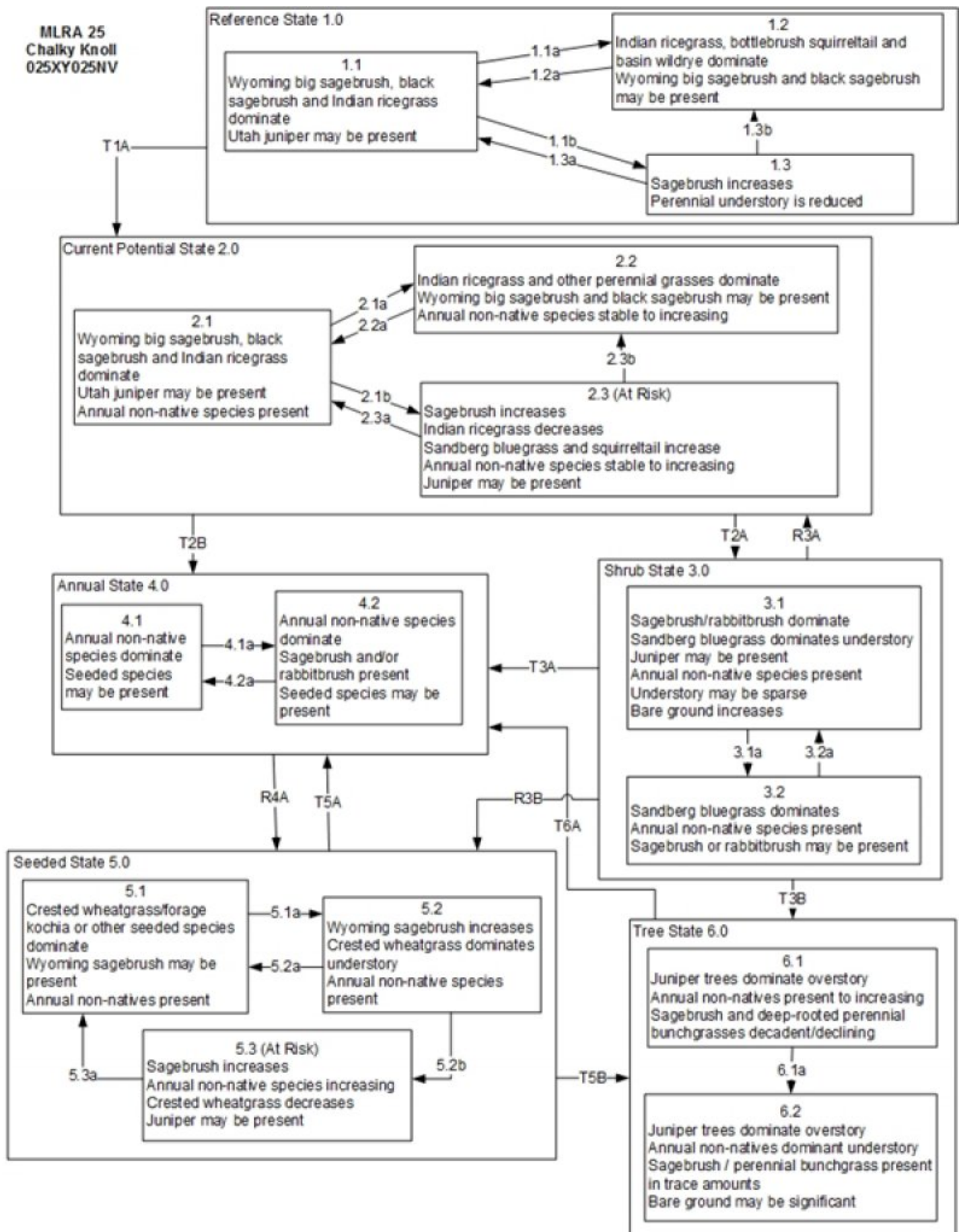


Figure 7. T. Stringham July 2015

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 may also decrease perennial understory.
- 1.2a: Time and lack of disturbance allows for shrub regeneration.
- 1.3a: Low severity fire or Aroga moth infestation resulting in a mosaic pattern.
- 1.3b: High severity fire or Aroga moth significantly reduces sagebrush cover leading to early/mid-seral community.

Transition T1A: Introduction of non-native species.

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 as fire or drought. Inappropriate grazing management may also reduce perennial understory.
- 2.2a: Time and lack of disturbance allows for regeneration of sagebrush.
- 2.3a: Low severity fire or Aroga moth infestation creates sagebrush/grass mosaic. Brush treatment with minimal soil disturbance; late-fall/winter grazing causing mechanical damage to sagebrush.
- 2.3b: High severity fire or Aroga moth significantly reduces sagebrush cover leading to a early/mid-seral community.

Transition T2A: Inappropriate grazing management favoring shrub dominance and reducing perennial bunchgrasses will lead to phase 3.1. Soil disturbing treatments will lead to phase 3.2.

Transition T2B: Catastrophic fire (to 4.1); inappropriate cattle/horse grazing management that removes bunchgrasses, favors shrubs and promotes the presence of non-native annual species (to 4.2)

Shrub State 3.0 Community Phase Pathways

- 3.1a: Low severity fire or Aroga moth infestation creates sagebrush/grass mosaic. Brush treatment with minimal soil disturbance; late-fall/winter grazing causing mechanical damage to sagebrush.
- 3.2a: Time and lack of disturbance.

Restoration R3A: Brush management and seeding of native deep rooted bunchgrasses (probability of success is low).

Restoration R3B: Brush management and seeding of crested wheatgrass and/or other non-native desirable species.

Transition T3A: Fire and/or soil disturbing treatments.

Transition T3B: Time and lack of disturbance such as fire favors an increase in tree dominance (from phase 3.1.)

Annual State 4.0 Community Phase Pathways

- 4.1a: Time and lack of disturbance. Big sagebrush is unlikely to reestablish and may take many years.
- 4.2a: High-severity fire.

Restoration R4A: Application of herbicide and seeding of desired species (probability of success best immediately following fire).

Seeded State 5.0 Community Phase Pathways

- 5.1a: Time without disturbance.
- 5.2a: Fire, brush management, or Aroga moth infestation reduces shrub component.
- 5.2b: Inappropriate grazing management decreases perennial bunchgrass understory.
- 5.3a: Fire, brush management, Aroga moth infestation.

Transition T5A: Catastrophic fire (coming from 5.3).

Transition T5B: Time and lack of disturbance allows trees to dominate site resources.

Tree State 6.0 Community Phase Pathways

- 6.1a: Time without disturbance.

Transition T6A: Catastrophic fire that kills trees. Inappropriate tree removal practices may also lead to dominance by non-native annuals.

Figure 8. T. Stringham July 2015

## State 1 Reference State

The Reference State 1.0 is a representative of the natural range of variability under pristine conditions. The reference state has three general community phases: a shrub-grass dominant phase, a perennial grass dominant

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

## Community 1.1

### Sagebrush-Indian ricegrass

The representative plant community is dominated by Indian ricegrass, Wyoming big sagebrush and black sagebrush. Shrubs dominate the aspect of the site. Antelope bitterbrush, spiny hopsage and bottlebrush squirreltail are other important species associated with this site. Potential vegetative composition is about 40 percent grasses, 10 percent forbs and 50 percent shrubs. Approximate ground cover (basal and crown) is 5 to 15 percent.

Table 6. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Shrub/Vine	100	175	250
Grass/Grasslike	80	140	200
Forb	20	35	50
<b>Total</b>	<b>200</b>	<b>350</b>	<b>500</b>

## Community 1.2

### Herbaceous

This community phase is characteristic of a post-disturbance, early to mid-seral community phase. Rabbitbrush, horsebrush, spiny hopsage and perennial grasses such as bluebunch wheatgrass, Indian ricegrass and squirreltail are common. Sagebrush is killed by fire, therefore decreasing within the burned community. Sagebrush could still be present in unburned patches. Thurber's needlegrass can experience high mortality from fire and may be reduced in the community for several years.

## Community 1.3

### Sagebrush

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 or from herbivory. Sandberg bluegrass will likely increase in the understory and may be the dominant grass on the site.

## Pathway 1.1a

### Community 1.1 to 1.2

Fire would decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses to dominate the site. Fires would typically be small and patchy due to low fuel loads. A fire following an unusually wet spring or a change in management may be more severe and reduce sagebrush cover to trace amounts. A severe infestation of Aroga moth could also cause a large decrease in sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs.

## Pathway 1.1b

### Community 1.1 to 1.3

Long-term drought, time and/or herbivory favor an increase in Wyoming and black sagebrush over deep-rooted perennial bunchgrasses. Combinations of these would allow the sagebrush overstory to increase and dominate the site, causing a reduction in the perennial bunchgrasses. Sandberg bluegrass may increase in density depending on the grazing management.



## **Pathway 1.2a**

### **Community 1.2 to 1.1**

Time and lack of disturbance allows for sagebrush to reestablish.

## **Pathway 1.3a**

### **Community 1.3 to 1.1**

Aroga moth infestation and or release from growing season herbivory may reduce sagebrush dominance and allow recovery of the perennial bunchgrass understory.

## **Pathway 1.3b**

### **Community 1.3 to 1.2**

Fire would decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses to dominate the site. Fires would typically be small and patchy due to low fuel loads. A fire following an unusually wet spring or a change in management may be more severe and reduce sagebrush cover to trace amounts. A severe infestation of Aroga moth could also cause a large decrease in sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs.

## **State 2**

### **Current Potential State**

This state is similar to the Reference State 1.0. Ecological function has not changed, however the resiliency of the state has been reduced by the presence of invasive weeds. This state has the same three general community phases. 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. 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. Additionally, the presence of highly flammable, non-native species reduces State resilience because these species can promote fire where historically fire has been infrequent leading to positive feedbacks that further the degradation of the system.

## **Community 2.1**

### **Sagebrush-Indian ricegrass/non-native annual species present**



**Figure 10. Chalky Knoll (R025XY025NV) Phase 2.1 T. K. Stringham, June 2011**

Wyoming and black sagebrush and Indian ricegrass dominate the site. Squirreltail, basin wildrye, and other perennial grasses and forbs are also common on this site. Non-native annual species are present in minor amounts.

## **Community 2.2**

### **Herbaceous**

This community phase is characteristic of a post-disturbance, early seral community phase. Rabbitbrush, horsebrush, spiny hopsage and perennial bunchgrasses such as bluebunch wheatgrass, needleandthread and Indian ricegrass are common. Wyoming big sagebrush is killed by fire, therefore decreasing within the burned community. Sagebrush could still be present in unburned patches. Perennial forbs may increase or dominate after fire for several years. Thurber's needlegrass can experience high mortality from fire and may be reduced in the community for several years. Annual non-native species generally respond well after fire and may be stable or increasing within the community. Rabbitbrush may dominate the aspect for a number of years following wildfire.

## **Community 2.3**

### **Sagebrush/non-native annual species (at risk)**

Sagebrush increases and the perennial understory is reduced. Decadent sagebrush dominates the overstory and the deep-rooted perennial bunchgrasses in the understory are reduced either from competition with shrubs or from inappropriate grazing management. Sandberg bluegrass will likely increase in the understory and may be the dominant grass on the site. Utah juniper may be present. Annual non-native species present.

## **Pathway 2.1a**

### **Community 2.1 to 2.2**

Fire would decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses to dominate the site. Fires would typically be small and patchy due to low fuel loads. A fire following an unusually wet spring or a change in management may be more severe and reduce sagebrush cover to trace amounts. A severe infestation of Aroga moth could also cause a large decrease in sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs. Annual non-native species generally respond well after fire and may be stable or increasing within the community.

## **Pathway 2.1b**

### **Community 2.1 to 2.3**

Time, long-term drought, grazing management that favors shrubs or combinations of these would allow the sagebrush overstory to increase and dominate the site, causing a reduction in the perennial bunchgrasses. However, Sandberg bluegrass and/or squirreltail may increase in the understory depending on the grazing management. Heavy spring grazing will favor an increase in sagebrush. Annual non-native species may be stable or increasing within the understory.

## **Pathway 2.2a**

### **Community 2.2 to 2.1**

Absence of disturbance over time allows for the sagebrush to recover, or grazing management that favors shrubs.

## **Pathway 2.3a**

### **Community 2.3 to 2.1**

Low severity fire or Aroga moth infestation creates sagebrush/grass mosaic. Other disturbances/practices include brush management with minimal soil disturbance; late-fall/winter grazing causing mechanical damage to sagebrush.

## **Pathway 2.3b**

### **Community 2.3 to 2.2**

Fire would decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses to dominate the site. Fires would typically be small and patchy due to low fuel loads. A fire following an unusually wet spring or a change in management may be more severe and reduce sagebrush cover to trace amounts. A severe infestation of Aroga moth could also cause a large decrease in sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs.

## **State 3**

### **Shrub State**

This state has two community phases: a Wyoming and black sagebrush dominated phase and a rabbitbrush dominated phase. This state is a product of many years of heavy grazing during time periods harmful to perennial bunchgrasses. Sandberg bluegrass will increase with a reduction in deep rooted perennial bunchgrass competition and become the dominant grass. Sagebrush dominates the overstory and rabbitbrush may be a significant component. Sagebrush canopy cover is high and sagebrush 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.

### **Community 3.1**

#### **Sagebrush/Sandberg bluegrass**

Sagebrush dominates the overstory and rabbitbrush may be a significant component. Sandberg bluegrass dominates the understory and squirreltail may also be a significant component of the plant community. Utah juniper may be present or increasing. Annual non-native species are present to increasing. Understory may be sparse, with bare ground increasing.

### **Community 3.2**

#### **Sandberg bluegrass/rabbitbrush**

Sandberg bluegrass dominates the understory; annual non-natives are present but are not dominant. Trace amounts of sagebrush may be present. Rabbitbrush may dominate for a number of years following fire.

### **Pathway 3.1a**

#### **Community 3.1 to 3.2**

Fire would decrease or eliminate the overstory of sagebrush. A severe infestation of Aroga moth could also cause a large decrease in sagebrush within the community, giving a competitive advantage to the Sandberg bluegrass, forbs and sprouting shrubs. Heavy fall grazing causing mechanical damage to shrubs, and/or brush treatments with minimal soil disturbance, would greatly reduce the overstory shrubs and allow for Sandberg bluegrass to dominate the site.

### **Pathway 3.2a**

#### **Community 3.2 to 3.1**

Absence of disturbance over time would allow for sagebrush and other shrubs to recover.

## **State 4**

### **Annual State**

This state has two community phases. The first is dominated by annual non-native species and the other is a shrub dominated site. This state is characterized by the dominance of annual non-native species such as cheatgrass and tansy mustard in the understory. Sagebrush and/or rabbitbrush may dominate the overstory. Annual non-native species and squirreltail dominate the understory.

### **Community 4.1**

#### **Annual non-native species**

Annual non-native plants such as cheatgrass or tansy mustard dominate the site. This phase may have seeded species present if resulting from a failed seeding attempt.

### **Community 4.2**

#### **Annual non-native species/shrubs**

Wyoming big sagebrush remains in the overstory with annual non-native species, likely cheatgrass, dominating the understory. Trace amounts of desirable bunchgrasses may be present.

#### **Pathway 4.1a** **Community 4.1 to 4.2**

Time and lack of disturbance. Occurrence of this pathway is unlikely.

#### **Pathway 4.2a** **Community 4.2 to 4.1**

Fire allows for annual non-native species to dominate site.

### **State 5** **Seeded State**

This state has three community phases: a grass-dominated phase, and grass-shrub dominated phase, and a shrub dominated phase. This state is characterized by the dominance of seeded introduced wheatgrass species in the understory. Forage kochia and other desired seeded species including Wyoming and black sagebrush, native and non-native forbs may be present.

#### **Community 5.1** **Seeded species**

Crested wheatgrass and/or other seeded species dominate the community. Non-native annual species are present. Trace amounts of sagebrush may be present, especially if seeded.

#### **Community 5.2** **Seeded species/Wyoming big sagebrush**

Sagebrush increases and may become the dominant overstory. Seeded wheatgrass species dominate understory. Annual non-native species may be present in trace amounts.

#### **Community 5.3** **Sagebrush/seeded species/non-native annual species (at risk)**

Sagebrush becomes the dominant plant. Perennial bunchgrasses in the understory are reduced due to increased competition. Annual non-native species may be increasing. Utah juniper may be present.

#### **Pathway 5.1a** **Community 5.1 to 5.2**

Time and lack of disturbance may be coupled with inappropriate grazing management.

#### **Pathway 5.2a** **Community 5.2 to 5.1**

Fire, brush management and/or Aroga moth infestation reduces sagebrush overstory and allows for seeded wheatgrasses or other seeded grasses to increase.

#### **Pathway 5.2b** **Community 5.2 to 5.3**

Continued inappropriate grazing management reduces bunchgrasses and increases density of sagebrush; this is usually a slow transition.



## **Pathway 5.3a**

### **Community 5.3 to 5.1**

Fire or brush management with minimal soil disturbance would reduce sagebrush to trace amounts and allow for the perennial understory to increase.

## **State 6**

### **Tree State**

This state has two community phases that are characterized by the dominance of Utah juniper and singleleaf pinyon in the overstory. Sagebrush and perennial bunchgrasses may still be present, but they are no longer controlling site resources. Soil moisture, soil nutrients, soil organic matter distribution and nutrient cycling have been spatially and temporally altered.

## **Community 6.1**

### **Juniper/annual non-native species**

Juniper trees dominate overstory, sagebrush is decadent and dying, deep rooted perennial bunchgrasses are decreasing. Recruitment of sagebrush cohorts is minimal. Annual non-natives may be present or increasing.

## **Community 6.2**

### **Juniper**

Utah juniper dominates the site and tree leader growth is minimal; annual non-native species may be the dominant understory species and will typically be found under the tree canopies. Trace amounts of sagebrush may be present however dead skeletons will be more numerous than living sagebrush. Bunchgrasses may or may not be present. Sandberg bluegrass or mat forming forbs may be present in trace amounts. Bare ground interspaces are large and connected. Soil redistribution is evident.

## **Pathway 6.1a**

### **Community 6.1 to 6.2**

Absence of disturbance over time allows for tree cover and density to further increase and out-compete the herbaceous understory species for sunlight and water.

## **Transition T1A**

### **State 1 to 2**

Trigger: This transition is caused by the introduction of non-native annual weeds, such as cheatgrass, mustard and halogeton. Slow variables: Over time the annual non-native plants will increase within the community decreasing organic matter inputs from deep-rooted perennial bunchgrasses resulting in reductions in soil water availability for perennial bunchgrasses. 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 T2A**

### **State 2 to 3**

Trigger: Inappropriate, long-term grazing of perennial bunchgrasses during growing season would favor shrubs and initiate transition to Community Phase 3.1. Fire would cause a transition to Community Phase 3.2. Slow variables: Long term decrease in deep-rooted perennial grass density resulting in a decrease in organic matter inputs and subsequent soil water decline. Threshold: Loss of deep-rooted perennial bunchgrasses changes spatial and temporal nutrient cycling and nutrient redistribution, and reduces soil organic matter.

## **Transition T2B**

### **State 2 to 4**

Trigger: Fire or a failed range seeding leads to plant community phase 4.1. Inappropriate grazing management that favors shrubs in the presence of non-native annual species leads to community phase 4.2. Slow variables: Increased production and cover of non-native annual species. Threshold: Cheatgrass or other non-native annuals dominate understory.

### **Restoration pathway R3A**

#### **State 3 to 2**

Brush management, herbicide or sub-soiling of Sandberg bluegrass and seeding of desired perennial bunchgrass.

### **Transition T3A**

#### **State 3 to 4**

Trigger: Fire or inappropriate grazing management can eliminate the Sandberg bluegrass understory and transition to community phase 4.1 or 4.2. Slow variable: Increased seed production and cover of annual non-native species. Threshold: Increased, continuous fine fuels modify the fire regime by changing intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture and impact the nutrient cycling and distribution.

### **Restoration pathway R3B**

#### **State 3 to 5**

Brush management, herbicide of Sandberg bluegrass and seeding of crested wheatgrass and/or other desired species.

### **Transition T3B**

#### **State 3 to 6**

Trigger: Lack of fire allows for trees to dominate site; may be coupled with inappropriate grazing management that reduces fine fuels. Slow variables: Increased establishment and cover of juniper trees, reduction in organic matter inputs. Threshold: Trees overtop sagebrush and out-compete shrubs for water and sunlight. Shrub skeletons exceed live shrubs with minimal recruitment of new cohorts.

### **Restoration pathway R4A**

#### **State 4 to 5**

Application of herbicide and seeding of desired species. Success for this restoration pathway is unlikely; probability of success is best immediately following fire.

### **Transition T5A**

#### **State 5 to 4**

Trigger: Fire. Slow variables: Increased production and cover of non-native annual species Threshold: Cheatgrass or other non-native annuals dominate understory.

### **Transition T5B**

#### **State 5 to 6**

Trigger: Lack of fire allows for trees to dominate site; may be coupled with inappropriate grazing management that reduces fine fuels. Slow variables: Increased establishment and cover of juniper trees, reduced infiltration and increased runoff. Threshold: Trees overtop sagebrush and out-compete shrubs for water and sunlight. Shrub skeletons exceed live shrubs with minimal recruitment of new cohorts.

### **Transition T6A**

#### **State 6 to 4**

Trigger: Catastrophic crown fire would reduce or eliminate trees to transition the site to 4.1. Tree removal when annual non-natives such as cheatgrass are present would also transition the site to state 4.0. Slow variable: Increased seed production and cover of annual non-native species. Threshold: Increased, continuous fine fuels modify the fire regime by changing intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture and impact the nutrient cycling and distribution.

## Additional community tables

Table 7. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
<b>Grass/Grasslike</b>					
1	<b>Primary Perennial Grasses</b>			78–168	
	Indian ricegrass	ACHY	<i>Achnatherum hymenoides</i>	53–105	–
	squirreltail	ELEL5	<i>Elymus elymoides</i>	18–35	–
	basin wildrye	LECI4	<i>Leymus cinereus</i>	7–28	–
2	<b>Secondary Perennial Grasses</b>			18–53	
	Webber needlegrass	ACWE3	<i>Achnatherum webberi</i>	2–18	–
	tufted wheatgrass	ELMA7	<i>Elymus macrourus</i>	2–18	–
	needle and thread	HECO26	<i>Hesperostipa comata</i>	2–18	–
	Sandberg bluegrass	POSE	<i>Poa secunda</i>	2–18	–
<b>Forb</b>					
3	<b>Perennial</b>			18–53	
	tufted wheatgrass	ELMA7	<i>Elymus macrourus</i>	2–18	–
	buckwheat	ERIOG	<i>Eriogonum</i>	2–11	–
	phlox	PHLOX	<i>Phlox</i>	2–11	–
	goldenweed	PYRRO	<i>Pyrrocoma</i>	2–11	–
	princesplume	STANL	<i>Stanleya</i>	2–11	–
<b>Shrub/Vine</b>					
4	<b>Primary Shrubs</b>			102–221	
	black sagebrush	ARNO4	<i>Artemisia nova</i>	35–70	–
	antelope bitterbrush	PUTR2	<i>Purshia tridentata</i>	7–28	–
	spiny hopsage	GRSP	<i>Grayia spinosa</i>	7–18	–
	buckwheat	ERIOG	<i>Eriogonum</i>	2–11	–
	phlox	PHLOX	<i>Phlox</i>	2–11	–
	goldenweed	PYRRO	<i>Pyrrocoma</i>	2–11	–
	princesplume	STANL	<i>Stanleya</i>	2–11	–
5	<b>Secondary Shrubs</b>			18–53	
	shadscale saltbush	ATCO	<i>Atriplex confertifolia</i>	2–11	–
	yellow rabbitbrush	CHVI8	<i>Chrysothamnus viscidiflorus</i>	2–11	–
	winterfat	KRLA2	<i>Krascheninnikovia lanata</i>	2–11	–
	purple sage	SADOI	<i>Salvia dorrii</i> ssp. <i>dorrii</i> var. <i>incana</i>	2–11	–
	littleleaf horsebrush	TEGL	<i>Tetradymia glabrata</i>	2–11	–
<b>Tree</b>					
6	<b>Evergreen</b>			2–11	
	spiny hopsage	GRSP	<i>Grayia spinosa</i>	7–18	–
	winterfat	KRLA2	<i>Krascheninnikovia lanata</i>	2–11	–
	shadscale saltbush	ATCO	<i>Atriplex confertifolia</i>	2–11	–
	Utah juniper	JUOS	<i>Juniperus osteosperma</i>	2–11	–

## Animal community

Livestock Interpretations:

This site has limited value for livestock use because of its low forage production. Higher condition sites furnish some early spring, fall and winter grazing to cattle and especially sheep. Attentive grazing management is required

on steeper slopes due to severe erosion hazards. Considerations for grazing management include timing, intensity and duration of grazing.

Overgrazing leads to an increase in sagebrush and a decline in understory plants like Indian ricegrass. Squirreltail or Sandberg bluegrass will increase temporarily with further degradation. Invasion of annual weedy forbs and cheatgrass could occur with further grazing degradation, leading to a decline in squirreltail and bluegrass and an increase in bare ground. A combination of overgrazing and prolonged drought leads to soil erosion, increased bare ground and a loss in plant production. Wildfire in sites with cheatgrass present could transition to cheatgrass-dominated communities. Without management, cheatgrass and annual forbs are likely to invade and dominate the site, especially after fire. Although trees are not part of the site concept, Utah juniper and/or singleleaf pinyon can also invade and eventually dominate this site.

Reduced bunchgrass vigor or density provides an opportunity for Sandberg bluegrass expansion and/or cheatgrass and other invasive species such as saltlover (*Halogeton glomeratus*), bur buttercup (*Ceratocephala testiculata*) and annual mustards to occupy interspaces. 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 grazer and site conditions, either Sandberg bluegrass or cheatgrass may become the dominant understory with inappropriate grazing management.

Long-term disturbance response may be influenced by small differences in landscape topography. Concave areas hold more moisture and may retain deep-rooted perennial grasses whereas convex areas are slightly less resilient and may have more Sandberg bluegrass present.

Indian ricegrass is a preferred forage species for livestock and wildlife (Cook 1962, Booth et al. 2006). It is readily utilized in early spring as it is a source of green feed before most other perennial grasses have produced new growth (Quinones 1981). Booth et al. (2006) note that the plant does well when utilized in winter and spring. Cook and Child (1971), however, found that repeated heavy grazing reduces crown cover, which may reduce seed production, density, and basal area of these plants. Additionally, heavy early spring grazing reduces plant vigor and stand density (Stubbendieck 1985). In eastern Idaho, productivity of Indian ricegrass was at least 10 times greater in undisturbed plots than in those that had been heavily grazed (Pearson 1965). Cook and Child (1971) found significant reduction in plant cover after 7 years of rest from heavy (90%) and moderate (60%) spring use. The seed crop may be reduced where grazing is heavy (Bich et al. 1995). Tolerance to grazing increases after May, thus spring deferment may be necessary for stand enhancement (Pearson 1964, Cook and Child 1971); however, utilization of less than 60% is recommended for Indian ricegrass.

Bottlebrush squirreltail is very palatable winter forage for domestic sheep of Intermountain ranges as they relish the green foliage. Overall, bottlebrush squirreltail is considered moderately palatable to livestock.

During settlement, many of the cattle in the Great Basin were wintered on extensive basin wildrye stands; due to sensitivity to spring, use many stands were decimated by the early 20th century (Young et al. 1976). Less palatable species, such as big sagebrush and rabbitbrush (*Chrysothamnus* spp.), increased in dominance along with invasive non-native species such as Russian thistle, mustards, and cheatgrass (Roundy 1985). The early growth and abundant production of basin wildrye make it a valuable source of forage for livestock. It is important forage for livestock and is readily grazed by cattle and horses in early spring and fall. Though coarse-textured during the winter, basin wildrye may be utilized more frequently by livestock and wildlife when snow has covered low shrubs and other grasses. Basin wildrye is used often as a winter feed for livestock and wildlife by not only providing roughage above the snow but also cover in the early spring months (Majerus 1992). Inadequate rest and recovery from defoliation causes a decrease in basin wildrye and an increase in basin big sagebrush and rubber rabbitbrush (*Ericameria nauseosa*) (Young et al. 1976, Roundy 1985). Spring defoliation of basin wildrye and/or consistent, heavy grazing during the growing season has been found to significantly reduce basin wildrye production and density (Krall et al. 1971). Additionally, native basin wildrye seed viability has been found to be low and seedlings lack vigor (Young and Evans 1981). Roundy (1985) found that although basin wildrye is adapted to seasonally dry saline soils, high and frequent spring precipitation is necessary to establish it from seed. This suggests that establishment of native basin wildrye seedlings occurs only during years of unusually high precipitation; thus, reestablishment of a stand may be episodic.

Black sagebrush is an important browse species to domestic livestock. 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. 1979), though 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).

Livestock browse Wyoming big sagebrush, but may use it only lightly when palatable herbaceous species are available. In winter, at lower elevations, black sagebrush is heavily utilized by domestic sheep.

Stocking rates vary over time depending upon season of use, climate variations, site, and previous and current management goals. A safe starting stocking rate is an estimated stocking rate that is fine-tuned by the client by adaptive management through the year and from year to year.

#### Wildlife Interpretations:

Indian ricegrass is eaten by pronghorn in "moderate" amounts whenever available. In Nevada, it is consumed by desert bighorns. A number of heteromyid rodents inhabiting desert rangelands show preference for seed of Indian ricegrass. Indian ricegrass seed provides food for many species of birds as well. Doves, for example, eat large amounts of shattered Indian ricegrass seed lying on the ground. This species is often heavily utilized in winter because it cures well (Booth et al. 2006).

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

Wyoming big sagebrush is preferred browse for wild ungulates. Pronghorn usually browse Wyoming big sagebrush heavily. Sagebrush-grassland communities provide critical sage-grouse breeding and nesting habitats. Open Wyoming sagebrush communities are preferred nesting habitat. Meadows surrounded by sagebrush may be used as feeding and strutting grounds. Sagebrush is a crucial component of their diet year-round, and sage-grouse select sagebrush almost exclusively for cover. Lekks are often located on low sagebrush sites, grassy openings, dry meadows, ridgetops, and disturbed sites. Sage-grouse prefer mountain big sagebrush and Wyoming big sagebrush communities to basin big sagebrush communities.

Black sagebrush is a significant browse species within the Intermountain region. It is especially important on low elevation winter ranges in the southern Great Basin, where extended snow free periods allow animal's access to plants throughout most of the winter. In these areas it is heavily utilized by pronghorn and mule deer. Black sagebrush palatability has been rated as moderate to high depending on the ungulate and the season of use (Horton 1989, Wambolt 1996). The palatability of black sagebrush increases the potential for negative impacts on remaining black sagebrush plants from grazing or browsing pressure following fire (Wambolt 1996). 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).

Spiny hopsage provides a palatable and nutritious food source for big game animals. It is also used as forage to at least some extent by deer, pronghorn, and rabbits.

Pronghorn antelope, mule deer, elk, and bighorn sheep utilize antelope bitterbrush extensively. Mule deer use of antelope bitterbrush peaks in September, when antelope bitterbrush may compose 91 percent of the diet. Winter use is greatest during periods of deep snow. Antelope bitterbrush seed is a large part of the diets of rodents, especially deer mice and kangaroo rats. In addition, antelope bitterbrush is often utilized by domestic livestock (Wood 1995). Domestic livestock and mule deer may compete for antelope bitterbrush in late summer, fall, and/or winter. Cattle prefer antelope bitterbrush from mid-May through June and again in September and October. Grazing tolerance is dependent on site conditions (Garrison 1953) and the shrub can be severely hedged during the dormant season for grasses and forbs.

## Hydrological functions

Runoff is medium to very high. Permeability is moderate to moderately rapid. Rills are rare. A few rills can be expected on steeper slopes in areas subjected to summer convection storms or rapid spring snowmelt. Water flow

patterns are rare, but can be expected in areas subjected to summer convection storms or rapid snowmelt. Pedestals are rare. Frost heaving of shallow rooted plants should not be considered a normal condition. Gullies are none to rare. Perennial herbaceous plants (especially deep-rooted bunchgrasses [i.e., Indian ricegrass] slow runoff and increase infiltration. Shrub canopy and associated litter break raindrop impact and provide opportunity for snow catch and accumulation on site.

**Recreational uses**

This site has minimal recreational potential. It is low in aesthetic appeal and natural beauty. Steep slopes and erosive surface conditions prohibit many forms of recreation. The site is poor for camping, picnicking, hiking and hunting.

**Other products**

Native Americans made tea from big sagebrush leaves. They used the tea as a tonic, an antiseptic, for treating colds, diarrhea, and sore eyes and as a rinse to ward off ticks. Big sagebrush seeds were eaten raw or made into meal. Some Native American peoples traditionally ground parched seeds of spiny hopsage to make pinole flour. Indian ricegrass was traditionally eaten by some Native American peoples. The Paiutes used seed as a reserve food source. Basin wildrye was used as bedding for various Native American ceremonies, providing a cool place for dancers to stand.

**Other information**

Wyoming big sagebrush is used for stabilizing slopes and gullies and for restoring degraded wildlife habitat, rangelands, mine spoils and other disturbed sites. It is particularly recommended on dry upland sites where other shrubs are difficult to establish. 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. Spiny hopsage has moderate potential for erosion control and low to high potential for long-term revegetation projects. It can improve forage, control wind erosion, and increase soil stability on gentle to moderate slopes. Antelope bitterbrush has been used extensively in land reclamation. Antelope bitterbrush enhances succession by retaining soil and depositing organic material and in some habitats and with some ecotypes, by fixing nitrogen. Spiny hopsage is suitable for highway plantings on dry sites in Nevada. Indian ricegrass is well-suited for surface erosion control and desert revegetation although it is not highly effective in controlling sand movement. Bottlebrush squirreltail is tolerant of disturbance and is a suitable species for revegetation. Basin wildrye is useful in mine reclamation, fire rehabilitation and stabilizing disturbed areas. Its usefulness in range seeding, however, may be limited by initially weak stand establishment.

**Inventory data references**

Physiographic and Soils features were gathered from NASIS.

**Type locality**

Location 1: Elko County, NV	
Township/Range/Section	T34N R52E S9
General legal description	About 10 miles north of Carlin, Dry Gulch area, Elko County, Nevada Distribution and extent. Elko, Lander and Eureka Counties, Nevada.

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## **Approval**

Kendra Moseley, 4/25/2024

## **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	12/07/2009
Approved by	Kendra Moseley
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

## Indicators

1. **Number and extent of rills:** Rills are none to rare. A few rills can be expected on steeper slopes in areas subjected to summer convection storms or rapid spring snowmelt.  

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2. **Presence of water flow patterns:** Water flow patterns are none to rare, but can be expected in areas subjected to summer convection storms or rapid snowmelt.  

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3. **Number and height of erosional pedestals or terracettes:** Pedestals are rare. Frost heaving of shallow rooted plants should not be considered a normal condition.  

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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 is  $\pm$  40-50% 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  

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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.  

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Surface structure is thin platy, subangular blocky, or massive. Soil surface colors are light and soils are typified by an ochric epipedon. Organic matter of the surface 2 to 3 inches is typically 1 to 1.5 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 (especially deep-rooted bunchgrasses [i.e., Indian ricegrass] 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. Subangular blocky or massive sub-surface horizons are not to be interpreted as compacted layers.
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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: shrubs (Wyoming big sagebrush) = deep-rooted, cool season, perennial bunchgrasses (Indian ricegrass)
- Sub-dominant: associated shrubs = shallow-rooted, cool season, perennial bunchgrasses > deep-rooted, cool season, perennial forbs = fibrous, shallow-rooted, cool season, perennial and 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 25% of total woody canopy; some of the mature bunchgrasses (<20%) have dead centers.
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14. **Average percent litter cover (%) and depth ( in):** Under canopy and within plant interspaces ( $\pm$  10-20%) and depth of litter is < ½ inch.
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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** For normal or average growing season (end of May)  $\pm$  350 lbs/ac; Spring moisture significantly affects total production.
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16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:** Potential invaders include halogeton, Russian thistle, annual mustards, bur buttercup, and cheatgrass.
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17. **Perennial plant reproductive capability:** All functional groups should reproduce in average (or normal) and above average growing season years.
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