

## **Ecological site R025XY021NV SHALLOW LOAM 8-12 P.Z.**

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### **General information**

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

### **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 hills, fan remnants, rock-pediment remnants and partial ballenas on all aspects. Slopes range from 4 to 50 percent, but slope gradients are generally less than 30 percent. Elevations are 4,500 to 6,500 feet (1,372 to 1,981 meters).

The soils in this site have a shallow effective rooting depth and are well drained. The soils have 35 to 75 percent gravels and other coarse fragments throughout the profile. The soils of this site have a high percentage of gravels, cobbles and stone cover on the surface providing a stabilizing effect on surface erosion conditions.

The representative plant community is dominated by bluebunch wheatgrass, Thurber's needlegrass and big sagebrush.

### Associated sites

R025XY014NV	<b>LOAMY 10-12 P.Z.</b>
R025XY015NV	<b>SOUTH SLOPE 8-12 P.Z.</b>
R025XY018NV	<b>CLAYPAN 10-12 P.Z.</b>
R025XY019NV	<b>LOAMY 8-10 P.Z.</b>

### Similar sites

R025XY014NV	<b>LOAMY 10-12 P.Z.</b> More productive site
R025XY066NV	<b>ASHY LOAM 10-12 P.Z.</b> More productive site
R025XY019NV	<b>LOAMY 8-10 P.Z.</b> More productive site
R025XY015NV	<b>SOUTH SLOPE 8-12 P.Z.</b> PSSPS dominant grass; more productive site

**Table 1. Dominant plant species**

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

## Physiographic features

This site is on hills, fan remnants, rock-pediment remnants and partial ballenas on all aspects. Slopes range from 4 to 50 percent, but slope gradients are generally less than 30 percent. Elevations are 4,500 to 6,500 feet (1,372 to 1,981 meters).

**Table 2. Representative physiographic features**

Landforms	(1) Hill (2) Fan remnant (3) Ballena (4) Rock pediment
Runoff class	High to very high
Flooding frequency	None
Ponding frequency	None
Elevation	4,500–6,500 ft
Slope	4–50%
Water table depth	40 in
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.

Mean annual precipitation across the range in which this ES occurs is 9.85 inches (25cm). Mean annual air temperature is typically 45 to 50 degrees F.

Monthly mean precipitation in inches: January 1.00 (2.54cm); February 0.72 (1.83cm); March 0.87 (2.21cm); April 0.79 (2.01cm); May 1.32 (3.35cm); June 1.06 (2.69cm); July 0.47 (1.19cm); August 0.53 (1.35cm); September 0.59 (1.50cm); October 0.70 (1.78cm); November 0.84 (2.13cm); December 0.96 (2.44cm).

\*The above data is averaged from the Elko AP and Contact climate stations, NASIS, and Western Regional Climate Center.

**Table 3. Representative climatic features**

Frost-free period (characteristic range)	50-95 days
Freeze-free period (characteristic range)	20-85 days
Precipitation total (characteristic range)	8-10 in
Frost-free period (actual range)	50-95 days
Freeze-free period (actual range)	20-85 days
Precipitation total (actual range)	8-10 in
Frost-free period (average)	76 days
Freeze-free period (average)	68 days
Precipitation total (average)	9 in

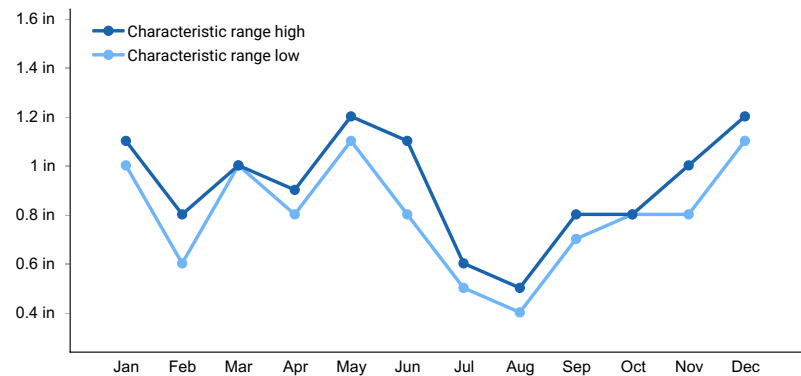


Figure 1. Monthly precipitation range

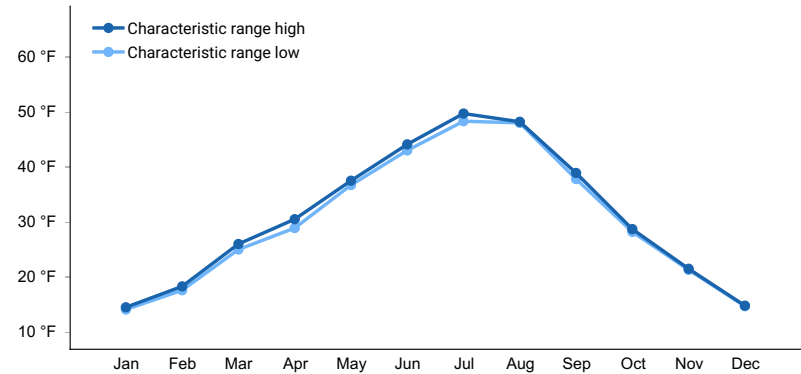


Figure 2. Monthly minimum temperature range

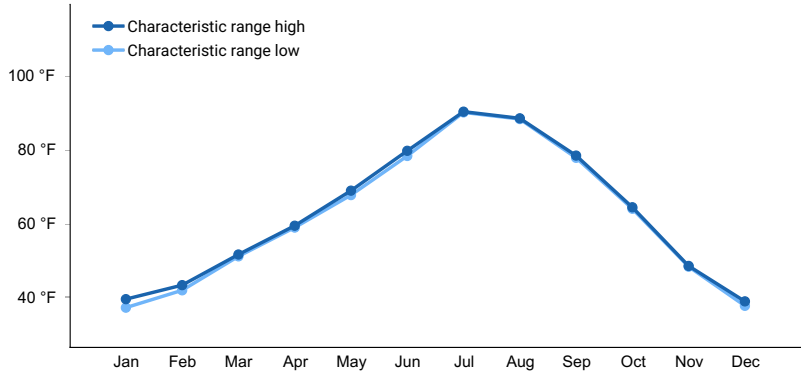
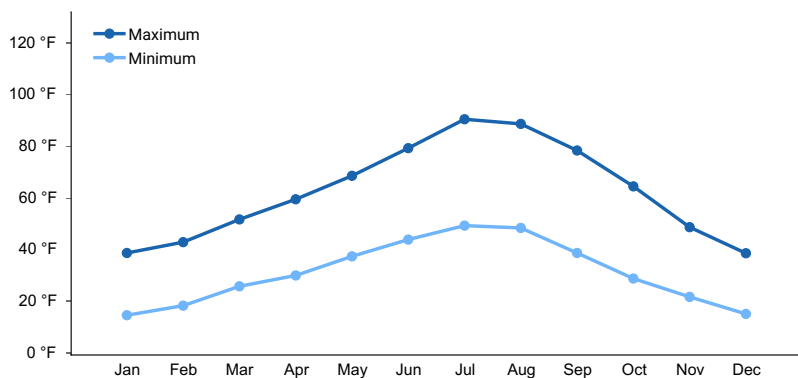
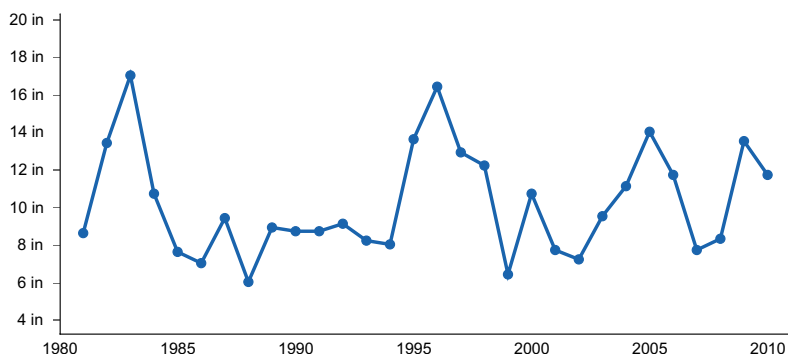


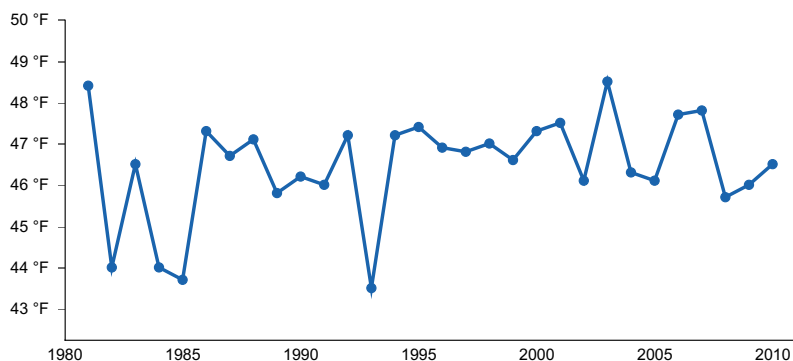
Figure 3. Monthly maximum temperature range



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



**Figure 5. Annual precipitation pattern**



**Figure 6. Annual average temperature pattern**

## Climate stations used

- (1) CONTACT [USC00261905], Jackpot, NV
- (2) ELKO RGNL AP [USW00024121], Elko, NV

## Influencing water features

This site does not have influencing water features.

## Soil features

The soils associated with this site have a shallow effective rooting depth and are well drained. The soils have 35 to 75 percent gravels and other coarse fragments throughout the profile. The soils have a high percentage of gravels, cobbles and stones on the surface providing a stabilizing effect on surface erosion conditions. Available water capacity of these soils is low to very low but a surface cover of coarse fragments helps to reduce evaporation and conserve soil moisture. Runoff is medium and potential for sheet and rill erosion is slight to moderate depending on slope. Soil stability values should be 3 to 6 on most soil textures found on this site. Areas of this site occurring on soils that have a physical crust will probably have stability values less than 3.

The soil series associated with this site are Carstump, Creva, Mascamp, Shalper, Wedekind and Xexres.

A representative soil series is Creva, classified as a clayey-skeletal, smectitic, frigid Lithic Ruptic-Entic Haplargid. The Creva series consists of very shallow and shallow, well drained soils that formed in residuum and colluvium derived from volcanic rocks. Reaction is neutral. Diagnostic horizons include an ochric epipedon that occurs from the soil surface to 5 inches and a discontinuous argillic horizon that occurs from 5 inches to 19 inches. Clay content in the particle-size control section ranges from 35 to 40 percent. Rock fragments range from 35 to 45 percent and are mostly gravel, but up to 15 percent are cobbles in some pedons.

**Table 4. Representative soil features**

Parent material	(1) Colluvium (2) Residuum (3) Alluvium
Surface texture	(1) Very gravelly loam (2) Extremely stony sandy loam (3) Gravelly loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Slow to moderately rapid
Depth to restrictive layer	4–40 in
Soil depth	4–40 in
Surface fragment cover ≤3"	0–50%
Surface fragment cover >3"	0–50%
Available water capacity (0–40in)	0.7–4.3 in
Calcium carbonate equivalent (0–40in)	0%
Electrical conductivity (0–40in)	0–2 mmhos/cm
Sodium adsorption ratio (0–40in)	0
Soil reaction (1:1 water) (0–40in)	6.1–9
Subsurface fragment volume ≤3" (Depth not specified)	0–35%
Subsurface fragment volume >3" (Depth not specified)	0–75%

## Ecological dynamics

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

This 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. (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 the deeper rooted shrubs lag in phenological development because they draw from deeply infiltrating moisture from snowmelt 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. 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 like 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, is generally long-lived; therefore it is not necessary for new individuals to recruit every year for perpetuation of the stand. Infrequent large recruitment events and simultaneous low, continuous recruitment is the foundation of population maintenance (Noy-Meir 1973). Survival of the seedlings is dependent on adequate moisture conditions.

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 a sagebrush defoliator, Aroga moth (Aroga websteri). 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 observed. Aroga moth can partially or entirely kill individual plants or entire stands of big sagebrush (Furniss and Barr 1975).

Perennial bunchgrasses generally have somewhat 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 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 the 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 or can increase resource pools by 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).

The introduction of annual weedy species, like 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 the perennial bunchgrasses and forbs may be reduced.

At the upper elevational range of this site, 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 out-compete 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).

Where management results in abusive livestock use, big sagebrush and rabbitbrush become dominant with increases of Sandberg bluegrass, bottlebrush squirreltail, phlox and arrowleaf balsamroot in the understory. The potential invasive/noxious weeds are cheatgrass, Douglas' rabbitbrush, snakeweed, halogeton, Russian thistle, annual mustards, bassia and Utah juniper.

This site has low resilience to disturbance and low resistance to invasion. Increased resilience increases with elevation, aspect, increased precipitation and increased nutrient availability. Five alternative stable states have been identified for this 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 to 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 were around 50 to 100 years. More recently, Baker (2011) estimates fire rotation to be 200 to 350 years in Wyoming big sagebrush communities. Wyoming big sagebrush is killed by fire and only regenerates from seed. Recovery time for Wyoming big sagebrush may require 50 to 120 or more years (Baker 2006). However, the introduction and expansion of cheatgrass has dramatically altered the fire regime (Balch et al. 2013) and restoration potential of Wyoming big sagebrush communities.

The effect of fire on bunchgrasses relates to culm density, culm-leaf morphology, and the size of the plant. The initial condition of bunchgrasses within the site along with seasonality and intensity of the fire all factor into the individual species response. For most forbs and grasses the growing points are located at or below the soil surface providing relative protection from disturbances which decrease above ground biomass, such as grazing or fire. Thus, fire mortality is more correlated to duration and intensity of heat which is related to culm density, culm-leaf morphology, size of plant and abundance of old growth (Wright 1971, Young 1983).

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). 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).

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.

Indian ricegrass 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 bunchgrass. 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.

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).



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 frequencies between 0.23 and 0.43 times a year; then even sprouting shrubs such as rabbitbrush will not survive (Whisenant 1990).

## **State and transition model**

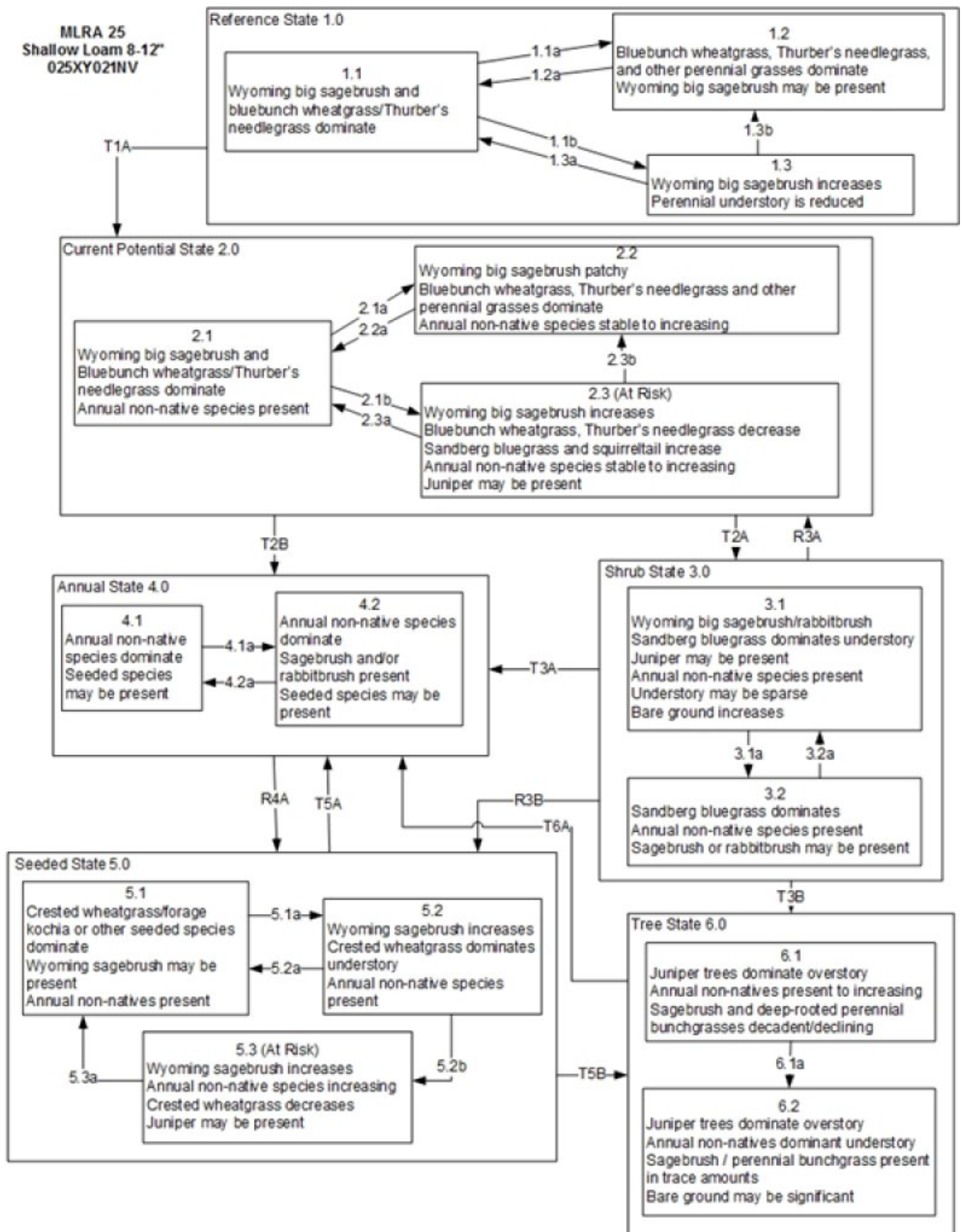


Figure 7. T. Stringham July 2015

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.

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

### Wyoming big sagebrush-perennial bunchgrasses

The representative plant community is dominated by bluebunch wheatgrass, Thurber's needlegrass and Wyoming big sagebrush. Potential vegetative composition is about 60 percent grasses, 5 percent forbs and 35 percent shrubs. Approximate ground cover (basal and crown) is 15 to 25 percent. Bare ground is approximately 30 percent. Dead branches within individual shrubs are common and standing dead shrub canopy material may be as much as 35 percent of total woody canopy; some of the mature bunchgrasses (<20 percent) have dead centers. Litter cover (approximately 10 percent) occurs within plant interspaces at a depth of approximately 1/4 inch.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	150	240	360
Shrub/Vine	88	140	210
Forb	12	20	30
<b>Total</b>	<b>250</b>	<b>400</b>	<b>600</b>

## Community 1.2

### Herbaceous dominated

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. Wyoming big 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

### Shrub dominated

Wyoming big 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 big 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** **Wyoming big sagebrush-perennial bunchgrasses/annual non-native species**

Wyoming big sagebrush, bluebunch wheatgrass, and Thurber's needlegrass dominate the site. Indian ricegrass, Sandberg bluegrass, basin wildrye, squirreltail and perennial forbs are also common on this site. Non-native annual species are present in minor amounts.

### **Community 2.2** **Herbaceous dominated**

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** **Shrub dominated (at risk)**

Wyoming big 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 big 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**



## Wyoming big sagebrush/Sandberg bluegrass



Figure 10. Shallow Loam 8-12" (R025XY021NV) Phase 3.1 T. K. Stringham, August 2011

Wyoming big sagebrush dominates 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/annual non-native species

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; one 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

Cheatgrass and/or other annual grasses and forbs (e.g. mustards) dominate the herbaceous community. Most perennial herbaceous species cannot compete with the dense population of cheatgrass and are absent or nearly so. Fire intervals often shorten to 2-10 years. Sagebrush is generally unable to survive and reproduce with this fire frequency. Sprouting, fire-tolerant shrubs may form a shrub overstory where fires are too frequent for sagebrush but

infrequent enough to support non-palatable sprouting shrubs.

## **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 big sagebrush, native and non-native forbs may be present.

## **Community 5.1**

### **Seeded perennial bunchgrasses**

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

## **Community 5.2**

### **Wyoming big sagebrush/seeded perennial bunchgrasses**

Wyoming big 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**

### **Wyoming big sagebrush (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; 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. Wyoming big 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.

#### **Conservation practices**

Brush Management
Herbaceous Weed Control

## **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.

#### **Conservation practices**

Brush Management
Range Planting

## **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 Wyoming big 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.

#### **Conservation practices**

Range Planting
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## 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 Wyoming big 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 6. 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>			140–240	
	bluebunch wheatgrass	PSSPS	<i>Pseudoroegneria spicata</i> ssp. <i>spicata</i>	80–140	–
	Thurber's needlegrass	ACTH7	<i>Achnatherum thurberianum</i>	60–100	–
2	<b>Secondary Perennial Grasses</b>			20–60	
	Indian ricegrass	ACHY	<i>Achnatherum hymenoides</i>	2–20	–
	squirreltail	ELEL5	<i>Elymus elymoides</i>	2–20	–
	seaside erylgo	ERMA7	<i>Eryngium maritimum</i>	2–20	–
	basin wildrye	LECI4	<i>Leymus cinereus</i>	2–20	–
	Sandberg bluegrass	POSE	<i>Poa secunda</i>	2–20	–
<b>Forb</b>					
3	<b>Perennial</b>			8–32	
	tufted wheatgrass	ELMA7	<i>Elymus macrourus</i>	2–20	–
	arrowleaf balsamroot	BASA3	<i>Balsamorhiza sagittata</i>	2–8	–
	tapertip hawksbeard	CRAC2	<i>Crepis acuminata</i>	2–8	–
<b>Shrub/Vine</b>					
4	<b>Primary Shrubs</b>			88–140	
	antelope bitterbrush	PUTR2	<i>Purshia tridentata</i>	8–20	–
	arrowleaf balsamroot	BASA3	<i>Balsamorhiza sagittata</i>	2–8	–
	tapertip hawksbeard	CRAC2	<i>Crepis acuminata</i>	2–8	–
5	<b>Secondary Shrubs</b>			8–32	
	yellow rabbitbrush	CHV18	<i>Chrysothamnus viscidiflorus</i>	2–12	–
	buckwheat	ERIOG	<i>Eriogonum</i>	2–12	–
	littleleaf horsebrush	TEGL	<i>Tetradymia glabrata</i>	2–12	–

## Animal community

### Livestock Interpretations:

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

Overgrazing leads to an increase in sagebrush and a decline in understory plants like bluebunch wheatgrass and Thurber's needlegrass. 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.

Thurber's needlegrass is an important forage source for livestock and wildlife in the arid regions of the west (Ganskopp 1988). Thurber's needlegrass begins growth early in the year and remains green throughout a relatively long growing season. This pattern of development enables animals to use Thurber's needlegrass when many other grasses are unavailable. Cattle prefer Thurber's needlegrass in early spring before fruits have developed as it becomes less palatable when mature. Thurber's needlegrasses are grazed in the fall only if the fruits are softened by rain. Although the seeds are 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 Thurber's needlegrass (Ganskopp 1988).

Bluebunch wheatgrass is considered one of the most important forage grass species on western rangelands for livestock. Although bluebunch wheatgrass can be a crucial source of forage, it is not necessarily the most highly preferred species. 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). 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, Britton et al. 1990). Tiller production and growth of bluebunch was greatly reduced when drought was coupled with clipping (Busso and Richards 1995). Mueggler (1975) estimated that low-vigor bluebunch wheatgrass may need up to 8 years rest to recover. Bluebunch wheatgrass does not generally provide sufficient cover for ungulates; however, mule deer were frequently found in bluebunch-dominated grasslands.

Livestock browse Wyoming big sagebrush, but may use it only lightly when palatable herbaceous species are available.

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.

#### Wildlife Interpretations:

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.

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 their 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.

## Hydrological functions

Rills are rare. A few rills can be expected on steeper slopes in areas subjected to summer convection storms or rapid snowmelt. Water flow patterns are rare but can be expected in areas subjected to summer convection storms or rapid snowmelt. Pedestalls are rare. Occurrence is usually limited to areas of water flow patterns. Frost heaving of shallow rooted plants should not be considered a "normal" condition. Fine litter (foliage from grasses and annual

and 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. Perennial herbaceous plants (especially deep-rooted bunchgrasses) slow runoff and increase infiltration. Shrub canopy and associated litter break raindrop impact and provide opportunity for snow catch and accumulation on site.

## Recreational uses

This site has fair recreational potential. It is fair for picnicking and camping and offers good potential for hiking and upland game hunting. It has potential for deer hunting, nature study and photography. Aesthetic value is derived from the colorful flowering of many diverse wildflowers in the spring and early summer.

## Wood products

None

## 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.

## 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. 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.

## Inventory data references

NRCS-RANGE-417 - 1 record

NV-ECS-1 - 2 records

NV-4400-13 (BLM) - 9 records

Soils and Physiographic features were gathered from NASIS database.

## Type locality

Location 1: Elko County, NV	
Township/Range/Section	T44N R62E S8
General legal description	Hills west of Black Mountain, about 10 miles southwest of Contact, Cold Springs Mountains, Elko County, Nevada.
Location 2: Elko County, NV	
Township/Range/Section	T43N R64E S15
General legal description	Bloody Gulch area about 3 miles west of Silkworm Mine, Knoll Mountains, Elko County, Nevada. This site also occurs in Eureka and Lander Counties, Nevada.

## Other references

Akinsoji, A. 1988. Postfire vegetation dynamics in a sagebrush steppe in southeastern Idaho, USA. *Vegetatio* 78:151-155.

Anderson, E. W. and R. J. Scherzinger. 1975. Improving quality of winter forage for elk by cattle grazing. *Journal of*

Barrington, M., S. Bunting, and G. Wright. 1988. A fire management plan for Craters of the Moon National Monument. Cooperative Agreement CA-9000-8-0005. Moscow, ID: University of Idaho, Range Resources Department. 52 p. Draft.

Bates, J. D., T. Svejcar, R. F. Miller, and R. A. Angell. 2006. The effects of precipitation timing on sagebrush steppe vegetation. *Journal of Arid Environments* 64:670-697.

Bentz, B., D. Alston, and T. Evans. 2008. Great Basin Insect Outbreaks. In: J. Chambers, N. Devoe, A. Evenden [eds]. Collaborative Management and Research in the Great Basin -- Examining the issues and developing a framework for action Gen. Tech. Rep. RMRS-GTR-204. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO. p. 45-48.

Blaisdell, J. P. 1953. Ecological effects of planned burning of sagebrush-grass range on the upper Snake River Plains. US Dept. of Agriculture.

Blaisdell, J. P. and W. F. Mueggler. 1956. Sprouting of bitterbrush (*Purshia tridentata*) following burning or top removal. *Ecology* 37:365-370.

Blaisdell, J. P., R. B. Murray, and E. D. McArthur. 1982. Managing intermountain rangelands-sagebrush-grass ranges. USDA Forest Serv. Intermountain Forest and Range Exp. Sta. Gen. Tech. Rep. INT-134.

Blaisdell, J. P. and J. F. Pechanec. 1949. Effects of herbage removal at various dates on vigor of bluebunch wheatgrass and arrowleaf balsamroot. *Ecology* 30:298-305.

Bradley, A. F. 1984. Rhizome morphology, soil distribution, and the potential fire survival of eight woody understory species in western Montana. University of Montana.

Britton, C. M., G. R. McPherson, and F. A. Sneva. 1990. Effects of burning and clipping on five bunchgrasses in eastern Oregon. *Great Basin Naturalist* 50:115-120.

Bunting, S. C., B. M. Kilgore, and C. L. Bushey. 1987. Guidelines for prescribed burning sagebrush-grass rangelands in the northern Great Basin. US Department of Agriculture, Forest Service, Intermountain Research Station Ogden, UT, USA.

Burkhardt, J. W. and E. Tisdale. 1969. Nature and successional status of western juniper vegetation in Idaho. *Journal of Range Management*:264-270.

Busse, D., A. Simon, and M. Riegel. 2000. Tree-growth and understory responses to low-severity prescribed burning in thinned *Pinus ponderosa* forests of central Oregon. *Forest Science* 46:258-268.

Caudle, D., J. DiBenedetto, M. Karl, H. Sanchez, and C. Talbot. 2013. Interagency ecological site handbook for rangelands. Available at: <http://jornada.nmsu.edu/sites/jornada.nmsu.edu/files/InteragencyEcolSiteHandbook.pdf>. Accessed 4 October 2013.

Chambers, J., B. Bradley, C. Brown, C. D'Antonio, M. Germino, J. Grace, S. Hardegree, R. Miller, and D. Pyke. 2013. Resilience to stress and disturbance, and resistance to *Bromus tectorum* L. Invasion in cold desert shrublands of Western North America. *Ecosystems* 17:1-16.

Chambers, J. C., B. A. Roundy, R. R. Blank, S. E. Meyer, and A. Whittaker. 2007. What makes great basin sagebrush ecosystems invasible by *Bromus tectorum*? *Ecological Monographs* 77:117-145.

Clark, R. G., M. B. Carlton, and F. A. Sneva. 1982. Mortality of bitterbrush after burning and clipping in eastern Oregon. *Journal of Range Management* 35:711-714.

Clements, C. D. and J. A. Young. 2002. Restoring antelope bitterbrush. *Rangelands* 24:3-6.

- Comstock, J. P. and J. R. Ehleringer. 1992. Plant adaptation in the Great Basin and Colorado plateau. *Western North American Naturalist* 52:195-215.
- Conrad, C. E. and C. E. Poulton. 1966. Effect of a wildfire on Idaho fescue and bluebunch wheatgrass. *Journal of Range Management* 19:138-141.
- Cook, J. G., T. J. Hershey, and L. L. Irwin. 1994. Vegetative response to burning on Wyoming mountain-shrub big game ranges.. *Journal of Range Management* 47:296-302.
- Daubenmire, R. 1970. *Steppe vegetation of Washington*. 131 pp.
- Daubenmire, R. 1975. Plant succession on abandoned fields, and fire influences in a steppe area in southeastern Washington. *Northwest Science* 49:36-48.
- Driscoll, R. S. 1964. A Relict Area in the Central Oregon Juniper Zone. *Ecology* 45:345-353.
- Dobrowolski, J. P., M. M. Caldwell, and J. H. Richards. 1990. Basin hydrology and plant root systems. In: C. B. Osmand, L. F. Pitelka, G. M. Hildy [eds]. *Plant biology of the Basin and range*. *Ecological Studies*. 80: 243-292.
- Eckert Jr, R. E. and J. S. Spencer. 1986. Vegetation response on allotments grazed under rest-rotation management. *Journal of Range Management*:166-174.
- Eckert, R. E., Jr. and J. S. Spencer. 1987. Growth and reproduction of grasses heavily grazed under rest-rotation management. *Journal of Range Management* 40:156-159.
- Furniss, M. M. and W. F. Barr. 1975. Insects affecting important native shrubs of the northwestern United States General Technical Report INT-19. Intermountain Forest and Range Experiment Station, U.S. Department of Agriculture, Forest Service. Ogden, UT. p. 68.
- Gaffney, W. S. 1941. The effects of winter elk browsing, South Fork of the Flathead River, Montana. *The Journal of Wildlife Management* 5:427-453.
- Ganskopp, D., L. Aguilera, and M. Vavra. 2007. Livestock forage conditioning among six northern Great Basin grasses. *Rangeland Ecology & Management* 60:71-78.
- Garrison, G. A. 1953. Effects of Clipping on Some Range Shrubs. *Journal of Range Management* 6:309-317.
- Houston, D. B. 1973. Wildfires in northern Yellowstone National Park. *Ecology* 54:1111-1117.
- Johnson, C. G., R. R. Clausnitzer, P. J. Mehringer, and C. Oilver. 1994. Biotic and abiotic processes of eastside ecosystems: The effects of management on plant and community ecology, and on stand and landscape vegetation dynamics. Forest Service general technical report. Forest Service, Portland, OR (United States). Pacific Northwest Research Station.
- Kasworm, W. F., L. R. Irby, and H. B. I. Pac. 1984. Diets of Ungulates Using Winter Ranges in Northcentral Montana. *Journal of Range Management* 37:67-71.
- Kerns, B. K., W. G. Thies, and C. G. Niwa. 2006. Season and severity of prescribed burn in ponderosa pine forests: implications for understory native and exotic plants. *Ecoscience* 13:44-55.
- Krall, J. L., J. R. Stroh, C. S. Cooper, and S. R. Chapman. 1971. Effect of time and extent of harvesting basin wildrye. *Journal of Range Management* 24:414-418.
- Kuntz, D. E. 1982. Plant response following spring burning in an *Artemisia tridentata* subsp. *vaseyana*/*Festuca idahoensis* habitat type. University of Idaho.
- Laycock, W. A. 1967. How heavy grazing and protection affect sagebrush-grass ranges. *Journal of Range Management*:206-213.



- Leege, T. A. and W. O. Hickey. 1971. Sprouting of northern Idaho shrubs after prescribed burning. *The Journal of Wildlife Management*:508-515.
- Majerus, M. E. 1992. High-stature grasses for winter grazing. *Journal of soil and water conservation* 47:224-225.
- McArthur, E. D., A. Blaner, A. P. Plummer, and R. Stevens. 1982. Characteristics and hybridization of important Intermountain shrubs: 3. Sunflower family. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. Research Paper INT-177 43.
- McConnell, B. R. 1961. Notes on some rooting characteristics of antelope bitterbrush. PNW Old Series Research Note No. 204:1-5.
- McConnell, B. R. and J. G. Smith. 1977.  
Influence of grazing on age-yield interactions in bitterbrush. *Journal of Range Management* 30:91-93.
- Merrill, E. H., H. Mayland, and J. Peek. 1982. Shrub responses after fire in an Idaho ponderosa pine community. *The Journal of Wildlife Management* 46:496-502.
- Miller, R. F. and E. K. Heyerdahl. 2008. Fine-scale variation of historical fire regimes in sagebrush-steppe and juniper woodland: an example from California, USA. *International Journal of Wildland Fire* 17:245-254.
- Miller, R. F. R. J. T. 2000. The role of fire in juniper and pinyon woodlands: a descriptive analysis. Pages p. 15-30 in *Proceedings of the invasive species workshop: the role of fire in the control and spread of invasive species.*, Tallahassee, Florida.
- Miller, R. F. C., Jeanne C.; Pyke, David A.; Pierson, Fred B.; Williams, C. Jason 2013. A review of fire effects on vegetation and soils in the Great Basin Region: response and ecological site characteristics. Gen. Tech. Rep. RMRS-GTR-308. Fort Collins CO: U.S. Department of Agriculture, United State Forest Service, Rocky Mountain Research Station. p. 126.
- Mueggler, W. F. and J. P. Blaisdell. 1951. Replacing wyethia with desirable forage species. *Journal of Range Management* 4:143-150.
- Murray, R. 1983. Response of antelope bitterbrush to burning and spraying in southeastern Idaho. Tiedemann, Arthur R.; Johnson, Kendall L., compilers. Research and management of bitterbrush and cliffrose in western North America. General Technical Report INT-152. Ogden, UT: US Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station:142-152.
- Neuenschwander, L. 1980. Broadcast burning of sagebrush in the winter. *Journal of Range Management*:233-236.
- Noste, N. V. and C. L. Bushey. 1987. Fire response of shrubs of dry forest habitat types in Montana and Idaho. General technical report INT.
- Noy-Meir, I. 1973. Desert Ecosystems: Environment and Producers. *Annual Review of Ecology and Systematics*. Vol. 4:25-51.
- Personius, T.L., C. L. Wambolt, J. R. Stephens and R. G. Kelsey. 1987. Crude Terpenoid Influence on Mule Deer Preference for Sagebrush. *Journal of Range Management*, 40:1 p. 84-88.
- Richards, J. H. and M. M. Caldwell. 1987. Hydraulic lift: Substantial nocturnal water transport between soil layers by *Artemisia tridentata* roots. *Oecologia* 73:486-489.
- Robberecht, R. and G. Defossé. 1995. The relative sensitivity of two bunchgrass species to fire. *International Journal of Wildland Fire* 5:127-134.
- Sheehy, D. P. and A. Winward. 1981. Relative palatability of seven *Artemisia* taxa to mule deer and sheep. *Journal of Range Management* 34:397-399.

- Smith, J. K. and W. C. Fischer. 1997. Fire ecology of the forest habitat types of northern Idaho. US Department of Agriculture, Forest Service, Intermountain Research Station.
- Tisdale, E. W. and M. Hironaka. 1981. The sagebrush-grass region: A review of the ecological literature. University of Idaho, Forest, Wildlife and Range Experiment Station.
- Uresk, D. W., J. F. Cline, and W. H. Rickard. 1976. Impact of wildfire on three perennial grasses in south-central Washington. *Journal of Range Management* 29:309-310.
- Whisenant, S. G. 1990. Changing fire frequencies on Idaho's Snake River Plains: ecological and management implications. Pages 4-10 in Symposium on cheatgrass invasion, shrub die-off, and other aspects of shrub biology and management. General Technical Report, Intermountain Research Station, USDA Forest Service.
- Wood, M. K., Bruce A. Buchanan, & William Skeet. 1995. Shrub preference and utilization by big game on New Mexico reclaimed mine land. *Journal of Range Management* 48:431-437.
- Wright, H. A. 1971. Why squirreltail is more tolerant to burning than needle-and-thread. *Journal of Range Management* 24:277-284.
- Wright, H. A. 1985. Effects of fire on grasses and forbs in sagebrush-grass communities. Pages 12-21 in *Rangeland Fire Effects; A Symposium*: Boise, ID, USDI-BLM.
- Wright, H.A., L.F. Neuenschwander, and C.M. Britton. 1979. The role and use of fire in sagebrush-grass and pinyon-juniper plant communities: A state-of-the-art review. Gen. Tech. Rep. INT-58. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 48 p.
- Young, R.P. 1983. Fire as a vegetation management tool in rangelands of the Intermountain region. In: Monsen, S.B. and N. Shaw (eds). *Managing Intermountain rangelands—improvement of range and wildlife habitats: Proceedings of symposia*; 1981 September 15-17; Twin Falls, ID; 1982 June 22-24; Elko, NV. Gen. Tech. Rep. INT-157. Ogden, UT. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. Pgs 18-31.
- Ziegenhagen, L. L. 2003. Shrub reestablishment following fire in the mountain big sagebrush (*Artemisia tridentata* Nutt. ssp. *vaseyana* (Rydb.) Beetle) alliance. M.S. Oregon State University.
- Ziegenhagen, L. L. and R. F. Miller. 2009. Postfire recovery of two shrubs in the interiors of large burns in the Intermountain West, USA. *Western North American Naturalist* 69:195-205.
- Zschaechner, G. A. 1985. Studying rangeland fire effects: a case study in Nevada. Pages 66-84 in *Rangeland fire effects, a symposium*. Bureau of Land Management, Boise, Idaho.

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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)	GK BRACKLEY
Contact for lead author	State Rangeland Management Specialist
Date	06/05/2006
Approved by	Kendra Moseley
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

## Indicators

1. **Number and extent of rills:** Rills are 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 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. Occurrence is usually limited to areas of water flow patterns. 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  $\pm$  30%; surface rock fragments  $\pm$ 50%; shrub canopy 15 to 25%; basal area for perennial herbaceous plants =5%.  

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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) is expected to move the distance of slope length during intense summer convection storms or rapid snowmelt events. Persistent litter (large woody material) will remain in place except during catastrophic 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. Areas of this site occurring on soils that have a physical crust will probably have stability values less than 3. (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 thin to thick platy or massive. Soil surface colors are light and the 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.

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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., bluebunch wheatgrass & Thurber's needlegrass] 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 not typical. Platy or massive sub-surface horizons, subsoil argillic horizons or hardpans shallow to the surface 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: Reference Plant Community: Deep-rooted, cool season, perennial bunchgrasses>>tall shrubs (Wyoming big sagebrush). (By above ground production)
- Sub-dominant: Associated shrubs > shallow-rooted, cool season, perennial grasses > deep-rooted, cool season, perennial forbs = fibrous, shallow-rooted, cool season, annual and perennial forbs. (By above ground production)
- Other:
- Additional:
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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 are common and standing dead shrub canopy material may be as much as 35% 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):** Between plant interspaces ( $\pm 10\%$ ) and litter depth is  $\pm \frac{1}{4}$  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 (through May)  $\pm 400$  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 cheatgrass, snakeweed, halogeton, Russian thistle, annual mustards, bassia, and Utah juniper are invaders on this site.
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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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