# Ecological site R028BY010NV
# LOAMY 8-10 P.Z.

Accessed: 04/28/2024

## General information

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

## Ecological site concept

This ecological site is found on fan remnants. Soils associated with this site are shallow to a duripan, well drained, and formed in alluvium derived from volcanic parent material. The soil profile is characterized by an ochric epipedon, a strongly cemented duripan between 35-50cm and an argillic horizon with no abrupt textural change. Soil map unit components of Watoopah, Veet and Richinde will be considered for correlation to a more appropriate ecological site concept.

## Associated sites

| | |
|---|---|
| F028BY083NV | **Cobbly Calcareous Mountain Slopes 10-12 P.Z.** |
| R028BY007NV | **LOAMY 10-12 P.Z.** |
| R028BY016NV | **SHALLOW CALCAREOUS SLOPE 8-10 P.Z.** |
| R028BY045NV | **LOAMY FAN 8-12 P.Z.** |
| R028BY052NV | **DROUGHTY LOAM 8-10 P.Z.** |
| R028BY080NV | **SHALLOW LOAM 8-10 P.Z.** |
| R028BY084NV | **COARSE SILTY 6-8 P.Z.** |
| R028BY094NV | **CALCAREOUS LOAM 10-14 P.Z.** |

## Similar sites

| | |
|---|---|
| R028BY014NV | **LOAMY PLAIN 8-10 P.Z.**<br>ELMA7 codominant grasses; HECO26 rare to absent. |
| R028BY007NV | **LOAMY 10-12 P.Z.**<br>ACTH7-GRSP codominant grasses; more productive site. |
| R028BY045NV | **LOAMY FAN 8-12 P.Z.**<br>LECI4-ELLAL codominant grasses; occurs on inset fans. |
| R028BY005NV | **SANDY 8-10 P.Z.**<br>HECO26-ACHY-ELMA7 codominant grasses; sandy soils; greater shrub diversity. |
| R028BY052NV | **DROUGHTY LOAM 8-10 P.Z.**<br>ARTRW-GRSP typically codominant shrubs; ATCO often on this site. |

**Table 1. Dominant plant species**

| | |
|---|---|
| Tree | Not specified |
| Shrub | (1) *Artemisia tridentata subsp. wyomingensis* |
| Herbaceous | (1) *Achnatherum hymenoides*<br>(2) *Hesperostipa comata* |

## Physiographic features

This site commonly occurs on fan remnants, but can also occur fan piedmonts, inset fans and hills. Slopes range from 0 to 50 percent, but slope gradients of 2 to 10 percent are most typical. Elevations are typically 5000 to 6500 feet, but can range from 4400 to 7200 feet in some places.

**Table 2. Representative physiographic features**

| | |
|---|---|
| Landforms | (1) Fan remnant<br>(2) Fan piedmont<br>(3) Inset fan |
| Flooding duration | Extremely brief (0.1 to 4 hours) |
| Flooding frequency | None to rare |
| Ponding frequency | None |
| Elevation | 5,000–6,500 ft |
| Slope | 2–10% |
| Ponding depth | 0 in |
| Water table depth | 0 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.

The average annual precipitation ranges from 8 to 10 inches. Mean annual air temperature is about 45 to 50 degrees F. The average growing season is 100 to 120 days.

Mean annual precipitation across the range in which this ES occurs is 9.01". Monthly mean precipitation:
January 0.69; February 0.65; March 0.87; April 0.88; May 1.14; June 0.73; July 0.65; August 0.77; September 0.66; October 0.79; November 0.62; December 0.60.
*The above data is averaged from the Diamond Valley- Eureka and McGill WRCC climate stations.

**Table 3. Representative climatic features**

| | |
|---|---|
| Frost-free period (average) | 90 days |
| Freeze-free period (average) | 120 days |
| Precipitation total (average) | 9 in |

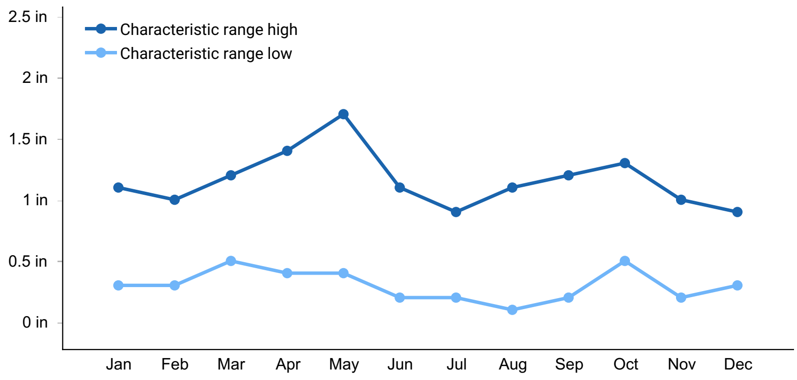


**Figure 1. Monthly precipitation range**

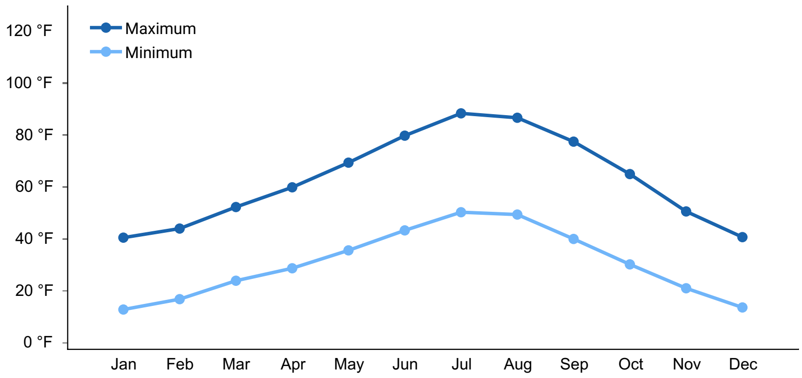


**Figure 2. Monthly average minimum and maximum temperature**

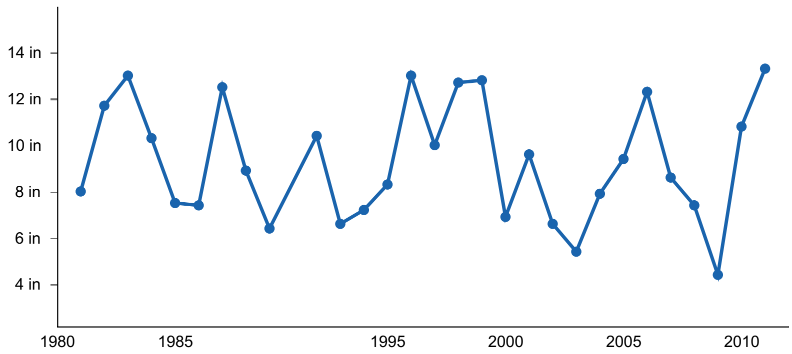


**Figure 3. Annual precipitation pattern**

### Climate stations used

- (1) DIAMOND VALLEY - EUREKA 14NNW [USC00262296], Eureka, NV
- (2) MCGILL [USC00264950], Ely, NV

### Influencing water features

Influencing water features are not associated with this site.

### Soil features

The soils associated with this site are generally very deep and well drained. A typical soil profile is modified by a high volume of rock fragments, characterized by an ochric epipedon and is effervescent throughout. The soil moisture regime is aridic bordering on xeric and the soil temperature regime is mesic.

Soil series associated with this site inlcude: Abgese, Akercan, Alhambra, Alley, Allker, Allor, Bijorja, Breko, Cobre, Cowgil, Credo, Enko, Filiran, Fortank, Glyphs, Idway, Kobeh, Kunzler, Lone, McConnel, Nayped, Orovada, Orr, Parisa, Pedoli, Pineval, Poorcal, Portmount, Pula, Pyrat, Rasille, Ridit, Risley, Rito, Rubyhill, Rutab, Shantown, Silverado, Siri, Threesee, Tonkin, Wieland, Zafod, and Zineb.

A representative soil series is Pyrat, a loamy-skeletal, mixed, superactive, mesic Durinodic Xeric Haplocalcids. Pyrat series is a very deep, well drained soil formed in alluvium derived from mixed rocks. This soil is characterized by an ochric epipedon from the surface to 18cm, a calcic horizon from 15-99cm. Clay content in the particle size control section averages 5 to 18 percent and rock fragments range from 35 to 80 percent.

Where this ecological site is correlated to the following soil series that are shallow to bedrock or shallow to a duripan (Buffaran, Dewar, Muni. Shabliss, Chiara, Ratto, Genaw, Jericho, Locane and Gumble) full consideration should be given to re-correlating the location to 028BY080NV Shallow Loam 8-10" P.Z.

Where this ecological site is correlated to Torriorthents consideration should be given to re-correlating the site to 028BY052NV Droughty Loam 8-10" PZ, 028BY014NV Loamy Plain 8-10" PZ, or 028BY045NV Loamy Fan 8-12" PZ as appropriate depending on landscape position, species composition and production potential.

**Table 4. Representative soil features**

| | |
|---|---|
| Surface texture | (1) Gravelly sandy loam |
| Family particle size | (1) Loamy |
| Drainage class | Well drained |
| Permeability class | Moderate to moderately rapid |
| Soil depth | 60–84 in |
| Surface fragment cover <=3" | 45–50% |
| Surface fragment cover >3" | 0% |
| Available water capacity (0-40in) | 3–7.6 in |
| Calcium carbonate equivalent (0-40in) | 15–35% |
| Electrical conductivity (0-40in) | 0 mmhos/cm |
| Sodium adsorption ratio (0-40in) | 0 |
| Soil reaction (1:1 water) (0-40in) | 8–8.8 |
| Subsurface fragment volume <=3" (Depth not specified) | 35–80% |
| Subsurface fragment volume >3" (Depth not specified) | 0% |

## Ecological dynamics

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

The ecological site is dominated by deep-rooted cool season perennial bunchgrasses and long-lived shrubs (50+ years) with high root to shoot ratios. The dominant shrubs usually root to the full depth of the winter-spring soil moisture recharge, which ranges from 1.0 to over 3.0 m. (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 (Comstock and Ehleringer 1992).

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. Needleandthread grass is adapted to coarser textured soils whereas Indian ricegrass will increase with sandy soil surfaces, and bottlebrush squirreltail will increase with silty soil surfaces. Production generally increases with soil depth. The calcium carbonate content often found in the rooting zone of the grass species is thought to be the primary reason for the lack of Thurber's needlegrass in this Loamy 8-10 as compared to the similar sites in MLRA 24 and 25. The amount of sagebrush in the plant community is dependent upon disturbances like fire, Aroga moth infestations, and grazing.

Wyoming big sagebrush, 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 depended 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 is 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).
The perennial bunchgrasses generally have somewhat shallower root systems than the shrubs, but root densities are often as high as or higher than those of shrubs in the upper 0.5 m but taper off more rapidly than shrubs. General differences in root depth distributions between grasses and shrubs results 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 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.

Infilling and expansion by singleleaf pinyon and Utah juniper may also occur with an extended fire return interval. Eventually, singleleaf pinyon and Utah juniper will dominate the site and out-compete sagebrush for water and sunlight severely reducing both the shrub and herbaceous understory (Lett and Knapp 2005, Miller et al. 2000). Bluegrasses may remain underneath trees on north-facing slopes. The potential for soil erosion increases as the Utah juniper woodland matures and the understory plant community cover declines (Pierson et al. 2010).

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

Fire Ecology:
Fire is the principal means of renewal of decadent stands of Wyoming big sagebrush. 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. (2007) suggest fire return intervals in Wyoming big sagebrush communities were around 50 to 100 years. More recently, Baker (2011) estimates fire rotation to be 200-350 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). Post-fire hydrologic recovery and resilience is primarily influenced by pre-fire site conditions, fire severity, and post-fire weather and land use that relate to vegetation recovery. Sites with low abundances of native perennial grasses and forbs typically have reduced resiliency following disturbance and are less resistant to invasion or increases in cheatgrass (Miller et al 2013). 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 related to duration and intensity of heat which is related to culm density, culm-leaf morphology, size of plant and abundance of old growth (Young 1983, Wright 1971).

Indian ricegrass is fairly fire tolerant (Wright 1985), which is likely due to its low culm density and below ground plant crowns. Vallentine (1989) cites several studies in the sagebrush zone that classified Indian ricegrass as being slightly damaged from late summer burning. Indian ricegrass has also 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 facilitates reestablishment of Indian ricegrass. Grazing management following fire to promote seed production and establishment of seedlings is important.

Needleandthread is top-killed by fire but is likely to resprout if fire does not consume above ground stems (Akinsoji 1988, Bradley, Noste and Fischer 1992). In a study by Wright and Klemmedson (1965), season of burn rather than fire intensity seemed to be the crucial factor in mortality for needleandthread grass. Early spring season burning was seen to kill the plants while August burning had no effect. Thus under wildfire scenarios needle-and-thread is often present in the post-burn community. However, due to its lack of grazing tolerance, grazing after fire should be managed carefully.

Squirreltail is considered more fire tolerant than Indian ricegrass due to its small size, coarse stems, broad leaves and generally sparse leafy material (Wright 1971, Britton et al. 1990). Postfire regeneration occurs from surviving root crowns and from on-and off-site seed sources. Bottlebrush squirreltail has the ability to produce large numbers of highly germinable seeds, with relatively rapid germination (Young and Evans 1977) when exposed to the correct environmental cues. Early spring growth and ability to grow at low temperatures contribute to the persistence of bottle brush squirreltail among cheatgrass dominated ranges (Hironaka and Tisdale 1972).

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). 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. 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. Repeated frequent fire in this community will eliminate big sagebrush and severely decrease or eliminate the deep rooted perennial bunchgrasses from the site and facilitate the establishment of an annual weed community with varying amounts of Sandberg bluegrass and rabbitbrush.

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. Utah juniper and/or singleleaf pinyon may be present and with a lack in disturbances such as fire can eventually out-compete understory vegetation for site resources.

## State and transition model

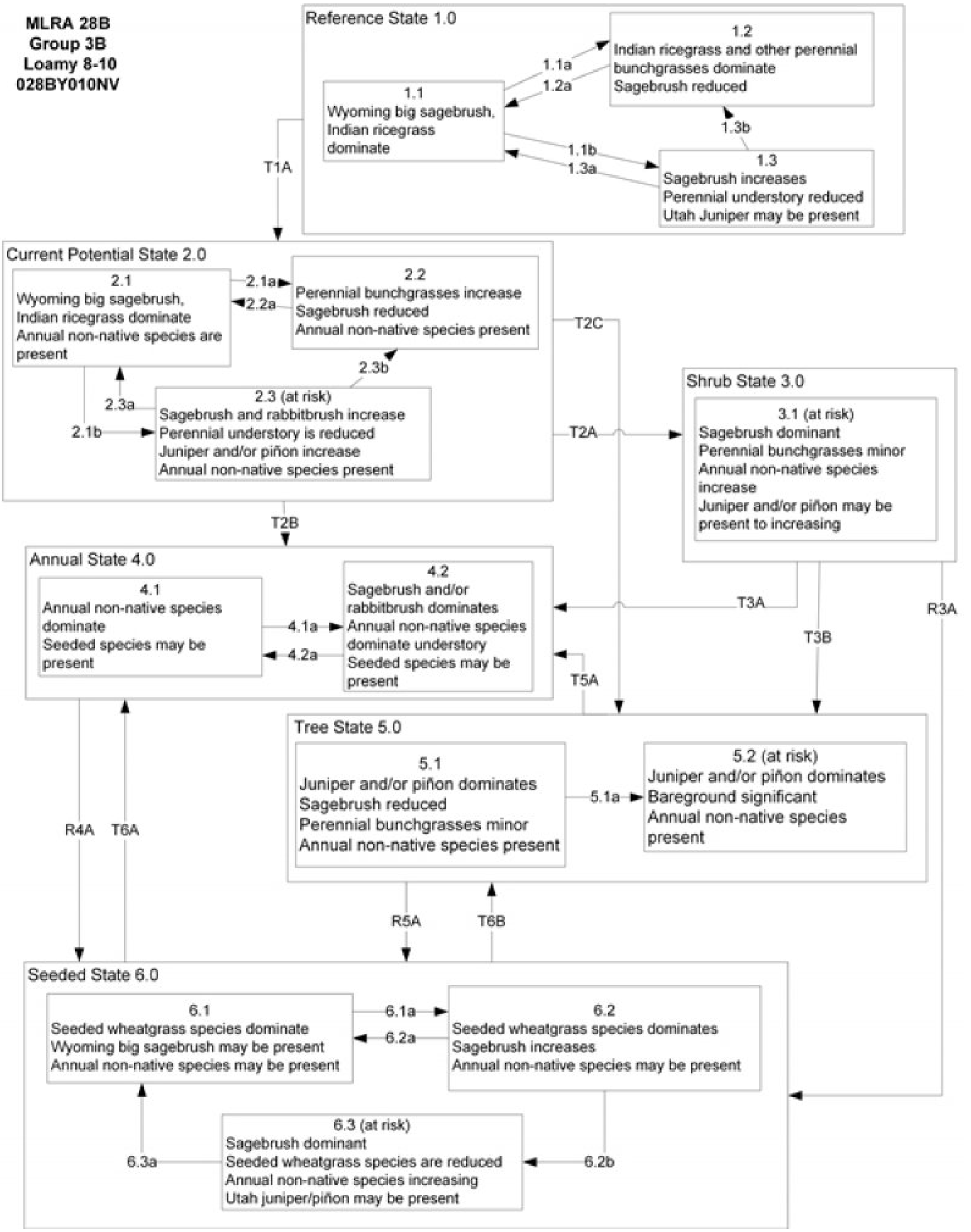


**Figure 5. Loamy 8-10**

## State 1
## Reference State

## Community 1.1

## Community Phase

This plant community is dominated by Wyoming big sagebrush, Indian ricegrass, and needleandthread. Common perennial forbs include globemallow, phlox and lupine. Potential vegetative composition is about 50% grasses, 5% forbs, and 45% shrubs and trees. Approximate ground cover (basal and crown) is 20 to 30 percent.

**Table 5. Annual production by plant type**

| Plant Type | Low (Lb/Acre) | Representative Value (Lb/Acre) | High (Lb/Acre) |
|---|---|---|---|
| Grass/Grasslike | 200 | 300 | 400 |
| Shrub/Vine | 177 | 262 | 348 |
| Forb | 20 | 30 | 40 |
| Tree | 3 | 8 | 12 |
| **Total** | **400** | **600** | **800** |

## Community 1.2
## Community Phase

This community phase is characteristic of a post-disturbance, early seral community phase. Indian ricegrass and other perennial grasses dominate. Depending on fire severity or intensity of Aroga moth infestation, patches of intact sagebrush may remain.

## Community 1.3
## Community Phase

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 and/or from herbivory.

## Pathway a
## 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 b
## Community 1.1 to 1.3

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

## Pathway a
## Community 1.2 to 1.1

Absence of disturbance over time would allow for sagebrush to increase.

## Pathway a
## Community 1.3 to 1.1

A low severity fire, Aroga moth or combination would reduce the sagebrush overstory and create a sagebrush/grass mosaic with sagebrush and perennial bunchgrasses co-dominant. Utah juniper may be present.

## Pathway b
## 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 low severity resulting in a mosaic pattern due to low fine fuel loads. A fire following an unusually wet spring or a change in management favoring an increase in fine fuels, may be more severe and reduce sagebrush cover to trace amounts. 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. This state has the same three general community phases. Ecological function has not changed, however the resiliency of the state has been reduced by the presence of invasive weeds. Non-natives may increase in abundance but will not become dominant within this State. These non-natives can be highly flammable and can promote fire where historically fire had been infrequent. Negative feedbacks enhance ecosystem resilience and contribute to the stability of the state. These feedbacks include the presence of all structural and functional groups, low fine fuel loads and retention of organic matter and nutrients. Positive feedbacks decrease ecosystem resilience and stability of the state. These include the non-natives' high seed output, persistent seed bank, rapid growth rate, ability to cross pollinate and adaptations for seed dispersal.

## Community 2.1
## Community Phase

Wyoming big sagebrush and Indian ricegrass dominate the site. Needle-and-thread grass and squirreltail may be significant components while Sandberg bluegrass and forbs make up smaller percentages by weight of the understory. Non-native annual species are present.

## Community 2.2
## Community Phase

This community phase is characteristic of a post-disturbance, early seral community phase. Indian ricegrass and other perennial grasses dominate. Wyoming big sagebrush is presence in trace amounts. Depending on fire severity or intensity of Aroga moth infestations, patches of intact sagebrush may remain. Rabbitbrush may be sprouting. Forbs may increase post-fire but will likely return to pre-burn levels within a few years. Annual non-native species generally respond well after fire and may be stable or increasing within the community.

## Community 2.3
## Community Phase (at risk)

This community is at risk of crossing a threshold to another state. Sagebrush dominates the overstory and perennial bunchgrasses in the understory are reduced, either from competition with shrubs or from inappropriate grazing management, or from both. Rabbitbrush may be a significant component. Sandberg bluegrass may increase and become co-dominate with deep rooted bunchgrasses. Utah juniper may be present and without management will likely increase. Annual non-natives species may be stable or increasing due to lack of competition with perennial bunchgrasses. This site is susceptible to further degradation from grazing, drought, and fire.

## Pathway a
## Community 2.1 to 2.2

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

## Pathway b
## Community 2.1 to 2.3

Time and lack of disturbance such as fire allows for sagebrush to increase and become decadent. Chronic drought reduces fine fuels and leads to a reduced fire frequency allowing Wyoming big sagebrush to dominate the site. Inappropriate grazing management reduces the perennial bunchgrass understory; conversely Sandberg bluegrass may increase in the understory depending on grazing management. Excessive sheep grazing favors Sandberg bluegrass; however, where cattle and/or horses are the dominant grazers, cheatgrass often increases.

## Pathway a
## Community 2.2 to 2.1

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

## Pathway a
## Community 2.3 to 2.1

A change in grazing management that decreases shrubs would allow for the perennial bunchgrasses in the understory to increase. Heavy late-fall/winter grazing may cause mechanical damage and subsequent death to sagebrush, facilitating an increase in the herbaceous understory. An infestation of Aroga moth or a low severity fire would reduce some sagebrush overstory and allow perennial grasses to increase in the community. Brush treatments with minimal soil disturbance would also decrease sagebrush and release the perennial understory. Annual non-native species are present and may increase in the community.

## Pathway b
## 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 is a product of many years of heavy grazing during time periods harmful to perennial bunchgrasses. Sandberg bluegrass may increase with a reduction in deep rooted perennial bunchgrass competition and may become the dominate grass or the herbaceous understory may be completely eliminated. Sagebrush dominates the overstory and rabbitbrush may be a significant component. Sagebrush cover exceeds site concept and may be decadent, reflecting stand maturity and lack of seedling establishment due to competition with mature plants. The shrub overstory dominates site resources such that soil water, nutrient capture, nutrient cycling and soil organic matter are temporally and spatially redistributed. Bare ground may be significant with soil redistribution occurring between interspace and canopy locations.

## Community 3.1
## Community Phase (at risk)

**Figure 7. P. Novak-Echenique_6/2012**

**Figure 8. P. Novak-Echenique_6/2012**

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

## State 4
## Annual State

This community is characterized by the dominance of annual non-native species such as cheatgrass and tansy mustard in the understory. Wyoming big sagebrush and/or rabbitbrush may dominate the overstory.

### Community 4.1
### Community Phase

Annual non-native plants such as cheatgrass or tansy mustard dominate the site. Rabbitbrush may or may not be present.

### Community 4.2
### Community Phase

Wyoming big sagebrush overstory with annual non-native species understory. Trace amounts of desirable bunchgrasses may be present.

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

Time and lack of fire allows for the sagebrush to establish. Probability of sagebrush establishment is extremely low.

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

Fire removes sagebrush and allows for annual non-native species to dominate the site.

**State 5**
**Tree State**

This state is characterized by a dominance of Utah juniper 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 and soil organic matter distribution and cycling have been spatially and temporally altered.

**Community 5.1**
**Community Phase**

Utah juniper and/or singleleaf pinyon pine dominates the overstory and site resources. Trees are actively growing with noticeable leader growth. Trace amounts of bunchgrass may be found under tree canopies with or without trace amounts of Sandberg bluegrass and forbs in the interspaces. Sagebrush is stressed and dying. Annual non-native species are present under tree canopies. Bare ground interspaces are large and connected.

**Community 5.2**
**Community Phase**

Utah juniper trees and/or singleleaf pinyon pine 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 a**
**Community 5.1 to 5.2**

Time and lack of disturbance or management action allows Utah juniper to further mature and dominate site resources.

**State 6**
**Seeded State**

This state is characterized by the dominance of seeded introduced wheatgrass species. Forage kochia and other desired seeded species including Wyoming big sagebrush and native and non-native forbs may be present. Soil nutrients and soil organic matter distribution and cycling are primarily driven by deep rooted bunchgrasses.

**Community 6.1**
**Community Phase**

Introduced wheatgrass species and other non-native species such as forage kochia dominate the community. Native and non-native seeded forbs may be present. Trace amounts of big sagebrush may be present, especially if seeded. Annual non-native species present.

**Community 6.2**
**Community Phase**

Figure 9. P. Novak-Echenique_6/2012

Wyoming big sagebrush and seeded wheatgrass species co-dominate. Annual non-native species stable to increasing.

## Community 6.3
## Community Phase (at risk)

Figure 10. Sagebrush dominated - Seeded State P.Novak-Echeniq

This community phase is at-risk of crossing a threshold to another state. Wyoming big sagebrush dominates. Rabbitbrush may be a significant component. Wheatgrass vigor and density reduced. Annual non-native species stable to increasing. Juniper may be present.

## Pathway a
## Community 6.1 to 6.2

Inappropriate grazing management particularly during the growing season reduces perennial bunchgrass vigor and density and facilitates shrub establishment.

## Pathway a
## Community 6.2 to 6.1

Low severity fire, brush management, and/or Aroga moth infestation would reduce the sagebrush overstory and allow seeded wheatgrass species to become dominant.

## Pathway b
## Community 6.2 to 6.3

Community Phase

Community Phase (at risk)

Absence of shrub removal disturbances over time coupled with inappropriate grazing management that promotes a reduction in perennial bunchgrasses and facilitates shrub dominance.

### Pathway a
### Community 6.3 to 6.1

Fire eliminates/decreases the overstory of sagebrush and allows for the understory perennial grasses to increase. Fires would typically be low severity resulting in a mosaic pattern due to low fine fuel loads. A fire following an unusually wet spring or change in management favoring an increase in fine fuels, may be more severe and reduce the shrub component to trace amounts. A severe infestation of Aroga moth would also cause a large decrease in sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs. Brush treatments with minimal soil disturbance would also decrease sagebrush and release the perennial understory. Annual non-native species respond well to fire and may increase post-burn.

**Conservation practices**

| Brush Management |
| --- |

### Transition A
### State 1 to 2

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

### Transition A
### State 2 to 3

Trigger: Inappropriate, long-term grazing of perennial bunchgrasses during the growing season would favor sagebrush. Slow variables: Long term decrease in deep-rooted perennial grass density. Threshold: Loss of deep-rooted perennial bunchgrasses changes spatial and temporal nutrient cycling and nutrient redistribution, and reduces soil organic matter.

### Transition B
### State 2 to 4

Trigger: To Community Phase 4.1: Severe fire. To Community Phase 4.2: Inappropriate grazing management that favors shrubs in the presence of non-native species. Slow variables: Increased production and cover of non-native annual species. Threshold: Loss of deep-rooted perennial bunchgrasses and shrubs truncates, spatially and temporally, nutrient capture and cycling within the community. Increased, continuous fine fuels from annual non-native plants modify the fire regime by changing intensity, size and spatial variability of fires.

### Transition C
### State 2 to 5

Trigger: Time and lack of disturbance or management action allows for Utah Juniper to dominate. This may be coupled with grazing management that favors tree establishment by reducing understory herbaceous competition for site resources Slow variables: Over time the abundance and size of trees will increase. Threshold: Trees dominate ecological processes and number of shrub skeletons exceed number of live shrubs.

### Transition A
### State 3 to 4

Trigger: To Community Phase 4.1: Severe fire. To Community Phase 4.2: Inappropriate grazing management in the presence of annual non-native species. Slow variables: Increased production and cover of non-native annual 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 spatially and temporally thus impacting nutrient cycling and distribution.

### Transition B
### State 3 to 5

Trigger: Time and a lack of disturbance or management action allows for Utah Juniper to dominate site. This may be coupled with grazing management that favors tree establishment by reducing understory herbaceous competition for site resources. Slow variables: Over time the abundance and size of trees will increase. Threshold: Trees dominate ecological processes and number of shrub skeletons exceed number of live shrubs.

### Restoration pathway A
### State 3 to 6

Brush management with minimal soil disturbance, coupled with seeding of desired species, usually wheatgrass (6.1 or 6.2). Probability of success very low (6.1).

### Restoration pathway A
### State 4 to 6

Seeding of deep-rooted introduced bunchgrasses and other desired species; may be coupled with brush management and/or herbicide. Probability of success is extremely low.

#### Conservation practices

| |
|---|
| Brush Management |
| Range Planting |

### Transition A
### State 5 to 4

Trigger: Catastrophic fire causing a stand replacement event would transition Annual State 4.0. Inappropriate tree removal practices with soil disturbance would cause a transition to the Annual State 4. Slow variables: Increased production and cover of non-native annual species under tree canopies. Threshold: Closed tree canopy with non-native annual species dominant in the understory changes the 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 nutrient cycling and distribution.

### Restoration pathway A
### State 5 to 6

Tree removal and seeding of desired species. Tree removal practices that minimize soil disturbance are recommended. Probability of success declines with increased presence of non-native annual species (Community Phase 5.2).

#### Conservation practices

| |
|---|
| Brush Management |
| Range Planting |

## Transition A
## State 6 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 B
## State 6 to 5

Trigger: Time and a lack of disturbance or management action allows for Utah Juniper to dominate site. This may be coupled with grazing management that favors tree establishment by reducing understory herbaceous competition for site resources. Slow variables: Increased establishment and cover of juniper trees Threshold: Trees dominate ecological processes and number of shrub skeletons exceed number of live shrubs. There is minimal recruitment of sagebrush cohorts.

## Additional community tables

**Table 6. Community 1.1 plant community composition**

| Group | Common Name | Symbol | Scientific Name | Annual Production (Lb/Acre) | Foliar Cover (%) |
|---|---|---|---|---|---|
| **Grass/Grasslike** | | | | | |
| 1 | **Primary Perennial Grasses** | | | 204–378 | |
| | Indian ricegrass | ACHY | *Achnatherum hymenoides* | 120–180 | – |
| | needle and thread | HECO26 | *Hesperostipa comata* | 60–120 | – |
| | squirreltail | ELEL5 | *Elymus elymoides* | 12–48 | – |
| | Sandberg bluegrass | POSE | *Poa secunda* | 12–30 | – |
| 2 | **Secondary Perennial Grasses** | | | 12–48 | |
| | basin wildrye | LECI4 | *Leymus cinereus* | 3–18 | – |
| | western wheatgrass | PASM | *Pascopyrum smithii* | 3–18 | – |
| **Forb** | | | | | |
| 3 | **Perennial** | | | 24–60 | |
| | globemallow | SPHAE | *Sphaeralcea* | 12–30 | – |
| | Indian paintbrush | CASTI2 | *Castilleja* | 3–12 | – |
| | phlox | PHLOX | *Phlox* | 3–12 | – |
| **Shrub/Vine** | | | | | |
| 4 | **Primary Shrubs** | | | 162–240 | |
| | Wyoming big sagebrush | ARTRW8 | *Artemisia tridentata ssp. wyomingensis* | 150–210 | – |
| | yellow rabbitbrush | CHVI8 | *Chrysothamnus viscidiflorus* | 12–30 | – |
| 5 | **Secondary Shrubs** | | | 27–48 | |
| | fourwing saltbush | ATCA2 | *Atriplex canescens* | 3–18 | – |
| | Nevada jointfir | EPNE | *Ephedra nevadensis* | 3–18 | – |
| | spiny hopsage | GRSP | *Grayia spinosa* | 3–18 | – |
| **Tree** | | | | | |
| 6 | **Evergreen** | | | 3–12 | |
| | yellow rabbitbrush | CHVI8 | *Chrysothamnus viscidiflorus* | 12–30 | – |
| | Utah juniper | JUOS | *Juniperus osteosperma* | 3–12 | – |

## Animal community

Livestock/Wildlife Grazing Interpretations:
This site is suitable for livestock grazing. Considerations for grazing management including timing, intensity and duration of grazing. Targeted grazing could be used to decrease the density of non-natives.
Overgrazing leads to an increase in big sagebrush and a decline in understory plants like Indian ricegrass and needle-and-thread grass. Squirreltail and 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 an increase in bare ground. A combination of overgrazing and prolonged drought may lead to soil redistribution, increased bare ground and a loss in plant production.
Indian ricegrass is a deep-rooted, cool season perennial bunchgrass that is adapted primarily to well-drained soils. Indian ricegrass is a preferred forage species for livestock and wildlife (Cook 1962, Booth et al. 2006). This species is often heavily utilized in winter because it cures well (Booth et al. 2006). It is also readily utilized in early spring, being a source of green feed before most other perennial grasses have produced new growth (Quinones 1981). Booth et al (2006) also notes that the plant does well when utilized in winter and spring. Cook and Child (1971), however, found that repeated heavy grazing reduced crown cover, which may reduce seed production, density, and basal area of these plants. The seed crop may be reduced where grazing is heavy (Bich et al. 1995). Additionally, heavy early spring grazing was found to reduce plant vigor and stand density (Stubbendieck et al. 1985). In eastern Idaho, productivity of Indian ricegrass was at least 10 times greater in undisturbed plots than in heavily grazed ones (Pearson 1976). Yet, Cook and Child (1971) found significant reduction in plant cover after 7 years of rest from heavy (90%) and moderate (60%) spring use. 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.
Needleandthread, the co-dominant grass on this site, is most commonly found on warm/dry soils and is widely distributed over the western states and Great Plains (USDA 1988)). This plant is a deep-rooted bunchgrass which depends upon seed for reproduction therefore on drier sites where seed production is variable it is easily removed by overgrazing (USDA 1988). Therefore it is considered not grazing tolerant in the arid west and will be one of the first grasses to decrease under heavy grazing pressure (Smoliak et al. 1972, Tueller and Blackburn 1974). Heavy grazing is likely to reduce basal area of these plants ((Smoliak et al. 1972).
Bottlebrush squirreltail, a minor component of this ecological site is a short lived perennial bunchgrass that is generally an early seral species (Jones 1998). It is thought to be grazing tolerant but will decrease in basal area with heavy grazing (Eckert and Spencer 1987). Its grazing tolerance is likely due to its morphology and early dormancy during the summer months (Wright 1967). Squirreltail is considered to be fair forage for livestock and wildlife until the heads develop (Dayton 1937). Squirreltail also exhibits traits that allow it to be a good competitor with cheatgrass (Bromus tectorum) and make it a viable option when rehabilitating invaded rangelands (Rowe and Leger 2010). Sandberg bluegrass is a palatable species, but its production is closely tied to weather conditions. It produces little forage in drought years, making it a less dependable food source than other perennial bunchgrasses.
The majority of research concerning rabbitbrush has been conducted on green rabbitbrush. Green rabbitbrush has a large taproot and is known to be shorter-lived and less competitive than sagebrush. Seedling density, flower production, and shoot growth decline as competition from other species increases (McKell and Chilcote 1957, Miller et al. 2013, Young and Evans 1974). Depending on fire severity, rabbitbrush may increase after fire. Rubber rabbitbrush is top-killed by fire, but can resprout after fire and can also establish from seed (Young 1983). Douglas' rabbitbrush is top-killed by fire, but sprouts vigorously after fire (Kuntz 1982, Akinsoji 1988). Shortened fire intervals within this ecological site favor an annual invasive herbaceous understory with varying amounts of Sandberg bluegrass and an overstory of rabbitbrush.
Livestock browse Wyoming big sagebrush, but may use it only lightly when palatable herbaceous species are available. Wyoming big sagebrush may increase moderately under heavy grazing; however, because of its relatively high palatability it does not increase as much as other big sagebrush subspecies usually do.
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:
Wyoming big sagebrush communities are important winter ranges for big game (Allen et al 1984, Tweit and Houston 1980). Pronghorn usually browse Wyoming big sagebrush heavily.The literature is unclear as to the palatability of Wyoming big sagebrush. Generally, Wyoming sagebrush is the least palatable of the big sagebrush taxa (Bray et al 1991, Sheehy and Winward 1981) however it may receive light or moderate use depending upon the amount of understory herbaceous cover (Tweit and Houston 1980). Personius et al (1987) found Wyoming big sagebrush and basin big sagebrush to be intermediately palatable to mule deer when compared to mountain big

sagebrush (most palatable) and black sagebrush (least palatable). Many wildlife species are dependent on the sagebrush ecosystem including the greater sage grouse, sage sparrow, pygmy rabbit and the sagebrush vole. Dobkin and Sauder (2004) identified 61 animal species, including 24 mammals and 37 birds, associated with the shrub-steppe habitats of the Intermountain West. Wyoming big sagebrush communities are critical habitat for the birds. 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. Leks 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. Indian ricegrass is eaten by pronghorn in "moderate" amounts whenever available. A number of heteromyid rodents inhabiting desert rangelands show preference for seed of Indian ricegrass. Indian ricegrass is an important component of jackrabbit diets in spring and summer. Indian ricegrass seed provides food for many species of birds. Doves, for example, eat large amounts of shattered Indian ricegrass seed lying on the ground. Needleandthread is moderately important spring forage for mule deer, but use declines considerably as more preferred forages become available. Bottlebrush squirreltail is a dietary component of several wildlife species. Bottlebrush squirreltail may provide forage for mule deer and pronghorn.

## Hydrological functions

Runoff is negligible to very high. Rills and waterflow patterns are none to rare. Occurrence is limited to steeper slopes in areas subjected to summer convection storms or rapid spring snowmelt. Water flow patterns, if present, are short in length and not connected. Pedestals are rare. Should pedestals occur, they are confined to areas of water flow. Frost heaving of shallow rooted plants should not be considered as pedestalling. 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

Aesthetic value is derived from the diverse floral and faunal composition. This site offers rewarding opportunities to photographers and for nature study. This site has potential for upland and big game 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. The wood is extremely aromatic when burned, and the wood smoke was used to mask the effects of an encounter with a skunk. Big sagebrush was little used by European-American settlers. They occasionally used the branches for thatching. The wood produces a very hot fire, and was used in mine smelters. Big sagebrush has little current commercial use. It is sometimes used for xeriscaping.
Indian ricegrass was traditionally eaten by some Native Americans. The Paiutes used seed as a reserve food source. The large-seeded panicle is often used in dry floral arrangements.

## 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. It can be established by direct seeding and by transplanting greenhouse seedlings or wildings.
Indian ricegrass is well-suited for surface erosion control and desert revegetation although it is not highly effective in controlling sand movement. Certain native ecotypes exhibit desirable characteristics such as drought and salinity tolerance, low seed dormancy, and good nutritional qualities. However, Indian ricegrass can be difficult to establish. Indian ricegrass can be useful in the reclamation of many arid and semiarid areas in the western United States. Typical sites include those in which vegetation has been removed due to surface mining, construction activity, brush control, heavy grazing, or fire. Indian ricegrass can be used for revegetating degraded rangelands in areas of low precipitation and has naturally revegetated overgrazed ranges.
Needleandthread grass is useful for stabilizing eroded or degraded sites. The presence of the long and tough seed

awn on needleandthread grass reduces is usefulness as a commercial seed, but needleandthread grass hay has been used successfully in revegetation projects.

## Type locality

| Location 1: White Pine County, NV | |
|---|---|
| Township/Range/Section | T16 N R57 E S31 |
| General legal description | West side of main road to Green Springs; approximately 0.3 miles south of southern-most turnoff to Monte Cristo, White Pine County, Nevada. This site also occurs in Elko, Eureka, and Lander counties, Nevada. |

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## Contributors

CP/HA
T. Stringham

## 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/P.NOVAK-ECHENIQUE |
| Contact for lead author | State Rangeland Management Specialist |
| Date | 06/20/2006 |
| Approved by | P. Novak-Echenique |
| Approval date | |
| Composition (Indicators 10 and 12) based on | Annual Production |

## Indicators

1. **Number and extent of rills:** Rills are none to rare. Occurrence is limited to steeper slopes in areas subjected to summer convection storms or rapid spring snowmelt.

2. **Presence of water flow patterns:** Water flow patterns are none to rare and limited to steeper slopes in areas subjected to summer convection storms or rapid snowmelt. Water flow patterns, if present, are short in length (< 1m) and not connected. They will meander and are interrupted by vegetation.

3. **Number and height of erosional pedestals or terracettes:** Pedestals are none to rare. Should pedestals occur, they are confined to areas of water flow. Frost heaving of shallow rooted plants should not be considered as pedestalling. Terracettes are none.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare Ground ± 50%; surface rock fragments 15 to 25%; shrub canopy 15 to 25%; basal area for perennial herbaceous plants ± 8%.

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

6. **Extent of wind scoured, blowouts and/or depositional areas:** None

7. **Amount of litter movement (describe size and distance expected to travel):** Fine litter (foliage from grasses and annual & perennial forbs) 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 large rainfall events.

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil stability values should be 3 to 6 on most soil textures found on this site. Areas of this site occurring on soils that have a physical crust will probably have stability values less than 3.

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. Surface textures are typically loams and sandy loams. Soil surface colors are light brownish grays and soils are typified by an ochric epipedon. Organic carbon 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.

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.

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. Platy or massive sub-surface horizons, subsoil calcic, argillic horizons or duripans are not to be interpreted as compacted layers.

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

    Dominant: Reference State: Deep-rooted, cool season, perennial bunchgrasses >> Wyoming big sagebrush. (By above ground production)

    Sub-dominant: Associated shrubs >shallow-rooted, cool season, perennial bunchgrasses>deep-rooted, cool season, perennial forbs>fibrous, shallow-rooted, cool season, perennial forbs. (By above ground production)

    Other: evergreen trees

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

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 25% of total woody canopy; some of the mature bunchgrasses (<20%) have dead centers.

14. **Average percent litter cover (%) and depth ( in):** Between plant interspaces (15-25%) and depth (<0.25 in.)

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** For normal or average growing season (through June) ~600 lbs/ac; Spring moisture significantly affects total production. Favorable years ~800 lbs/ac and unfavorable years ~400 lbs/ac.

16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:** Potential invaders include cheatgrass, halogeton, Russian thistle and annual mustards. Utah juniper will increase on this site and eventually dominate. Singleleaf pinyon may invade this site and eventually dominate.

17. **Perennial plant reproductive capability:** All functional groups should reproduce in average (or normal) and above average growing season years. Little growth or reproduction occurs in extreme drought years.