

## **Ecological site R026XY015NV SHALLOW LOAM 10-12 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): 026X–Carson Basin and Mountains

The area lies within western Nevada and eastern California, with about 69 percent being within Nevada, and 31 percent being within California. Almost all this area is in the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. Isolated north-south trending mountain ranges are separated by aggraded desert plains. The mountains are uplifted fault blocks with steep side slopes. Most of the valleys are drained by three major rivers flowing east across this MLRA. A narrow strip along the western border of the area is in the Sierra Nevada Section of the Cascade-Sierra Mountains Province of the Pacific Mountain System. The Sierra Nevada Mountains are primarily a large fault block that has been uplifted with a dominant tilt to the west. This structure leaves an impressive wall of mountains directly west of this area. This helps create a rain shadow affect to MLRA 26. Parts of this eastern face, but mostly just the foothills, mark the western boundary of this area. Elevations range from about 3,806 feet (1,160 meters) on the west shore of Pyramid Lake to 11,653 feet (3,552 meters) on the summit of Mount Patterson in the Sweetwater Mountains.

Valley areas are dominantly composed of Quaternary alluvial deposits with Quaternary playa or alluvial flat deposits often occupying the lowest valley bottoms in the internally drained valleys, and river deposited alluvium being dominant in externally drained valleys. Hills and mountains are dominantly Tertiary andesitic flows, breccias, ash flow tuffs, rhyolite tuffs or granodioritic rocks. Quaternary basalt flows are present in lesser amounts, and Jurassic and Triassic limestone and shale, and Precambrian limestone and dolomite are also present in very limited amounts. Also of limited extent are glacial till deposits along the east flank of the Sierra Nevada Mountains, the result of alpine glaciation.

The average annual precipitation in this area is 5 to 36 inches (125 to 915 millimeters), increasing with elevation. Most of the rainfall occurs as high-intensity, convective storms in spring and autumn. Precipitation is mostly snow in winter. Summers are dry. The average annual temperature is 37 to 54 degrees F (3 to 12 degrees C). The freeze-free period averages 115 days and ranges from 40 to 195 days, decreasing in length with elevation.

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

This area supports shrub-grass vegetation characterized by big sagebrush. Low sagebrush and Lahontan sagebrush occur on some soils. Antelope bitterbrush, squirreltail, desert needlegrass, Thurber needlegrass, and Indian ricegrass are important associated plants. Green ephedra, Sandberg bluegrass, Anderson peachbrush, and several forb species also are common. Juniper-pinyon woodland is typical on mountain slopes. Jeffrey pine, lodgepole pine, white fir, and manzanita grow on the highest mountain slopes. Shadscale is the typical plant in the drier parts of the area. Sedges, rushes, and moisture-loving grasses grow on the wettest parts of the wet flood plains and terraces. Basin wildrye, alkali sacaton, saltgrass, buffaloberry, black greasewood, and rubber rabbitbrush grow on the drier sites that have a high concentration of salts.

Some of the major wildlife species in this area are mule deer, coyote, beaver, muskrat, jackrabbit, cottontail, raptors, pheasant, chukar, blue grouse, mountain quail, and mourning dove. The species of fish in the area include trout and catfish. The Lahontan cutthroat trout in the Truckee River is a threatened and endangered species.

## **LRU notes**

The Sierra Influenced Ranges LRU is characterized by wooded great basin mountains with climatic and biotic affinities to the Sierra Nevada mountain range. The Sierra Influences Ranges LRU receives greater precipitation than the mountain ranges of central NV. Amount of precipitation varies in relation to the local strength of the Sierra NV rain shadow, characterized by pinyon and juniper trees. The White, Sweetwater, Pine Nut, Wassuk, and Virginia ranges of Nevada support varying amounts of Sierra Nevada flora, such as ponderosa pine. Elevations range from 1610 to 2420 meters and slopes range from 5 to 49 percent, with a median value of 22 percent. Frost free days (FFD) ranges from 92 to 163.

## **Ecological site concept**

The Shallow Loam 10-12 P.Z. site is found on mountains and hills on slopes less than 50 percent. The elevations are between 4,500 and 7,550 feet. The soil is shallow to bedrock. The soil surface texture is cobbly loam. The dominant vegetation is big sagebrush (*Artemisia tridentata*) and Thurber's needlegrass (*Achnatherum thurberianum*).

## Associated sites

R026XY010NV	<b>LOAMY 10-12 P.Z.</b>
R026XY023NV	<b>CLAYPAN 10-12 P.Z.</b>
R026XY050NV	<b>GRAVELLY CLAY 10-12 P.Z.</b>

## Similar sites

R026XY098NV	<b>GRAVELLY LOAM 8-10 P.Z.</b> ACTH7 dominant grass; slopes typically less than 30%
R026XY089NV	<b>SOUTH SLOPE 12-14 P.Z.</b> More productive site
R026XY010NV	<b>LOAMY 10-12 P.Z.</b> More productive site; ACTH7 dominant grass; slopes typically less than 30%
R026XY022NV	<b>STONY SLOPE 8-10 P.Z.</b> ACSP12 dominant grass; PUTR2 minor species
R026XY017NV	<b>LOAMY HILL 10-12 P.Z.</b> JUOS dominates visual aspect of site
R026XY029NV	<b>ERODED SLOPE 10-12 P.Z.</b> Less productive site
R026XY016NV	<b>LOAMY 8-10 P.Z.</b> ACTH7 dominant grass; slopes typically less than 30%
R026XY033NV	<b>SANDY CLAYPAN 8-10 P.Z.</b> PUTR2 codominant shrub

**Table 1. Dominant plant species**

Tree	Not specified
Shrub	(1) <i>Artemisia tridentata</i> (2) <i>Purshia tridentata</i>
Herbaceous	(1) <i>Achnatherum thurberianum</i> (2) <i>Achnatherum speciosum</i>

## Physiographic features

This site occurs on plateaus, upper pediment slopes, hills and lower mountain sideslopes. Slopes range from 4 to 50 percent, but are typically 15 to 30 percent. Elevations are 5000 to 7400 feet.

**Table 2. Representative physiographic features**

Landforms	(1) Plateau (2) Pediment (3) Hill
Elevation	1,524–2,256 m
Slope	15–30%
Aspect	Aspect is not a significant factor

## Climatic features

The climate associated with this site is semiarid, characterized by cool, moist winters and warm, dry summers. Average annual precipitation is 10 to 12 inches. Mean annual air temperature is 44 to 52 degrees F. The average growing season is about 50 to 120 days.

Nevada's climate is predominantly arid, with large daily ranges of temperature, infrequent severe storms, heavy snowfall in the higher mountains, and great location variations with elevation. Three basic geographical factors largely influence Nevada's climate: continentality, latitude, and elevation. Continentality is the most important factor. The strong continental effect is expressed in the form of both dryness and large temperature variations. Nevada lies on the eastern, lee side of the Sierra Nevada Range, a massive mountain barrier that markedly influences the climate of the State. The prevailing winds are from the west, and as the warm moist air from the Pacific Ocean ascend the western slopes of the Sierra Range, the air cools, condensation occurs and most of the moisture falls as precipitation. As the air descends the eastern slope, it is warmed by compression, and very little precipitation occurs. The effects of this mountain barrier are felt not only in the West but throughout the state, with the result that the lowlands of Nevada are largely desert or steppes. The temperature regime is also affected by the blocking of the inland-moving maritime air. Nevada sheltered from maritime winds, has a continental climate with well-developed seasons and the terrain responds quickly to changes in solar heating.

Nevada lies within the mid-latitude belt of prevailing westerly winds which occur most of the year. These winds bring frequent changes in weather during the late fall, winter and spring months, when most of the precipitation occurs. To the south of the mid-latitude westerlies, lies a zone of high pressure in subtropical latitudes, with a center over the Pacific Ocean. In the summer, this high-pressure belt shifts northward over the latitudes of Nevada, blocking storms from the ocean. The resulting weather is mostly clear and dry during the summer and early fall, with scattered thundershowers. The eastern portion of the state receives significant summer thunderstorms generated from monsoonal moisture pushed up from the Gulf of California, known as the North American monsoon. The monsoon system peaks in August and by October the monsoon high over the Western U.S. begins to weaken and the precipitation retreats southward towards the tropics (NOAA 2004).

**Table 3. Representative climatic features**

Frost-free period (characteristic range)	
Freeze-free period (characteristic range)	
Precipitation total (characteristic range)	254-305 mm
Frost-free period (average)	85 days
Freeze-free period (average)	
Precipitation total (average)	279 mm

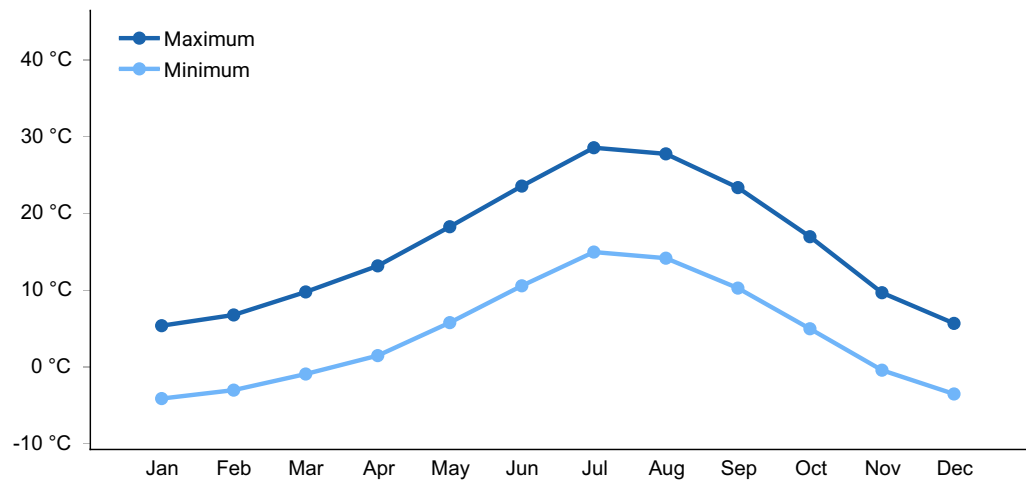


Figure 1. Monthly average minimum and maximum temperature

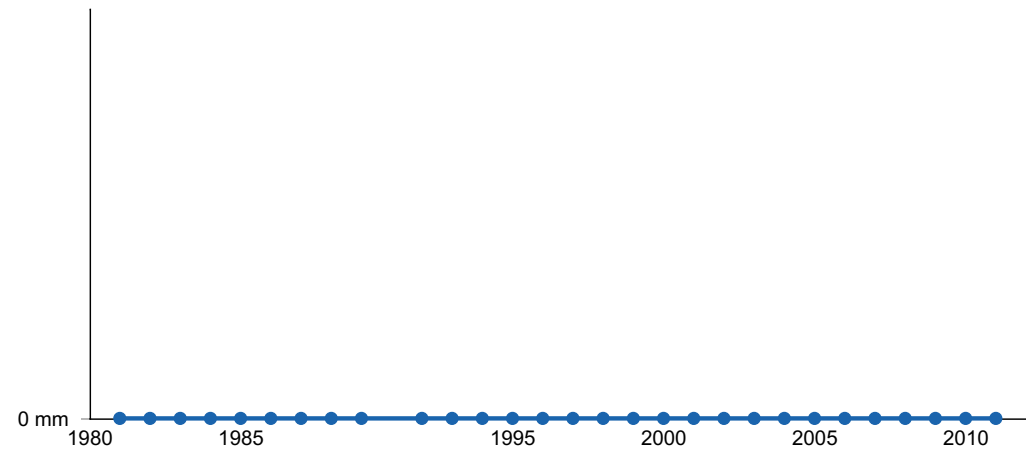


Figure 2. Annual precipitation pattern

Influencing water features

There are no influencing water features associated with this site.

Soil features

The soils associated with this site are shallow, well drained and have a very low available water capacity. Inherent soil fertility is high, but because of the shallow rooting depth, productivity and plant density are reduced. Surface gravel, cobbles or stones provide a

stabilizing affect on surface erosion. Runoff is high to very high on this site. Soil series associated with this site include: Aldax, Chalco, Flex, Hocar, Ister, Koontz, Longcreek, Reywat, Stodick, Terca, and Wedekind.

**Table 4. Representative soil features**

Parent material	(1) Colluvium–volcanic rock (2) Residuum–volcanic rock
Surface texture	(1) Cobbly loam
Family particle size	(1) Loamy-skeletal
Drainage class	Well drained
Permeability class	Moderately slow to rapid
Soil depth	20–51 cm
Surface fragment cover ≤3"	9–50%
Surface fragment cover >3"	2–45%
Available water capacity (0-101.6cm)	2.79–7.11 cm
Calcium carbonate equivalent (0-101.6cm)	0%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	6.1–8.4
Subsurface fragment volume ≤3" (Depth not specified)	11–50%
Subsurface fragment volume >3" (Depth not specified)	2–14%

## Ecological dynamics

Where management results in abusive livestock and/or feral horse use, big sagebrush, Anderson's peachbrush and Douglas' rabbitbrush increase as perennial bunchgrasses decline. Utah juniper and singleleaf pinyon readily increase on this site where it occurs adjacent to these woodland types. When Utah juniper and singleleaf pinyon occupy this site, these trees compete with other species for available light, moisture and nutrients.

### Fire Ecology:

Sagebrush steppe communities have historically been subjected to fires at varying intervals (20-70 years). Wyoming big sagebrush is killed by fire and establishes after fire

from a seedbank; from seed produced by remnant plants that escaped fire; and from plants adjacent to the burn that seed in. Mountain big sagebrush is highly susceptible to injury from fire. It is often top-killed by fire and will not resprout. Antelope bitterbrush is considered a weak sprouter and is often killed by summer or fall fire. Antelope bitterbrush in some areas may sprout after light-severity spring fire. High fuel consumptions increase antelope bitterbrush mortality and therefore favors seedling establishment. Desert needlegrass has persistent dead leaf bases, which make it susceptible to burning. Fire removes the accumulation; a rapid, cool fire will not burn deep into the root crown. Thurber's needlegrass is classified as moderately resistant, but depending on season of burn, phenology, and fire severity, this perennial bunchgrass is moderately to severely damaged by fire. Burning has been found to decrease the vegetation and reproductive vigor. Early season burning is more damaging to this needlegrass than late season burning. Indian ricegrass can be killed by fire, depending on severity and season of burn. Indian ricegrass reestablishes on burned sites through seed dispersed from adjacent unburned areas. Bottlebrush squirreltail's small size, coarse stems, and sparse leafy material aid in its tolerance of fire. Postfire regeneration occurs from surviving root crowns and from on- and off-site seed sources. Frequency of disturbance greatly influences postfire response of bottlebrush squirreltail. Undisturbed plants within a 6 to 9 year age class generally contain large amounts of dead material, increasing bottlebrush squirreltail's susceptibility to fire.

Reference State 1.0: 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.

State and Transition Model narratives:

Community Phase 1.1: Thurber's needlegrass is codominant with big sagebrush. Sagebrush may be a mix of Wyoming big sagebrush, basin big sagebrush, and mountain big sagebrush. Pinyon and/or juniper may be present.

Community Phase Pathway 1.1a, from Phase 1.1 to 1.2: Low severity fire creates a sagebrush/grass mosaic. High severity fire significantly reduces sagebrush cover and leads to early/mid-seral community dominated by grasses and forbs. In reference condition, fires would typically be small and patchy due to low fuel loads. 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.

Community Phase Pathway 1.1b, from Phase 1.1 to 1.3: Time and lack of disturbance

such as fire or drought allows shrubs to become dominant and may reduce grass production. Excessive herbivory and/or long-term drought may also reduce the perennial understory.

Community Phase 1.2: This community phase is characteristic of a post-disturbance, early to mid-seral community. Bitterbrush, ephedra, and spiny hopsage may be sprouting and may become the dominant shrubs in this phase. Big sagebrush is killed by fire and is reduced within the burned community but may be present in unburned patches. Thurber's needlegrass can experience high mortality from fire and may be reduced in the community for several years. With low fire severity, Thurber's needlegrass may dominate the site post-fire.

Community Phase Pathway 1.2a, from Phase 1.2 to 1.1: Time and lack of disturbance allows for shrubs to reestablish.

Community Phase 1.3: Big sagebrush increases in the absence of disturbance. Thurber's needlegrass and other perennial grasses reduced. Decadent sagebrush dominates the overstory and the deep-rooted perennial bunchgrasses in the understory are reduced either from competition with shrubs or from herbivory. Bluegrass (*Poa*) species will likely increase in the understory and may be the dominant grass on the site. Pinyon and/or juniper may be present but constitute less than 2% of production on the site.

Community Phase Pathway 1.3a, from Phase 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.

Community Phase Pathway 1.3b, from Phase 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.

T1A: Transition from Reference State 1.0 to Current Potential State 2.0: Trigger: This transition is caused by the introduction of non-native annual weeds, such as cheatgrass, mustards and Russian thistle (*Salsola tragus*). 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.

Current Potential State 2.0: 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 Phase 2.1: Thurber's needlegrass is codominant with big sagebrush. Sagebrush may be a mix of Wyoming big sagebrush, basin big sagebrush, and mountain big sagebrush. Pinyon and/or juniper may be present. Non-native annual species are present in minor amounts.

Community Phase Pathway 2.1a, from Phase 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.

Community Phase Pathway 2.1b, from Phase 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.

Community Phase 2.2: This community phase is characteristic of a post-disturbance, early to mid-seral community. Bitterbrush, ephedra, and spiny hopsage may be sprouting and may become the dominant shrubs in this phase. Big sagebrush is killed by fire and is reduced within the burned community but may be present in unburned patches. Thurber's needlegrass can experience high mortality from fire and may be reduced in the community for several years. With low fire severity, Thurber's needlegrass may dominate the site post-fire. Annual non-native species generally respond well after fire and may be stable or increasing within the community.

Community Phase Pathway 2.2a, from Phase 2.2 to 2.1: Absence of disturbance over time allows for the sagebrush to recover may be combined with grazing management that favors shrubs.

Community Phase Pathway 2.2b, from Phase 2.2 to 2.4: Higher than normal spring precipitation favors annual non-native species such as cheatgrass. Non-native annual species will increase in production and density throughout the site. Perennial bunchgrasses may also increase in production.

Community Phase 2.3(At Risk): Big sagebrush increases in the absence of disturbance. Thurber's needlegrass and other perennial grasses reduced. Decadent sagebrush dominates the overstory and the deep-rooted perennial bunchgrasses in the understory are reduced either from competition with shrubs or from herbivory. Bluegrass (*Poa*) species will likely increase in the understory and may be the dominant grass on the site. Pinyon and/or juniper may be increasing. Annual non-native species are present. This phase may be at risk of transitioning to the Shrub State 3.0 or the Tree State 5.0.

Community Phase Pathway 2.3a, from Phase 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.

Community Phase Pathway 2.3b, from Phase 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.

Community Phase Pathway 2.3c, from Phase 2.3 to 2.4: Fall, winter, and spring precipitation and temperatures mediate the ability for annual grasses and perennial grasses to germinate and/or survive. Higher than normal spring precipitation creates high annual production of annual grasses (Bradley et al. 2016). Non-native annual species increase in production and density throughout the site. Perennial bunchgrasses may also increase in production.

Community Phase 2.4 (At Risk): This community is at risk of crossing into an annual state. Native bunchgrasses dominate; however, annual non-native species such as cheatgrass may be sub or co-dominant in the understory. Annual production and abundance of these annuals may increase drastically in years with heavy spring precipitation. Seeded species may be present. Sagebrush may be present if coming from phase 2.3. This site is susceptible to further degradation from grazing, drought, and fire. Pinyon and/or juniper may be present.

Community Phase Pathway 2.4a, from phase 2.4 to 2.3: Rainfall patterns favoring perennial bunchgrasses. Less than normal spring precipitation followed by higher than

normal summer precipitation will increase perennial bunchgrass production.

Community Phase Pathway 2.4b, from phase 2.4 to 2.2: Fall, winter, and spring precipitation and temperatures mediate the ability for annual grasses and perennial grasses to germinate and/or survive. Depending on temperatures and precipitation in winter and spring, annual grass production may be reduced in favor of perennial bunchgrasses.

T2A: Transition from Current Potential State 2.0 to Shrub State 3.0: 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 redistribution and reduces soil organic matter.

T2B: Transition from Current Potential State 2.0 to Annual State 4.0: 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.

T2C: Transition from Current Potential State 2.0 to Tree State 5.0: 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/pinyon 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.

Shrub State 3.0: This state has two community phases; a big sagebrush dominated phase and a sprouting shrub 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 sprouting shrubs 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 Phase 3.1 (At Risk): Big sagebrush dominates overstory. Thurber's needlegrass and other perennial grasses are reduced, with bluegrass species dominant in the understory. Pinyon and juniper may be present. Annual non-native species may be present. Bare ground may be significant. Seeded species may be present. Pinyon and/or juniper may be present or increasing.

Community Phase Pathway 3.1a, from Phase 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 bluegrasses, 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 bluegrasses to dominate the site.

Community Phase 3.2(At Risk): Bluegrass species dominate the understory. Sprouting shrubs may be present. Perennial grasses trace or missing. Annual non-native species dominate understory. Bare ground may be significant. Seeded species may be present.

Community Phase Pathway 3.2a, from Phase 3.2 to 3.1: Absence of disturbance over time would allow for sagebrush and other shrubs to recover.

T3A: Transition from Shrub State 3.0 to Annual State 4.0: 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.

T3B: Transition from Shrub State 3.0 to Tree State 5.0: 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/pinyon 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.

R3A: Restoration from Shrub State 3.0 to Seeded State 6.0: Brush management, herbicide, and seeding of crested wheatgrass (*Agropyron cristatum*) and/or other desired species.

Annual State 4.0: This state has two community phases; one dominated by annual non-native species and the other is a shrub dominated state. This state is characterized by the dominance of annual non-native species such as cheatgrass in the understory. Sagebrush and/or sprouting shrubs may dominate the overstory.

Community Phase 4.1: Annual non-native plants such as cheatgrass dominate the site. Perennial plants are a minor component or missing from the site. This phase may have seeded species present if resulting from a failed seeding attempt.

Community Phase Pathway 4.1a, from Phase 4.1 to 4.2: Time and lack of disturbance

allows for shrubs to reestablish. Sprouting shrubs such as ephedra, desert peach and rabbitbrush will be the first to reappear after fire. Probability of sagebrush establishment is extremely low.

Community Phase 4.2: Annual non-native species dominate understory. Sagebrush or sprouting shrubs dominate the overstory. Perennial bunchgrasses are a minor component. This phase may have seeded species present if resulting from a failed seeding attempt.

Community Phase Pathway 4.2a, from Phase 4.2 to 4.1: Fire kills shrubs and allows for annual non-native species to dominate the site.

R4A: Restoration from Annual State 4.0 to Seeded State 6.0: Application of herbicide and seeding of desired species. Probability of success is best immediately following fire.

Tree State 5.0: This state has two community phases that are characterized by the dominance of Utah juniper and/or 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 Phase 5.1: Utah juniper and/or singleleaf pinyon dominate overstory. Big sagebrush is subdominant and may be decadent. Thurber's needlegrass and other perennial grasses are reduced. Annual non-native may be present. Bare ground areas are large and connected.

Community Phase Pathway 5.1a, from Phase 5.1 to 5.2: Absence of disturbance over time allows for tree cover and density to further increase and out-compete the herbaceous understory species.

Community Phase 5.2 (At Risk): Utah juniper and/or singleleaf pinyon 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 shrub skeletons will be more numerous than living sagebrush. Bunchgrasses may or may not be present. Bottlebrush squirreltail or mat forming forbs may be present in trace amounts. Bare ground interspaces are large and connected. Soil redistribution is evident.

Community Phase Pathway 5.2a, from phase 5.2 to 5.1: Manual or mechanical thinning of trees allows understory regrowth due to less competition for resources. This treatment is typically done for fuel management.

T5A: Transition from Tree State 5.0 to Annual State 4.0: 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.

R5A: Restoration from Tree State 5.0 to Shrub State 3.0: Tree removal with no seeding. Treatments done in phase 5.1 will be more successful. Tree removal practices that minimize soil disturbance are recommended. Probability of success declines with increased presence of nonnative annual species.

R5B: Restoration from Tree State 5.0 to Seeded State 6.0: Tree removal and seeding of desired species. Tree removal practices that minimize soil disturbance are recommended. Probability of success declines with increased presence of nonnative annual species.

Seeded State 6.0: 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 (*Bassia prostrata*) and other desired seeded species including Wyoming big sagebrush, native and non-native forbs may be present.

Community Phase 6.1: Seeded wheatgrass and/or other seeded species dominate the community. Non-native annual species are present. Trace amounts of big sagebrush may be present, especially if seeded.

Community Phase Pathway 6.1a, from Phase 6.1 to 6.2: Time and lack of disturbance allow shrubs to increase. Pathway may be coupled with inappropriate grazing management.

Community Phase 6.2: Big sagebrush increases and may be codominant with seeded wheatgrass species. Annual non-native species may be present in trace amounts.

Community Phase Pathway 6.2a, from Phase 6.2 to 6.1: Fire and/or brush management allows seeded grasses to return to dominance.

Community Phase Pathway 6.2b, from Phase 6.2 to 6.3: Inappropriate grazing reduces bunchgrasses and increases density of sagebrush. This is usually a slow transition.

Community Phase 6.3: Sagebrush and/or sprouting shrubs dominate. Seeded wheatgrass species decrease. Annual non-native species may be present. Pinyon and /or juniper may be present.

Community Phase Pathway 6.3a, from Phase 6.3 to 6.1: Fire or brush management with minimal soil disturbance.

## **State and transition model**

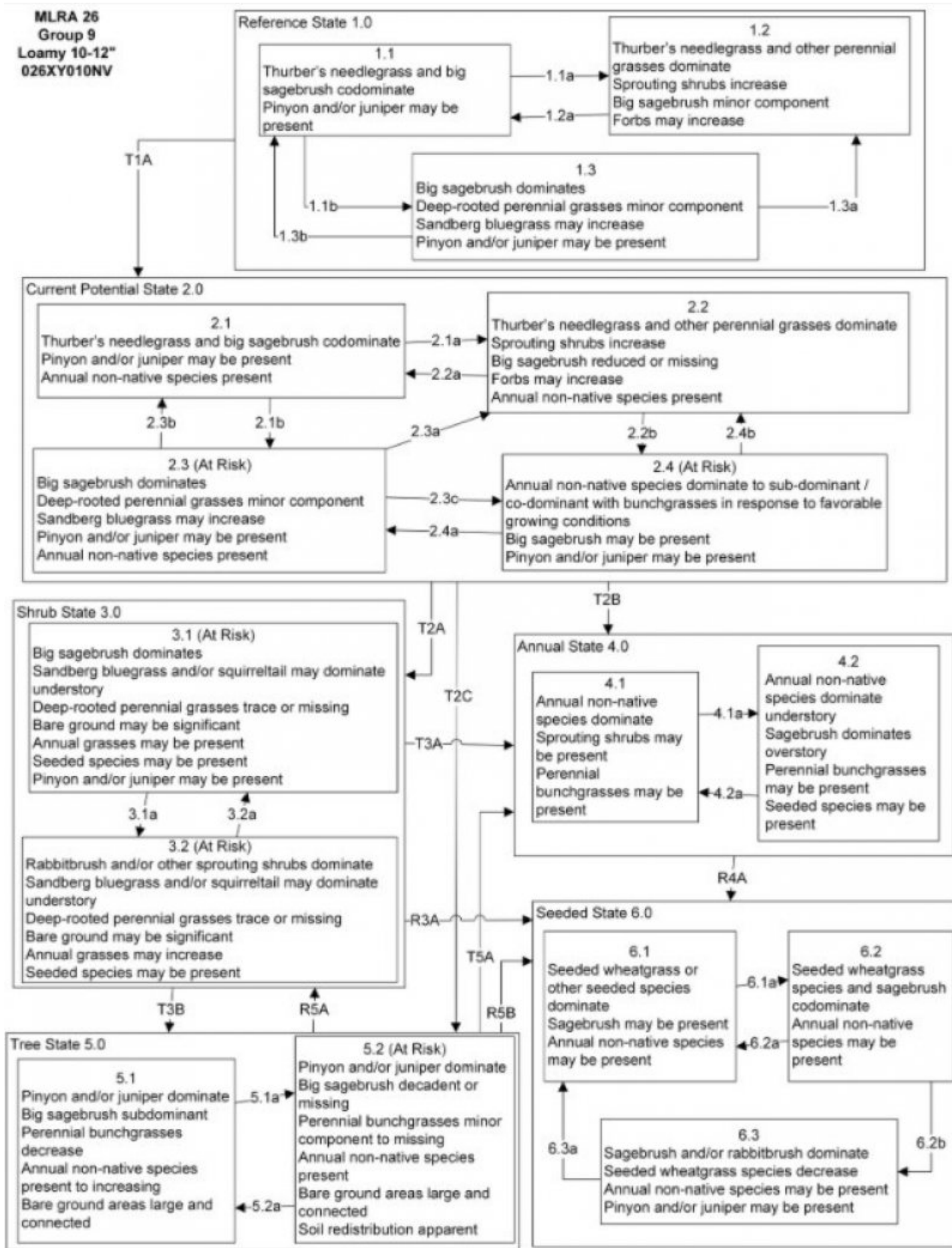


Figure 4. Similar STM

#### Reference State 1.0 Community Phase Pathways

- 1.1a: Low severity fire creates sagebrush/grass 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 and/or long-term drought may also reduce perennial understory.
- 1.2a: Time and lack of disturbance allows for shrub regeneration.
- 1.3a: High severity fire significantly reduces sagebrush cover leading to early or mid-seral community.
- 1.3b: Low severity fire creates sagebrush/grass mosaic. Brush management with minimal soil disturbance reduces sagebrush.

Transition T1A: Introduction of non-native annual species.

#### Current Potential State 2.0 Community Phase Pathways

- 2.1a: Low severity fire creates sagebrush/grass 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. Inappropriate grazing management and/or long-term drought may also reduce perennial understory.
- 2.2a: Time and lack of disturbance allows for regeneration of sagebrush.
- 2.2b: Fall and spring growing conditions that favors the germination and production of non-native, annual grasses. Pathway typically occurs 3 to 5 years post-fire and 2.4 may be a transitory plant community.
- 2.3a: High severity fire significantly reduces sagebrush cover leading to early or mid-seral community. Brush management with minimal soil disturbance reduces sagebrush.
- 2.3b: Low severity fire creates sagebrush/grass mosaic. Brush management with minimal soil disturbance reduces sagebrush.
- 2.3c: Fall and spring growing season conditions that favors the germination and production of non-native annual grasses. 2.4 may be a transitory plant community.
- 2.4a: Growing season conditions favoring perennial bunchgrass production and reduced cheatgrass production.
- 2.4b: Growing season conditions favoring perennial bunchgrass production and reduced cheatgrass production.

Transition T2A: Inappropriate grazing management (to 3.1), or fire, if coming from phase 2.3 or 2.4 (to 3.2).

Transition T2B: Severe fire and/or multiple fires, or brush management causing severe soil disturbance.

Transition T2C: Time and lack of fire allows pinyon and/or juniper to establish and dominate site resources; may be coupled with inappropriate grazing management that reduces perennial grass density and increases tree establishment.

#### Shrub State 3.0 Community Phase Pathways

- 3.1a: Low severity fire, non-native annual species increase with higher than normal spring precipitation.
- 3.2a: Time and lack of disturbance.

Transition T3A: Catastrophic fire or multiple fires, and/or treatments that disturb the existing plant community (to 4.1). Transition to 4.2 caused by continued inappropriate grazing management in the presence of annual grasses.

Transition T3B: Time and lack of fire allows pinyon and/or juniper to establish and dominate site resources; may be coupled with inappropriate grazing management that reduces perennial grass density and increases tree establishment.

Restoration R3A: Brush management combined with seeding of desired species.

#### 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: Fire.

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

#### Tree State 5.0 Community Phase Pathways

- 5.1a: Time and lack of disturbance allows for maturation of tree community.
- 5.2a: Tree thinning treatment (typically for fuels management).

Transition T5A: Catastrophic fire (to 4.1).

Restoration R5A: Tree removal with no seeding from Phase 5.1.

Restoration R5B: Tree management coupled with seeding of desired species.

#### Seeded State 6.0 Community Phase Pathways

- 6.1a: Time and lack of disturbance, coupled with repeated spring grazing allows shrubs to regenerate.
- 6.2a: Fire and/or brush management allows seeded grasses to return to dominance.
- 6.2b: Inappropriate grazing management reduces bunchgrasses and increases density of sagebrush; usually a slow transition.
- 6.3a: Fire or brush treatment with minimal soil disturbance.

## State 1 Reference Plant Community

### Community 1.1 Reference Plant Community



The reference plant community is dominated by Thurber's needlegrass, desert needlegrass and big sagebrush. Indian ricegrass and antelope bitterbrush are other important species on this site. Potential vegetative composition is about 60% grasses, 10% forbs and 30% shrubs and trees. Approximate ground cover (basal and crown) is 20 to 25 percent.

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

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	235	336	471
Shrub/Vine	106	151	212
Forb	39	56	78
Tree	11	17	24
<b>Total</b>	<b>391</b>	<b>560</b>	<b>785</b>

## Additional community tables

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

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
<b>Grass/Grasslike</b>					
1	<b>Primary Perennial Grasses</b>			247–476	
	Thurber's needlegrass	ACTH7	<i>Achnatherum thurberianum</i>	112–196	–
	desert needlegrass	ACSP12	<i>Achnatherum speciosum</i>	84–168	–
	Indian ricegrass	ACHY	<i>Achnatherum hymenoides</i>	28–56	–
	squirreltail	ELEL5	<i>Elymus elymoides</i>	11–28	–
	bluegrass	POA	<i>Poa</i>	11–28	–
2	<b>Secondary Perennial Grasses</b>			28–56	
	needle and thread	HECO26	<i>Hesperostipa comata</i>	3–17	–
	basin wildrye	LECI4	<i>Leymus cinereus</i>	3–17	–
<b>Forb</b>					
3	<b>Perennial</b>			11–84	
	Forb, perennial	2FP	<i>Forb, perennial</i>	1–34	–
	arrowleaf balsamroot	BASA3	<i>Balsamorhiza sagittata</i>	3–17	–
	tabertio	CRAC2	<i>Crepis acuminata</i>	3–17	–

	hawksbeard				
	lupine	LUPIN	<i>Lupinus</i>	3–17	–
<b>Shrub/Vine</b>					
4	<b>Primary Shrubs</b>			95–185	
	Wyoming big sagebrush	ARTRW8	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i>	43–71	–
	mountain big sagebrush	ARTRV	<i>Artemisia tridentata</i> ssp. <i>vaseyana</i>	41–69	–
	antelope bitterbrush	PUTR2	<i>Purshia tridentata</i>	11–45	–
5	<b>Secondary Shrubs</b>			11–56	
	yellow rabbitbrush	CHVI8	<i>Chrysothamnus viscidiflorus</i>	3–17	–
	mormon tea	EPVI	<i>Ephedra viridis</i>	3–17	–
	desert peach	PRAN2	<i>Prunus andersonii</i>	3–17	–
	currant	RIBES	<i>Ribes</i>	3–17	–
	horsebrush	TETRA3	<i>Tetradymia</i>	3–17	–
<b>Tree</b>					
6	<b>Evergreen</b>			7–22	
	purple sage	SADOD3	<i>Salvia dorrii</i> ssp. <i>dorrii</i> var. <i>dorrii</i>	3–17	–
	Utah juniper	JUOS	<i>Juniperus osteosperma</i>	3–11	–
	singleleaf pinyon	PIMO	<i>Pinus monophylla</i>	3–11	–

## Animal community

### Livestock Interpretations:

This site has limited use for livestock grazing due to steep slopes. Grazing management should be keyed to Thurber's and desert needlegrass. Needlegrass species begin growth early in the year and remain green throughout a relatively long growing season. This pattern of development enables animals to use needlegrass when many other grasses are unavailable. Cattle prefer needlegrass in early spring before fruits have developed as it becomes less palatable when mature. Needlegrasses are grazed in the fall only if the fruits are softened by rain. Indian ricegrass is highly palatable to all classes of livestock in both green and cured condition. It supplies a source of green feed before most other native grasses have produced much new growth. Bottlebrush squirreltail is very palatable winter forage for domestic sheep of Intermountain ranges. Domestic sheep relish the green foliage. Overall, bottlebrush squirreltail is considered moderately palatable to livestock. Mountain big sagebrush is eaten by domestic livestock but has long been considered to be of low palatability, and a competitor to more desirable species. Livestock

browse Wyoming big sagebrush, but may use it only lightly when palatable herbaceous species are available. 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. Antelope bitterbrush is palatable to all types of livestock.

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:

Big sagebrush is highly preferred and nutritious winter forage for mule deer and elk. Sagebrush-grassland communities provide critical sage-grouse and other bird species 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. Lek sites 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. Antelope bitterbrush is a critical winter food for mule deer. Antelope bitterbrush seed is a large part of the diets of rodents, especially deer mice and kangaroo rats. Antelope bitterbrush is palatable to all types of wildlife. Thurber's and desert needlegrass are other important forage species for several wildlife species. Indian ricegrass is eaten by pronghorn in "moderate" amounts whenever available. In Nevada it is consumed by desert bighorns. A number of heteromyid rodents inhabiting desert rangelands show preference for seed of Indian ricegrass. Indian ricegrass is an important component of jackrabbit diets in spring and summer. In Nevada, Indian ricegrass may even dominate jackrabbit diets during the spring through early summer months. 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. Bottlebrush squirreltail is a dietary component of several wildlife species. Bottlebrush squirreltail may provide forage for mule deer and pronghorn.

## Hydrological functions

Runoff is high to very high. Rills and water flow patterns are rare, but a few can be expected on steeper slopes in areas subjected to summer convection storms or rapid spring snowmelt. 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. Gullies are rare in areas of this site that occur on stable landforms. 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. Perennial herbaceous plants (especially deep-rooted bunchgrasses [i.e., desert

needlegrass & 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.

## Recreational uses

Aesthetic value is derived from the diverse floral and faunal composition and the colorful flowering of wild flowers and shrubs during the spring and early summer. This site is used for camping and hiking and 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. Indian ricegrass was traditionally eaten by some Native Americans. The Paiutes used seed as a reserve food source.

## 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. Bottlebrush squirreltail is tolerant of disturbance and is a suitable species for revegetation.

## Type locality

Location 1: Carson City County, NV	
General legal description	This site also occurs in Douglas, Lyon, Mineral, Storey and Washoe counties, Nevada.

## Other references

Fire Effects Information System (Online; <http://www.fs.fed.us/database/feis/plants/>).

USDA-NRCS Plants Database (Online; <http://plants.usda.gov/>).

## Contributors

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## Approval

Kendra Moseley, 4/10/2024

## 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	06/01/1979
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  $\pm$  45%; surface rock fragments  $\pm$ 35%; shrub canopy 15 to 25%; basal area for perennial herbaceous plants =5%.

- 
5. **Number of gullies and erosion associated with gullies:** Gullies are rare in areas of this site that occur on stable landforms.
- 
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 catastrophic 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 5 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.)
- 
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 carbon of the surface 2 to 3 inches is typically 1 to 1.5 percent dropping off quickly below.
- 
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., desert needlegrass & 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.
- 
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.

- 
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.
- 

14. **Average percent litter cover (%) and depth ( in):** Between plant interspaces ( $\pm 10\%$ ) and litter depth is  $\pm \frac{1}{4}$  inch.
- 

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** For normal or average growing season (through May)  $\pm 500$  lbs/ac; Spring moisture significantly affects total production.
- 

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:** Cheatgrass, rubber

rabbitbrush, snakeweed, halogeton, knapweed, yellowstar thistle, Russian thistle, annual mustards, and bassia are invaders on this site. Utah juniper and pinyon are increasers 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.
-