Ecological site R026XY010NV
LOAMY 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 that 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 Loamy 10-12 P.Z. site is found on a wide range of landforms, including fan remnants, alluvial fans, mountains, mountain slopes and hills. The Loamy 10-12 P.Z. site is found on low to moderate slopes (2 to 50 percent) at elevations between 4,000 and 7,500 feet. Soils are typically moderately deep to deep with a very stony sandy loam/loam texture. The dominant plant species are big sagebrush (Artemisia tridentata) and Thurber's needlegrass (Achnatherum thurberianum).

Associated sites

R026XY008NV	**GRANITIC FAN 10-12 P.Z.**
R026XY016NV	**LOAMY 8-10 P.Z.**
R026XY023NV	**CLAYPAN 10-12 P.Z.**
R026XY030NV	**LOAMY BOTTOM 8-12 P.Z.**

Similar sites

R026XY017NV	**LOAMY HILL 10-12 P.Z.** JUOS dominates visual aspect of site
R026XY026NV	**GRANITIC SLOPE 10-12 P.Z.** ACTH7-ACSP12 codominant grasses
R026XY046NV	**GRANITIC SLOPE 12-14 P.Z.** ACTH7-ACOCO codominant grasses
R026XY099NV	**COARSE LOAMY 10-12 P.Z.** ACTH7-ACHY codominant grasses
R026XY015NV	**SHALLOW LOAM 10-12 P.Z.** Less productive site
R026XY016NV	**LOAMY 8-10 P.Z.** ARTRW8 dominant shrub; less productive site
R026XY008NV	**GRANITIC FAN 10-12 P.Z.** HECO26-ACHY codominant grasses; less productive site
R026XY098NV	**GRAVELLY LOAM 8-10 P.Z.** Less productive site
R026XY102NV	**GRANITIC CLAY LOAM 8-10 P.Z.** ACTH7-ACSP12 codominant grasses; GLSPA important shrub

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Artemisia tridentata*

Herbaceous	(1) *Achnatherum thurberianum*

Physiographic features

This site occurs on summits and sideslopes of hills, mountain slopes and upper fan piedmonts and alluvial fans. Slopes range from 2 to 50 percent, but slope gradients of 2 to 15 percent are most typical. Elevations are 4000 to 7500 feet.

Table 2. Representative physiographic features

Landforms	(1) Hill (2) Fan piedmont (3) Mountain slope (4) Alluvial fan
Elevation	1,219–2,286 m
Slope	2–15%
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 8 to 14 inches. Mean annual air temperature is 44 to 51 degrees F. The average growing season is about 80 to 130 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)	203-356 mm
Frost-free period (average)	105 days
Freeze-free period (average)	
Precipitation total (average)	279 mm

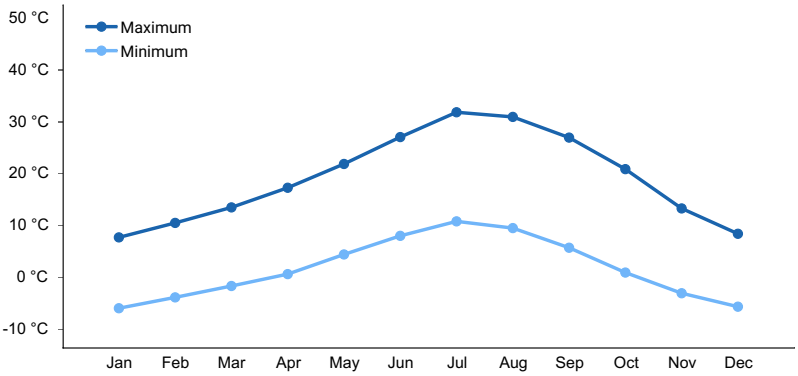


Figure 1. Monthly average minimum and maximum temperature

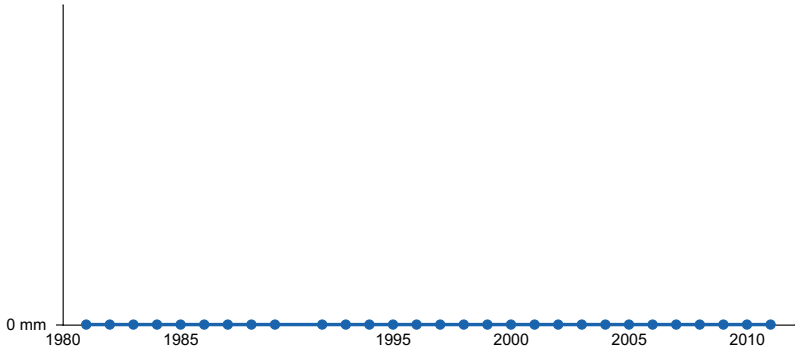


Figure 2. Annual precipitation pattern

Influencing water features

There are no influencing water features associated with this site.

Soil features

The soils associated with this site are predominantly moderately deep to very deep and well drained. They are derived from alluvium from mixed rock sources. Surface soils are coarse to medium textured and normally more than 10 inches thick to the subsoil or underlying material. The soils typically have a thin mollic epipedon and an argillic horizon. The available water capacity is very low to moderate. Some soils are modified with high volumes of rock fragments through the soil profile. Runoff is medium to very high and the potential for sheet and rill erosion is medium to high depending on slope. The soil moisture regime is aridic bordering on xeric and the soil temperature regime is mesic. Major soil series associated with this site include: Ister, Shree, Tristan, Indiano, Holbrook, Springmeyer, Oest, and Galeppi.

A representative soil series is Springmeyer, a fine-loamy, mixed, superactive, mesic Aridic Argixerolls. A mollic epipedon occurs from the soil surface to 41 cm and argillic horizon occurs from 26 to 56 cm.

Table 4. Representative soil features

Parent material	(1) Alluvium–granodiorite (2) Colluvium
Surface texture	(1) Very stony sandy loam (2) Very stony loam (3) Very gravelly loam (4) Stony sandy loam
Family particle size	(1) Loamy-skeletal (2) Fine-loamy
Drainage class	Well drained

Permeability class	Slow to moderately rapid
Soil depth	51–183 cm
Surface fragment cover <=3"	5–35%
Surface fragment cover >3"	0–25%
Available water capacity (0-101.6cm)	5.59–14.22 cm
Calcium carbonate equivalent (0-101.6cm)	0–1%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	6.1–7.8
Subsurface fragment volume <=3" (Depth not specified)	5–47%
Subsurface fragment volume >3" (Depth not specified)	0–33%

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 that influence resilience include site productivity, species composition and structure, and population regulation and regeneration (Chambers et al 2013).

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

Wyoming big sagebrush, the most 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.

Variability in plant community composition and production depends on soil surface texture and depth. 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 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 mountain big 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).

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).

Antelope bitterbrush in some areas may sprout after light-severity spring fire. High fuel consumptions increase antelope bitterbrush mortality and therefore favors seedling establishment. 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. Early season burning is more damaging to this needlegrass than late season burning. Basin wildrye is top-killed by fire. Older basin wildrye plants with large proportions of dead material within the perennial crown can be expected to show higher mortality due to fire than younger plants having little debris. Basin wildrye is generally tolerant of fire but may be damaged by early season fire combined with dry soil conditions.
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.

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

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.

Community Phase1.1: 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 PhasePathway1.1a, 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 ascheatgrass 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 State5.0: 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.

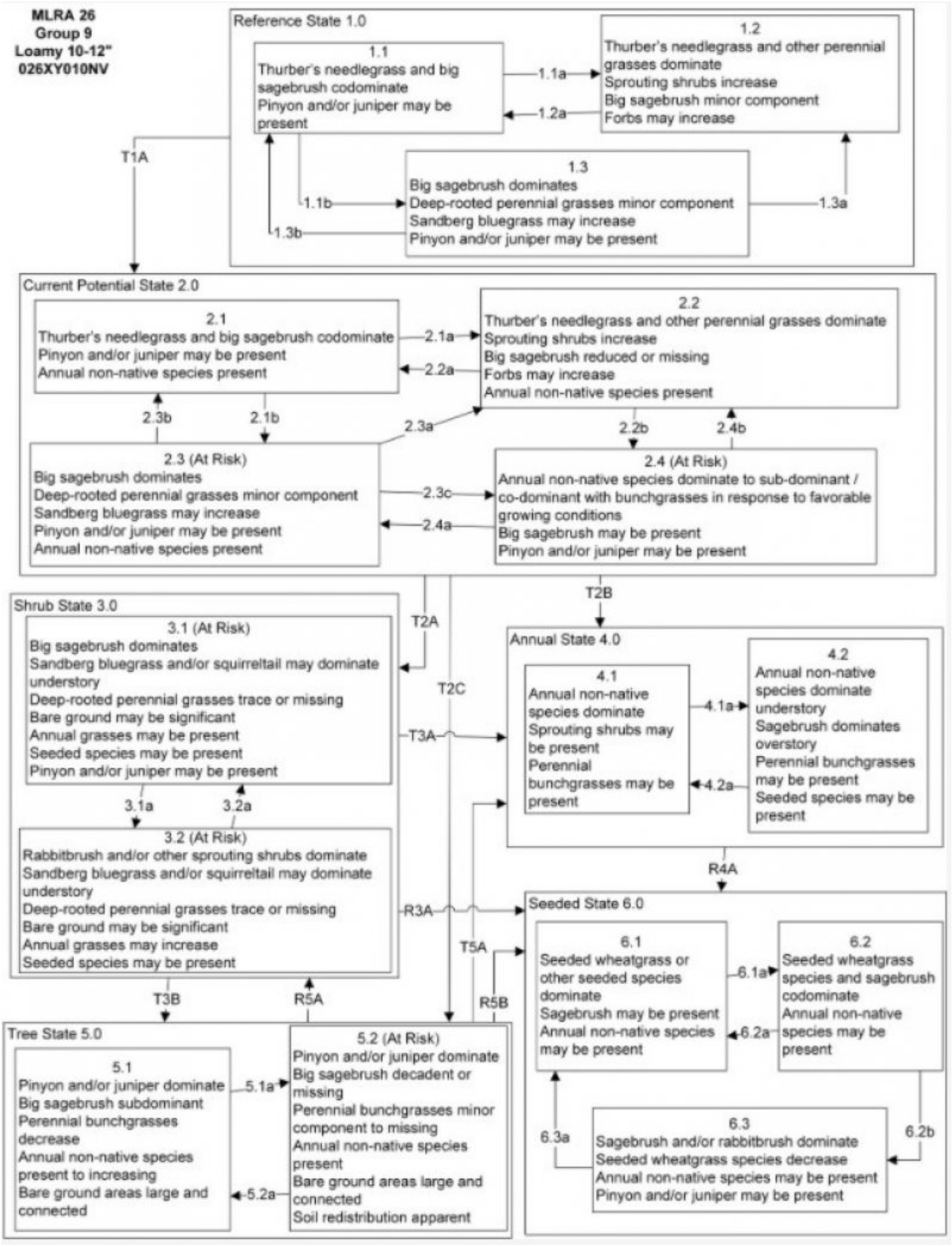
Community Phase 6.2: Big sagebrush increases and may be codominant with seeded wheatgrass species. Annual non-native species may be present in trace amounts.
Community Phase Pathway 6.2a, from Phase 6.2 to 6.1: Fire and/or brush management allows seeded grasses to return to dominance.

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 6.3to 6.1: Fire or brush management with minimal soil disturbance.

State and transition model


MLRA 26
Group 9
Loamy 10-12"
026XY010NV
Reference State 1.0
1.1
Thurber's needlegrass and big sagebrush codominate
Pinyon and/or juniper may be present
1.1a
1.2a
1.2
Thurber's needlegrass and other perennial grasses dominate
Sprouting shrubs increase
Big sagebrush minor component
Forbs may increase
T1A
1.1b
1.3b
1.3
Big sagebrush dominates
Deep-rooted perennial grasses minor component
Sandberg bluegrass may increase
Pinyon and/or juniper may be present
1.3a
Current Potential State 2.0
2.1
Thurber's needlegrass and big sagebrush codominate
Pinyon and/or juniper may be present
Annual non-native species present
2.1a
2.2a
2.2
Thurber's needlegrass and other perennial grasses dominate
Sprouting shrubs increase
Big sagebrush reduced or missing
Forbs may increase
Annual non-native species present
2.3b
2.1b
2.3a
2.2b
2.4b
2.3 (At Risk)
Big sagebrush dominates
Deep-rooted perennial grasses minor component
Sandberg bluegrass may increase
Pinyon and/or juniper may be present
Annual non-native species present
2.3c
2.4a
2.4 (At Risk)
Annual non-native species dominate to sub-dominant / co-dominant with bunchgrasses in response to favorable growing conditions
Big sagebrush may be present
Pinyon and/or juniper may be present
T2B
Shrub State 3.0
3.1 (At Risk)
Big sagebrush dominates
Sandberg bluegrass and/or squirreltail may dominate understory
Deep-rooted perennial grasses trace or missing
Bare ground may be significant
Annual grasses may be present
Seeded species may be present
Pinyon and/or juniper may be present
T2A
T2C
T3A
3.1a
3.2a
3.2 (At Risk)
Rabbitbrush and/or other sprouting shrubs dominate
Sandberg bluegrass and/or squirreltail may dominate understory
Deep-rooted perennial grasses trace or missing
Bare ground may be significant
Annual grasses may increase
Seeded species may be present
R3A
Annual State 4.0
4.1
Annual non-native species dominate
Sprouting shrubs may be present
Perennial bunchgrasses may be present
4.1a
4.2a
4.2
Annual non-native species dominate understory
Sagebrush dominates overstory
Perennial bunchgrasses may be present
Seeded species may be present
R4A
Seeded State 6.0
T5A
6.1
Seeded wheatgrass or other seeded species dominate
Sagebrush may be present
Annual non-native species may be present
6.1a
6.2a
6.2
Seeded wheatgrass species and sagebrush codominate
Annual non-native species may be present
6.3a
6.3
Sagebrush and/or rabbitbrush dominate
Seeded wheatgrass species decrease
Annual non-native species may be present
Pinyon and/or juniper may be present
6.2b
T3B
R5A
R5B
Tree State 5.0
5.1
Pinyon and/or juniper dominate
Big sagebrush subdominant
Perennial bunchgrasses decrease
Annual non-native species present to increasing
Bare ground areas large and connected
5.1a
5.2a
5.2 (At Risk)
Pinyon and/or juniper dominate
Big sagebrush decadent or missing
Perennial bunchgrasses minor component to missing
Annual non-native species present
Bare ground areas large and connected
Soil redistribution apparent

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 State

Community 1.1
Reference Plant Community

The reference plant community is dominated by Thurber's needlegrass and big sagebrush. Antelope bitterbrush and

basin wildrye are other important species associated with this site. Potential vegetative composition is about 60% grasses, 10% forbs, and 30% shrubs and sparse trees. Approximate ground cover (basal and crown) is 25 to 35 percent.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	404	538	673
Shrub/Vine	188	251	314
Forb	67	90	112
Tree	13	18	22
Total	**672**	**897**	**1121**

Additional community tables

Table 6. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Primary Perennial Grasses**			305–502	
	Thurber's needlegrass	ACTH7	*Achnatherum thurberianum*	269–359	–
	basin wildrye	LECI4	*Leymus cinereus*	18–72	–
	bluegrass	POA	*Poa*	18–72	–
2	**Secondary Perennial Grasses**			45–90	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	4–27	–
	western needlegrass	ACOCO	*Achnatherum occidentale ssp. occidentale*	4–27	–
	desert needlegrass	ACSP12	*Achnatherum speciosum*	4–27	–
	squirreltail	ELEL5	*Elymus elymoides*	4–27	–
	needle and thread	HECO26	*Hesperostipa comata*	4–27	–
Forb					
3	**Perennial**			45–135	
	lupine	LUPIN	*Lupinus*	20–34	–
	phlox	PHLOX	*Phlox*	7–17	–
Shrub/Vine					
4	**Primary Shrubs**			108–296	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	45–112	–
	mountain big sagebrush	ARTRV	*Artemisia tridentata ssp. vaseyana*	31–78	–
	antelope bitterbrush	PUTR2	*Purshia tridentata*	18–72	–
	basin big sagebrush	ARTRT	*Artemisia tridentata ssp. tridentata*	13–34	–
5	**Secondary Shrubs**			18–72	
	mormon tea	EPVI	*Ephedra viridis*	9–18	–
	buckwheat	ERIOG	*Eriogonum*	9–18	–
	spiny hopsage	GRSP	*Grayia spinosa*	9–18	–
	desert peach	PRAN2	*Prunus andersonii*	9–18	–
	currant	RIBES	*Ribes*	9–18	–
Tree					
6	**Evergreen**			9–36	
	antelope bitterbrush	PUTR2	*Purshia tridentata*	18–72	–
	currant	RIBES	*Ribes*	4–18	–
	Utah juniper	JUOS	*Juniperus osteosperma*	4–18	–
	singleleaf pinyon	PIMO	*Pinus monophylla*	4–18	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	4–18	–
	buckwheat	ERIOG	*Eriogonum*	4–18	–
	desert peach	PRAN2	*Prunus andersonii*	4–18	–

Animal community

Livestock Interpretations:

This site is suited to grazing by cattle and sheep during the late spring, summer, and early fall. Grazing management should be keyed to Thurber's 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 usually grazed in the fall only if the fruits are softened by rain. The early growth and abundant production of basin wildrye make it a valuable source of forage for livestock. It is important forage for cattle and is readily grazed by cattle and horses in early spring and fall. Though coarse-textured during the winter, basin wildrye may be utilized more frequently by livestock and wildlife when snow has covered low shrubs and other grasses. Bluegrass is another important forage species on this site. Big sagebrush is eaten by domestic livestock but has long been considered to be of low palatability, and a competitor to more desirable species. Antelope bitterbrush is important browse for livestock. 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.

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:
Mountain big sagebrush is highly preferred and nutritious winter forage for mule deer. Basin big sagebrush is browsed by mule deer from fall to early spring, but is not preferred. Basin big sagebrush is the least palatable of all the subspecies of big sagebrush. Wyoming big sagebrush is preferred browse for wild ungulates. Pronghorn usually browse Wyoming big sagebrush heavily. 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. Pronghorn antelope, mule deer, elk, and bighorn sheep utilize antelope bitterbrush extensively. Mule deer use of antelope bitterbrush peaks in September, when antelope bitterbrush may compose 91 percent of the diet. Winter use is greatest during periods of deep snow. Antelope bitterbrush seed is a large part of the diets of rodents, especially deer mice and kangaroo rats. Basin wildrye provides winter forage for mule deer, though use is often low compared to other native grasses. Basin wildrye provides summer forage for black-tailed jackrabbits. Because basin wildrye remains green throughout early summer, it remains available for small mammal forage for longer time than other grasses. Thurber's needlegrass, and bluegrass are also an important forage species for wildlife.

Hydrological functions

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. Where this site occurs on inset fans gullies, head cuts associated with ephemeral channel entrenchment may occur. Gullies and head cuts, if present, should be healing or stable. 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., 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

This site has value for hiking, camping, hunting, photography, and bird-watching.

Wood products

This site is susceptible to encroachment by pinyon and juniper to the extent that it will support a timber stand that produces Christmas trees, firewood, fence posts, and other wood products.

Other products

Native Americans made tea from big sagebrush leaves and leaves were also used as a fumigant. They used the tea as a tonic, an antiseptic, for treating colds, diarrhea, and sore eyes and as a rinse to ward off ticks. Big sagebrush seeds were eaten raw or made into meal. Some Native American peoples used the bark of big sagebrush to make rope, baskets, mats, bags, and clothing. Basin wildrye was used as bedding for various Native American ceremonies, providing a cool place for dancers to stand.

Other information

Wyoming big sagebrush is used for stabilizing slopes and gullies and for restoring degraded wildlife habitat, rangelands, mine spoils and other disturbed sites. It is particularly recommended on dry upland sites where other shrubs are difficult to establish.
Basin big sagebrush shows high potential for range restoration and soil stabilization. Basin big sagebrush grows rapidly and spreads readily from seed. 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. Basin wildrye is useful in mine reclamation, fire rehabilitation and stabilizing disturbed areas. Its usefulness in range seeding, however, may be limited by initially weak stand establishment.

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://www.plants.usda.gov).

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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,DA PYKE AND IIRH CLASS 2016
Contact for lead author	State Rangeland Management Specialist
Date	05/09/2016
Approved by	Kendra Moseley

Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** None on slopes less than 10% (most typical). Short (less than 3 feet) and shallow (less than ½ inch) rills may appear after convective storms or after fast snowmelting events when soils are saturated. These rills should be infrequent across slopes (less than 1 per 20 feet across the slope). Rills may become more frequent on slopes greater than 10% especially if water flow patterns become constricted. They should dissipate 2beyond these constrictions remaining short (less than 3 feet).

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2. **Presence of water flow patterns:** Water flow patterns should be short (less than 3 feet) and disconnected on slopes up to 10% with vegetation breaking and slowing the flow. On slopes greater than 10%, flow patterns may extend to 6 feet, but should be sinuous and not straight. On these steeper slopes they may be more apparent after convective storms or after sudden snow melt when soils are saturated. Flow patterns may be more frequent across slopes than rills, but should be less apparent on flatter landscapes than on steeper.

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3. **Number and height of erosional pedestals or terracettes:** Erosional pedestals should not be present on this ecological site on any slopes. Occasional terracettes may develop at the ends of rills or water flow patterns.

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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 should be less than 20% and occur in disconnected patches between vegetation and biological soil crusts (mosses and lichens) that are less than 2 feet in diameter. Bare ground may increase around animal burrows and ant discs. Bare ground will increase dramatically the first year after a fire, but after the first two postfire growing seasons the bare ground should return to less than 20%. Extended droughts may increase bare ground slightly (less than 25%), but should return to below 20% after two normal precipitation years.

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

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6. **Extent of wind scoured, blowouts and/or depositional areas:** None, except during the first fall after wildfires, before precipitation. Small wind-scoured areas may occur on finer textured soils. Depositional areas may occur in unburned areas on the lea-ward side of the fire, but these should be appear as fine soil particles on litter or biological soil crusts, but should not have measureable depth to them.

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7. **Amount of litter movement (describe size and distance expected to travel):** On slopes less than 10%, all litter should remain in place except in short flow paths where fine litter (less than 1/4 inch) may move up to 3 feet. On steeper slopes, fine litter may move in water flow patterns to the distance of these features (less than 6 feet) on slopes greater than 10%. Woody litter greater than ¼ inch should remain in place.

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil stability should be 4-5 in the interspaces and 5-6 under vegetation. Newly disturbed rodent activity may result in 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, subangular blocky or massive. Soil surface colors are dark grays and the soils are typified by a relatively thin mollic epipedon. Organic carbon of the surface 2 to 4 inches is typically 1.25 to 2.5 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., Thurber needlegrass]) slow runoff and increase infiltration. They should be dominant on these sites and spaces nearly 2-3 plants per 10 sq ft. They should be dispersed in the interspaces and not concentrated under shrubs. Shrub canopy, when it occurs, provides 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):** None. Argillic horizons might appear compacted, but should not be platy in appearance and are generally deeper in the soil except on eroded surfaces.

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 (big sagebrush). (By above ground production)

    Sub-dominant: Deep-rooted, cool season, perennial forbs > associated shrubs = shallow-rooted, cool season, perennial bunchgrasses = fibrous, shallow-rooted, cool season, perennial and annual forbs. (By above ground production)

    Other: evergreen trees, succulents. Cover of lichens and mosses should approach that of the minor vascular plant groups.

    Additional: After fires, tall shrubs would become minor components for upwards to 20 years especially on drier sites. Cover of lichens and mosses will be reduced to low levels initially after fires, but mosses should increase to pre-fire levels within 10 years of the fire. With an extended fire return interval, the woody component will become dominant and the herbaceous component will be greatly reduced.

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):** Litter cover both under vegetation and in interspaces should range between 20-30%. This should be reduced to near zero after a fire, but should return to prefire levels within 2 to 3 years.

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** For normal or average growing season (through mid-June) ± 800 lbs/ac; Spring moisture significantly affects total production. Favorable production ±1000 lbs/ac and unfavorable years ± 600 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, annual mustards, and knapweeds. With an extended fire return interval, Utah juniper and singleleaf pinyon will increase on 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 drought years.