USDA Natural Resources Conservation Service

Ecological site R026XY020NV SANDY 8-10 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 Semiarid Fans and Basins LRU includes basins, alluvial fans and adjacent hill slopes immediately east of the Sierra Nevada mountain range and are affected by its climate or have its granitic substrate. Elevations range from 1355 to 1920 meters and slopes range from 0 to 30 percent, with a median value of 6 percent. Frost free days range from 121 to 170.

Ecological site concept

The Sandy 8-10 P.Z. site occurs on sand sheets occurring on alluvial fans and concave slopes in depositional (wind-borne material) positions of low hills. Slopes range from 0 to 15 percent, but slope gradients of 2 to 8 percent are most typical. The soils associated with this site are typically very deep and well drained. The soils are highly susceptible to erosion by wind if the vegetative cover is removed. The plant community is dominated by needle and thread (Hesperostipa comata) grass and a mix of Wyoming and basin big sagebrush (Artemisia tridentata ssp. wyomingensis and ssp. tridentata).

Associated sites

R026XY016NV	**LOAMY 8-10 P.Z.**
R026XY024NV	**DROUGHTY LOAM 8-10 P.Z.**
R026XY037NV	**CLAY BASIN**

Similar sites

R026XY024NV	**DROUGHTY LOAM 8-10 P.Z.** ACSP12 & ACHY codominant
R026XY016NV	**LOAMY 8-10 P.Z.** ACSP12 dominant grass
R026XY098NV	**GRAVELLY LOAM 8-10 P.Z.** ACTH7 dominant grass
R026XY099NV	**COARSE LOAMY 10-12 P.Z.** ACTH7 & ACHY codominant; PUTR2 important shrub
R026XY014NV	**DUNE 10-12 P.Z.** PUTR2 dominant shrub
R026XY096NV	**SANDY PLAIN** ACHY & LECI2 codominant

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Artemisia tridentata ssp. tridentata* (2) *Artemisia tridentata ssp. wyomingensis*
Herbaceous	(1) *Hesperostipa comata* (2) *Achnatherum hymenoides*

Physiographic features

This site occurs on sand sheets occurring on alluvial fans and concave slopes in depositional (wind-borne material) positions of low hills. Slopes range from 0 to 15 percent, but slope gradients of 2 to 8 percent are most typical. Elevations are 4500 to 5900 feet.

Table 2. Representative physiographic features

Landforms	(1) Sand sheet (2) Alluvial fan
Flooding duration	Very brief (4 to 48 hours)
Flooding frequency	None to rare

Elevation	1,372–1,798 m
Slope	2–8%
Aspect	Aspect is not a significant factor

Climatic features

The climate associated with this site is arid, characterized by cool, moist winters and warm, dry summers. Average annual precipitation is 8 to 12 inches. Mean annual air temperature is 44 to 54 degrees F. The average growing season is about 60 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)	203-305 mm
Frost-free period (average)	95 days
Freeze-free period (average)	
Precipitation total (average)	254 mm

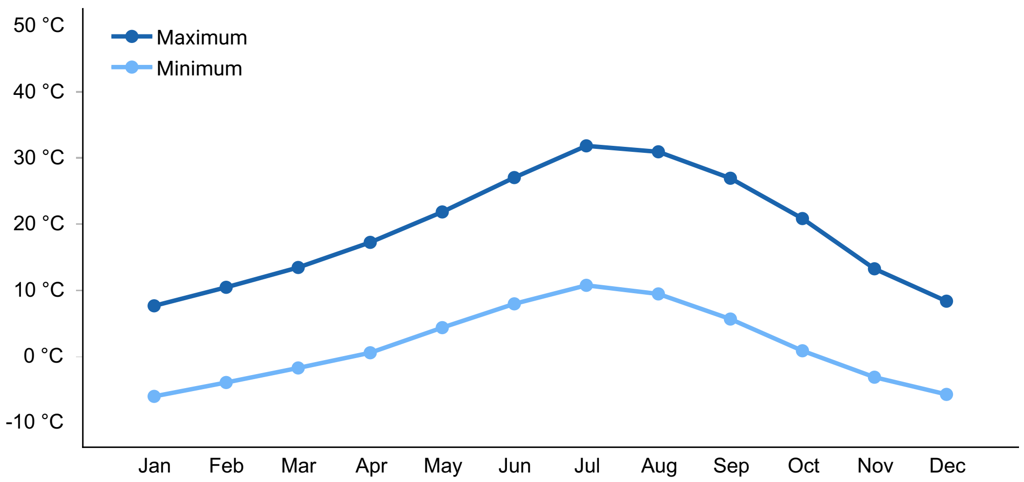


Figure 1. Monthly average minimum and maximum temperature

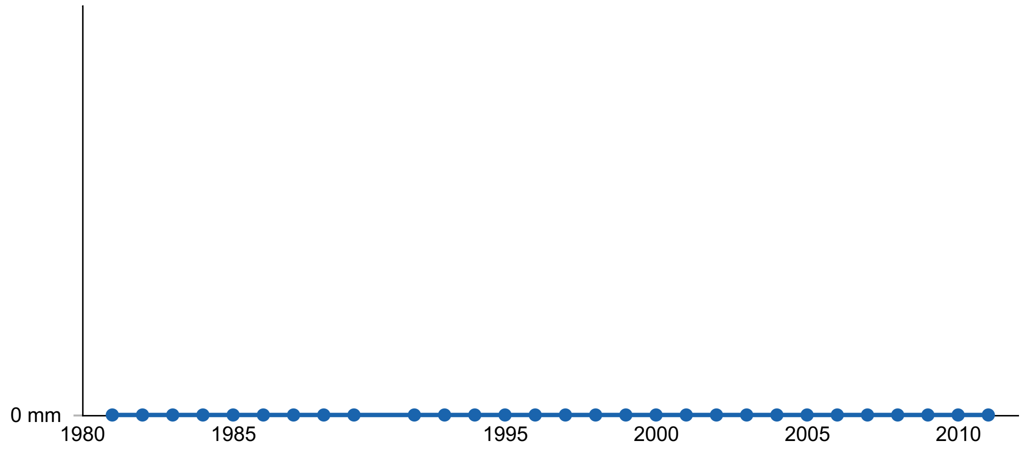


Figure 2. Annual precipitation pattern

Influencing water features

There are no influencing water features associated with this site.

Soil features

The soils associated with this site are typically very deep and well drained. The available water capacity is low to moderate. Due to rapid intake and deep percolation of precipitation, moisture loss from evaporation and runoff is very low to low. These conditions permit deep rooted plants to grow vigorously under arid conditions. The soils are highly susceptible to erosion by wind if the vegetative cover is removed. Soil series associated with this site include: Haybourne, Incy, Luppino, Saralegui, Toll and Wedertz.

Table 4. Representative soil features

Parent material	(1) Alluvium–granite
Surface texture	(1) Loamy sand (2) Sand
Family particle size	(1) Sandy
Drainage class	Well drained
Permeability class	Moderately rapid to rapid
Soil depth	183–213 cm
Surface fragment cover <=3"	6–10%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	5.84–12.19 cm
Calcium carbonate equivalent (0-101.6cm)	0%
Electrical conductivity (0-101.6cm)	0 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)	3–17%
Subsurface fragment volume >3" (Depth not specified)	0%

Ecological dynamics

The ecological sites in this DRG are 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 (Dobrowolski et al. 1990). 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).

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 invasibility of plant communities is often linked to resource availability. Disturbance can decrease resource uptake due to damage or mortality of the native species and depressed competition or can increase resource pools by the decomposition of dead plant material following disturbance. The invasion of sagebrush communities by cheatgrass (*Bromus tectorum*) has been linked to disturbances (fire, abusive grazing) that have resulted in fluctuations in resources (Chambers et al. 2007). Variability in plant community composition and production depends on soil surface texture and depth. The amount of sagebrush in the plant community is dependent upon disturbances like fire, Aroga moth (Aroga websteri) infestations, wildfire, and grazing.

Periodic drought regularly influences sagebrush ecosystems and drought duration and severity has increased throughout the 20th century in much of the Intermountain West. Major shifts away from historic precipitation patterns have the greatest potential to alter ecosystem function and productivity. Species composition and productivity can be altered by the timing of precipitation and water availability within the soil profile (Bates et al. 2006). Native insect outbreaks are also important drivers of ecosystem dynamics in sagebrush communities. Climate is generally believed to influence the timing of insect outbreaks especially a sagebrush defoliator, Aroga moth. Aroga moth infestations have occurred in the Great Basin in the 1960s, early 1970s, and have been ongoing in Nevada since 2004 (Bentz, et al 2008). Thousands of acres of big sagebrush have been impacted, with partial to complete die-off observed. Aroga moth can partially or entirely kill individual plants or entire stands of big sagebrush (Furniss and Barr 1975).

The perennial bunchgrasses that dominate this group are Indian ricegrass, needle and thread grass, and basin wildrye. Other species are present in smaller amounts. Indian ricegrass is a deep-rooted cool season perennial bunchgrass that is adapted primarily to sandy soils. Needle and thread is a very drought-tolerant tufted perennial grass that is frequently found on course, well-drained soil.

Perennial bunchgrasses generally have somewhat shallower root systems than the shrubs in this group. Root densities are often as high as or higher than those of shrubs in the upper 0.5 m and 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.
Basin wildrye is a large, cool-season perennial bunchgrass with an extensive deep, coarse, fibrous root system (Reynolds and Fraley 1989). Clumps may reach up to six feet in height (Ogle et al 2012b). Basin wildrye does not tolerate long periods of inundation; it prefers cycles of wet winters and dry summers and is most commonly found in deep soils with high water holding capacities or seasonally high water tables (Ogle et al 2012b, Perryman and Skinner 2007). Basin wildrye is weakly rhizomatous and has been found to root to depths of up to 2 meters and exhibits greater lateral root spread than many other grass species (Abbott et al. 1991, Reynolds and Fraley 1989).

Wyoming big sagebrush is the most drought tolerant of the big sagebrushes (Winward

1980). When growing together with Wyoming big sagebrush, basin big sagebrush tends to occupy areas with deeper soil that receives run-on moisture (Barker and McKell 1983, Winward 1980). Both species exist on this site. Big sagebrush 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 of both subspecies is dependent on adequate moisture conditions.

There is potential for infilling by Utah juniper (*Juniperus osteosperma*) and/or singleleaf pinyon (*Pinus monophylla*) on these sites. Infilling may occur if the site is adjacent to woodland sites or other ecological sites with juniper present. Without disturbance in these areas, pinyon or juniper will eventually dominate the site and out-compete sagebrush for water and sunlight, severely reducing both the shrub and herbaceous understory (Miller and Tausch 2000, Lett and Knapp 2005). The potential for soil erosion increases as the woodland matures and the understory plant community cover declines (Pierson et al. 2010).
The ecological sites in this DRG have moderate resilience to disturbance and resistance to invasion. Increased resilience increases with elevation, aspect, increased precipitation and increased nutrient availability. Five possible alternative stable states have been identified for this DRG.

Fire Ecology:
In many basin big sagebrush communities, changes in fire frequency occurred along with fire suppression, livestock grazing, and OHV use. Fire severity in big sagebrush communities is described as "variable" depending on weather, fuels, and topography. However, fire in basin big sagebrush communities are typically stand-replacing (Sapsis and Kauffman 1991). Basin big sagebrush and Wyoming big sagebrush are easily killed by fire and do not sprout after fire. Repeated fires may eliminate the onsite seed source; reinvasion into these areas may be extremely slow (Bunting et al. 1987). 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. 1983, West and Hassan 1985, Bunting et al. 1987). Davies et al. (2006) suggest fire return intervals in Wyoming big sagebrush communities were around 50 to 100 years. Basin big sagebrush and Wyoming big sagebrush reinvade a site primarily by off-site seed or seed from plants that survive in unburned patches. Approximately 90% of big sagebrush seed is dispersed within 30 feet (9 m) of the parent shrub (Goodrich et al. 1985) with maximum seed dispersal at approximately 108 feet (33 m) from the parent shrub (Shumar and Anderson 1986). Therefore, regeneration of big sagebrush after stand replacing fires is difficult for it is dependent upon the proximity of residual mature plants and favorable moisture conditions (Johnson and Payne 1968, Humphrey 1984). Reestablishment after fire may require 50 to 120 or more years (Baker 2006). However, the introduction and expansion of cheatgrass has dramatically altered the fire regime (Balch et al. 2013) and restoration potential of Wyoming big sagebrush communities.

Antelope bitterbrush is moderately fire tolerant (McConnell and Smith 1977). It regenerates by seed and resprouting (Blaisdell and Mueggler 1956, McArthur et al. 1982), however sprouting ability is highly variable and has been attributed to genetics, plant age, phenology, soil moisture and texture and fire severity (Blaisdell and Mueggler 1956, Blaisdell et al. 1982, Clark et al. 1982, Cook et al. 1994). Bitterbrush sprouts from a region on the stem approximately 1.5 inches above and below the soil surface; the plant rarely sprouts if the root crown is killed by fire (Blaisdell and Mueggler 1956). Low intensity fires may allow bitterbrush to sprout; however, community response also depends on soil moisture levels at time of fire (Murray 1983). Lower soil moisture allows more charring of the stem below ground level (Blaisdell and Mueggler 1956), thus sprouting will usually be more successful after a spring fire than after a fire in summer or fall (Murray 1983, Busse et al. 2000, Kerns et al. 2006). Only 1.5% of measured bitterbrush plants sprouted from the root crown in one study (Ziegenhagen and Miller 2009). If cheatgrass is present, bitterbrush seedling success is much lower. The factor that most limits establishment of bitterbrush seedlings is competition for water resources with the invasive species cheatgrass (Clements and Young 2002).

Depending on fire severity, various sprouting shrubs may increase after fire. Yellow rabbitbrush is top-killed by fire, but sprouts vigorously after fire (Kuntz 1982, Akinsoji 1988). As cheatgrass increases, fire frequencies will also increase. If fire occurs more frequently than every 5 years, even sprouting shrubs such as rabbitbrush will not survive (Whisenant 1990).

Spiny hopsage is a shrub that is capable of sprouting after fire (Daubenmire 1970). Spiny hopsage is loses its leaves in the summer, and thus are considered dormant during the time period most likely to experience fire (Rickard and McShane 1994). These shrubs tend to sprout the following spring after a wildfire (Daubenmire 1970), and can produce significant new growth if there is enough moisture available (Shaw 1992). Other environmental conditions also determine the level of re-establishment that occurs, such as the salinity and temperature of soil. Rickard and Spencer recorded post-fire mortality of spiny hopsage in a site where it co-occurred with black greasewood, potentially indicating that the site conditions were sub-optimal for the plant. Simmons and Rickard (2003) also recorded total stand mortality after a fire on the Colombia Plateau. The authors indicated the plants may have been drought-stressed. Spiny hopsage is capable of reproducing by seed, however seedlings do not compete well with annual invasive species and re-colonization of burn scars by seeding has rarely been recorded (Simmons and Rickard 2003, Monsen et al. 2004).

Fourwing saltbush is the most widely distributed shrubby saltbush in North America (Meyer 2003). It is highly variable across landscapes and even within populations (McArthur et al. 1983, Petersen et al. 1987). Its ability to sprout following fire may depend on the population and fire severity. A study by Parmenter (2008) showed 58% mortality rate of fourwing saltbush following fire in New Mexico, the surviving shrubs produced sprouts shortly after fire.

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

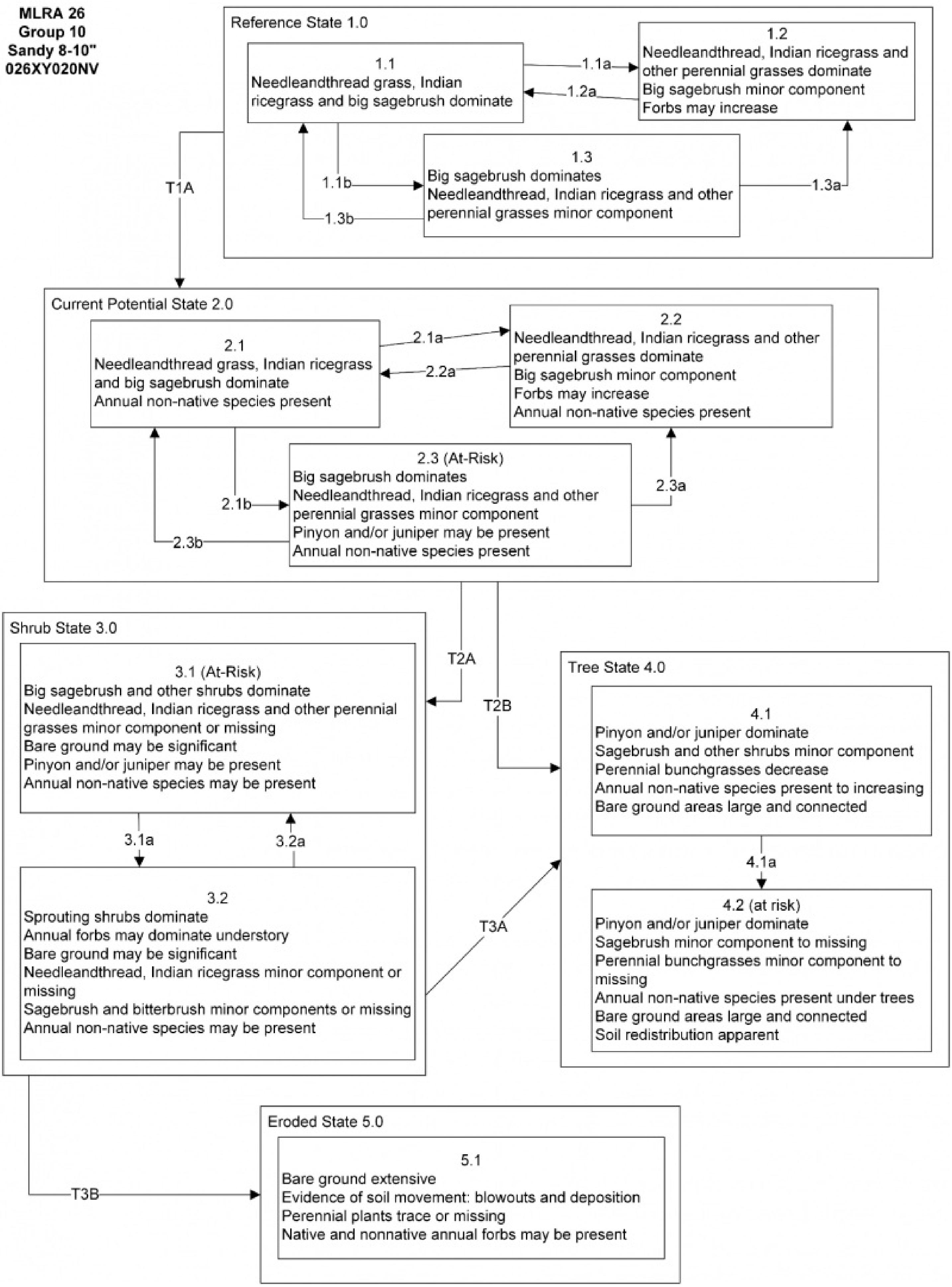
Needle and thread is a fine-leaved grass and is considered sensitive to fire due (Miller et al. 2013). It is top-killed by fire but is likely to resprout if fire does not entirely consume aboveground stems (Akinsoji 1988, Bradley et al. 1992). In a study by Wright and Klemmedson (1965), season of burn rather than fire intensity seemed to be the crucial factor in mortality for needle and thread grass. Early spring season burning was found to kill the plants, while August burning had no effect. Thus, under typical wildfire scenarios, needleandthread is often present in the post-burn community.

Indian ricegrass is fairly fire tolerant (Wright 1985), due to its low culm density and below-ground root crowns. Vallentine (1989) cites several studies in the sagebrush zone that classified Indian ricegrass as being slightly damaged from late summer burning. Indian ricegrass has also been found to reestablish on burned sites through seed dispersed from adjacent unburned areas (West 1994, Young, 1983). Thus, the presence of surviving, seed producing plants facilitates the reestablishment of Indian ricegrass. Grazing management following fire to promote seed production and establishment of seedlings is important.
Basin wildrye is relatively resistant to fire, particularly dormant season fire, as plants sprout from surviving root crowns and rhizomes (Zschaechner 1985). Miller et al. (2013) reported increased total shoot and reproductive shoot densities in the first year following fire, although by year two there was little difference between burned and control treatments.

The grass most likely to invade this site is cheatgrass. This invasive grass displaces desirable perennial grasses, reduces livestock forage, and accumulates large fuel loads that foster frequent fires (Davies and Svejcar 2008). Invasion by annual grasses can alter the fire cycle by increasing fire size, fire season length, rate of spread, numbers of individual fires, and likelihood of fires spreading into native or managed ecosystems (D'Antonio and Vitousek 1992, Brooks et al. 2004). Areas dominated with cheatgrass are estimated to have a fire return interval of 3-5 years (Whisenant 1990). The mechanisms by which invasive annual grasses alter fire regimes likely interact with climate. For example, cheatgrass cover and biomass vary with climate (Chambers et al. 2007) and are promoted by wet and warm conditions during the fall and spring. Invasive annual species have been shown able to take advantage of high N availability following fire through higher growth rates and increased seedling establishment relative to native perennial grasses (Monaco et al. 2003).

Conversely, without fire, sagebrush will increase and the potential for encroachment by pinyon and/or juniper also increases. Without fire or changes in management, pinyon and/or juniper will dominate the site and big sagebrush will be severely reduced. The herbaceous understory will also be reduced. The potential for soil erosion increases as the juniper woodland matures and the understory plant community cover declines. Catastrophic wildfire in juniper-controlled sites may lead to an annual weed dominated site.

State and transition model


MLRA 26
Group 10
Sandy 8-10"
026XY020NV
Reference State 1.0
1.1
Needleandthread grass, Indian ricegrass and big sagebrush dominate
1.1a
1.2a
1.2
Needleandthread, Indian ricegrass and other perennial grasses dominate
Big sagebrush minor component
Forbs may increase
1.1b
1.3b
1.3
Big sagebrush dominates
Needleandthread, Indian ricegrass and other perennial grasses minor component
1.3a
T1A
Current Potential State 2.0
2.1
Needleandthread grass, Indian ricegrass and big sagebrush dominate
Annual non-native species present
2.1a
2.2a
2.2
Needleandthread, Indian ricegrass and other perennial grasses dominate
Big sagebrush minor component
Forbs may increase
Annual non-native species present
2.1b
2.3b
2.3 (At-Risk)
Big sagebrush dominates
Needleandthread, Indian ricegrass and other perennial grasses minor component
Pinyon and/or juniper may be present
Annual non-native species present
2.3a
T2A
T2B
Shrub State 3.0
3.1 (At-Risk)
Big sagebrush and other shrubs dominate
Needleandthread, Indian ricegrass and other perennial grasses minor component or missing
Bare ground may be significant
Pinyon and/or juniper may be present
Annual non-native species may be present
3.1a
3.2a
3.2
Sprouting shrubs dominate
Annual forbs may dominate understory
Bare ground may be significant
Needleandthread, Indian ricegrass minor component or missing
Sagebrush and bitterbrush minor components or missing
Annual non-native species may be present
T3A
Tree State 4.0
4.1
Pinyon and/or juniper dominate
Sagebrush and other shrubs minor component
Perennial bunchgrasses decrease
Annual non-native species present to increasing
Bare ground areas large and connected
4.1a
4.2 (at risk)
Pinyon and/or juniper dominate
Sagebrush minor component to missing
Perennial bunchgrasses minor component to missing
Annual non-native species present under trees
Bare ground areas large and connected
Soil redistribution apparent
T3B
Eroded State 5.0
5.1
Bare ground extensive
Evidence of soil movement: blowouts and deposition
Perennial plants trace or missing
Native and nonnative annual forbs may be present

MLRA 26
Group 10
Sandy 8-10"
026XY020NV
KEY

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 and/or severe Aroga moth infestation significantly reduces sagebrush cover leading to early mid-seral community.
1.3b: Low severity fire or Aroga moth infestation resulting in a mosaic pattern.

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.
2.3a: Low severity fire creates sagebrush/grass mosaic, herbivory or combinations. Brush management with minimal soil disturbance reduces sagebrush.
2.3b: Low severity fire or Aroga moth infestation resulting in a mosaic pattern.

Transition T2A: Inappropriate grazing management (3.1), or high severity fire (3.2).
Transition T2B: Time and lack of disturbance allows maturation of the tree community.

Shrub State 3.0 Community Phase Pathways
3.1a: Fire reduces shrub canopy.
3.2a: Time and lack of disturbance allows for regeneration of sagebrush.

Transition T3A: Time and lack of disturbance allows maturation of the tree community.
Transition T3B: Catastrophic fire in dense shrub cover results in mortality of most perennial plants. Possible from phase 3.1.

Tree State 4.0 Community Phase Pathways
4.1a: Time and lack of disturbance allows for maturation of tree community.
4.2a: Tree thinning treatment (typically for fuels management).

Eroded State 5.0 Community Phase Pathways
None.

State 1
Reference State

The Reference State 1.0 is a representation of the natural range of variability under pristine conditions. The reference state has three general community phases; a shrub-grass dominant phase, a perennial grass dominant phase and a shrub dominant phase. State dynamics are maintained by interactions between climatic patterns and disturbance regimes. Negative feedbacks enhance ecosystem resilience and contribute to the stability of the state. These include the presence of all structural and functional groups, low fine fuel loads, and retention of organic matter and nutrients. Plant community phase changes are primarily driven by fire, periodic drought, and/or insect or disease attack.

Community 1.1
Community Phase 1.1

This community is dominated by needle and thread grass, Indian ricegrass and big sagebrush. Fourwing saltbush, ephedra, and other shrubs are present. Desert needlegrass, basin wildrye, and a variety of perennial and annual forbs are also present in this phase.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	269	404	605
Shrub/Vine	157	235	353
Forb	22	34	50
Total	**448**	**673**	**1008**

Community 1.2
Community Phase 1.2

This community phase is characteristic of a post-disturbance, early seral community. Needle and thread, Indian ricegrass and other perennial grasses dominate. Big sagebrush is a minor component. Forbs and sprouting shrubs may increase.

Community 1.3
Community Phase 1.3

Big sagebrush increases in the absence of disturbance. Needle and thread, Indian ricegrass, and other perennial grasses may be a minor component.

Pathway 1.1a
Community 1.1 to 1.2

Fire would decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses to dominate the site. 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. Release from drought may allow needle and thread and Indian ricegrass to increase in production.

Pathway 1.1b
Community 1.1 to 1.3

Time and lack of disturbance such as fire or drought allows shrubs to become dominant. Excessive herbivory and/or long-term drought may also reduce perennial herbaceous understory.

Pathway 1.2a
Community 1.2 to 1.1

Time and lack of disturbance allows sagebrush to reestablish.

Pathway 1.3b
Community 1.3 to 1.1

Fire would decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses to dominate the site. 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. This pathway may also occur after a severe Aroga moth infestation that significantly reduces live sagebrush cover.

Pathway 1.3a
Community 1.3 to 1.2

Aroga moth infestation reduces live sagebrush cover and allows grasses to increase in the understory. Release from drought may allow needle and thread and Indian ricegrass to increase in production.

State 2
Current Potential State

The Current Potential State is characterized by the presence of non-native invasive species in the understory. 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 as the Reference State. 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 reduce 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 annual non-native species reduces State resilience because these species can promote fire where historically fire has been infrequent. This leads to positive feedbacks that further the degradation of the system.

Community 2.1
Community Phase 2.1

This community is dominated by needle and thread grass, Indian ricegrass and big sagebrush. Fourwing saltbush, ephedra, and other shrubs are present. Desert needlegrass, basin wildrye, and a variety of perennial and annual forbs are also present in this phase. Annual non-native species present.

Community 2.2
Community Phase 2.2

This community phase is characteristic of a post-disturbance, early seral community. Needle and thread, Indian ricegrass and other perennial grasses dominate. Big sagebrush is a minor component. Forbs and sprouting shrubs may increase. Annual non-native species present.

Community 2.3
Community Phase 2.3 (At-Risk)

Big sagebrush dominates and the perennial grasses become a minor component. Pinyon and juniper may be present. Annual non-native species present.

Pathway 2.1a
Community 2.1 to 2.2

Fire would decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses to dominate the site. 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.

Pathway 2.1b
Community 2.1 to 2.3

Time, long-term drought, grazing management that favors shrubs or combinations of these would allow the sagebrush overstory to increase and dominate the site, causing a reduction in the perennial bunchgrasses.

Pathway 2.2a
Community 2.2 to 2.1

Absence of disturbance over time allows for the sagebrush to recover. This may be combined with grazing management that favors shrubs.

Pathway 2.3b
Community 2.3 to 2.1

A change in grazing management that reduces shrubs will allow the perennial bunchgrasses in the understory to dominate. Heavy late-fall or winter grazing may cause mechanical damage and subsequent death to sagebrush, facilitating an increase in the herbaceous understory. Brush treatments with minimal soil disturbance will also decrease sagebrush and release the perennial understory. A low severity fire would decrease the overstory of sagebrush or leave patches of shrubs, and would allow the understory perennial grasses to dominate. This pathway may also occur after a severe Aroga moth infestation that significantly reduces live sagebrush cover. Annual non-native species are present and may increase in the community.

Pathway 2.3a
Community 2.3 to 2.2

Fire would decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses to dominate the site. 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. This pathway may also occur after a severe Aroga moth infestation that significantly reduces live sagebrush cover. Brush treatments with minimal soil disturbance will also decrease sagebrush and release the perennial understory. Annual non-native species are present and may increase in the community.

State 3
Shrub State

The Shrub 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. Shrubs dominate the plant community. If coming from phase 2.3, big sagebrush canopy cover is high and these plants may be decadent, reflecting stand maturity and lack of seedling establishment due to competition with mature plants. Typically, this state has little herbaceous understory and may be experiencing soil movement in the interspaces. The shrub overstory dominates site resources such that soil water, nutrient capture, nutrient cycling and soil organic matter are temporally and spatially redistributed.

Community 3.1
Community Phase 3.1

Big sagebrush and other shrubs dominate. Needle and thread, Indian ricegrass and other perennial grasses are only present in trace amounts, under shrubs, or may be missing entirely. Pinyon and/or juniper may be present. Annual non-native species may be present.

Community 3.2
Community Phase 3.2

Sprouting shrubs such as fourwing saltbush, spiny hopsage, ephedra, and desert peach dominate the site. Annual forbs may dominate the understory. Perennial grasses and sagebrush may be a minor component or missing entirely. Bitterbrush may be present. Bare ground may be significant. Annual non-native species may be present.

Pathway 3.1a
Community 3.1 to 3.2

Fire, heavy fall grazing that causes mechanical damage to shrubs, and/or brush treatments with minimal soil disturbance will greatly reduce the overstory shrubs to trace amounts and allow annual forbs and sprouting shrubs to dominate the site.

Pathway 3.2a
Community 3.2 to 3.1

Time and lack of disturbance allows the shrub component to recover. The establishment of sagebrush can take many years unless aided with restoration efforts.

State 4
Tree State

The Tree 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 4.1
Community Phase 4.1

Utah juniper and/or singleleaf pinyon dominate the overstory and site resources. Trees are actively growing with noticeable leader growth. Trace amounts of bunchgrasses may be found under tree canopies and in interspaces. Sagebrush is stressed and dying. Annual non-native species are present under tree canopies. Bare ground interspaces are large and connected.

Community 4.2
Community Phase 4.2

Utah juniper and/or singleleaf pinyon dominate 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 live sagebrush. Bunchgrasses may or may not be present. Needle and thread or mat forming forbs may be present in trace amounts. Bare ground interspaces are large and connected. Soil redistribution is evident.

Pathway 4.1a
Community 4.1 to 4.2

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

State 5
Eroded State

This state has one community phase, a non-native annual phase. This state has crossed both a biotic and abiotic threshold. Non-native, annual invasive species primarily cheatgrass and mustard, dominate the plant community. Sprouting shrubs may be present in trace amounts, however, sagebrush is missing. Ecological processes are controlled by the non-native annual community during the spring growing season and by the physical process of wind movement of soil after the annual plant cover has senesced. In extremely degraded sites, wind erosion may progress to dune formation or flattening(depending on landscape position) and near elimination of the annual plant community. Negative feedbacks contributing to the stability of this state include the persistence of non-natives. Competition from non-natives for soil moisture and nutrients prevent recruitment of native species. Fine fuels provided by non-native annuals support a fire regime too frequent for the successful establishment of sagebrush and favor an increase in non-native invasive annuals. Biogeochemical cycling is altered by the dominance of cheatgrass modifying the soil environment. Cheatgrass monocultures have low VAM fungal populations, increasing the difficulty of reestablishing sagebrush and native bunchgrasses that require these mycorrhizae.

Community 5.1
Sparse Vegetation

Vegetation is sparse and bare ground dominates the visual aspect. Plants that tolerate soil movement and may remain, including Indian ricegrass, needle and thread, desert peach, and annual forbs. Russian thistle may be present. Soil deposition is apparent at the bases of plants and may form small dunes. Skeletons of burned shrubs may be present.

Transition T1A
State 1 to 2

Trigger: This transition is caused by the introduction of non-native annual weeds, such as cheatgrass, mustard (Descurainia or Sisymbrium spp.), 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. This leads to reductions in soil water holding capacity. Threshold: Any amount of introduced non-native species causes an immediate reduction in the resilience of the site. Annual non-native species cannot be easily removed from the system and have the potential to significantly alter disturbance regimes from their historic range of variation.

Transition T2A
State 2 to 3

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

Transition T2B
State 2 to 4

Trigger: Time and lack of disturbance or management action allows juniper and/or Pinion to dominate. This may be coupled with grazing management that favors tree establishment by reducing understory herbaceous competition for site resources Feedbacks and ecological processes: Trees increasingly dominate use of soil water, contributing to reductions in soil water availability to grasses and shrubs. Overtime, grasses and shrubs are outcompeted. Reduced herbaceous and shrub production slows soil organic matter inputs and increases soil erodibility through loss of cover and root structure. Slow variables: Over time the abundance and size of trees will increase. Threshold: Trees dominate ecological processes and number of shrub skeletons exceed number of live shrubs. Minimal recruitment of new shrub cohorts.

Transition T3A
State 3 to 4

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

Transition T3B
State 3 to 5

Trigger: High-intensity fire (from 3.1) kills all non-sprouting shrubs and many sprouting shrubs. Slow variables: Increased dominance of sagebrush and/or bitterbrush creates extreme woody fuel conditions. Loss of the deep-rooted bunchgrass understory leaves few plants capable of regenerating post-fire, and eliminates the seed bank of these species. Threshold: Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses truncates energy capture and impacts nutrient cycling and distribution. Large, potentially decadent shrubs dominate the landscape with a closed canopy.

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**			363–592	
	needle and thread	HECO26	*Hesperostipa comata*	168–235	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	168–235	–
	desert needlegrass	ACSP12	*Achnatherum speciosum*	13–67	–
	basin wildrye	LECI4	*Leymus cinereus*	13–54	–
2	**Secondary Perennial Grasses**			13–54	
	Thurber's needlegrass	ACTH7	*Achnatherum thurberianum*	3–20	–
	squirreltail	ELEL5	*Elymus elymoides*	3–20	–
	Sandberg bluegrass	POSE	*Poa secunda*	3–20	–
Forb					
3	**Perennial**			13–54	
	milkvetch	ASTRA	*Astragalus*	3–20	–
	lupine	LUPIN	*Lupinus*	3–20	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	3–20	–
4	**Annual**			0–34	
	basin big sagebrush	ARTRT	*Artemisia tridentata ssp. tridentata*	17–50	–
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	17–50	–
	jointfir	EPHED	*Ephedra*	13–34	–
Shrub/Vine					
5	**Primary Shrubs**			87–235	

5	**Primary Shrubs**			87–235	
	basin big sagebrush	ARTRT	*Artemisia tridentata ssp. tridentata*	17–50	–
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	17–50	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	13–34	–
	jointfir	EPHED	*Ephedra*	13–34	–
	spiny hopsage	GRSP	*Grayia spinosa*	13–34	–
	desert peach	PRAN2	*Prunus andersonii*	13–34	–
6	**Secondary Shrubs**			13–54	
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	7–20	–
	Nevada dalea	PSPO	*Psorothamnus polydenius*	7–20	–
	horsebrush	TETRA3	*Tetradymia*	7–20	–

Animal community

Big sagebrush is browsed in the winter by native ungulates. Personius et al. (1987) found Wyoming big sagebrush and basin big sagebrush to be intermediately palatable to mule deer when compared to mountain big sagebrush (most palatable) and black sagebrush (least palatable).

Antelope bitterbrush is an important shrub species to a variety of animals, such as domestic livestock, antelope, deer, and elk. Bitterbrush is critical browse for mule deer, as well as domestic livestock, antelope, and elk (Wood et al. 1995). Grazing tolerance of antelope bitterbrush is dependent on site conditions (Garrison 1953).

Spiny hopsage is palatable to livestock, especially sheep, during the spring and early summer (Phillips et al. 1996). However, the shrub goes to seed and loses its leaves in July and August so its usefulness in the fall and winter is limited (Sanderson and Stutz 1992). Two studies showed little to no utilization by sheep during the winter (Harrison and Thatcher 1970, Green et al. 1951). Some scientists are concerned about the longevity of the species. One study showed no change in cover or density when excluded from livestock and wildlife grazing for 10+ years (Rice and Westoby 1978), while another seldom observed seedling establishment (Daubenmire 1970). With poor recruitment rates, some are concerned that with repeated fires and overgrazing, local populations of spiny hopsage may be lost (Simmons and Rickard 2003).

Fourwing saltbush is one of the most important forage shrubs in arid sites. Its importance is due to its abundance, accessibility, size, large volume of forage, evergreen habit, high palatability and nutritive value. The palatability rates from fairly good to good for cattle, and as good for sheep and goats, deer usually relish it as a winter browse (Dayton, 1937). It has similar protein, fat, and carbohydrate levels as alfalfa (Medicago sativa) (Catlin, 1925). It is especially valuable as winter forage. It was noted in a study by Otsyina et al. (1982) that sheep readily grazed fourwing saltbush when introduced into a new pasture.

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

Needle and thread is not grazing tolerant and will be one of the first grasses to decrease under heavy grazing pressure (Smoliak et al. 1972, Tueller and Blackburn 1974). Heavy grazing is likely to reduce basal area of these plants (Smoliak et al. 1972).

Reduced bunchgrass vigor or density provides an opportunity for cheatgrass and other invasive species to occupy interspaces, leading to increased fire frequency and potentially an annual plant community. This site is likely to see an increase in shrubs and will have significant bare ground in the interspaces as few native perennial species are able to recolonize the sandy soil surfaces.

Basin wildrye is valuable forage for livestock (Ganskopp et al. 2007) and wildlife, but is intolerant of heavy, repeated, or spring grazing (Krall et al. 1971). Basin wildrye is used often as a winter feed for livestock and wildlife; not only providing roughage above the snow but also cover in the early spring months (Majerus 1992).

Hydrological functions

Runoff is very low to low. Permeability is moderately rapid to rapid. Rills and water flow patterns are none. Pedestals are rare with wind scouring occurring after disturbance. Perennial herbaceous plants (especially deep-rooted bunchgrasses [i.e., Indian ricegrass]) slow runoff and increase infiltration. Shrub canopy and associated litter break raindrop impact and provide opportunity for snow catch and accumulation on site.

Recreational uses

This site supports a variety of wild flowers in the spring, which offer rewarding opportunities for nature study and photography. This site is suitable for upland game and large 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. Some Native American peoples used the bark of big sagebrush to make rope and baskets. Fourwing saltbush is traditionally important to Native Americans. They ground the seeds for flour. The leaves, placed on coals, impart a salty flavor to corn and other roasted food. Top-growth produces a yellow dye. Young leaves and shoots were used to dye wool and other materials. The roots and flowers were ground to soothe insect bites. Native Americans used Nevada ephedra as a tea to treat stomach and kidney ailments. Ephedra is listed as a successful shrub for restoring western rangeland communities and can be used to rehabilitate disturbed lands. It also has value for reducing soil erosion on both clay and sandy soils. Native Americans near desert peach habitats utilized fruits, leaves, and twigs. The Paiute of the Great Basin boiled twigs and leaves into a tea to treat colds and rheumatism. The Lake Mono Paiute along with the Cahuilla gathered desert peach fruits. Desert peaches could be boiled, sweetened with sugar and preserved as jelly. Some Native Americans traditionally ground parched seeds of spiny hopsage to make pinole flour.
Indian ricegrass was traditionally eaten by some Native American peoples. The Paiutes used seed as a reserve food source. Basin wildrye was used as bedding for various Native American ceremonies, providing a cool place for dancers to stand.

Other information

Wyoming big sagebrush is used for stabilizing slopes and gullies and for restoring degraded wildlife habitat, rangelands, mine spoils and other disturbed sites. It is particularly recommended on dry upland sites where other shrubs are difficult to establish. Basin big sagebrush shows high potential for range restoration and soil stabilization. Basin big sagebrush grows rapidly and spreads readily from seed. Fourwing saltbush is widely used in rangeland and riparian improvement and reclamation projects, including burned area recovery. It is probably the most widely used shrub for restoration of winter ranges and mined land reclamation. Desert peach is effective in revegetation or rehabilitation projects on disturbed sites within its range due to high survival rates of transplanted seedlings. Spiny hopsage has moderate potential for erosion control and low to high potential for long-term revegetation projects. It can improve forage, control wind erosion, and increase soil stability on gentle to moderate slopes. Spiny hopsage is suitable for highway plantings on dry sites in Nevada. Indian ricegrass is well-suited for surface erosion control and desert revegetation although it is not highly effective in controlling sand movement. 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.

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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	02/21/2007
Approved by	Kendra Moseley
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** None

2. **Presence of water flow patterns:** None

3. **Number and height of erosional pedestals or terracettes:** Pedestals are none to few. Pedastalling may be severe after wildfires or other land clearing disturbances.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare Ground to 50%

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

6. **Extent of wind scoured, blowouts and/or depositional areas:** Wind scouring and depositional areas uncommon. After wildfire and subsequent loss of vegetative cover, wind scouring and depositional areas may be common.

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 extreme wind events. Persistent litter (large woody material) will remain typically remain in place.

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 1 to 4 on most soil textures found on this site. (To be field tested.)

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Structure of soil surface may be single-grained or platy. Soil surface colors are light and the soils are typified by an ochric epipedon. Organic carbon of the surface 2 to 3 inches is less than to 1 percent. Surface soils are typically very fine sandy loams to silt loams. The surface layer of these soils will normally develop a vesicular crust, inhibiting water infiltration and seedling emergence.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Perennial herbaceous plants (especially deep-rooted bunchgrasses [i.e., Indian ricegrass]) slow runoff and increase infiltration. Shrub canopy and associated litter break raindrop impact and provide opportunity for snow catch and accumulation on site.

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11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** Compacted layers are none.

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

    Dominant: Reference Plant Community: deep-rooted, cool season, perennial bunchgrasses (i.e., Indian ricegrass) >> tall shrubs (big sagebrush) > (By above ground production)

    Sub-dominant: Associated shrubs > shallow-rooted, cool season, perennial bunchgrasses > perennial forbs = annual 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 25% of total woody canopy; mature bunchgrasses commonly (±25%) have dead centers.

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14. **Average percent litter cover (%) and depth (in):** Between plant interspaces (20-30%) and depth (< ¼-inch).

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** For normal or average growing season (thru May) ± 600lbs/ac. Favorable years ± 900 lbs/ac and unfavorable years ± 400 lbs/ac.

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

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