

Ecological site R026XY008NV GRANITIC FAN 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 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 Granitic Fan 10-12 P.Z. site is found on alluvial fans on slopes less than 15 percent. Elevations range from 4,500 to 5,500 feet. The soil is deep with a surface texture of loamy sand to very gravelly coarse sand. The dominant vegetation is big sagebrush (*Artemisia tridentata*), bitter brush (*Purshia tridentata*), needle and thread (*Hesperostipa comata*), and Indian ricegrass (*Achnatherum hymenoides*).

Associated sites

R026XY010NV	LOAMY 10-12 P.Z.
R026XY018NV	GRANITIC SOUTH SLOPE 10-12 P.Z.
R026XY026NV	GRANITIC SLOPE 10-12 P.Z.
R026XY046NV	GRANITIC SLOPE 12-14 P.Z.
R026XY085NV	GRANITIC FAN 12-14 P.Z.

Similar sites

R026XY046NV	GRANITIC SLOPE 12-14 P.Z. ACTH7 - ACOCO codominant grasses; less productive site
R026XY018NV	GRANITIC SOUTH SLOPE 10-12 P.Z. ACSP12 dominant grass; less productive site
R026XY085NV	GRANITIC FAN 12-14 P.Z. ACTH7 - ACOCO codominant grasses; more productive site
R026XY014NV	DUNE 10-12 P.Z. PUTR2 dominant shrub; occurs on sandy hills
R026XY026NV	GRANITIC SLOPE 10-12 P.Z. ACTH7 - ACSP12; codominant grasses

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) <i>Artemisia tridentata</i> (2) <i>Purshia tridentata</i>
Herbaceous	(1) <i>Hesperostipa comata</i> (2) <i>Achnatherum hymenoides</i>

Physiographic features

This site occurs on alluvial fans that border mountains and foothills. Slopes generally range from 2 to 15 percent, but slopes from 2 to 8 percent are most typical. Elevations are 4500 to 5500 feet.

Table 2. Representative physiographic features

Landforms	(1) Alluvial fan
Flooding duration	Very brief (4 to 48 hours)
Flooding frequency	None to rare
Elevation	4,500–5,500 ft
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 10 to 12 inches. Mean annual air temperature is 46 to 53 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)	10-12 in
Frost-free period (average)	95 days
Freeze-free period (average)	
Precipitation total (average)	11 in

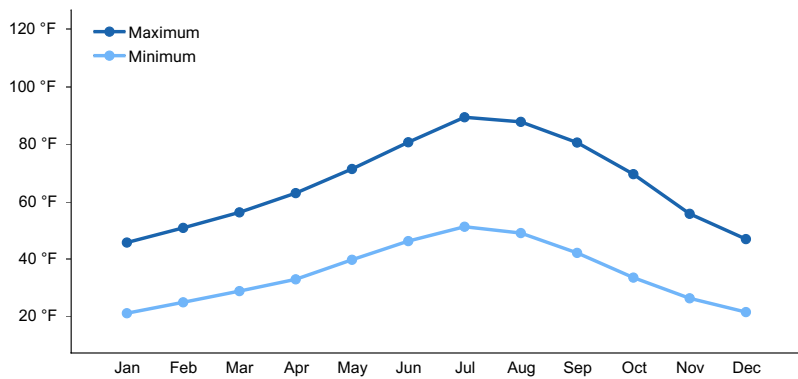


Figure 1. Monthly average minimum and maximum temperature

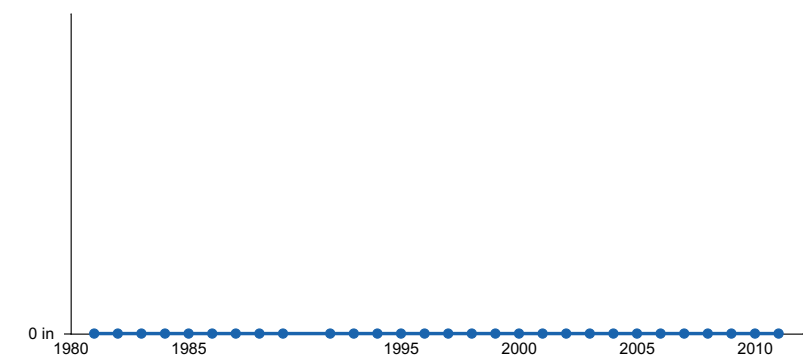


Figure 2. Annual precipitation pattern

Influencing water features

There are no influencing water features associated with this site.

Soil features

The soils associated with this site are very deep and somewhat excessively to excessively drained. The coarse textured surface layer allows a rapid intake of moisture and loss to evaporation and runoff is very low in storms of normal or less than normal intensity. Deep percolating moisture is available to deep rooted plants. The droughty surface layer limits seedling establishment. The soils have a mollic epipedon. The soils are highly susceptible to water erosion when cover is removed. The soil series associated with site include: Bedell, Calpine, Linhart, Mottskel and Mottsville.

Table 4. Representative soil features

Parent material	(1) Alluvium–granite
Surface texture	(1) Loamy sand (2) Very gravelly coarse sand (3) Gravelly loamy coarse sand (4) Sand
Family particle size	(1) Sandy-skeletal
Drainage class	Somewhat excessively drained to excessively drained
Permeability class	Rapid
Soil depth	72 in
Surface fragment cover <=3"	8–42%
Surface fragment cover >3"	0–20%
Available water capacity (0–40in)	2.4–3.1 in

Calcium carbonate equivalent (0-40in)	0%
Electrical conductivity (0-40in)	0 mmhos/cm
Sodium adsorption ratio (0-40in)	0
Soil reaction (1:1 water) (0-40in)	5.6–7.3
Subsurface fragment volume <=3" (Depth not specified)	0–2%
Subsurface fragment volume >3" (Depth not specified)	8–35%

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 invasion. Key characteristics include 1) climate (precipitation, temperature), 2) topography (aspect, slope, elevation, and landform), 3) hydrology (infiltration, runoff), 4) soils (depth, texture, structure, organic matter), 5) plant communities (functional groups, productivity), and 6) natural disturbance regime (fire, herbivory, etc.) (Caudle et al. 2013). Biotic factors that influence resilience include site productivity, species composition and structure, and population regulation and regeneration (Chambers et al 2013).

This 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 and over 3.0 m. (Comstock and Ehleringer 1992). Root length of mature sagebrush plants was measured to a depth of two meters in alluvial soils in Utah (Richards and Caldwell 1987). Tap roots of antelope bitterbrush have been documented from 4.5 to 5.4 m in length (McConnell 1961). These shrubs have a flexible generalized root system with development of both deep taproots and laterals near the surface (Comstock and Ehleringer 1992).

Mountain big sagebrush and antelope bitterbrush are generally long-lived; therefore it is not necessary for new individuals to recruit every year for perpetuation of the stand. Infrequent large recruitment events and simultaneous low, continuous recruitment is the foundation of population maintenance (Noy-Meir 1973). Survival of the seedlings is dependent on adequate moisture conditions.

The perennial bunchgrasses that are co-dominant with the shrubs include needle and thread, Indian ricegrass, desert needlegrass, and squirreltail. These species 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. Differences in root depth distributions between grasses and shrubs result in resource partitioning in these shrub/grass systems.

The Great Basin sagebrush communities have high spatial and temporal variability in precipitation both among years and within growing seasons. Nutrient availability is typically low but increases with elevation and closely follows moisture availability. The moisture resource supporting the greatest amount of plant growth is usually the water stored in the soil profile during the winter. The invasibility of plant communities is often linked to resource availability. Disturbance can decrease resource uptake due to damage or mortality of the native species and depressed competition or can increase resource uptake 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). Dobrowolski et al. (1990) cite multiple authors on the extent of the soil profile exploited by the competitive exotic annual cheatgrass. Specifically, the depth of rooting is dependent on the size the plant achieves and in competitive environments cheatgrass roots were found to penetrate only 15 cm whereas isolated plants and pure stands were found to root at least 1 m in depth with some plants rooting as deep as 1.5 to 1.7 m.

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 mountain big sagebrush will be severely reduced along with the herbaceous understory. 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.

This ecological site has low to moderate resilience to disturbance and resistance to invasion. Increased resilience increases with elevation, aspect, increased precipitation and increased nutrient availability. Long-term disturbance response may be influenced by small differences in landscape topography. Five possible alternative stable states have been identified for this site

Fire Ecology:

Fire is believed to be the dominant disturbance force in natural big sagebrush communities. Several authors suggest pre-settlement fire return intervals in mountain big sagebrush communities varied from 15 to 25 years (Burkhardt and Tisdale 1969, Houston 1973, and Miller et al. 2000). Kitchen and McArthur (2007) suggest a mean fire return interval of 40 to 80 years for mountain big sagebrush communities. The range from 15 to 80 years is probably more accurate and reflects the differences in elevation and precipitation where mountain big sagebrush communities occur. On a landscape scale, multiple seral stages were represented in a mosaic reflecting periodic reoccurrence of fire and other disturbances (Crawford et al 2004). 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. Fire adaptation by herbaceous species is generally superior to the dominant shrubs, which are typically killed by fire. 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).

Mountain big sagebrush is killed by fire (Neunswander 1980, Blaisdell et al. 1982) and does not resprout (Blaisdell 1953). Post-fire regeneration occurs from seed and will vary depending on site characteristics, seed source, and fire characteristics. Mountain big sagebrush seedlings can grow rapidly and may reach reproductive maturity within 3 to 5 years (Bunting et al. 1987). Mountain big sagebrush may return to pre-burn density and cover within 15-20 years following fire, but establishment after severe fires may proceed more slowly (Bunting et al. 1987).

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 for 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). 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).

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 (Young 1983, Wright 1971). Fire will remove aboveground biomass from bluebunch wheatgrass but plant mortality is generally low (Robberecht and Defosse 1995). However, season and severity of the fire will influence plant response. Plant response will vary depending on post-fire soil moisture availability.

Catastrophic wildfire in Utah juniper and/or singleleaf pinyon controlled sites may lead to an annual weed dominated site. Depending on fire severity, rabbitbrush, Anderson's peachbrush and other sprouters will increase after fire. Douglas' rabbitbrush is top-killed by fire, but sprouts vigorously after fire (Kuntz 1982, Akinsoji 1988).

State and transition model

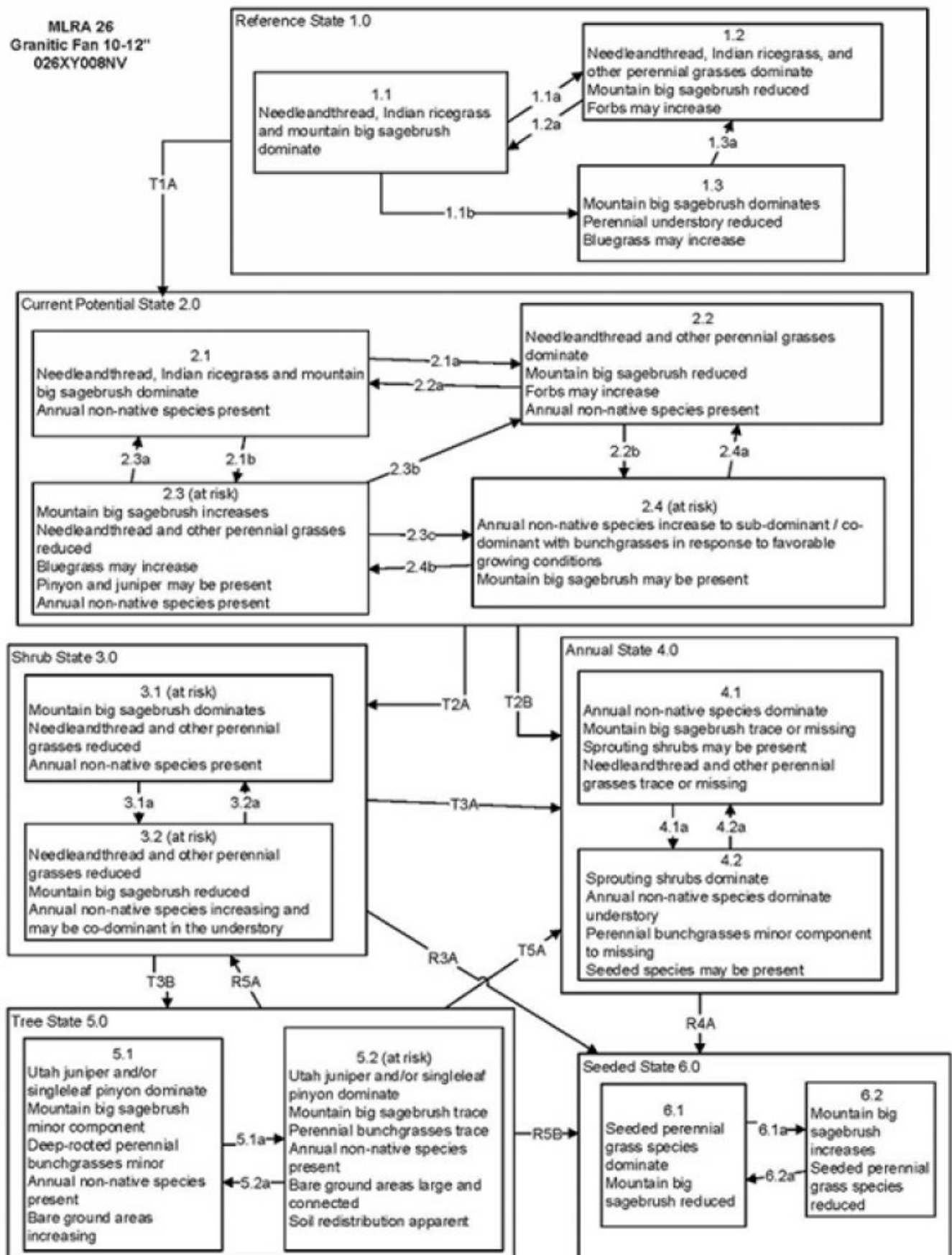


Figure 4. T. Stringham 4/2018

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: Low severity fire would create sagebrush/grass mosaic.

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: Rainfall pattern favoring annual species production (higher than normal spring precipitation).
- 2.3a: Low severity fire creates sagebrush/grass mosaic, herbivory or combinations. Brush management with minimal soil disturbance reduces sagebrush.
- 2.3b: High severity fire significantly reduces sagebrush cover leading to early mid-seral community. Brush management with minimal soil disturbance reduces sagebrush.
- 2.3c: Rainfall pattern favoring annual species production (higher than normal spring precipitation).
- 2.4a: Rainfall pattern favoring perennial bunchgrass production and reduced cheatgrass production.
- 2.4b: Rainfall pattern favoring perennial bunchgrass production and reduced cheatgrass production.

Transition T2A: Inappropriate grazing management (3.1), or high severity fire (3.2).

Transition T2B: Fire or brush management causing severe soil disturbance.

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 and/or treatments that disturb the existing plant community.

Transition T3B: Time and lack of disturbance allows maturation of the tree community.

Restoration R3A: Brush management combined with seeding of desired species

Annual State 4.0

- 4.1a: Time and lack of disturbance. Big sagebrush is unlikely to reestablish and may take many years.
- 4.2a: Fire.

Restoration 4A: Application of herbicide and seeding of desired species (probability of success best immediately following fire).

Tree State 5.0

- 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

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

- 6.1a: Time and lack of disturbance.
- 6.2a: Fire and/or brush management.

Figure 5. T. Stringham 4/2018 - DRAFT

State 1 Reference State

The Reference State 1.0 is a representative of the natural range of variability under pristine conditions. The

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

Community 1.1

Plant Community 1.1

Thurber's needlegrass is codominant with big sagebrush. Sagebrush may be a mix of Wyoming big sagebrush, basin big sagebrush, and mountain big sagebrush. Pinyon and/or juniper may be present. The reference plant community is dominated by needle and thread, Indian ricegrass, antelope bitterbrush, and big sagebrush. Potential vegetative composition is about 50 percent grasses, 10 percent forbs and 40 percent shrubs. Approximate ground cover (basal and crown) is 30 to 45 percent.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	300	400	500
Shrub/Vine	240	320	400
Forb	60	80	100
Total	600	800	1000

Community 1.2

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 1.3

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 percent of production on the site.

Pathway 1.1a

Community 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.

Pathway 1.1b

Community 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.

Pathway 1.2a

Community 1.2 to 1.1

Time and lack of disturbance allows for shrubs to reestablish.

Pathway 1.3a

Community 1.3 to 1.2

Fire would decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses to dominate the site. Fires would typically be small and patchy due to low fuel loads. A fire following an unusually wet spring or a change in management may be more severe and reduce sagebrush cover to trace amounts. A severe infestation of Aroga moth could also cause a large decrease in sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs.

State 2

Current Potential State

This state is similar to the Reference State 1.0. with similar community phases plus the 2.4 at-risk community phase. Ecological function has not changed, however the resiliency of the state has been reduced by the presence of invasive weeds. Negative feedbacks enhance ecosystem resilience and contribute to the stability of the state. These include the presence of all structural and functional groups, low fine fuel loads and retention of organic matter and nutrients. Positive feedbacks decrease ecosystem resilience and stability of the state. These include the non-natives high seed output, persistent seed bank, rapid growth rate, ability to cross pollinate and adaptations for seed dispersal. Additionally, the presence of highly flammable, non-native species reduces state resilience because these species can promote fire where historically fire has been infrequent leading to positive feedbacks that further the degradation of the system.

Community 2.1

Community Phase 2.1

This community phase is similar to the Reference State Community Phase 1.1, with the presence of non-native species in trace amounts. 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 2.2

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 2.3

Community Phase 2.3

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 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 2.4

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.

Pathway 2.1a

Community 2.1 to 2.2

Fire would decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses to dominate the site. Fires would typically be small and patchy due to low fuel loads. A fire following an unusually wet spring or a change in management may be more severe and reduce sagebrush cover to trace amounts. A severe infestation of Aroga moth could also cause a large decrease in sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs. Annual non-native species generally respond well after fire and may be stable or increasing within the community.

Pathway 2.1b

Community 2.1 to 2.3

Time, long-term drought, grazing management that favors shrubs or combinations of these would allow the sagebrush overstory to increase and dominate the site, causing a reduction in the perennial bunchgrasses. However, Sandberg bluegrass and/or squirreltail may increase in the understory depending on the grazing management. Heavy spring grazing will favor an increase in sagebrush. Annual non-native species may be stable or increasing within the understory.

Pathway 2.2a

Community 2.2 to 2.1

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

Pathway 2.2b

Community 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.

Pathway 2.3b

Community 2.3 to 2.1

Low severity fire or Aroga moth infestation creates sagebrush/grass mosaic. Other disturbances/practices include brush management with minimal soil disturbance; late-fall/winter grazing causing mechanical damage to sagebrush.

Pathway 2.3a

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. Fires would typically be small and patchy due to low fuel loads. A fire following an unusually wet spring or a change in management may be more severe and reduce sagebrush cover to trace amounts. A severe infestation of Aroga moth could also cause a large decrease in sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs.

Pathway 2.3c

Community 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.

Pathway 2.4b

Community 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.

Pathway 2.4a

Community 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.

State 3

Shrub State

This state has two community phases and is the product of many years of heavy grazing during time periods harmful to deep-rooted perennial bunchgrasses. With a reduction in deep-rooted perennial bunchgrass competition, bluegrasses and squirreltail will increase and become the dominant grass. Sagebrush dominates the overstory. Bitterbrush and/or rabbitbrush may be significant components. Sagebrush cover exceeds site concept and may be decadent, reflecting stand maturity and lack of seedling establishment due to competition with mature plants. Bare ground is also increasing. The shrub overstory and bluegrass understory dominate site resources such that soil water, nutrient capture, nutrient cycling and soil organic matter are temporally and spatially redistributed.

Community 3.1

Community Phase 3.1



Figure 7. T. Stringham MU 491, Mottsville series, 5/2016

This site is at risk of transitioning to another state. Mountain big sagebrush, possibly decadent, dominates overstory and rabbitbrush may be a significant component. Deep-rooted perennial bunchgrasses may be present in trace amounts or absent from the community. Utah juniper may be present or increasing. Annual non-native species are present to increasing. Understory may be sparse, with bare ground increasing. Utah juniper or singleleaf pinyon may be present as a result of encroachment from neighboring sites and lack of disturbance.

Community 3.2

Community Phase 3.2

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.

Pathway 3.1a

Community 3.1 to 3.2

Fire would decrease or eliminate the overstory of sagebrush. A severe infestation of Aroga moth could also cause a large decrease in sagebrush within the community, giving a competitive advantage to 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.

Pathway 3.2a

Community 3.2 to 3.1

Absence of disturbance over time would allow for sagebrush and other shrubs to recover.

State 4

Annual State

This state has two community phases. One phase is characterized by the dominance of annual non-native species such as cheatgrass and tansy mustard. The second phase has either mountain big sagebrush and/or rabbitbrush dominating the overstory with an understory of annual non-natives.

Community 4.1

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 4.2

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.

Pathway 4.1a

Community 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.

Pathway 4.2a

Community 4.2 to 4.1

Fire kills shrubs and allows for annual non-native species to dominate the site.

State 5

Tree State

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 5.1

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 5.2

Community Phase 5.2

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.

Pathway 5.1a

Community 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.

Pathway 5.2a

Community 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.

State 6

Seeded State

This state has two community phases. 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 6.1

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 6.2

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.

Pathway 6.1a

Community 6.1 to 6.2

Time and lack of disturbance allow shrubs to increase. Pathway may be coupled with inappropriate grazing management.

Pathway 6.2a

Community 6.2 to 6.1

Fire and/or brush management allows seeded grasses to return to dominance.

Transition T1A

State 1 to 2

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.

Transition T2A

State 2 to 3

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

Transition T2B

State 2 to 4

Trigger: Fire or a failed range seeding leads to plant community phase 4.1. Inappropriate grazing management that favors shrubs in the presence of non-native annual species leads to community phase 4.2. Slow variables: Increased production and cover of non-native annual species. Threshold: Cheatgrass or other non-native annuals dominate understory.

Transition T3A

State 3 to 4

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.

Transition T3B

State 3 to 5

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.

Restoration pathway R3A

State 3 to 6

Brush management, herbicide, and seeding of crested wheatgrass (*Agropyron cristatum*) and/or other desired species.

Restoration pathway R4A

State 4 to 6

Application of herbicide and seeding of desired species. Probability of success is best immediately following fire.

Restoration pathway R5A

State 5 to 3

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.

Transition T5A
State 5 to 4

Trigger: Catastrophic crown fire would reduce or eliminate trees to transition the site to 4.1. Tree removal when annual non-natives such as cheatgrass are present would also transition the site to state 4.0. Slow variable: Increased seed production and cover of annual non-native species. Threshold: Increased, continuous fine fuels modify the fire regime by changing intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture and impact the nutrient cycling and distribution.

Restoration pathway R5B
State 5 to 6

Tree removal and seeding of desired species. Tree removal practices that minimize soil disturbance are recommended. Probability of success declines with increased presence of nonnative annual species.

Additional community tables

Table 6. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	Primary Perennial Grasses			320–594	
	needle and thread	HECO26	<i>Hesperostipa comata</i>	160–240	–
	Indian ricegrass	ACHY	<i>Achnatherum hymenoides</i>	120–200	–
	desert needlegrass	ACSP12	<i>Achnatherum speciosum</i>	16–64	–
	squirreltail	ELEL5	<i>Elymus elymoides</i>	16–64	–
2	Secondary Perennial Grasses			16–64	
	Thurber's needlegrass	ACTH7	<i>Achnatherum thurberianum</i>	4–24	–
	Sandberg bluegrass	POSE	<i>Poa secunda</i>	4–24	–
Forb					
3	Perennial			40–120	
	balsamroot	BALSA	<i>Balsamorhiza</i>	4–24	–
	tapertip hawksbeard	CRAC2	<i>Crepis acuminata</i>	4–24	–
	buckwheat	ERIOG	<i>Eriogonum</i>	4–24	–
	lupine	LUPIN	<i>Lupinus</i>	4–24	–
	scarlet globemallow	SPCO	<i>Sphaeralcea coccinea</i>	4–24	–
	mule-ears	WYAM	<i>Wyethia amplexicaulis</i>	4–24	–
Shrub/Vine					
4	Primary Shrubs			160–320	
	big sagebrush	ARTR2	<i>Artemisia tridentata</i>	120–200	–
	antelope bitterbrush	PUTR2	<i>Purshia tridentata</i>	40–120	–
5	Secondary Shrubs			40–80	
	yellow rabbitbrush	CHVI8	<i>Chrysothamnus viscidiflorus</i>	4–24	–
	mormon tea	EPVI	<i>Ephedra viridis</i>	4–24	–
	desert peach	PRAN2	<i>Prunus andersonii</i>	4–24	–
	currant	RIBES	<i>Ribes</i>	4–24	–
	spineless horsebrush	TECA2	<i>Tetradymia canescens</i>	4–24	–

Animal community

Livestock Interpretations:

This site is suited for livestock grazing. Grazing management should be keyed to needle and thread and Indian ricegrass. Needle and thread is important to livestock, especially in the spring.

Indian ricegrass has good forage value for domestic sheep, cattle and horses. It can be important cattle forage in winter, particularly in salt desert communities. Indian ricegrass is often used most heavily in the late winter, when succulent and nutritious new green leaves are produced. It supplies a source of green feed before most other native grasses have produced much new growth. Big sagebrush is eaten by domestic livestock but has long been considered to be of low palatability, and a competitor to more desirable species. Young desert needlegrass is palatable to all classes of livestock. Mature herbage is moderately grazed by horses and cattle, but rarely grazed by sheep. Bottlebrush squirreltail is very palatable winter forage for domestic sheep of Intermountain ranges. Domestic sheep relish the green foliage. Overall, bottlebrush squirreltail is considered moderately palatable to livestock. Antelope bitterbrush is important browse for cattle. Cattle prefer antelope bitterbrush from mid-May through June and again in September and October. Domestic livestock and mule deer may compete for antelope bitterbrush in late summer, fall, and/or winter.

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:

This site has a high potential for wildlife habitat. It receives its greatest use as a wintering area for mule deer, due to its proximity to summer range area and migrating routes. During the entire year this site will receive use by upland game, primarily valley quail and cottontail and pygmy rabbits. This site also provides habitat, at least for a part of the year, for various songbirds, raptors, coyotes, black-tailed jackrabbits and other rodents.

Sagebrush-grassland communities provide critical sage-grouse breeding and nesting habitats. Open Wyoming sagebrush communities are preferred nesting habitat. Meadows surrounded by sagebrush may be used as feeding and strutting grounds. Sagebrush is a crucial component of their diet year-round, and sage-grouse select sagebrush almost exclusively for cover. Lekks are often located on low sagebrush sites, grassy openings, dry meadows, ridgetops, and disturbed sites. Sage-grouse prefer mountain big sagebrush and Wyoming big sagebrush communities to basin big sagebrush communities. Mountain big sagebrush is highly preferred and nutritious winter forage for mule deer. Antelope bitterbrush is extensively used by pronghorn antelope and mule deer. 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. Needle and thread is a moderately important spring forage for mule deer, but use declines considerably as more preferred forages become available. Indian ricegrass is eaten by pronghorn in "moderate" amounts whenever available. In Nevada it is consumed by desert bighorns. A number of heteromyid rodents inhabiting desert rangelands show preference for seed of Indian ricegrass. Indian ricegrass is an important component of jackrabbit diets in spring and summer. In Nevada, Indian ricegrass may even dominate jackrabbit diets during the spring through early summer months. Indian ricegrass seed provides food for many species of birds. Doves, for example, eat large amounts of shattered Indian ricegrass seed lying on the ground. Young desert needlegrass is palatable to many species of wildlife. Desert needlegrass produces considerable basal foliage and is good forage while young. Desert bighorn sheep graze desert needlegrass. Bottlebrush squirreltail is a dietary component of several wildlife species. Bottlebrush squirreltail may provide forage for mule deer and pronghorn.

Hydrological functions

Runoff is very low to low. Permeability is moderately rapid. A few rills can be expected on steeper slopes in areas subjected to summer convection storms or rapid spring snowmelt. Water flow patterns are rare but can be expected in areas recently subjected to summer convection storms or rapid snowmelt, usually on steeper slopes. 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 and head-cuts associated with ephemeral channel entrenchment may occur. Gullies and head-cuts, if present, should be healing or stable. 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

The profusely blooming bitterbrush and forbs in the spring offer rewarding opportunities for photographers. There is potential for deer and quail hunting on this site.

Wood products

Scattered Jeffery pine and pinyon pine may occur occasionally on this site along drainageways.

Other products

Native peoples used big sagebrush leaves and branches for medicinal teas, and the leaves as a fumigant. Bark was woven into mats, bags and clothing. Indian ricegrass was traditionally eaten by some Native American peoples. The Paiutes used seed as a reserve food source.

Other information

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.

Needle and thread grass is useful for stabilizing eroded or degraded sites. Indian ricegrass is well-suited for surface erosion control and desert revegetation although it is not highly effective in controlling sand movement. Bottlebrush squirreltail is tolerant of disturbance and is a suitable species for revegetation.

Type locality

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

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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:** A few rills can be expected on steeper slopes in areas subjected to summer convection storms or rapid spring snowmelt.

2. **Presence of water flow patterns:** Water flow patterns are rare but can be expected in areas recently subjected to summer convection storms or rapid snowmelt, usually on steeper slopes.

3. **Number and height of erosional pedestals or terracettes:** Pedestals are rare. Occurrence is usually limited to areas of water flow patterns. Frost heaving of shallow rooted plants should not be considered a "normal" condition.
-
4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare Ground \pm 40%; surface rock fragments less than 15%; shrub canopy 15 to 25%; foliar cover of perennial herbaceous plants \pm 40%.
-
5. **Number of gullies and erosion associated with gullies:** Gullies are none to rare. Gullies and head-cuts, if present, should be healing or stable.
-
6. **Extent of wind scoured, blowouts and/or depositional areas:** None
-
7. **Amount of litter movement (describe size and distance expected to travel):** Fine litter (foliage from grasses and annual & perennial forbs) is expected to move the distance of slope length during intense summer convection storms or rapid snowmelt events. Persistent litter (large woody material) will remain in place except during heavy rainfall events.
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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil stability values should be 3 to 6 on most soil textures found on this site. (To be field tested.)
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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Surface structure is typically thin to thick platy or fine subangular blocky that is soft and very friable. Soil surface colors are dark browns 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.
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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Perennial herbaceous plants (especially deep-rooted bunchgrasses [i.e., 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. Platy or massive sub-surface horizons or subsoil argillic horizons shallow to the surface are not to be interpreted as compacted.
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12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**
- Dominant: Reference Plant Community: Deep-rooted, cool season, perennial bunchgrasses >> tall shrubs (big sagebrush & antelope bitterbrush). (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: Microbiotic crusts

Additional:

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 15% of total woody canopy; some of the mature bunchgrasses (<15%) have dead centers.

14. **Average percent litter cover (%) and depth (in):** Between plant interspaces ($\pm 20\%$) and litter depth is $\pm \frac{1}{4}$ inch.

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** For normal or average growing season (through mid-June) ± 800 lbs/ac; favorable years ± 1000 lbs/ac and unfavorable years ± 600 lbs/ac. Spring moisture significantly affects total production.

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

17. **Perennial plant reproductive capability:** All functional groups should reproduce in average (or normal) and above average growing season years. Reduced reproduction and growth occur during extreme or extended droughts.
