Ecological site R025XY009NV
SOUTH SLOPE 12-14 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): 025X–Owyhee High Plateau

MLRA Notes 25—Owyhee High Plateau
This area is in Nevada (56 percent), Idaho (30 percent), Oregon (12 percent), and Utah (2 percent). It makes up about 27,443 square miles. MLRA 25 is characteristically cooler and wetter than the neighboring MLRAs of the Great Basin. The western boundary is marked by a gradual transition to the lower and warmer basins of MLRA 24. The boundary to the south-southeast, with MLRA 28B, is marked by gradual changes in geology marked by an increased dominance of singleleaf pinyon and Utah juniper and a reduced presence of Idaho fescue. The boundary to the north, with MLRA 11, is a rapid transition from the lava plateau topography to the lower elevation Snake River Plain.
Physiography:
All of this area lies within the Intermontane Plateaus. The southern half is in the Great Basin section of the Basin and Range province. This part of the MLRA is characterized by isolated, uplifted fault-block mountain ranges separated by narrow, aggraded desert plains. This geologically older terrain has been dissected by numerous streams draining to the Humboldt River.
The northern half of the area lies within the Columbia Plateaus province. This part of the MLRA forms the southern boundary of the extensive Columbia Plateau basalt flows. Most of the northern half is in the Payette section, but the northeast corner is in the Snake River Plain section. Deep, narrow canyons draining into the Snake River have been incised into this broad basalt plain. Elevation ranges from 3,000 to 7,550 feet on rolling plateaus and in gently sloping basins. It is more than 9,840 feet on some steep mountains. The Humboldt River crosses the southern half of this area
Geology:
The dominant rock types in this MLRA are volcanic. They include andesite, basalt, tuff, and rhyolite. In the north and west parts of the area, Cretaceous granitic rocks are exposed among Miocene volcanic rocks in mountains. A Mesozoic igneous and metamorphic rock complex dominates the south and east parts of the area. Upper and Lower Paleozoic calcareous sediments, including oceanic deposits, are exposed with limited extent in the mountains. Alluvial fan and basin fill sediments occur in the valleys.
Climate:
The average annual precipitation in most of this area is typically 11 to 22 inches. It increases to as much as 49 inches at the higher elevations. Rainfall occurs in spring and sporadically in summer. Precipitation occurs mainly as snow in winter. The precipitation is distributed fairly evenly throughout fall, winter, and spring. The amount of precipitation is lowest from midsummer to early autumn. The average annual temperature is 33 to 51 degrees F. The freeze-free period averages 130 days and ranges from 65 to 190 days, decreasing in length with elevation. It is typically less than 70 days in the mountains.
Water:
The supply of water from precipitation and streamflow is small and unreliable, except along the Owyhee, Bruneau, and Humboldt Rivers. Streamflow depends largely on accumulated snow in the mountains. Surface water from mountain runoff is generally of excellent quality and suitable for all uses. The basin fill sediments in the narrow alluvial valleys between the mountain ranges provide some ground water for irrigation. The alluvial deposits along the large streams have the most ground water. Based on measurements of water quality in similar deposits in

adjacent areas, the basin fill deposits probably contain moderately hard water. The water is suitable for almost all uses. The carbonate rocks in this area are considered aquifers, but they are little used. Springs are common along the edges of the limestone outcrops.
Soils:
The dominant soil orders in this MLRA are Aridisols and Mollisols. The soils in the area dominantly have a mesic or frigid temperature regime and an aridic, aridic bordering on xeric, or xeric moisture regime. Soils with aquic moisture regimes are limited to drainage or spring areas, where moisture originates or runs on and through. These soils are of a very limited extent throughout the MLRA. They generally are well drained, clayey or loamy, and shallow or moderately deep. Most of the soils formed in mixed parent material. Volcanic ash and loess mantle the landscape. Surface soil textures are loam and silt loam with ashy texture modifiers in some areas. Argillic horizons occur on the more stable landforms. They are exposed nearer the soil surface on convex landforms, where ash and loess deposits are more likely to erode. Soils that formed in carbonatic parent material in areas that receive less than 12 inches of precipitation are characterized by calcic horizons throughout the profile, while soils in areas that receive more than 12 inches of precipitation do not have calcic horizons in the upper part of the profile. Soils that formed on stable landforms at the lower elevations are dominated by ochric horizons. Soils that formed at the middle and upper elevations are characterized by mollic epipedons. Soils in drainage areas at all elevations that receive moisture running on or through them are characterized by thicker mollic epipedons.
Biological Resources:
This MLRA supports shrub-grass vegetation. Lower elevations are characterized by Wyoming big sagebrush associated with bluebunch wheatgrass, western wheatgrass, and Thurber's needlegrass. Other important plants include bluegrass, squirreltail, penstemon, phlox, milkvetch, lupine, Indian paintbrush, aster, and rabbitbrush. Black sagebrush occurs but is less extensive. Singleleaf pinyon and Utah juniper occur in limited areas. With increasing elevation and precipitation, vast areas characterized by mountain big sagebrush or low sagebrush/early sagebrush in association with Idaho fescue, bluebunch wheatgrass, needlegrasses, and bluegrass become common. Snowberry, curl-leaf mountain mahogany, ceanothus, and juniper also occur. Mountains at the highest elevations support whitebark pine, Douglas-fir, limber pine, Engelmann spruce, subalpine fir, aspen, and curl-leaf mountain mahogany.
Major wildlife species include mule deer, bighorn sheep, pronghorn, mountain lion, coyote, bobcat, badger, river otter, mink, weasel, golden eagle, red-tailed hawk, ferruginous hawk, Swainson's hawk, northern harrier, prairie falcon, kestrel, great horned owl, short-eared owl, long-eared owl, burrowing owl, pheasant, sage grouse, chukar, gray partridge, and California quail. Reptiles and amphibians include western racer, gopher snake, western rattlesnake, side-blotched lizard, western toad, and spotted frog. Fish species include bull, red band, and rainbow trout.

Ecological site concept

The South Slope 12-14 P.Z. site is on mountain side slopes on all but northerly exposures. Slopes range from 30 to 75 percent, but slope gradients of 30 to 50 percent are most typical. Elevations range from 6,000 to 8,500 feet (1828 to 2590 meters).

The soils in this site are deep to moderately deep and well drained. Surface soils are medium to coarse textured and more than 10 inches (25 cm) thick. These soils have 35 to 50 percent rock fragments through the soil profile. These soils typically have a mollic epipedon and an argillic horizon. Available water capacity is low to moderate.

The Reference State is dominated by bluebunch wheatgrass and big sagebrush. Other important plants are antelope bitterbrush and basin wildrye. Production ranges from 700 to 1300 lbs/ac.

Associated sites

R025XY027NV	**LOAMY 12-14 P.Z.**
R025XY046NV	**FRACTURED STONY LOAM 14+ P.Z.**
R025XY071NV	**MAHOGANY SAVANNA 14-16 P.Z.**
R025XY012NV	**LOAMY SLOPE 12-16 P.Z.**
R025XY017NV	**CLAYPAN 12-16 P.Z.**

Similar sites

R025XY016NV	**SOUTH SLOPE 14-18 P.Z.** PSSPS-BRMA4 codominant grasses; more productive site; greater diversity of mountain browse species
R025XY042NV	**SHALLOW LOAM 14-16 P.Z.** Less productive site; usually occurs at higher elevations
R025XY012NV	**LOAMY SLOPE 12-16 P.Z.** FEID-PSSPS codominant grasses
R025XY015NV	**SOUTH SLOPE 8-12 P.Z.** ARTRW dominant shrub; less productive site
R025XY007NV	**GRAVELLY LOAM 12-16 P.Z.** FEID-PSSPS codominant grasses; PUTR2 dominant shrub

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Artemisia tridentata subsp. vaseyana* (2) *Purshia tridentata*
Herbaceous	(1) *Pseudoroegneria spicata*

Physiographic features

This site is on mountain side slopes on southern exposures. Slopes range from 30 to 75 percent, but slope gradients of 30 to 50 percent are most typical. Elevations range from 6000 to 8500 feet (1828 to 2590 meters).

Table 2. Representative physiographic features

Landforms	(1) Mountains > Mountain slope
Runoff class	High to very high
Flooding frequency	None
Ponding frequency	None
Elevation	6,000–8,500 ft
Slope	30–50%
Water table depth	72 in
Aspect	W, E, SE, S, SW

Table 3. Representative physiographic features (actual ranges)

Runoff class	Not specified
Flooding frequency	Not specified
Ponding frequency	Not specified
Elevation	Not specified
Slope	30–75%
Water table depth	Not specified

Climatic features

The climate associated with this site is semiarid, characterized by cold, moist winters and warm, dry summers. The average annual precipitation ranges from 10 to 14 inches (25 to 35 cm). Mean annual air temperature is typically greater than 45 degrees F.

Mean annual precipitation across the range in which this ES occurs is 13 inches (33cm).

Monthly mean precipitation in inches: January 1.45 (3.6cm); February 1.12 (2.8cm); March 1.20 (3.0cm); April 1.21 (3.0cm); May 1.62 (4.1cm); June 1.07 (2.7cm); July 0.55 (1.3cm); August 0.49 (1.2cm); September 0.62 (1.5cm); October 0.83 (2.1cm); November 1.41 (3.5cm); December 1.54 (4.0cm).

*The above data is averaged from the Mountain City RS and Wild horse RSVR WRCC climate stations.

Table 4. Representative climatic features

Frost-free period (characteristic range)	50-95 days
Freeze-free period (characteristic range)	70-115 days
Precipitation total (characteristic range)	10-14 in
Frost-free period (average)	75 days
Freeze-free period (average)	100 days
Precipitation total (average)	13 in

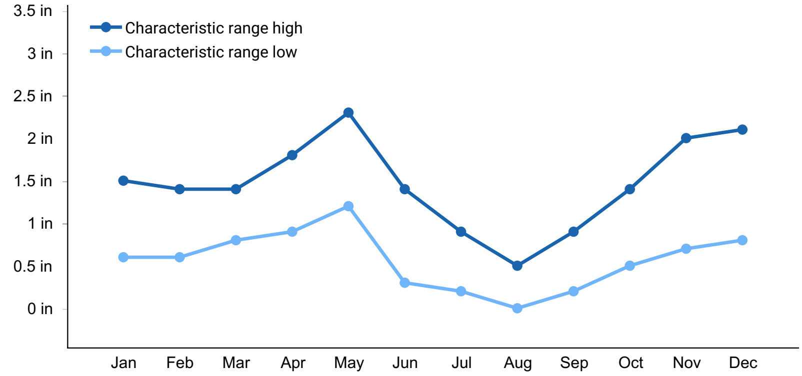

Figure 1. Monthly precipitation range

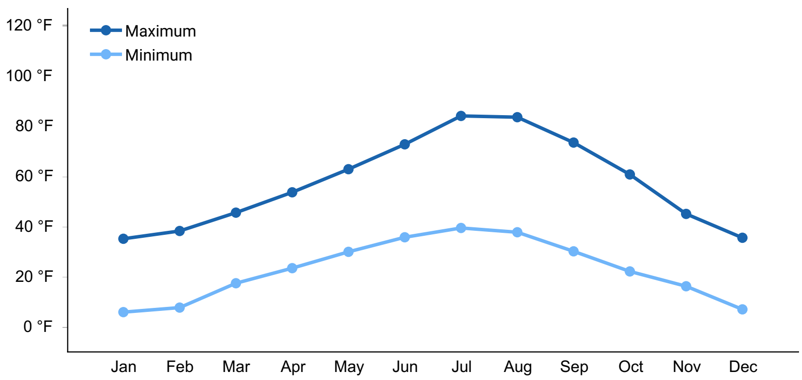

Figure 2. Monthly average minimum and maximum temperature

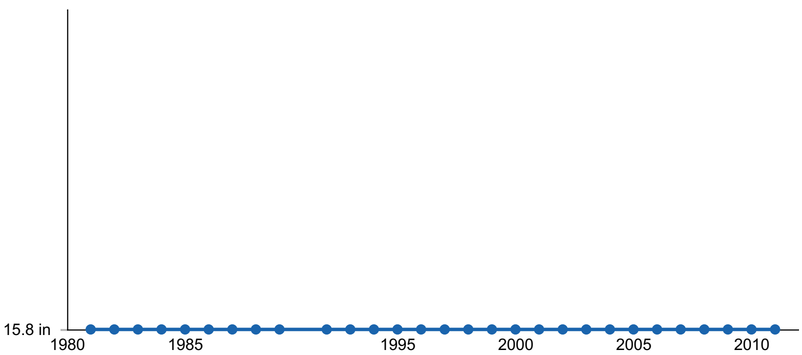

Figure 3. Annual precipitation pattern

Climate stations used

- (1) MTN CITY RS [USC00265392], Mountain City, NV
- (2) WILD HORSE RSVR [USC00269072], Deeth, NV

Influencing water features

No influencing water features are associated with this site.

Soil features

The soils in this site are deep to moderately deep and well drained. Surface soils are medium to coarse textured and more than 10 inches (25cm) thick. These soils have 35 to 50 percent rock fragments through the soil profile. These soils typically have a mollic epipedon and an argillic horizon. Available water capacity is low to moderate. Because of the southerly exposures of this site, more sunlight is received, and the soils tend to warm and plant growth is initiated earlier than on adjacent sites. High evapotranspiration potentials result in depletion of the available soil moisture supply sooner than on surrounding areas at elevations where this site occurs. Runoff is medium to high and the potential for sheet and rill erosion is moderate to high depending upon slope.

The soil series associated with this site are: Blitzen, Ekim, Granzan, Jack Creek, Jivas, Lerrow, Quarz, Say, Siri, Siscab, Sumine and Torro.

A representative soil series is Sumine, a loamy-skeletal, mixed, superactive, frigid Aridic Argixeroll. These soils are moderately deep and well drained, and was formed in residuum and colluvium derived from mixed rocks. Reaction is neutral or slightly alkaline. Diagnostic horizons include a mollic epipedon that occurs from the soil surface to 10 inches (25cm), and an argillic horizon that occurs from 6 inches to 28 inches (15 to 71cm). Clay content in the particle-size control section averages 25 to 35 percent. Rock fragments average 35 to 60 percent, mainly gravel or cobbles. Lithology of fragments is mixed.

Table 5. Representative soil features

Parent material	(1) Colluvium (2) Residuum
Surface texture	(1) Very cobbly loam
Family particle size	(1) Loamy-skeletal (2) Clayey-skeletal
Drainage class	Well drained to excessively drained
Permeability class	Slow to moderately rapid
Depth to restrictive layer	28–60 in
Soil depth	28–60 in
Surface fragment cover <=3"	10–50%
Surface fragment cover >3"	5–18%
Available water capacity (0-40in)	1.5–4.7 in
Calcium carbonate equivalent (0-40in)	0–15%
Electrical conductivity (0-40in)	0–2 mmhos/cm
Sodium adsorption ratio (0-40in)	1–5
Soil reaction (1:1 water) (0-40in)	6.1–9
Subsurface fragment volume <=3" (Depth not specified)	6–75%

Subsurface fragment volume >3" (Depth not specified)	3–20%

Ecological dynamics

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

This ecological site is dominated by deep-rooted cool season, perennial bunchgrasses and long-lived shrubs (50+ years) with high root to shoot ratios. The dominant shrubs usually root to the full depth of the winter-spring soil moisture recharge, which ranges from 1.0 to over 3.0 m. (Comstock and Ehleringer 1992). Root length of mature sagebrush plants was measured to a depth of 2 meters in alluvial soils in Utah (Richards and Caldwell 1987). These shrubs have a flexible generalized root system with development of both deep taproots and laterals near the surface (Dobrowolski et al. 1990).

In the Great Basin, the majority of annual precipitation is received during the winter and early spring. This continental semiarid climate regime favors growth and development of deep-rooted shrubs and herbaceous cool season plants using the C3 photosynthetic pathway (Comstock and Ehleringer 1992). Winter precipitation and slow melting of snow results in deeper percolation of moisture into the soil profile. Herbaceous plants, more shallow-rooted than shrubs, grow earlier in the growing season and thrive on spring rains, while the deeper rooted shrubs lag in phenological development because they draw from deeply infiltrating moisture from snowmelt the previous winter. Periodic drought regularly influences sagebrush ecosystems and drought duration and severity has increased throughout the 20th century in much of the Intermountain West. Major shifts away from historical precipitation patterns have the greatest potential to alter ecosystem function and productivity. Species composition and productivity can be altered by the timing of precipitation and water availability within the soil profile (Bates et al 2006).

Variability in plant community composition and production depends on soil surface texture and depth. Soils with argillic horizons promote the production of bluebunch wheatgrass. Production generally increases with soil depth. The amount of sagebrush in the plant community is dependent upon disturbances like fire, Aroga moth infestations, and grazing. Sandberg bluegrass more easily dominates sites where surface soils are gravelly loams or when there is an increase in ash in the upper soil profile.

Infrequent large recruitment events and simultaneous low, continuous recruitment is the foundation of population maintenance for big sagebrush species (Noy-Meir 1973). Survival of the seedlings is dependent on adequate moisture conditions.

Native insect outbreaks are also important drivers of ecosystem dynamics in sagebrush communities. Climate is generally believed to influence the timing of insect outbreaks especially a sagebrush defoliator, Aroga moth (Aroga websteri). Aroga moth infestations have occurred in the Great Basin in the 1960s, early 1970s, and 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).

Perennial bunchgrasses generally have somewhat shallower root systems than shrubs in these systems, but root densities are often as high as or higher than those of shrubs in the upper 0.5 m but taper off more rapidly than shrubs. General differences in root depth distributions between grasses and shrubs 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 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).

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.

At the upper range of this site's precipitation range, there is potential for infilling by Utah juniper (*Juniperus osteosperma*). Infilling may also occur if the site is adjacent to woodland sites or other ecological sites with these trees present. Without disturbance in these areas, the trees 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).

This ecological site has low resilience to disturbance and low resistance to invasion due to the southern exposure, slope and soil texture. Increased resilience increases with elevation, northerly aspects, increased precipitation, increased nutrient availability and soil depth. Long-term disturbance response may be influenced by small differences in landscape topography. Concave areas hold more moisture and may retain deep-rooted perennial grasses whereas convex areas are slightly less resilient and may have more Sandberg bluegrass present. Six possible stable states have been identified for this site.

Fire Ecology:
Pre-settlement fire return intervals in mountain big sagebrush communities varied from 15 to 25 years (Burkhardt and Tisdale 1969, Houston 1973, Miller 2000).

Mountain big sagebrush is killed by fire (Neuenschwander 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 and can take up to 50 years (Bunting et al. 1987, Ziegenhagen 2003, Miller and Heyerdahl 2008, Ziegenhagen and Miller 2009). The introduction of annual weedy species, like cheatgrass, may cause an increase in fire frequency and eventually lead to an annual dominated community. Conversely, without fire, sagebrush will increase and the potential for encroachment by pinyon and juniper also increases. Without fire or changes in management, pinyon and juniper will dominate the site and mountain big sagebrush will be severely reduced. The herbaceous understory will also be reduced; however Idaho fescue may remain underneath trees on north facing slopes. The potential for soil erosion increases as the woodland matures and the understory plant community cover declines. Catastrophic wildfire in these tree controlled sites may lead to an annual weed dominated site.

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).

Depending on fire severity, rabbitbrush, Utah serviceberry (*Amelanchier utahensis*) and mountain snowberry (*Symphoricarpos orbiculatus*) may increase after fire. Douglas' rabbitbrush is top-killed by fire, but sprouts vigorously after fire (Kuntz 1982, Akinsoji 1988). Mountain snowberry is also top-killed by fire, but resprouts after fire from rhizomes (Leege and Hickey 1971, Noste and Bushey 1987). Snowberry has been noted to regenerate well and exceed pre-burn biomass in the third season after a fire (Merrill et al. 1982). Utah serviceberry resprouts from the root crown. If balsamroot is common before fire, they will increase after fire or with heavy grazing (Wright 1985). As cheatgrass increases fire frequencies will also increase, at frequencies between 0.23 and 0.43 times a year, even sprouting shrubs such as rabbitbrush will not survive (Whisenant 1990).

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).

Idaho fescue's response to fire varies with condition and size of the plant, season and severity of fire, and ecological conditions. Mature Idaho fescue plants are commonly reported to be severely damaged by fire in all seasons (Wright et al. 1979). Initial mortality may be high (in excess of 75%) on severe burns, but usually varies from 20 to 50% (Barrington et al 1988). Rapid burns have been found to leave little damage to root crowns, and new tillers are produced with onset of fall moisture (Johnson et al. 1994). However, Wright and others (1979) found the dense, fine leaves of Idaho fescue provided enough fuel to burn for hours after a fire had passed, thereby killing or seriously injuring the plant regardless of the intensity of the fire (Wright et al. 1979). Idaho fescue is commonly reported to be more sensitive to fire than the other prominent grass on this site, bluebunch wheatgrass (Conrad and Poulton 1966). However, Robberecht and Defosse (1995) suggested the latter was more sensitive. They observed culm and biomass reduction with moderate fire severity in bluebunch wheatgrass, whereas a high fire severity was required for this reduction in Idaho fescue. Also, given the same fire severity treatment, post-fire culm production was initiated earlier and more rapidly in Idaho fescue (Robberecht and Defosse 1995).

Bluebunch wheatgrass has coarse stems with little leafy material, therefore the tops aboveground biomass burns rapidly and little heat is transferred downward into the crowns (Young 1983). Bluebunch wheatgrass was described as fairly tolerant of burning, other than in May in eastern Oregon (Britton et al. 1990). Uresk et al. (1976) reported burning increased vegetative and reproductive vigor of bluebunch wheatgrass. Thus, bluebunch wheatgrass is considered to experience slight damage to fire but is more susceptible in drought years (Young 1983). Most authors classify the plant as undamaged by fire (Kuntz 1982).

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 reports fall and spring burning increased total shoot and reproductive shoot densities in the first year, although live basal areas were similar between burn and unburned plants. By year two, however, there was little difference between burned and control treatments. Additionally, natural great basin wildrye seed viability has been found to be low and seedlings lack vigor (Young and Evans 1981). Roundy (1985) found that although basin wildrye is adapted to seasonally dry saline soils, high and frequent spring precipitation is necessary to establish it from seed. This suggests that establishment of natural basin wildrye seedlings occurs only during years of unusually high precipitation and thus reestablishment of a stand that has been lost due to grazing may be episodic.

State and transition model

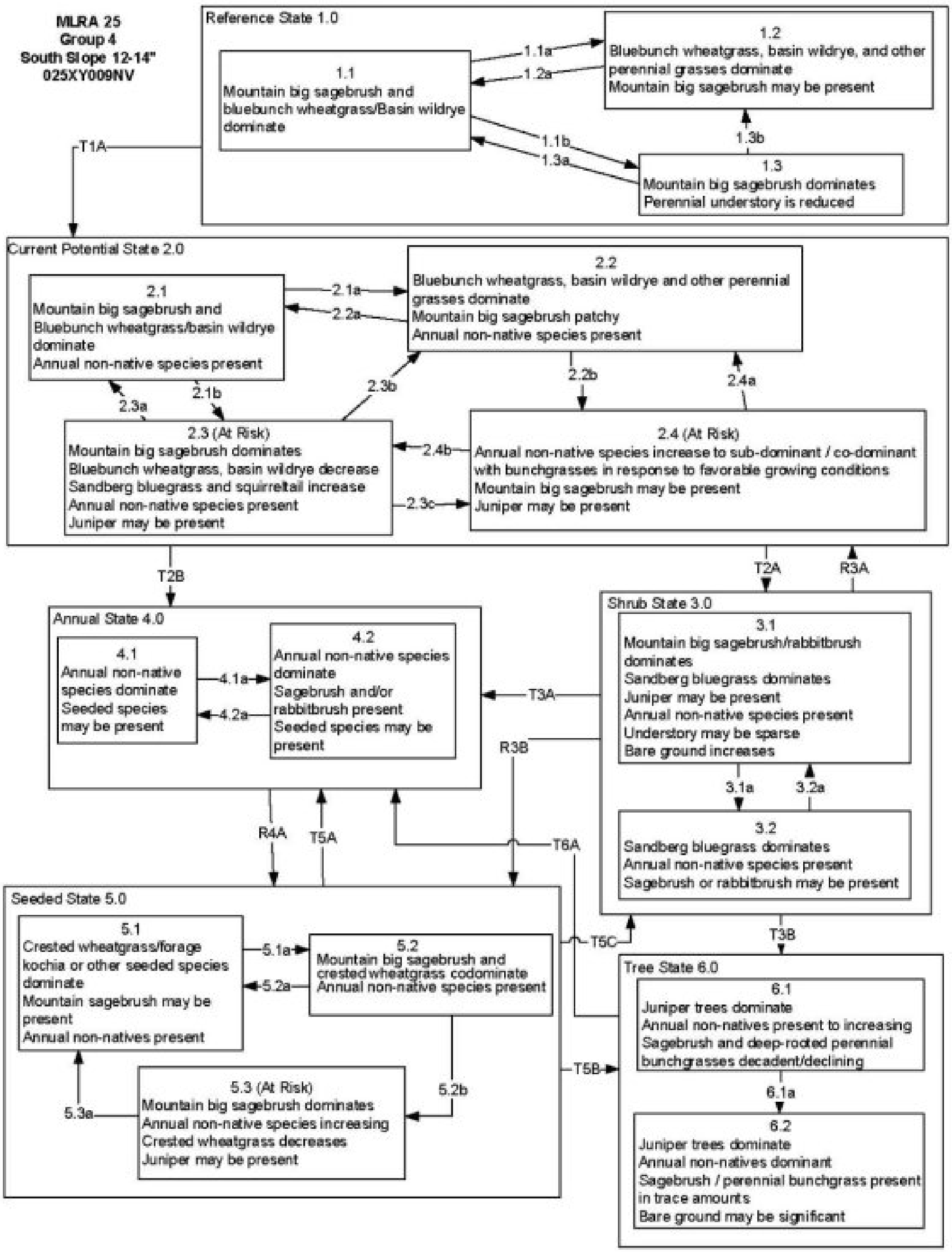

Figure 5. T.K. Stringham STM 2021

Key
MLRA 25
Group 4
South Slope 12-14"
025XY009NV

Reference State 1.0 Community Phase Pathways
1.1a: Low severity fire creates grass/sagebrush 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 may also decrease perennial understory.
1.2a: Time and lack of disturbance allows for shrub regeneration.
1.3a: Low severity fire or Aroga moth infestation resulting in a mosaic pattern.
1.3b: High severity fire or Aroga moth significantly reduces sagebrush cover leading to early/mid-seral community.

Transition T1A: Introduction of non-native species.

Current Potential State 2.0 Community Phase Pathways
2.1a: Low severity fire creates grass/sagebrush 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 such as fire or drought. Inappropriate grazing management may also reduce perennial understory.
2.2a: Time and lack of disturbance allows for regeneration of sagebrush.
2.2b: Fall and spring growing conditions that favor the germination and production of non-native annual grasses. Pathway typically occurs 3 to 5 years post-fire and 2.4 may be a transitory plant community.
2.3a: Low severity fire or Aroga moth infestation creates sagebrush/grass mosaic. Brush treatment with minimal soil disturbance; late-fall/winter grazing causing mechanical damage to sagebrush.
2.3b: High severity fire or Aroga moth significantly reduces sagebrush cover leading to a early/mid-seral community.
2.3c: Fall and spring growing season conditions that favor the germination and production of non-native annual grasses. 2.4 may be a transitory plant community.
2.4a: Fall and spring growing season conditions favoring perennial bunchgrass production and reduced cheatgrass production.
2.4b: Fall and spring growing season conditions unfavorable to cheatgrass production.

Transition T2A: Inappropriate grazing management favoring shrub dominance and reducing perennial bunchgrasses will lead to phase 3.1. Soil disturbing treatments will lead to phase 3.2.
Transition T2B: Catastrophic fire (to 4.1); inappropriate cattle/horse grazing management that removes bunchgrasses, favors shrubs and promotes the presence of non-native annual species (to 4.2)

Shrub State 3.0 Community Phase Pathways
3.1a: Low severity fire or Aroga moth infestation creates sagebrush/grass mosaic. Brush treatment with minimal soil disturbance; late-fall/winter grazing causing mechanical damage to sagebrush.
3.2a: Time and lack of disturbance.

Restoration R3A: Brush management and seeding of native deep rooted bunchgrasses (probability of success is low).
Restoration R3B: Brush management and seeding of crested wheatgrass and/or other non-native desirable species.

Transition T3A: Fire and/or soil disturbing treatments.
Transition T3B: Time and lack of disturbance such as fire favors an increase in tree dominance (from phase 3.1.)

Annual State 4.0 Community Phase Pathways
4.1a: Time and lack of disturbance. Big sagebrush is unlikely to reestablish and may take many years.
4.2a: High-severity fire.

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

Seeded State 5.0 Community Phase Pathways
5.1a: Time without disturbance.
5.2a: Fire, brush management, or Aroga moth infestation reduces shrub component.
5.2b: Inappropriate grazing management decreases perennial bunchgrass understory.
5.3a: Fire, brush management, Aroga moth infestation.

Transition T5A: Catastrophic fire (coming from 5.3).
Transition T5B: Time and lack of disturbance allows trees to dominate site resources.
Transition T5C: Inappropriate grazing management favoring shrub dominance and reducing perennial bunchgrasses will lead to phase 3.1. Soil disturbing treatments and/or fire will lead to phase 3.2.

Tree State 6.0 Community Phase Pathways
6.1a: Time without disturbance.

Transition T6A: Catastrophic fire that kills trees. Inappropriate tree removal practices may also lead to dominance by non-native annuals.

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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
Mountain big sagebrush-perennial bunchgrasses

This plant community phase is dominated by bluebunch wheatgrass although big sagebrush and antelope bitterbrush are often prevalent enough to dominate the visual aspect. Other common plants include basin wildrye, Thurber needlegrass, squirreltail, Idaho fescue and bluegrasses. Potential vegetative composition is about 65 percent grasses, 10 percent forbs, and 25 percent shrubs. Approximate ground cover (basal and crown) is 35 to 45 percent.

Table 6. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	455	585	845
Shrub/Vine	175	225	325
Forb	70	90	130
Total	**700**	**900**	**1300**

Community 1.2
Perennial bunchgrasses

This community phase is characteristic of a post-disturbance, early to mid-seral community phase. Rabbitbrush, Utah serviceberry, snowberry and perennial grasses such as bluebunch wheatgrass, basin wildrye and squirreltail are common. Mountain big sagebrush is killed by fire, therefore decreasing within the burned community. Sagebrush could still be present in unburned patches. Depending on fire severity, antelope bitterbrush may experience high mortality and can be reduced in the community for several years.

Community 1.3
Mountain big sagebrush

If a seed source is available, mountain big sagebrush will re-establish and increase in the absence of disturbance. With an extended fire return interval, eventually sagebrush will dominate the overstory and the deep-rooted perennial bunchgrasses in the understory are reduced either from competition with shrubs or from herbivory. Bluegrass and squirreltail will likely increase in the understory and may be the dominant grass on the site.

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. 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 1.1b
Community 1.1 to 1.3

Long-term drought, time and/or herbivory favor an increase in mountain big sagebrush over deep-rooted perennial bunchgrasses. Combinations of these would allow the sagebrush overstory to increase and dominate the site, causing a reduction in the perennial bunchgrasses. Sandberg bluegrass may increase in density depending on the grazing management.

Pathway 1.2a
Community 1.2 to 1.1

Time and lack of disturbance allows for sagebrush to reestablish.

Pathway 1.3a
Community 1.3 to 1.1

Aroga moth infestation and or release from growing season herbivory may reduce sagebrush dominance and allow recovery of the perennial bunchgrass understory.

Pathway 1.3b
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. Ecological function has not changed, however the resiliency of the state has been reduced by the presence of invasive weeds. This state has four community phases. Negative feedbacks enhance ecosystem resilience and contribute to the stability of the state. These include the presence of all structural and functional groups, low fine fuel loads and retention of organic matter and nutrients. Positive feedbacks decrease ecosystem resilience and stability of the state. These include the non-natives high seed output, persistent seed bank, rapid growth rate, ability to cross pollinate and adaptations for seed dispersal. Additionally, the presence of highly flammable, non-native species reduces State resilience because these species can promote fire where historically fire has been infrequent leading to positive feedbacks that further the degradation of the system.

Community 2.1
Mountain big sagebrush-perennial bunchgrasses/non-native species

This plant community phase is dominated by bluebunch wheatgrass although big sagebrush and antelope bitterbrush are often prevalent enough to dominate the visual aspect. Other common plants include basin wildrye, Thurber needlegrass, squirreltail, Idaho fescue and bluegrasses. Potential vegetative composition is about 65 percent grasses, 10 percent forbs, and 25 percent shrubs. Approximate ground cover (basal and crown) is 35 to 45 percent. Non-native annual species are present in minor amounts (<5 percent).

Community 2.2
Perennial bunchgrasses

This community phase is characteristic of a post-disturbance, early seral community phase. Rabbitbrush, serviceberry, antelope bitterbrush and perennial bunchgrasses such as bluebunch wheatgrass, squirreltail, basin wildrye and bluegrasses are common. Mountain big sagebrush is killed by fire, therefore decreasing within the burned community. Sagebrush could still be present in unburned patches. Perennial forbs may increase or dominate after fire for several years. Annual non-native species generally respond well after fire and may be stable or increasing within the community. Rabbitbrush may dominate the aspect for a number of years following wildfire.

Community 2.3
Mountain big sagebrush (at risk)

Mountain big sagebrush increases and the perennial understory is reduced. Decadent sagebrush dominates the overstory and the deep-rooted perennial bunchgrasses in the understory are reduced either from competition with shrubs or from inappropriate grazing management. Sandberg bluegrass will likely increase in the understory and may be the dominant grass on the site. Utah juniper may be present. Annual non-native species present.

Community 2.4
Perennial bunchgrasses/annual non-native species (at-risk)

This community is at risk of crossing into an annual state, but may be transitory in response to particular annual weather patterns. Native bunchgrasses dominate; however, annual non-native species such as cheatgrass may increase to codominance 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 and/or bitterbrush are a minor component. Juniper may be present. This site is susceptible to further degradation from grazing, drought, and fire.

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, or 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. Pathway typically occurs 3 to 5 years post-fire.

Pathway 2.3a
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.

Conservation practices

Brush Management

Pathway 2.3b
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

Higher than normal spring precipitation favors annual non-native species such as cheatgrass and can increase overall production on the site. Pathway occurs when there is available interspace for increased annual grass production.

Pathway 2.4a
Community 2.4 to 2.2

Rainfall patterns unfavorable to cheatgrass production. Less than normal spring precipitation followed by higher than normal summer precipitation will favor perennial bunchgrass production.

Pathway 2.4b
Community 2.4 to 2.3

Rainfall patterns unfavorable to cheatgrass production. Shrubs must be present in the 2.4 phase for this pathway to occur. Less than normal spring precipitation followed by higher than normal summer precipitation will favor perennial bunchgrass production.

State 3
Shrub State

This state has two community phases; a mountain big sagebrush-antelope bitterbrush dominated phase and a rabbitbrush dominated phase. This state is a product of many years of heavy grazing during time periods harmful to perennial bunchgrasses. Bluegrass will increase with a reduction in deep rooted perennial bunchgrass competition and become the dominant grass. Shrub canopy cover is high and shrubs may be decadent, reflecting stand maturity and lack of seedling establishment due to competition with mature plants. 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
Mountain big sagebrush/rabbitbrush

Mountain big sagebrush and antelope bitterbrush dominate the overstory and rabbitbrush may be a significant component. Bluegrasses dominate the understory and squirreltail may also be a significant component of the plant community. Utah juniper may be present or increasing. Annual non-native species are present to increasing. Understory may be sparse, with bare ground increasing.

Community 3.2
Sandberg bluegrass

Bluegrass dominates the understory; annual non-natives are present but are not dominant. Trace amounts of sagebrush and antelope bitterbrush may be present. Rabbitbrush may dominate for a number of years following fire.

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 the Sandberg bluegrass, 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 Sandberg bluegrass 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. The first is dominated by annual non-native species and the other is a shrub-dominated site. This state is characterized by the dominance of annual non-native species such as cheatgrass and annual mustards in the understory. Sagebrush and/or rabbitbrush may dominate the overstory. Annual non-native species and squirreltail dominate the understory.

Community 4.1
Annual non-native species

Annual non-native plants such as cheatgrass and annual mustards dominate the site. This phase may have seeded species present if resulting from a failed seeding attempt.

Community 4.2
Annual non-native species/shrubs

Mountain big sagebrush reestablishes in the overstory with annual non-native species, likely cheatgrass, dominating the understory. Trace amounts of desirable bunchgrasses may be present.

Pathway 4.1a
Community 4.1 to 4.2

Time and lack of disturbance. Occurrence of this pathway is unlikely.

Pathway 4.2a
Community 4.2 to 4.1

Fire allows for annual non-native species to dominate site.

State 5
Seeded State

This state has three community phases: a grass-dominated phase, and grass-shrub dominated phase, and a shrub dominated phase. This state is characterized by the dominance of seeded introduced perennial bunchgrasses in the understory. Mountain big sagebrush, and native and non-native forbs may also be present.

Community 5.1
Seeded perennial bunchgrasses

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

Community 5.2
Perennial bunchgrasses-mountain big sagebrush

Mountain big sagebrush eventually increases in the overstory. Seeded wheatgrass species dominate understory. Annual non-native species may be present in trace amounts.

Community 5.3
Mountain big sagebrush/annual non-native species (at risk)

Mountain big sagebrush dominates the overstory. Perennial bunchgrasses in the understory are reduced due to increased competition. Annual non-native species may be increasing. Utah juniper may be present.

Pathway 5.1a
Community 5.1 to 5.2

Time and lack of disturbance may be coupled with inappropriate grazing management.

Pathway 5.2a
Community 5.2 to 5.1

Fire, brush management and/or Aroga moth infestation reduces sagebrush overstory and allows for seeded wheatgrasses or other seeded grasses to increase.

Conservation practices

Brush Management

Pathway 5.2b
Community 5.2 to 5.3

Continued inappropriate grazing management reduces bunchgrasses and increases density of sagebrush; usually a slow transition.

Pathway 5.3a
Community 5.3 to 5.1

Fire or brush management with minimal soil disturbance would reduce sagebrush to trace amounts and allow for the perennial understory to increase.

Conservation practices

Brush Management

State 6
Tree State

This state has two community phases that are characterized by the dominance of Utah juniper in the overstory. Mountain big sagebrush, antelope bitterbrush 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. Sheet and rill erosion have increased with the loss of the understory.

Community 6.1
Juniper/annual non-native species/sagebrush

Utah juniper trees dominate the overstory, sagebrush is decadent and dying, deep rooted perennial bunchgrasses are decreasing. Recruitment of sagebrush cohorts is minimal. Annual non-natives may be present or increasing. Sheet erosion with soil redistribution is evident. Rills and water flow paths increase with increasing loss of the understory.

Community 6.2
Juniper/annual non-native species

Utah juniper dominates the site and tree leader growth is minimal; annual non-native species may be the dominant understory species and will typically be found under the tree canopies. Trace amounts of sagebrush may be present however dead skeletons will be more numerous than living sagebrush. Bunchgrasses may or may not be present. Bluegrasses or mat forming forbs may be present in trace amounts. Bare ground interspaces are large and connected. Soil redistribution is pronounced.

Pathway 6.1a
Community 6.1 to 6.2

Absence of disturbance over time allows for tree cover and density to further increase and out-compete the herbaceous understory species for sunlight and water.

Transition T1A
State 1 to 2

Trigger: This transition is caused by the introduction of non-native annual weeds, such as cheatgrass and annual mustards. 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 nutrient 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.

Restoration pathway R3A
State 3 to 2

Brush management, herbicide or sub-soiling of Sandberg bluegrass and seeding of desired perennial bunchgrasses and forbs.

Conservation practices

Brush Management
Range Planting
Herbaceous Weed Control

Transition T3A
State 3 to 4

Trigger: Fire or inappropriate grazing management can eliminate the Sandberg bluegrass understory and transition to community phase 4.1 or 4.2. Slow variable: Increased seed production and cover of annual non-native species. Threshold: Increased, continuous fine fuels modify the fire regime by changing intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture and impact the nutrient cycling and distribution.

Restoration pathway T3B
State 3 to 5

Brush management, herbicide of Sandberg bluegrass and seeding of crested wheatgrass and/or other desired species.

Conservation practices

Brush Management
Range Planting
Herbaceous Weed Control

Transition T3B
State 3 to 6

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 trees, reduction in organic matter inputs. Threshold: Trees overtop sagebrush and bitterbrush and out-compete shrubs for water and sunlight. Shrub skeletons exceed live shrubs with minimal recruitment of new cohorts.

Restoration pathway R4A
State 4 to 5

Application of herbicide and seeding of desired species. Success for this restoration pathway is unlikely; probability of success is best immediately following fire.

Conservation practices

Range Planting
Herbaceous Weed Control

Transition T5B
State 5 to 4

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 trees, reduced infiltration and increased runoff. Threshold: Trees overtop mountain big sagebrush antelope bitterbrush and out-compete shrubs for water and sunlight. Shrub skeletons exceed live shrubs with minimal recruitment of new cohorts

Transition B
State 5 to 4

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 trees, reduced infiltration and increased runoff. Threshold: Trees overtop mountain big sagebrush antelope bitterbrush and out-compete shrubs for water and sunlight. Shrub skeletons exceed live shrubs with minimal recruitment of new cohorts

Transition T6A
State 6 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.

Additional community tables

Table 7. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Primary Perennial Grasses**			549–882	
	bluebunch wheatgrass	PSSPS	*Pseudoroegneria spicata ssp. spicata*	450–540	–
	Thurber's needlegrass	ACTH7	*Achnatherum thurberianum*	18–162	–
	basin wildrye	LECI4	*Leymus cinereus*	45–90	–
	Sandberg bluegrass	POSE	*Poa secunda*	23–72	–
	Idaho fescue	FEID	*Festuca idahoensis*	18–45	–
2	**Secondary Perennial Grasses**			45–90	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	5–27	–
	tufted wheatgrass	ELMA7	*Elymus macrourus*	5–27	–
	melicgrass	MELIC	*Melica*	5–27	–
Forb					
3	**Perennial**			45–135	
	tufted wheatgrass	ELMA7	*Elymus macrourus*	5–27	–
	melicgrass	MELIC	*Melica*	5–27	–
	arrowleaf balsamroot	BASA3	*Balsamorhiza sagittata*	5–27	–
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	5–27	–
	buckwheat	ERIOG	*Eriogonum*	5–27	–
	lupine	LUPIN	*Lupinus*	5–27	–
	phlox	PHLOX	*Phlox*	5–27	–
	desertparsley	LOMAT	*Lomatium*	2–5	–
	onion	ALLIU	*Allium*	2–5	–
	milkvetch	ASTRA	*Astragalus*	2–5	–
Shrub/Vine					
4	**Primary Perennial Shrubs**			63–225	
	mountain big sagebrush	ARTRV	*Artemisia tridentata ssp. vaseyana*	45–135	–
	antelope bitterbrush	PUTR2	*Purshia tridentata*	18–90	–
	arrowleaf balsamroot	BASA3	*Balsamorhiza sagittata*	5–27	–
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	5–27	–
	buckwheat	ERIOG	*Eriogonum*	5–27	–
	lupine	LUPIN	*Lupinus*	5–27	–
	phlox	PHLOX	*Phlox*	5–27	–
5	**Secondary Perennial Shrubs**			18–45	
	Utah serviceberry	AMUT	*Amelanchier utahensis*	5–18	–
	rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	5–18	–
	mountain snowberry	SYOR2	*Symphoricarpos oreophilus*	5–18	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	2–10	–
	slender buckwheat	ERMI4	*Eriogonum microthecum*	2–10	–

Animal community

Livestock/Wildlife Grazing Interpretations:
This site is suited to cattle and sheep grazing during late spring, summer and fall. Considerations for grazing management include timing, intensity and duration of grazing. Livestock water is usually adequate as this site normally occurs at higher elevations where flowing streams and springs are common. Attentive grazing management is required due to steep slopes and erosive surface conditions. Grazing management should be keyed to bluebunch wheatgrass and all other perennial grass production. 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.

Overgrazing leads to an increase in sagebrush and a decline in understory plants like bluebunch wheatgrass and Thurber's needlegrass. Squirreltail or Sandberg bluegrass will increase temporarily with further degradation. Invasion of annual weedy forbs and cheatgrass could occur with further grazing degradation, leading to a decline in squirreltail and bluegrass and an increase in bare ground. A combination of overgrazing and prolonged drought leads to soil erosion, increased bare ground and a loss in plant production.

In general, bunchgrasses best tolerate light grazing after seed formation. Britton et al. (1990) observed the effects of clipping date on basal area of 5 bunchgrasses in eastern Oregon, and found that grazing from August to October (after seed set) has the least impact. Heavy grazing during the growing season will reduce perennial bunchgrasses and increase sagebrush (Laycock 1967). Reduced bunchgrass vigor or density provides an opportunity for Sandberg bluegrass expansion and/or cheatgrass and other invasive species to occupy interspaces. Bluegrass is a widespread, palatable forage grass that is one of the earliest grasses in the spring and is sought by domestic livestock and several wildlife species. Its production is closely tied to weather conditions; little forage is produced in drought years, making it a less dependable food source than other perennial bunchgrasses. Sandberg bluegrass increases under grazing pressure (Tisdale and Hironaka 1981) and is capable of co-existing with cheatgrass or other weedy species. Excessive sheep grazing favors Sandberg bluegrass; however, where cattle are the dominant grazers, cheatgrass often dominates (Daubenmire 1970). Thus, depending on the season of use, the grazer and site conditions, either Sandberg bluegrass or cheatgrass may become the dominant understory with inappropriate grazing management.

Thurber's needlegrass is an important forage source for livestock and wildlife in the arid regions of the west (Ganskopp 1988). Thurber's needlegrass begins growth early in the year and remain green throughout a relatively long growing season. This pattern of development enables animals to use Thurber's needlegrass when many other grasses are unavailable. Cattle prefer Thurber's needlegrass in early spring before fruits have developed as it becomes less palatable when mature. Thurber's needlegrasses are grazed in the fall only if the fruits are softened by rain. Although the seeds are not injurious, grazing animals avoid them when they begin to mature. Sheep, however, have been observed to graze the leaves closely, leaving stems untouched (Eckert and Spencer 1987). Heavy grazing during the growing season has been shown to reduce the basal area of Thurber's needlegrass (Eckert and Spencer 1987), suggesting that both seasonality and utilization are important factors in management of this plant. A single defoliation, particularly during the boot stage, was found to reduce herbage production and root mass thus potentially lowering the competitive ability of this needlegrass (Ganskopp 1988).

Bluebunch wheatgrass is moderately grazing-tolerant and is very sensitive to defoliation during the active growth period (Blaisdell and Pechanec 1949, Laycock 1967, Anderson and Scherzinger 1975, Britton et al. 1990). Herbage and flower stalk production was reduced with clipping at all times during the growing season; however, clipping was most harmful during the boot stage (Blaisdell and Pechanec 1949). Tiller production and growth of bluebunch was also greatly reduced when clipping was coupled with drought (Busso and Richards 1995). Mueggler (1975) estimated that low-vigor bluebunch wheatgrass may need up to 8 years rest to recover. Although an important forage species, it is not always the preferred species by livestock and wildlife.

Antelope bitterbrush is utilized heavily by domestic livestock (Wood 1995). Grazing tolerance is dependent on site conditions (Garrison 1953) and the shrub can be severely hedged during the dormant season for grasses and forbs.

Mountain big sagebrush is eaten by domestic livestock but has long been considered to be of low palatability, and a competitor to more desirable species.

Wildlife Interpretations:

This site is used year long by deer and provides key winter range. Early green-up of herbaceous plants on the site furnishes important spring range for deer. Small upland game such as rabbits, sage grouse, chukar and Hungarian partridge use this site. Chukar and Hungarian partridge use the site for wintering areas. It is also used by various songbirds, rodents, reptiles and associated predators natural to the area. Feral horses will also make use of this site.

Mountain big sagebrush is highly preferred and nutritious winter forage for mule deer and elk. Sagebrush-grassland communities provide critical sage-grouse breeding and nesting habitats. 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. Sage-grouse prefer mountain big sagebrush and Wyoming big sagebrush communities to basin big sagebrush communities.

Antelope bitterbrush is a critical browse species for mule deer, antelope and elk (Wood 1995). 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.

Hydrological functions

Rills and water flow patterns are rare but can be expected on steeper slopes in areas recently subjected to summer convection storms or rapid snowmelt. Pedestals are rare. Occurrence is usually limited to areas of water flow patterns. Frost heaving of shallow rooted plants should not be considered a "normal" condition. Fine litter (foliage from grasses and annual and perennial forbs) is expected to move the distance of slope length during intense summer convection storms or rapid snowmelt events. Persistent litter (large woody material) will remain in place except during catastrophic events. Perennial herbaceous plants (especially deep-rooted bunchgrasses) slow runoff and increase infiltration. Shrub canopy and associated litter break raindrop impact and provide opportunity for snow catch and accumulation on site.

Recreational uses

Aesthetic value is derived from the colorful flowering of numerous forbs and shrubs background by the verdure of native grasses in the spring and early summer. Steep slopes inhibit many forms of recreation. Off-road vehicle use can destroy the fragile soil/vegetation complex and resulting in severe erosion problems. The diverse floral and faunal populations inhabiting this site offer rewarding opportunities for photographers and nature study. This site has potential for deer and upland game hunting.

Wood products

None.

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. Basin wildrye was used as bedding for various Native American ceremonies, providing a cool place for dancers to stand.

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. 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.

Inventory data references

NASIS soil component data

Type locality

Location 1: Elko County, NV	
Township/Range/Section	T39N R50E S33
General legal description	About 5 miles west of Tuscarora, Elko County, Nevada. This site also occurs in Humboldt County, Nevada.

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Approval

Kendra Moseley, 4/24/2024

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/P.Novak-Echenique
Contact for lead author	State Rangeland Management Specialist
Date	06/22/2006
Approved by	Kendra Moseley
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rills are none to rare. A few can be expected on steeper slopes after summer convection storms or rapid snowmelt. These are typically short (<1m in length) and will become vegetated during the next growing season.

2. **Presence of water flow patterns:** Water flow patterns are rare but can be expected on steeper slopes in areas recently subjected to summer convection storms or rapid snowmelt. These are typically short (<1 m in length), meandering between grasses and shrubs and are not connected.

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 ± 25%; surface rock fragments ±35%; shrub canopy 20 to 30%; foliar cover of perennial herbaceous plants ± 45%.

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

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

7. **Amount of litter movement (describe size and distance expected to travel):** Fine litter (foliage from grasses and annual & perennial forbs) is expected to move the distance of slope length during intense summer convection storms or rapid snowmelt events. Persistent litter (large woody material) will remain in place except during large rainfall events.

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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 granular. Soil surface colors are browns and the soils are typified by an mollic epipedon. Organic matter of the surface 2 to 4 inches is typically 1.25 to 3 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., bluebunch wheatgrass] 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 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: Associated shrubs > shallow-rooted, cool season, perennial grasses > deep-rooted, cool season, perennial forbs > fibrous, shallow-rooted, cool season, perennial and annual forbs. (By above ground production)

    Other:

    Additional: With an extended fire return interval, the shrub component will increase at the expense of the herbaceous component. Where this site occurs adjacent to woodlands, Utah juniper may invade and eventually dominate this site.

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

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14. **Average percent litter cover (%) and depth (in):** Between plant interspaces (30-40%) and litter depth is < ½ 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 (through June) ± 900 lbs/ac; Spring moisture significantly affects total production. Favorable years ±1300 lbs/ac and unfavorable years ±700 lbs/ac.

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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, snakeweed, Russian thistle, annual mustards, and Utah juniper. Utah juniper may eventually increase and dominate this site.

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