Ecological site R025XY057NV
SHALLOW CLAY LOAM 10-14 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

This site occurs on summits and upper backslopes of hills and lower mountains on all aspects. Slopes range from 4 to 75 percent, but slope gradients of 15 to 50 percent are most typical. Elevations are 5500 to 8500 feet. The average growing season is about 80 to 100 days.

The soils associated with this site are shallow to very shallow and well drained. Textures are sandy clay loams and coarse sandy loams, modified by 15 to 30 percent rock fragments. The soils typically have a mollic epipedon and an argillic horizon. The soil moisture regime is xeric bordering on aridic. The soil temperature regime is frigid.

The reference plant community is dominated by Thurber''s needlegrass, bluebunch wheatgrass and black sagebrush. Potential vegetative composition is about 55% grasses, 10% forbs and 35% shrubs. Approximate ground cover (basal and crown) is 15 to 30 percent.

Associated sites

R025XY009NV	**SOUTH SLOPE 12-14 P.Z.**
R025XY014NV	**LOAMY 10-12 P.Z.**
R025XY058NV	**BOULDERY LOAM**

Similar sites

R025XY026NV	**CHANNERY HILL** ACHY dominant grass; less productive site
R025XY025NV	**CHALKY KNOLL** ARTRW8 codominant shrub; ACHY-ELEL5 codominant grasses; less productive site
R025XY055NV	**SHALLOW CLAY SLOPE 10-14 P.Z.** PSSPS dominant grass; less productive site; steeper slopes
R025XY024NV	**MOUNTAIN RIDGE** Higher elevations; FEID dominant grass

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Artemisia nova*
Herbaceous	(1) *Pseudoroegneria spicata subsp. spicata*

Physiographic features

This site occurs on summits and upper backslopes of hills and lower mountains on all aspects. Slopes range from 4 to 75 percent, but slope gradients of 15 to 50 percent are most typical. Elevations are 5500 to 8500 feet.

Table 2. Representative physiographic features

Landforms	(1) Mountain (2) Hill
Runoff class	Medium to very high
Flooding frequency	None
Ponding frequency	None
Elevation	5,500–8,500 ft
Slope	4–75%
Water table depth	50 in
Aspect	Aspect is not a significant factor

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 12 inches. Mean annual air temperature is about 45 to 50 degrees F.

Mean annual precipitation across the range in which this ES occurs is 12.20".

Monthly mean precipitation: January 1.22”; February 0.92”; March 1.17”; April 1.20”; May 1.54”; June 1.11”; July 0.44”; August 0.45”; September 0.73”; October 0.86”; November 1.26”; December 1.29”.

*The above data is averaged from the Deeth and Tuscarora WRCC climate stations.

Table 3. Representative climatic features

Frost-free period (average)	79 days
Freeze-free period (average)	102 days
Precipitation total (average)	13 in

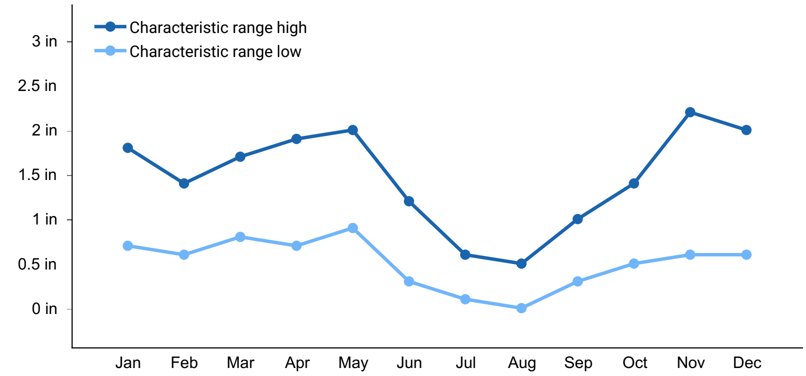

Figure 1. Monthly precipitation range

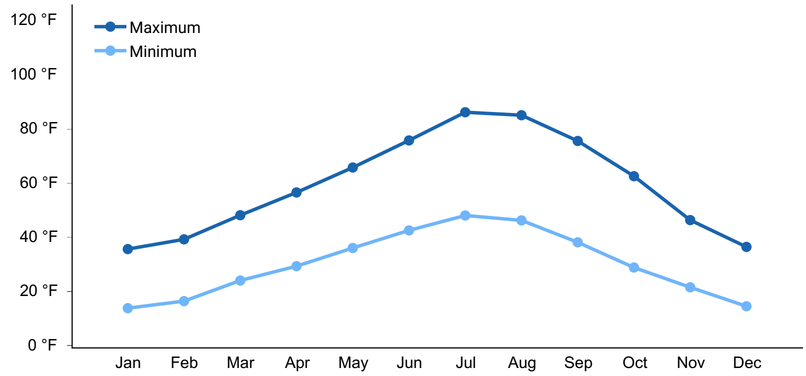

Figure 2. Monthly average minimum and maximum temperature

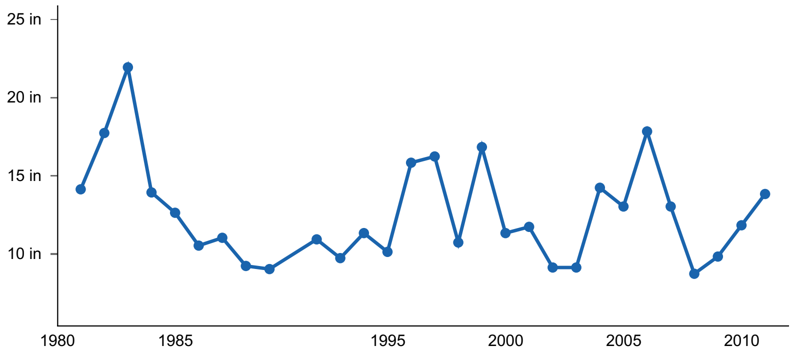

Figure 3. Annual precipitation pattern

Climate stations used

- (1) DEETH [USC00262189], Deeth, NV
- (2) TUSCARORA [USC00268346], Tuscarora, NV

Influencing water features

There are no influencing water features associated with this site.

Soil features

The soils associated with this site are shallow to very shallow and well drained. Textures are sandy clay loams and coarse sandy loams, modified by 15 to 30 percent rock fragments. The soils typically have a mollic epipedon and an argillic horizon. The soil moisture regime is xeric bordering on aridic. The soil temperature regime is frigid.

The soil series correlated with this site include Amtoft, Cleaver, Gollaher, Hooplite, Scalfar, Shalcleav, and Xica.

A representative soil series is Shalcleav, classified as a loamy-skeletal, mixed, superactive, frigid Lithic Argixeroll.

This soil is very shallow and shallow, well drained and is formed in residuum and colluvium derived from welded tuff, rhyolite, chert, shale, and argillite. Reaction is neutral. Diagnostic horizons include a mollic epipedon that occurs from the soil surface to 10 inches and an argillic horizon that occurs from 3 inches to 10 inches. Clay content in the particle-size control section averages 28 to 35 percent. Rock fragments average 60 to 75 percent, mainly channers and flagstones. Lithology of fragments is tuff, rhyolite, chert, or argillite.

Table 4. Representative soil features

Parent material	(1) Colluvium–welded tuff (2) Residuum–welded tuff
Surface texture	(1) Very gravelly loam (2) Sandy loam
Family particle size	(1) Loamy-skeletal (2) Loamy
Drainage class	Well drained to somewhat excessively drained
Permeability class	Moderate
Depth to restrictive layer	4–20 in
Soil depth	4–20 in
Surface fragment cover <=3"	30–65%
Surface fragment cover >3"	0–5%
Available water capacity (0-40in)	0.4–0.7 in
Calcium carbonate equivalent (0-40in)	0%
Electrical conductivity (0-40in)	0 mmhos/cm
Sodium adsorption ratio (0-40in)	0–5
Soil reaction (1:1 water) (0-40in)	6.6–7.2
Subsurface fragment volume <=3" (Depth not specified)	15–60%
Subsurface fragment volume >3" (Depth not specified)	1–60%

Ecological dynamics

An ecological site is the product of all the environmental factors responsible for its development and has a set of key characteristics that influence a site’s resilience to disturbance and resistance to invasives. Key characteristics include 1) climate (precipitation and temperature), 2) topography (aspect, slope, elevation, and landform), 3) hydrology (infiltration and runoff), 4) soils (depth, texture, structure, and organic matter), 5) plant communities (functional groups and 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 meters (Dobrowolski et al. 1990). Community types containing black sagebrush as the dominant shrub were found to have soil depths (and thus available rooting depths) of 77 to 81 centimeters in a study in northeast Nevada (Jensen 1990). These shrubs have a flexible generalized root system with development of both deep taproots and laterals near the surface (Comstock and Ehleringer 1992).

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).

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 with regard to sagebrush defoliator Aroga moth (Aroga websteri). Aroga moth infestations have occurred throughout the Great Basin in the 1960s, early 1970s, and has 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 (Gates 1964, Hall 1965); the research is inconclusive regarding the damage sustained by black sagebrush populations.

Black sagebrush is generally long-lived therefore deeming it unnecessary for new individuals to recruit every year for perpetuation of the stand. Simultaneous low, continuous recruitment and infrequent large recruitment events are the foundation of population maintenance (Noy-Meir 1973). Survival of the seedlings is dependent on adequate moisture conditions.

The perennial bunchgrasses that dominate this site include bluebunch wheatgrass and Thurber's needlegrass. These species generally have 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 of the soil profile. General differences in root depth distributions between grasses and shrubs results in resource partitioning in these shrub/grass systems.
The Great Basin sagebrush communities have high spatial and temporal variability in precipitation both among years and within growing seasons. Nutrient availability is typically low but increases with elevation and closely follows moisture availability. The 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. It can also increase resource pools via 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).

As ecological condition declines, black sagebrush and downy rabbitbrush dominate with increases of bluegrass and bottlebrush squirreltail. Cheatgrass and annual forbs are species likely to invade this site.

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. Three possible stable states have been identified for the Shallow Clay Loam 10-14" P.Z ecological site.

Fire Ecology:
Fire return intervals have recently been estimated at 100 to 200 years (Kitchen and McArthur 2007); however, fires were probably patchy and very infrequent due to the low productivity of these sites. Black sagebrush communities generally lack enough fine fuels to carry a fire. In addition to low fine fuel loading, wide shrub spacing makes fire infrequent or difficult to prescribe in black sagebrush types. Black sagebrush plants have no morphological adaptations for surviving fire and must reestablish from seed (Wright et al. 1979). The ability of black sagebrush to establish after fire is mostly dependent upon the amount of seed deposited in the seed bank the preceeding year. Seeds typically do not persist in the soil for more than one growing season (Beetle 1960). A few seeds may remain viable in soil for 2 years (Meyer 2008); however, even in dry storage, black sagebrush seed viability has been found to drop rapidly over time, from 81% to 1% viability after 2 and 10 years of storage respectively (Stevens et al. 1981). Thus, repeated frequent fires can eliminate black sagebrush from a site, though black sagebrush in zones receiving 12 to 16 inches of annual precipitation have been found to have greater fire survival (Boltz 1994). Repeated frequent fire in this community will also eliminate Thurber's needlegrass and other perennial bunchgrasses from these sites and facilitate the establishment of an annual weed community with varying amounts of Sandberg bluegrass, spiny hopsage and rabbitbrush. In lower precipitation zones, rabbitbrush has the potential to become the dominant shrub species following fire, often with an understory of Sandberg bluegrass and/or cheatgrass and other weedy species.

Thurber's needlegrass is very susceptible to fire. Burning has been found to decrease the vegetative and reproductive vigor of Thurber's needlegrass (Uresk et al. 1976). Fire can cause high mortality as well as reduction in basal area and yield of Thurber's needlegrass (Britton et al. 1990). The fine leaves and densely tufted growth form make this grass susceptible to subsurface charring of the crowns (Wright and Klemmedson 1965). Although timing of fire highly influences the response and mortality of Thurber's needlegrass, smaller bunch sizes are less likely to be damaged by fire (Wright and Klemmedson 1965). Reestablishment on burned sites has been found to be relatively slow due to low germination and seedling vigor. In a controlled environment study, Thurber's needlegrass was found to have a maximum germination rate of 25% under ideal conditions (Martens et al. 1994). However, Thurber's needlegrass often survives fire and will continue growth when conditions are favorable (Koniak 1985). Regeneration of Thurber's needlegrass is often dependent on competition from other species. Cheatgrass has been found to be a highly successful competitor with seedlings of this needlegrass and may preclude reestablishment (Evans and Young 1978). Thus, the initial condition of the bunchgrasses within the site along with seasonality and intensity of the fire contribute to individual species' responses.

Fire will remove aboveground biomass from bluebunch wheatgrass but plant mortality is generally low (Robberecht and Defossé 1995) because the buds are underground (Conrad and Poulton 1966) or protected by foliage. 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). Plant response will vary depending on season, fire severity, fire intensity and post-fire soil moisture availability.

Indian ricegrass is fairly fire tolerant (Wright 1985), which is likely due to its low culm density and below-ground plant crowns. Indian ricegrass has been found to reestablish on burned sites through seed dispersed from adjacent unburned areas (Young 1983, West 1994); thus, the presence of surviving, seed-producing plants is necessary for reestablishment of Indian ricegrass. Grazing management following fire to promote seed production and establishment of seedlings is important.

Sandberg bluegrass, a minor component of this ecological site, has been found to increase following fire likely due to its low stature and productivity (Daubenmire 1975). Sandberg bluegrass may retard reestablishment of deeper rooted bunchgrass.

State and transition model

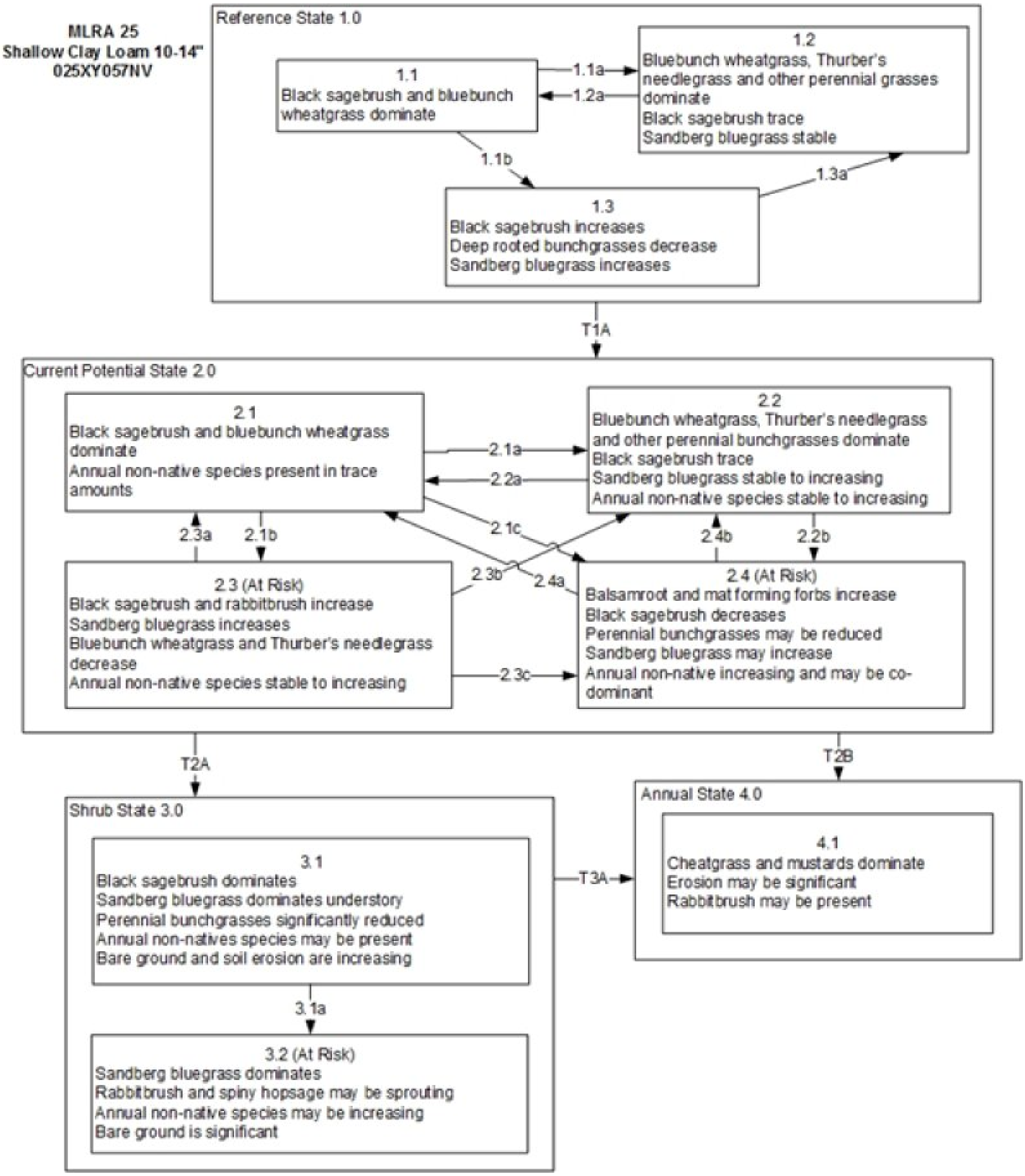

Figure 5. T. Stringham July 2015

MLRA 25
Shallow Clay Loam 10-14
025XY057NV

Reference State 1.0 Community 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: High severity fire significantly reduces sagebrush cover leading to early/mid-seral community.

Transition T1A: Introduction of annual non-native species.
Transition T1B: Inappropriate grazing management

Current Potential State 2.0 Community 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.
2.1c: Grazing management targeted at shrubs (i.e. sheep) reduces black sagebrush canopy. Inappropriate sheep grazing management allows unpalatable forbs to increase. Rainfall pattern favoring annual species production (higher than normal spring precipitation)
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: Grazing management targeted at shrubs (i.e. sheep) reduces black sagebrush canopy and favors deep-rooted perennial bunchgrasses.
2.3b: 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.
2.3c: Change in grazing management to allow for an increase in mat forming forbs and annual non-native species.
2.4a: Rainfall pattern favoring perennial bunchgrass production and reduced cheatgrass production (less than normal spring with higher than normal summer)
2.4b: Rainfall pattern favoring perennial bunchgrass production and reduced cheatgrass production (less than normal spring with higher than normal summer).

Transition T2A: Time and lack of disturbance and/or inappropriate grazing management (to 3.1) or fire (to 3.2).
Transition T2B: Fire in at-risk community phase (from 2.3 or 2.4) may transition to annual state (to 4.0).

Shrub State 3.0 Community Pathways
3.1a: Fire.

Transition T3A: High-severity fire or soil-disturbing treatments (to 4.0).

Figure 6. T. Stringham July 2015

State 1
Reference State

The Reference State 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, and a shrub dominant phase and a grass 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. Utah juniper may be present on the site, but will only occur as scattered trees and will not dominate the site.

Community 1.1
Community Phase

The reference plant community is dominated by Thurber's needlegrass, bluebunch wheatgrass and black sagebrush. Potential vegetative composition is about 55% grasses, 10% forbs and 35% shrubs. Approximate ground cover (basal and crown) is 15 to 30 percent.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	165	275	385
Shrub/Vine	102	168	235
Forb	30	50	70
Tree	3	7	10
Total	**300**	**500**	**700**

Community 1.2
Community Phase

This community phase is characteristic of a post-disturbance, early or mid-seral community. Bluebunch wheatgrass and other perennial grasses dominate. Thurber’s needlegrass can experience high mortality from fire and may be reduced in the community for several years. Depending on fire severity, patches of intact sagebrush may remain. Forbs may increase post-fire but will likely return to pre-burn levels within a few years. Sandberg bluegrass is stable within the community.

Community 1.3
Community Phase

Black sagebrush increases in the absence of disturbance. Decadent sagebrush dominates the overstory and the deep-rooted perennial bunchgrasses in the understory are reduced either from competition with shrubs and/or from herbivory. Sandberg bluegrass will likely increase in the understory and may be the dominant grass on the site. Scattered Utah juniper may be present on the site.

Pathway 1.1a
Community 1.1 to 1.2

A low severity fire would decrease the overstory of sagebrush and allow for the understory perennial grasses and forbs to increase. Fires are typically low severity resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring facilitating an increase in fine fuels may be more severe and reduce sagebrush cover to trace amounts.

Pathway 1.1b
Community 1.1 to 1.3

Time and lack of disturbance such as fire allows for sagebrush to increase and become decadent. Long-term drought, herbivory, or combinations of these will cause a decline in perennial bunchgrasses and fine fuels leading to a reduced fire frequency and allowing black sagebrush to dominate the site. Sandberg bluegrass may increase in the understory depending on the grazing management.

Pathway 1.2a
Community 1.2 to 1.1

Time and lack of disturbance will allow black sagebrush to increase.

Pathway 1.3a
Community 1.3 to 1.2

Fire will decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses to dominate the site. Fires will typically be high intensity due to the dominance of sagebrush in this community phase, resulting in removal of the overstory shrub community.

State 2

Current Potential State

This state is similar to the Reference State 1.0, though a fourth community phase exists. Ecological function of community phases 2.1, 2.2 and 2.3 has not changed, however the resiliency of the state has been reduced by the presence of invasive weeds. Non-natives may increase in abundance but will not become dominant in this state. These non-native species can be highly flammable, and promote fire where historically fire had been infrequent. Negative feedbacks enhance ecosystem resilience and contribute to the stability of the state. These include the presence of all structural and functional groups, low fine fuel loads, and retention of organic matter and nutrients. Positive feedbacks reduce ecosystem resilience and stability of the state. These include the non-natives high seed output, persistent seed bank, rapid growth rate, ability to cross pollinate, and adaptations for seed dispersal.

Community 2.1
Community Phase

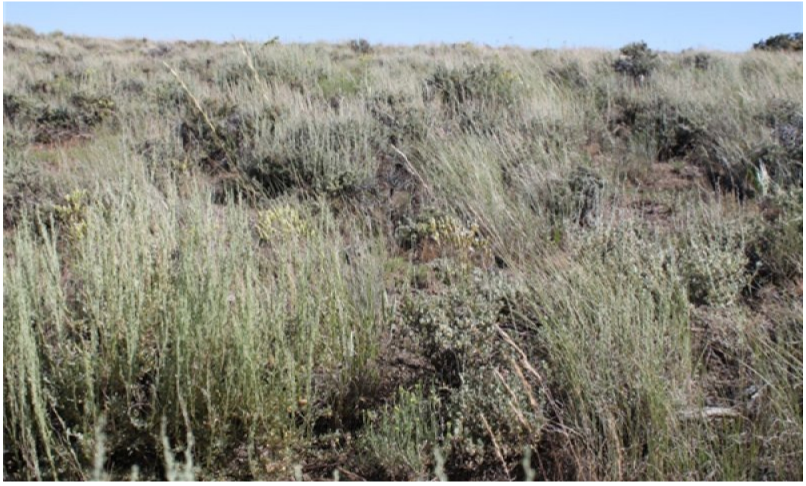

Figure 8. Shallow Clay Loam 10-14" (R025XY057NV) Phase 2.1 T. K. Stringham, July 2011

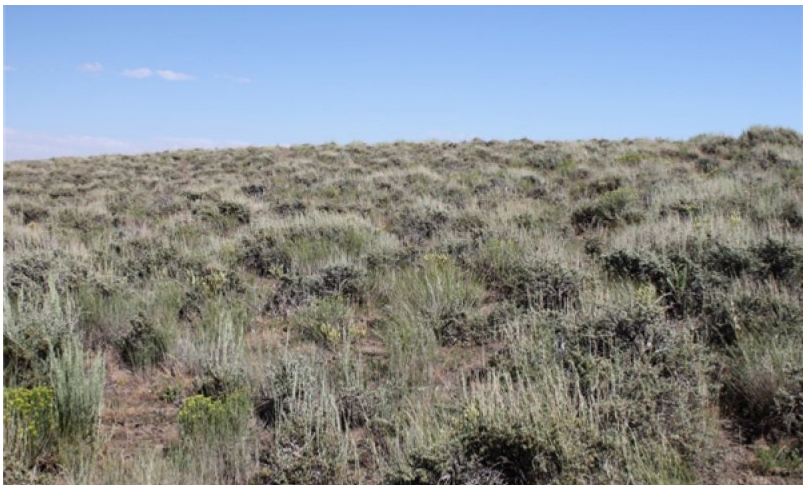

Figure 9. Shallow Clay Loam 10-14" (R025XY057NV) Phase 2.1 T. K. Stringham, July 2011

This community phase is compositionally similar to the Reference State Community Phase 1.1, with the addition of non-native species in trace amounts. Black sagebrush and bluebunch wheatgrass are dominant. Thurber's needlegrass is a sub-dominant species in the community. Forbs such as balsamroot are also common.

Community 2.2
Community Phase

This community phase is characteristic of a post-disturbance, early seral community where annual non-native species are present. Bluebunch wheatgrass, squirreltail, and other perennial grasses dominate. Thurber's needlegrass can experience high mortality from fire and may be reduced in the community for several years. Depending on fire severity patches of intact sagebrush may remain. Rabbitbrush may be sprouting. Forbs may increase post-fire and be a significant component for a number of years. Annual non-native species generally respond well after fire and may be stable or increasing within the community.

Community 2.3
Community Phase (at risk)

Black sagebrush dominates the overstory and perennial bunchgrasses in the understory are reduced, either from competition with shrubs or from inappropriate grazing, or from both. Rabbitbrush may be a significant component. Sandberg bluegrass may increase and become co-dominant with deep rooted bunchgrasses. Utah juniper and/or singleleaf pinyon may be present and without management will likely increase. Annual non-natives species may be stable or increasing due to lack of competition with perennial bunchgrasses. This site is susceptible to further degradation from inappropriate grazing management, drought, and fire. This community is at risk of crossing a threshold to either State 3.0 (grazing or fire) or State 4.0 (fire).

Community 2.4
Community Phase (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-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. Grazing management targeted at shrubs can decrease black sagebrush and increase perennial forbs. This site is susceptible to further degradation from grazing, drought, and fire.

Pathway 2.1a
Community 2.1 to 2.2

Fire reduces the shrub overstory and allows for perennial bunchgrasses and forbs to dominate the site. Fires are typically low severity resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring or a change in management favoring an increase in fine fuels may be more severe and reduce sagebrush cover to trace amounts. Annual non-native species are likely to increase after fire.

Pathway 2.1b
Community 2.1 to 2.3

Time and lack of disturbance allows for sagebrush to increase and become decadent. Long-term drought reduces fine fuels and leads to a reduced fire frequency, allowing black sagebrush to dominate the site. Inappropriate grazing management reduces the perennial bunchgrass understory; conversely Sandberg bluegrass and/or galleta grass may increase in the understory.

Pathway 2.1c
Community 2.1 to 2.4

Grazing management targeted at shrubs (i.e. sheep) reduces black sagebrush canopy. Inappropriate sheep grazing management allows unpalatable forbs to increase. Higher than normal spring precipitation favors annual non-native species such as cheatgrass and can increase overall production on the site.

Pathway 2.2a
Community 2.2 to 2.1

Time and lack of disturbance and/or grazing management that favors the establishment and growth of sagebrush allows the shrub component to recover. The establishment of black sagebrush may take many years.

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 2.3a
Community 2.3 to 2.1

Grazing management that reduces shrubs will allow for the perennial bunchgrasses in the understory to increase. Heavy late-fall/winter grazing may cause mechanical damage to sagebrush thus promoting the perennial bunchgrass understory. Brush treatments with minimal soil disturbance will also decrease sagebrush and release the perennial understory. Annual non-native species are present and may increase in the community. A low severity fire would decrease the overstory of sagebrush and allow for the understory perennial grasses to increase. Due to low fuel loads in this State, fires will likely be small creating a mosaic pattern.

Pathway 2.3b
Community 2.3 to 2.2

Fire will decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses to dominate the site. Fires will typically be high intensity due to the dominance of sagebrush resulting in removal of the overstory shrub community. Annual non-native species respond well to fire and may increase post-burn. Brush treatment would reduce black sagebrush overstory and allow for perennial bunchgrasses to increase.

Pathway 2.3c
Community 2.3 to 2.4

Grazing management targeted at shrubs (i.e. sheep) reduces black sagebrush canopy. Inappropriate sheep grazing management allows unpalatable forbs to increase. Higher than normal spring precipitation favors annual non-native species such as cheatgrass and can increase overall production on the site.

Pathway 2.4a
Community 2.4 to 2.1

Rainfall patterns favoring perennial bunchgrasses. Less than normal spring precipitation followed by higher than normal summer precipitation will increase perennial bunchgrass production. Grazing management may allow for black sagebrush to increase.

Pathway 2.4b
Community 2.4 to 2.2

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; one with a decadent black sagebrush overstory, and one with a post-fire shadscale or rabbitbrush overstory, with a Sandberg bluegrass and/or galleta grass understory. Sagebrush cover exceeds site concept and may be decadent, reflecting stand maturity and lack of seedling establishment due to competition with mature plants. The shrub overstory and Sandberg bluegrass understory dominate site resources such that soil water, nutrient capture, nutrient cycling and soil organic matter are temporally and spatially redistributed. Bare ground and soil redistribution may be increasing.

Community 3.1
Community Phase

Figure 10. Shallow Clay Loam 10-14” (R025XY057NV) Phase 3.1 T. K. Stringham, July 2011

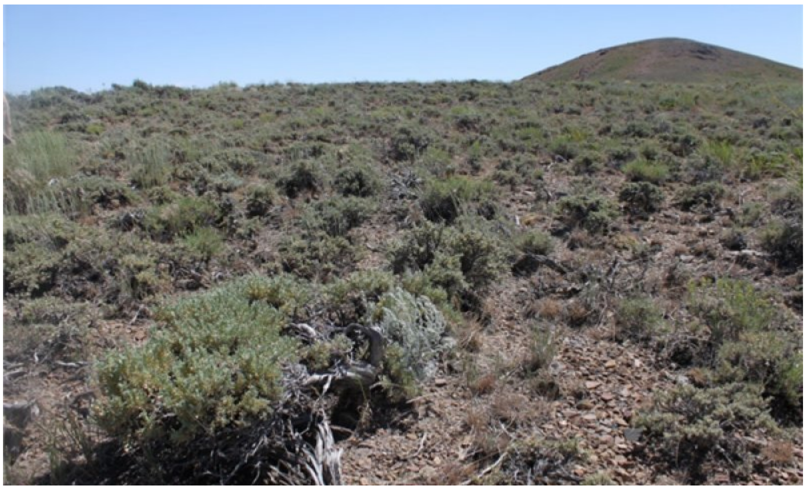

Figure 11. Shallow Clay Loam 10-14” (R025XY057NV) Phase 3.1 T. K. Stringham, July 2011

Figure 12. Shallow Clay Loam 10-14” (R025XY057NV) Phase 3.1 T. K. Stringham, August 2011

Decadent sagebrush dominates the overstory. Rabbitbrush and/or spiny hopsage may be significant components. Deep-rooted perennial bunchgrasses may be present in trace amounts or absent from the community. Sandberg bluegrass and annual non-native species increase. Bare ground and erosion are increasing.

Community 3.2
Community Phase (at risk)

Sandberg bluegrass dominates the site. Rabbitbrush and spiny hopsage may be sprouting. Annual non-native species may be increasing and bare ground is significant. This site is at risk for significant soil erosion and for an increase in invasive annual weeds.

Pathway 3.1a
Community 3.1 to 3.2

Fire reduces black sagebrush to trace amounts and allows for sprouting shrubs such as rabbitbrush to dominate. Shadscale may also establish post-fire and become dominant. Inappropriate or excessive sheep grazing could also reduce cover of sagebrush and allow for shadscale or sprouting shrubs to dominate the community. Brush treatments with minimal soil disturbance would facilitate sprouting shrubs and/or Sandberg's bluegrass.

State 4
Annual State

This state has one community phase and is characterized by the dominance of annual non-native species such as cheatgrass, mustards, and/or bur buttercup in the understory. The dominance of cheatgrass in the understory has shortened the fire return interval, which now drives site dynamics.

Community 4.1
Community Phase

Non-native species such as cheatgrass, mustards, bur buttercup and other annuals dominate the site. Sprouting shrubs may be present. Soil erosion may be significant.

Transition T1A
State 1 to 2

Trigger: This transition is caused by the introduction of non-native annual plants, such as cheatgrass and mustards. Slow variables: Over time the annual non-native species will increase within the community. 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: To Community Phase 3.1: Inappropriate cattle/horse grazing will decrease or eliminate deep rooted perennial bunchgrasses, increase Sandberg bluegrass and favor shrub growth and establishment. To Community Phase 3.2: Severe fire will remove sagebrush overstory, decrease perennial bunchgrasses and enhance Sandberg bluegrass. Soil disturbing brush treatments and/or inappropriate sheep grazing will reduce sagebrush and potentially increase sprouting shrubs and Sandberg bluegrass and/or galleta grass. Slow variables: Long term decrease in deep-rooted perennial grass density and/or black sagebrush. Threshold: Loss of deep-rooted perennial bunchgrasses changes nutrient cycling, nutrient redistribution, and reduces soil organic matter. Loss of long-lived, black sagebrush changes the temporal and depending on the replacement shrub, the spatial distribution of nutrient cycling.

Transition T2B
State 2 to 4

Trigger: Catastrophic fire or soil surface disturbance. Slow variables: Increased production and cover of non-native annual species. Threshold: Loss of deep-rooted perennial bunchgrasses and shrubs truncates, spatially and temporally, nutrient capture and cycling within the community. Increased, continuous fine fuels from annual non-native plants modify the fire regime by changing intensity, size and spatial variability of fires.

Transition T3A
State 3 to 4

Trigger: Severe fire. Slow variables: Increased production and cover of non-native annual 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 spatially and temporally thus impacting nutrient cycling and distribution.

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**			210–340	
	bluebunch wheatgrass	PSSPS	*Pseudoroegneria spicata ssp. spicata*	150–200	–
	Thurber's needlegrass	ACTH7	*Achnatherum thurberianum*	50–100	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	10–40	–
2	**Secondary Perennial Grasses**			10–100	
	Webber needlegrass	ACWE3	*Achnatherum webberi*	3–15	–
	squirreltail	ELEL5	*Elymus elymoides*	3–15	–
	needle and thread	HECO26	*Hesperostipa comata*	3–15	–
	bluegrass	POA	*Poa*	3–15	–
Forb					
3	**Perennial Forbs**			25–75	
	spiny hopsage	GRSP	*Grayia spinosa*	3–25	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	3–25	–
	aster	ASTER	*Aster*	3–15	–
	balsamroot	BALSA	*Balsamorhiza*	3–15	–
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	3–15	–
	buckwheat	ERIOG	*Eriogonum*	3–15	–
	phlox	PHLOX	*Phlox*	3–15	–
	goldenweed	PYRRO	*Pyrrocoma*	3–15	–
Shrub/Vine					
4	**Primary Shrubs**			100–150	
	black sagebrush	ARNO4	*Artemisia nova*	100–150	–
5	**Secondary Shrubs**			22–65	
	yellow rabbitbrush	CHVIP4	*Chrysothamnus viscidiflorus ssp. puberulus*	3–25	–
	spiny hopsage	GRSP	*Grayia spinosa*	3–25	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	3–25	–
	pricklypear	OPUNT	*Opuntia*	3–25	–
	antelope bitterbrush	PUTR2	*Purshia tridentata*	3–25	–
Tree					
6	**Evergreen**			3–10	
	yellow rabbitbrush	CHVIP4	*Chrysothamnus viscidiflorus ssp. puberulus*	3–25	–
	antelope bitterbrush	PUTR2	*Purshia tridentata*	3–25	–
	Utah juniper	JUOS	*Juniperus osteosperma*	3–10	–

Animal community

Livestock Interpretations:
This site is suited for livestock grazing. Considerations for grazing management include timing, intensity and duration of grazing. Targeted grazing could be used to decrease the density of non-natives.

Reduced bunchgrass vigor or density provides an opportunity for Sandberg bluegrass expansion and/or cheatgrass and other invasive species to occupy interspaces, leading to increased fire frequency and potentially an annual plant community. Sandberg bluegrass increases under grazing pressure (Tisdale and Hironaka 1981) and is capable of co-existing with cheatgrass. Excessive sheep grazing favors Sandberg bluegrass; however, where cattle are the dominant grazers, cheatgrass often dominates (Daubenmire 1970). 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.

Inappropriate grazing management during the growing season will cause a decline in understory plants such as bluebunch wheatgrass, Indian ricegrass and Thurber's needlegrass. Bluebunch wheatgrass is moderately grazing tolerant but is 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 is reduced with clipping at all times during the growing season; clipping is most harmful during the boot stage, however (Blaisdell and Pechanec 1949). Tiller production and growth of bluebunch is greatly reduced when clipping is 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.

Thurber's needlegrass is an important forage source for livestock and wildlife in the arid regions of the West (Ganskopp 1988). 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 but leave 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). Repeated growing season grazing, particularly by sheep, can reduce or eliminate both Thurber's needlegrass and black sagebrush, though growing season grazing by cattle may initially cause a decrease in the bunchgrass component and grant a competitive advantage to shrub species including black sagebrush (Eckert et al. 1972).

Indian ricegrass is a deep-rooted, cool season perennial bunchgrass that is adapted primarily to coarse textured soils. Indian ricegrass is a preferred forage species for livestock and wildlife (Cook 1962, Booth et al. 2006). This species is often heavily utilized in winter because it cures well (Booth et al. 2006). It is also readily utilized in early spring as it is a source of green feed before most other perennial grasses have produced new growth (Quinones 1981). Booth et al. (2006) note that the plant does well when utilized in winter and spring. Cook and Child (1971), however, found that repeated heavy grazing reduced crown cover, which may reduce seed production, density, and basal area of these plants. Additionally, heavy early spring grazing reduces plant vigor and stand density (Stubbendieck et al. 1985). In eastern Idaho, productivity of Indian ricegrass was at least 10 times greater in undisturbed plots than in heavily grazed ones (Pearson 1976). Cook and Child (1971) found significant reduction in plant cover after seven years of rest from heavy (90%) and moderate (60%) spring use. The seed crop may be reduced where grazing is heavy (Bich et al. 1995). Tolerance to grazing increases after May, thus spring deferment may be necessary for stand enhancement (Pearson 1964, Cook and Child 1971) but utilization of less than 60% is recommended. In summary, adaptive management is required to manage this bunchgrass well.

Black sagebrush is an important browse species to domestic livestock. The domestic sheep industry that emerged in the Great Basin in the early 1900s was largely based on wintering domestic sheep in black sagebrush communities (Mozingo 1987). Domestic sheep will browse black sagebrush during all seasons of the year depending on the availability of other forage species, with greater amounts being consumed in fall and winter. Black sagebrush is generally less palatable to cattle than to domestic sheep and wild ungulates (McArthur et al. 1979), though cattle use of black sagebrush has also been shown to be greatest in fall and winter (Schultz and McAdoo 2002), with only trace amounts being consumed in summer (Van Vuren 1984).

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:
Black sagebrush is a significant browse species within the Intermountain region. It is especially important on low elevation winter ranges in the southern Great Basin, where extended snow free periods allow animals' access to plants throughout most of the winter. In these areas it is heavily utilized by pronghorn and mule deer. Black sagebrush palatability has been rated as moderate to high depending on the ungulate and the season of use (Horton 1989, Wambolt 1996). The palatability of black sagebrush increases the potential for negative impacts on remaining black sagebrush plants from grazing or browsing pressure following fire (Wambolt 1996). Pronghorn utilize black sagebrush heavily (Beale and Smith 1970). On the Desert Experiment Range, black sagebrush was found to comprise 68% of pronghorn diet even though it was only the third most common plant. Fawns were found to prefer black sagebrush, utilizing it more than all other forage species combined (Beale and Smith 1970).

Recreational uses

Aesthetic value is derived from the diverse floral and faunal composition and the colorful flowering of wild flowers and shrubs during the spring and early summer. This site offers rewarding opportunities to photographers and for nature study. This site is used for camping and hiking and has potential for upland and big game hunting.

Other information

Black sagebrush is an excellent species to establish on sites where management objectives include restoration or improvement of domestic sheep, pronghorn, or mule deer winter range.

Inventory data references

Soils and Physiographic features were gathered from NASIS.

Type locality

Location 1: Elko County, NV	
Township/Range/Section	T45N R63E S34
General legal description	About 4 miles southwest of Contact, Elko County, Nevada.

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Contributors

RK

Approval

Kendra Moseley, 4/25/2024

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)	P Novak-Echenique
Contact for lead author	State Rangeland Management Specialist
Date	08/19/2010
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. Rock fragments armor the surface.

2. **Presence of water flow patterns:** Water flow patterns are few and can be expected in areas subjected to summer convection storms or rapid snowmelt.

3. **Number and height of erosional pedestals or terracettes:** Pedestals are none to 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 ± 20% depending on amount of surface rock fragments.

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) expected to move 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.

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.)

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Surface structure is typically thin to medium platy, subangular blocky, or granular. Soil surface colors are browns and soils are typified by a mollic epipedon. Organic matter of the surface 2 to 3 inches is typically 1.5 to 4 percent dropping off quickly below. Organic matter content can be more or less depending on micro-topography.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Perennial herbaceous plants (especially deep-rooted bunchgrasses [i.e., bluebunch wheatgrass & Thurber's needlegrass]) slow runoff and increase infiltration. Shrub canopy and associated litter break raindrop impact.

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. Subangular blocky, platy, or massive sub-surface horizons or subsoil argillic horizons are not to be interpreted as compacted layers.

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

    Dominant: Reference Plant Community: Deep-rooted, cool season, perennial bunchgrasses

    Sub-dominant: low shrubs (black sagebrush) > associated shrubs > shallow-rooted, cool season, perennial bunchgrasses > deep-rooted, cool season, perennial forbs = fibrous, shallow-rooted, cool season, perennial and annual forbs

    Other:

    Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Dead branches within individual shrubs 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.

14. **Average percent litter cover (%) and depth (in):** Within plant interspaces (± 30%) and depth of litter 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 mid-June) ± 500 lbs/ac; Spring moisture significantly affects total production. Favorable years ± 700 lbs/ac and unfavorable years ± 300 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, halogeton, Russian thistle, annual mustards, and knapweeds.

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