USDA Natural Resources Conservation Service

Ecological site R024XY035NV
SHALLOW 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): 024X–Humboldt Basin and Range Area

Major land resource area (MLRA) 24, the Humboldt Area, covers an area of approximately 8,115,200 acres (12,680 sq. mi.). It is found in the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. Elevations range from 3,950 to 5,900 feet (1,205 to 1,800 meters) in most of the area, some mountain peaks are more than 8,850 feet (2,700 meters).
A series of widely spaced north-south trending mountain ranges are separated by broad valleys filled with alluvium washed in from adjacent mountain ranges. Most valleys are drained by tributaries to the Humboldt River. However, playas occur in lower elevation valleys with closed drainage systems. Isolated ranges are dissected, uplifted fault-block mountains. Geology is comprised of Mesozoic and Paleozoic volcanic rock and marine and continental sediments. Occasional young andesite and basalt flows (6 to 17 million years old) occur at the margins of the mountains. Dominant soil orders include Aridisols, Entisols, Inceptisols and Mollisols. Soils of the area are generally characterized by a mesic soil temperature regime, an aridic soil moisture regime and mixed geology. They are generally well drained, loamy and very deep.
Approximately 75 percent of MLRA 24 is federally owned, the remainder is primarily used for farming, ranching and mining. Irrigated land makes up about 3 percent of the area; the majority of irrigation water is from surface water sources, such as the Humboldt River and Rye Patch Reservoir. Annual precipitation ranges from 6 to 12 inches (15 to 30 cm) for most of the area, but can be as much as 40 inches (101 cm) in the mountain ranges. The majority of annual precipitation occurs as snow in the winter. Rainfall occurs as high-intensity, convective thunderstorms in the spring and fall.

Classification relationships

National Vegetation Classification (USNVC): 3 Semi-Desert, 3.B Cool Semi-Desert Scrub and Grassland, 3.B.1 Cool Semi-Desert Scrub and Grassland, D040 Western North American Cool Semi-Desert Scrub and Grassland, M169 Great Basin and Intermountain Tall Sagebrush Shrubland and Steppe, G303 Intermountain Dry Tall Sagebrush

Ecological site concept

This site is on mountains. Soils are shallow to bedrock, well drained and formed in residuum. The soil profile is characterized by an ochric epipedon and an argillic horizon.
Important abiotic factors contributing to the presence of this ecological site include the shallow depth that limits productivity and prevents the development of a mollic.
Full consideration will be given to combining Shallow Loamy 10-14"PZ (024XY035NV), Shallow Loam 8-10"PZ (024XY047NV), Shallow Loam 8-10"PZ (024XY017NV). These sites do not compete on soil feature or landscape characteristics and may in fact be different community phases of the same ESC.

Associated sites

R024XY028NV	**SOUTH SLOPE 8-12 P.Z.** Site is found on steep, south facing piedmont slopes, hills and mountains. The soils associated with this site are mod-deep, well drained and formed in residuum. The soil profile is characterized by an ochric epipedon, an argillic horizon and greater than 35% rock fragments by volume. Important abiotic factors contributing to the presence of this site include southern aspect and clayey soil texture allowing Wyoming big sagebrush to dominate at a higher-than-expected elevation.
R024XY013NV	**LOAMY 10-12 P.Z.** Found on similar landforms at slightly higher elevation. Includes basin big and mountain big sagebrush in addition to Wyoming big sagebrush, bluebunch wheatgrass is the dominant grass.
R024XY005NV	**LOAMY 8-10 P.Z.** Important abiotic factors contributing to the presence of this ecological site include limited precipitation and the presence of the argillic horizon that helps retain soil moisture. The fine-textured/clay rich horizons, lying beneath the coarser-textured horizons become impermeable as the swelling matrix closes following wetting.
R024XY047NV	**SHALLOW LOAM 8-10 P.Z.** Soils are shallow to bedrock, well drained and formed in residuum. The soil profile is characterized by an ochric epipedon and an argillic horizon. Important abiotic factors contributing to the presence of this ecological site include the shallow depth that limits productivity and prevents the development of a mollic.

Similar sites

R024XY047NV	**SHALLOW LOAM 8-10 P.Z.** Thurber's needlegrass (ACTH7)-Indian ricegrass (ACHY) codominant grasses.
R024XY028NV	**SOUTH SLOPE 8-12 P.Z.** Bluebunch wheatgrass (PSSPS) dominant grass; more productive site.
R024XY013NV	**LOAMY 10-12 P.Z.** The sagebrush found on this site is primarily basin big sagebrush (ARTR4), with Wyoming sagebrush (ARTRW8) confined to the transitions. More productive site.
R024XY005NV	**LOAMY 8-10 P.Z.** Bluebunch wheatgrass (PSSPS) minor grass, if present.
R024XY029NV	**SOUTH SLOPE 12-16 P.Z.** Bluebunch wheatgrass (PSSPS) dominant grass; more productive site.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Artemisia tridentata*
Herbaceous	(1) *Pseudoroegneria spicata* (2) *Achnatherum thurberianum*

Physiographic features

This site is on side slopes of middle and upper piedmont slopes, hills and lower mountains on all aspects. Slopes range from 4 to 75 percent, but slope gradients of 15 to 50 percent are typical. Elevations are 5000 to 7000 feet (1524 to 2134m).

Table 2. Representative physiographic features

Landforms	(1) Fan piedmont (2) Hill (3) Mountain slope
Runoff class	High to very high
Flooding frequency	None
Ponding frequency	None

Elevation	5,000–7,000 ft
Slope	4–75%
Water table depth	72 in
Aspect	N, E, S

Climatic features

The climate associated with ecological site is semiarid characterized by cool, moist winters and hot, dry summers. Over 70 percent of the precipitation occurs from November through May. Average annual precipitation is 8 to 10 inches (20 to 25cm). Mean annual air temperature is 45 to 50 degrees F. The average precipitation across the range which this site occurs is 9.38 inches (23.82cm). The average growing season is approximately 90 to 130 days.

Table 3. Representative climatic features

Frost-free period (characteristic range)	80 days
Freeze-free period (characteristic range)	105 days
Precipitation total (characteristic range)	9 in
Frost-free period (actual range)	80 days
Freeze-free period (actual range)	105 days
Precipitation total (actual range)	9 in
Frost-free period (average)	80 days
Freeze-free period (average)	105 days
Precipitation total (average)	9 in

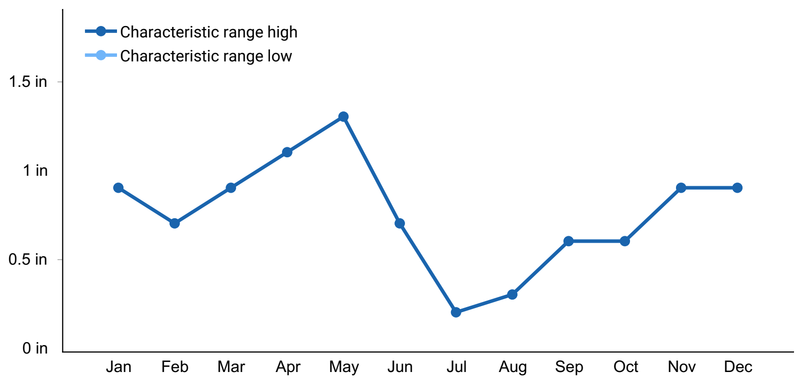

Figure 1. Monthly precipitation range

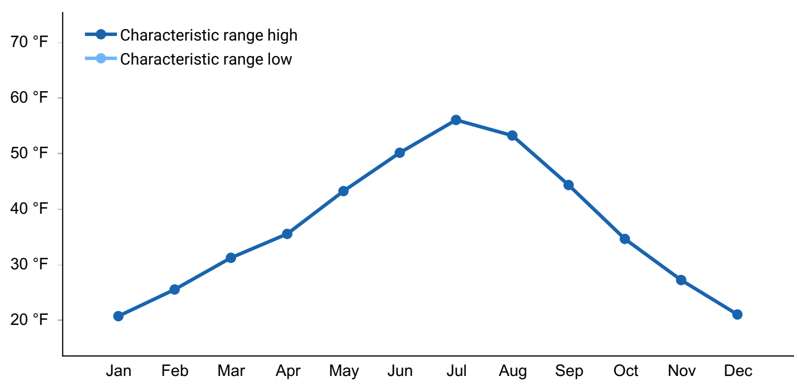

Figure 2. Monthly minimum temperature range

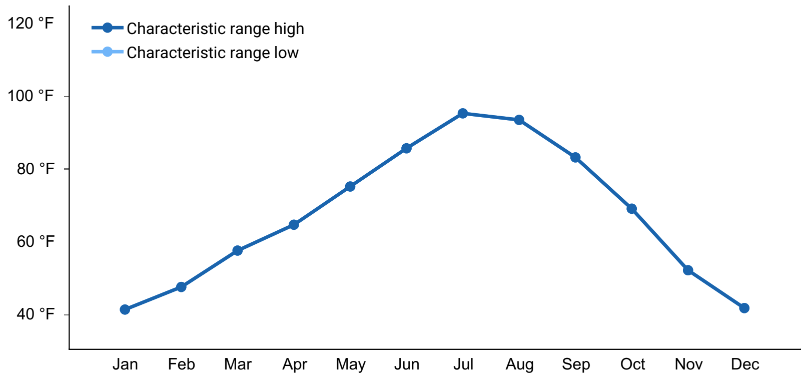

Figure 3. Monthly maximum temperature range

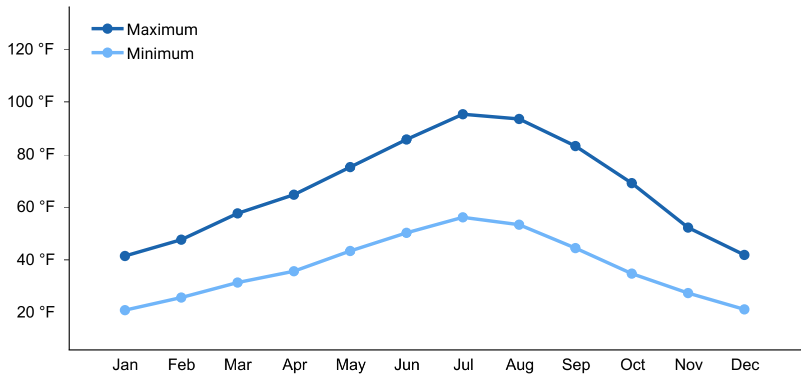

Figure 4. Monthly average minimum and maximum temperature

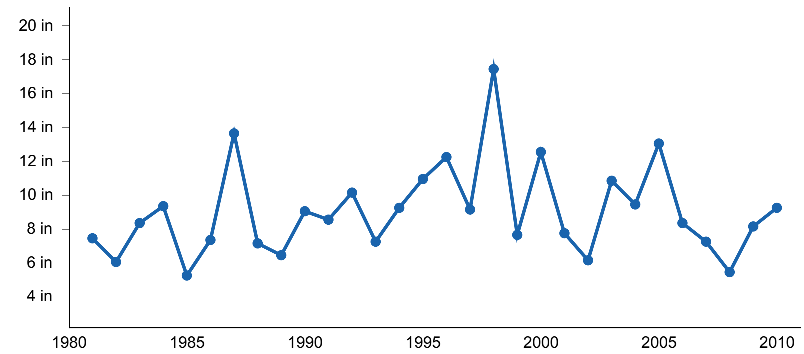

Figure 5. Annual precipitation pattern

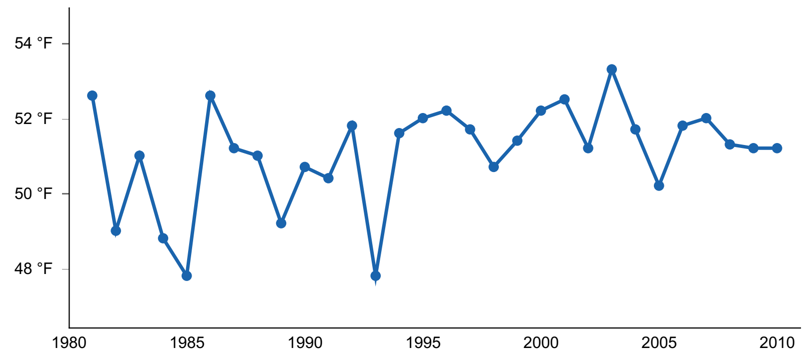

Figure 6. Annual average temperature pattern

Climate stations used

- (1) BATTLE MOUNTAIN 4SE [USW00024119], Battle Mountain, 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 bedrock, well drained and formed in residuum. Soils are characterized by an ochric epipedon, an argillic horizon and greater than 35 percent rock fragments by volume. Available water capacity of these soils is low but a surface cover of coarse fragments helps to reduce evaporation and conserve soil moisture. Potential for sheet and rill erosion is slight to moderate depending on slope.
Soil series associated with this site include: Burrita, Havingdon, Locane, and Soughe.

Table 4. Representative soil features

Parent material	(1) Residuum
Surface texture	(1) Extremely cobbly loam (2) Very cobbly loam (3) Stony loam
Family particle size	(1) Clayey
Drainage class	Well drained
Permeability class	Moderately slow to slow
Soil depth	10–26 in
Surface fragment cover <=3"	10–45%
Surface fragment cover >3"	0–20%
Available water capacity (0-40in)	1–3 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)	6.2–7.8
Subsurface fragment volume <=3" (Depth not specified)	10–50%
Subsurface fragment volume >3" (Depth not specified)	0–25%

Ecological dynamics

An ecological site is the product of all the environmental factors responsible for its development and it has a set of key characteristics that influence a site’s resilience to disturbance and resistance to invasives. Key characteristics include 1) climate (precipitation, temperature), 2) topography (aspect, slope, elevation, and landform), 3) hydrology (infiltration, runoff), 4) soils (depth, texture, structure, organic matter), 5) plant communities (functional groups, productivity), and 6) natural disturbance regime (fire, herbivory, etc.) (Caudle et al. 2013). Biotic factors that that influence resilience include site productivity, species composition and structure, and population regulation and regeneration (Chambers et al 2013).
This ecological site is dominated by deep-rooted cool season perennial bunchgrasses and long-lived shrubs (50+ years) with high root to shoot ratios. The dominant shrubs usually root to the full depth of the winter-spring soil moisture recharge, which ranges from 1.0 to over 3.0 m. (Comstock and Ehleringer 1992). Root length of mature sagebrush plants was measured to a depth of 2 meters in alluvial soils in Utah (Richards and Caldwell 1987). These shrubs have a flexible generalized root system with development of both deep taproots and laterals near the surface (Comstock and Ehleringer 1992).
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. Thurber's needlegrass will increase on gravelly soils, whereas Indian ricegrass will increase with sandy soil surfaces. A weak argillic horizon will promote production of bluebunch wheatgrass. Production increases with soil depth. The amount of sagebrush in the plant community is dependent upon disturbances such as fire, Aroga moth infestations and grazing. Sandberg bluegrass more easily dominates sites where surface soils are gravelly loams than those where surface soils are silt loams. The higher production sites would be much more resilient than other sites in this group.

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).

The perennial bunchgrasses generally have somewhat shallower root systems than the shrubs, but root densities are often as high as or higher than those of shrubs in the upper 0.5 m but taper off more rapidly than shrubs. General differences in root depth distributions between grasses and shrubs results in resource partitioning in these shrub/grass systems.

The Great Basin sagebrush communities have high spatial and temporal variability in precipitation both among years and within growing seasons. Nutrient availability is typically low but increases with elevation and closely follows moisture availability. The moisture resource supporting the greatest amount of plant growth is usually the water stored in the soil profile during the winter. The invasibility of plant communities is often linked to resource availability. Disturbance can decrease resource uptake due to damage or mortality of the native species and depressed competition or can increase resource pools by the decomposition of dead plant material following disturbance. The invasion of sagebrush communities by cheatgrass has been linked to disturbances (fire, abusive grazing) that have resulted in fluctuations in resources (Chambers et al 2007).

The introduction of annual weedy species, like cheatgrass, may cause an increase in fire frequency and eventually lead to an annual state. Conversely, as fire frequency decreases, sagebrush will increase and with inappropriate grazing management the perennial bunchgrasses and forbs may be reduced.

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

Fire Ecology:

Fire is the principal means of renewal of decadent stands of Wyoming big sagebrush. Wyoming big sagebrush communities historically had low fuel loads, and patchy fires that burned in a mosaic pattern were common at 10 to 70 year return intervals (West and Hassan 1985, Bunting et al. 1987). Davies et al. (2007) suggest fire return intervals in Wyoming big sagebrush communities were around 50 to 100 years. More recently, Baker (2011) estimates fire rotation to be 200-350 years in Wyoming big sagebrush communities. Wyoming big sagebrush is killed by fire and only regenerates from seed. Recovery time for Wyoming big sagebrush may require 50 to 120 or more years (Baker 2006). Post-fire hydrologic recovery and resilience is primarily influenced by pre-fire site conditions, fire severity, and post-fire weather and land use that relate to vegetation recovery. Sites with low abundances of native perennial grasses and forbs typically have reduced resiliency following disturbance and are less resistant to invasion or increases in cheatgrass (Miller et al 2013). However, the introduction and expansion of cheatgrass has dramatically altered the fire regime (Balch et al. 2013) and restoration potential of Wyoming big sagebrush communities.

The effect of fire on bunchgrasses relates to culm density, culm-leaf morphology, and the size of the plant. The initial condition of bunchgrasses within the site along with seasonality and intensity of the fire all factor into the individual species response. For most forbs and grasses the growing points are located at or below the soil surface providing relative protection from disturbances which decrease above ground biomass, such as grazing or fire.

Thus, fire mortality is more related to duration and intensity of heat which is related to culm density, culm-leaf morphology, size of plant and abundance of old growth (Young 1983, Wright 1971).
Burning has been found to decrease the vegetative and reproductive vigor of Thurber’s needlegrass (Uresk et al. 1976). Fire can cause high mortality, in addition to reducing basal area and yield of Thurber’s needlegrass (Britton et al. 1990a). 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 influenced the response and mortality of Thurber’s needlegrass, smaller bunch sizes were less likely to be damaged by fire (Wright and Klemmedson 1965). Thurber’s needlegrass often survives fire and will continue growth or regenerate from tillers when conditions are favorable (Koniak 1985, Britton et al. 1990a). Reestablishment on burned sites has been found to be relatively slow due to low germination and competitive ability (Koniak 1985). Cheatgrass has been found to be a highly successful competitor with seedlings of this needlegrass and may preclude reestablishment (Evans and Young 1978).
Indian ricegrass is fairly fire tolerant (Wright 1985), which is likely due to its low culm density and below-ground root crowns. Vallentine (1989) cites several studies in the sagebrush zone that classified Indian ricegrass as being slightly damaged from late summer burning. Indian ricegrass has also been found to reestablish on burned sites through seed dispersed from adjacent unburned areas (Young 1983, West 1994). Thus the presence of surviving, seed producing plants facilitates the reestablishment of Indian ricegrass. Grazing management following fire to promote seed production and establishment of seedlings is important.
Squirreltail is considered more fire tolerant than Indian ricegrass due to its small size, coarse stems, broad leaves and generally sparse leafy material (Wright 1971, Britton et al. 1990). Postfire regeneration occurs from surviving root crowns and from on-and off-site seed sources. Bottlebrush squirreltail has the ability to produce large numbers of highly germinable seeds, with relatively rapid germination (Young and Evans 1977) when exposed to the correct environmental cues. Early spring growth and ability to grow at low temperatures contribute to the persistence of bottle brush squirreltail among cheatgrass dominated ranges (Hironaka and Tisdale 1972).
Sandberg bluegrass, a minor component of this ecological site, has been found to increase following fire likely due to its low stature and productivity (Daubenmire 1975). Reduced bunchgrass vigor or density provides an opportunity for Sandberg bluegrass expansion and/or cheatgrass and other invasive species to occupy interspaces, leading to increased fire frequency and potentially an annual plant community. Sandberg bluegrass increases under grazing pressure (Tisdale and Hironaka 1981) and is capable of co-existing with cheatgrass. Excessive sheep grazing favors Sandberg bluegrass; however, where cattle are the dominant grazers, cheatgrass often dominates (Daubenmire 1970). Thus, depending on the season of use, the grazer and site conditions, either Sandberg bluegrass or cheatgrass may become the dominant understory with inappropriate grazing management. Repeated frequent fire in this community will eliminate big sagebrush and severely decrease or eliminate the deep rooted perennial bunchgrasses from the site and facilitate the establishment of an annual weed community with varying amounts of Sandberg bluegrass and rabbitbrush.
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.
Wildfire in sites with cheatgrass present could transition to cheatgrass dominated communities. Without management cheatgrass and annual forbs are likely to invade and dominate the site, especially after fire.

Variability in plant community composition and production depends on soil surface texture and depth. Thurber’s needlegrass will increase on gravelly soils, whereas Indian ricegrass will increase with sandy soil surfaces. A weak argillic horizon will promote production of bluebunch wheatgrass. Production increases with soil depth. The amount of sagebrush in the plant community is dependent upon fire frequency, which would be highly infrequent. Sandberg’s bluegrass more easily dominates sites where surface soils are gravelly loams than those where surface soils are silt loams. The higher production sites would be much more resilient than other sites in this group.

Overgrazing leads to an increase in sagebrush and a decline in understory plants like Thurber’s needlegrass, bluebunch wheatgrass and Indian ricegrass. Squirreltail 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 an increase in bare ground. Wetter sites are more resistant to degradation and may end up having sagebrush and Sandberg’s bluegrass dominate the site. A combination of overgrazing and prolonged drought leads to soil erosion, increased bare ground and a loss in plant production. Wildfire in sites with cheatgrass present could transition to cheatgrass dominated communities. Without management cheatgrass and annual forbs are likely to

invade and dominate the site, especially after fire.
Cheatgrass, thistles, and annual mustards are species likely to invade this site. Repeated burning of the plant community at intervals less than 10 to 15 years results in complete site dominance by annuals (primarily cheatgrass and tansy mustard) and the near total absence of woody plants, including sagebrush.

State and transition model

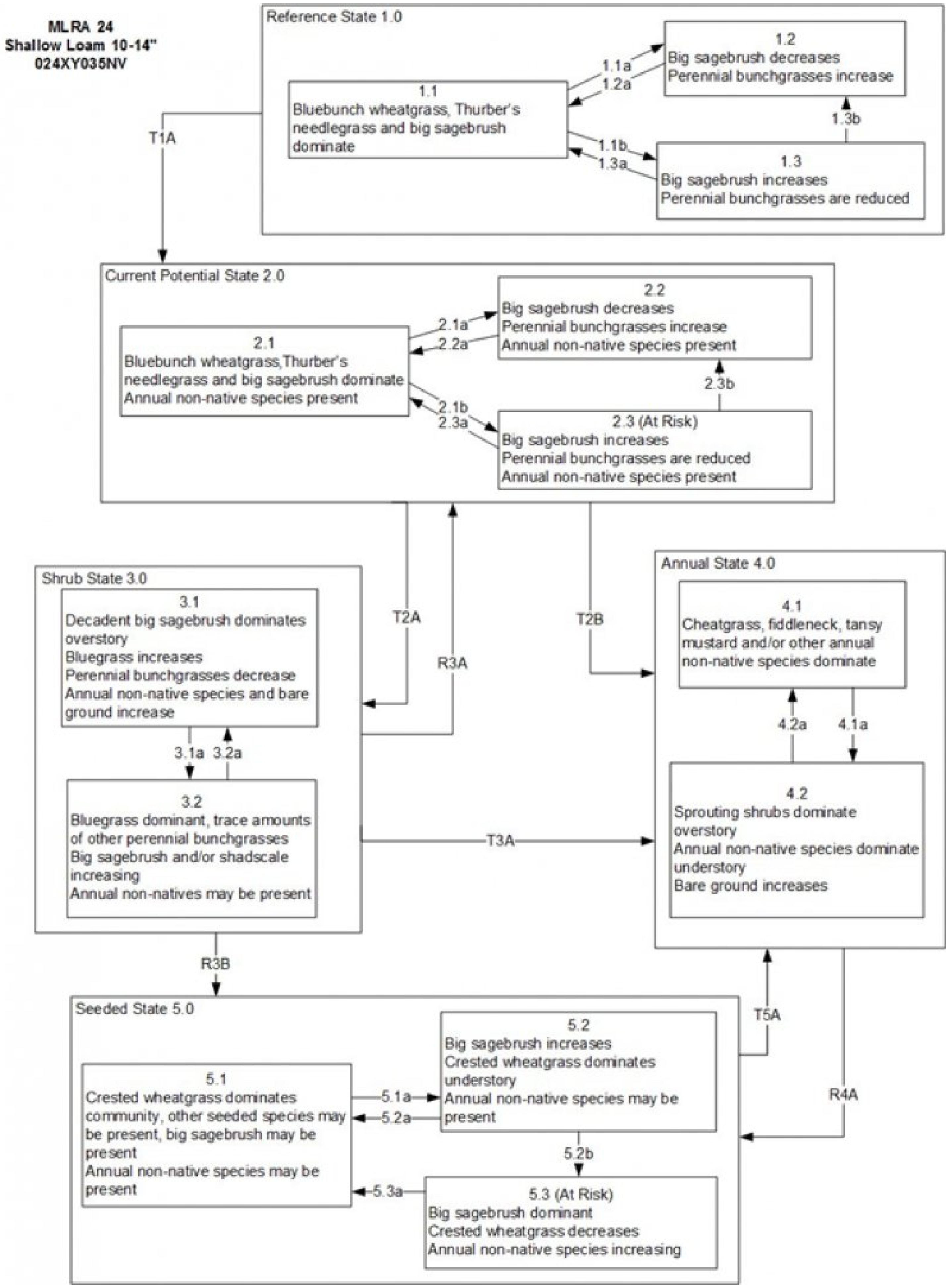

Figure 7. T. Stringham/PNovakEchenique 2016

MLRA 24
Shallow Loam 10-14"
024XY035NV

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. A severe infestation of Aroga moth could also reduce sagebrush cover.
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. A severe infestation of Aroga moth could also reduce sagebrush cover.
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.
2.3a: 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.

Transition T2A: 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.
Transition T2B: Catastrophic fire and/or soil disturbing treatments (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 may allow for sagebrush to increase.

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.

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: Inappropriate grazing management facilitates shrub reestablishment. Time and lack of disturbance/management would also allow for shrubs to establish and increase.
5.2a: Fire, brush management, or Aroga moth infestation reduces shrub component.
5.2b: Inappropriate grazing management decreases perennial bunchgrass understory.
5.3a: High severity fire, Aroga moth or brush management reduces sagebrush cover leading to an early/mid seral community.

Transition T5A: Catastrophic fire (coming from 5.3).

Figure 8. Legend

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
Reference Plant Community

Wyoming big sagebrush, bluebunch wheatgrass, and Thurber's needlegrass dominate the site. Indian ricegrass, Sandberg bluegrass and squirreltail are also common. Forbs are present but not abundant. Potential vegetative composition is approximately 60% grasses, 10% forbs and 30% shrubs.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	150	240	300
Shrub/Vine	75	120	150
Forb	25	40	50
Total	**250**	**400**	**500**

Community 1.2
Perennial grass Phase

This community phase is characteristic of a post-disturbance, early seral community phase. Thurber's needlegrass and other perennial grasses dominate. Depending on fire severity or intensity of Aroga moth infestation, patches of intact sagebrush may remain.

Community 1.3
Shrub Phase

Wyoming big 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.

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

Time and lack of disturbance such as fire allows for sagebrush to increase and become decadent. Long-term drought, herbivory, or combinations of these would cause a decline in perennial bunchgrasses and fine fuels and lead to a reduced fire frequency allowing big sagebrush to dominate the site.

Pathway 1.2a
Community 1.2 to 1.1

Absence of disturbance over time would allow for sagebrush to increase.

Pathway 1.3a
Community 1.3 to 1.1

A low severity fire, Aroga moth or combination would reduce the sagebrush overstory and create a sagebrush/grass mosaic with sagebrush and perennial bunchgrasses co-dominant.

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 low severity resulting in a mosaic pattern due to low fine 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. 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. This state has the same three general community phases. Ecological function 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 within this State. These non-natives can be highly flammable and can promote fire where historically fire had been infrequent. Negative feedbacks enhance ecosystem resilience and contribute to the stability of the state. These feedbacks 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.

Community 2.1
Community Phase

Wyoming big sagebrush, bluebunch wheatgrass and Thurber's needlegrass dominate the site. Indian ricegrass and squirreltail may be significant components while Sandberg bluegrass and forbs make up smaller percentages by weight of the understory. Non-native annual species are present.

Community 2.2
Community Phase

This community phase is characteristic of a post-disturbance, early seral community phase. Bluebunch wheatgrass, Thurber's needlegrass and other perennial grasses dominate. Wyoming big sagebrush is present in trace amounts. Depending on fire severity or intensity of Aroga moth infestations, patches of intact sagebrush may remain. Rabbitbrush may be sprouting. Forbs may increase post-fire but will likely return to pre-burn levels within a few 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)

This community is at risk of crossing a threshold to another state. Sagebrush dominates the overstory and perennial bunchgrasses in the understory are reduced, either from competition with shrubs or from inappropriate grazing management, or from both. Rabbitbrush may be a significant component. Sandberg bluegrass may increase and become co-dominate with deep rooted bunchgrasses. 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 grazing, drought, and fire.

Pathway 2.1a
Community 2.1 to 2.2

Fire reduces the shrub overstory and allows for perennial bunchgrasses 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. 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 are likely to increase after fire.

Pathway 2.1b
Community 2.1 to 2.3

Time and lack of disturbance such as fire allows for sagebrush to increase and become decadent. Chronic drought reduces fine fuels and leads to a reduced fire frequency allowing Wyoming big sagebrush to dominate the site. Inappropriate grazing management reduces the perennial bunchgrass understory; conversely Sandberg bluegrass may increase in the understory depending on grazing management. Excessive sheep grazing favors Sandberg bluegrass; however, where cattle and/or horses are the dominant grazers, cheatgrass often increases.

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 Wyoming big sagebrush can take many years.

Pathway 2.3a
Community 2.3 to 2.1

A change in grazing management that decreases shrubs would allow for the perennial bunchgrasses in the understory to increase. Heavy late-fall/winter grazing may cause mechanical damage and subsequent death to sagebrush, facilitating an increase in the herbaceous understory. An infestation of Aroga moth or a low severity fire would reduce some sagebrush overstory and allow perennial grasses to increase in the community. Brush treatments with minimal soil disturbance would also decrease sagebrush and release the perennial understory. Annual non-native species are present and may increase in the community.

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.

State 3
Shrub State

This state is a product of many years of heavy grazing during time periods harmful to perennial bunchgrasses. Sandberg bluegrass may increase with a reduction in deep rooted perennial bunchgrass competition and may become the dominate grass or the herbaceous understory may be completely eliminated. Sagebrush dominates the overstory and rabbitbrush may be a significant component. 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 dominates site resources such that soil water, nutrient capture, nutrient cycling and soil organic matter are temporally and spatially redistributed. Bare ground may be significant with soil redistribution occurring between interspace and canopy locations.

Community 3.1
Community Phase

Wyoming big sagebrush dominates overstory and rabbitbrush may be a significant component. Deep-rooted perennial bunchgrasses may be present in trace amounts or absent from the community. Sandberg bluegrass may dominate the understory. Annual non-native species are present and may be co-dominant. Bare ground is significant.

Community 3.2
Community Phase

Bluegrass dominates the site; annual non-native species may be present but are not dominant. Trace amounts of sagebrush may be present. Sprouting shrubs such as Anderson's peachbrush or rabbitbrush may be dominant.

Pathway 3.1a
Community 3.1 to 3.2

Fire, heavy fall grazing causing mechanical damage to shrubs, and/or brush treatments with minimal soil disturbance, will greatly reduce the overstory shrubs to trace amounts and allow for Sandberg bluegrass to dominate the site.

Conservation practices

Brush Management

Pathway 3.2a
Community 3.2 to 3.1

Time and lack of disturbance and/or grazing management that favors the establishment and growth of sagebrush allows the shrub component to recover. The re-establishment of Wyoming big sagebrush can take many years. With the dominance of bluegrass this pathway is unlikely to occur.

State 4
Annual State

This community is characterized by the dominance of annual non-native species such as cheatgrass and annual mustards in the understory. Sprouting shrubs such as rabbitbrush and Anderson's peachbrush may dominate the overstory.

Community 4.1
Community Phase

Figure 10. Shallow Loam 10-14 P.Z. Community Phase 4.1

Annual non-native plants such as cheatgrass and mustards dominate the site. Rabbitbrush may or may not be present.

Community 4.2

Community Phase

Sprouting shrubs such as rabbitbrush and Anderson's peachbrush dominate the overstory. Wyoming big sagebrush may be a minor component. Annual non-native species dominate understory. Trace amounts of desirable bunchgrasses may be present.

Pathway 4.1a
Community 4.1 to 4.2

Time and lack of fire allows for the sagebrush to establish. Probability of sagebrush establishment is extremely low.

Pathway 4.2a
Community 4.2 to 4.1

Fire removes sagebrush and allows for annual non-native species to dominate the site.

State 5
Seeded State

This state is characterized by the dominance of seeded introduced wheatgrass species. Forage kochia and other desired seeded species including Wyoming big sagebrush and native and non-native forbs may be present. Soil nutrients and soil organic matter distribution and cycling are primarily driven by deep rooted bunchgrasses.

Community 5.1
Community Phase

Introduced wheatgrass species and other non-native species such as forage kochia dominate the community. Native and non-native seeded forbs may be present. Trace amounts of big sagebrush may be present, especially if seeded. Annual non-native species present.

Community 5.2
Community Phase

Wyoming big sagebrush and seeded wheatgrass species co-dominate. Annual non-native species stable to increasing.

Community 5.3
Community Phase (At-Risk)

This community phase is at-risk of crossing a threshold to another state. Wyoming big sagebrush dominates. Rabbitbrush may be a significant component. Wheatgrass vigor and density reduced. Annual non-native species stable to increasing.

Pathway 5.1a
Community 5.1 to 5.2

Inappropriate grazing management particularly during the growing season reduces perennial bunchgrass vigor and density and facilitates shrub establishment. Absence of shrub removal disturbances over time coupled with inappropriate grazing management facilitates shrub dominance.

Pathway 5.2a
Community 5.2 to 5.1

Low severity fire, brush management, and/or Aroga moth infestation would reduce the sagebrush overstory and allow seeded wheatgrass species to become dominant.

Pathway 5.2b

Community 5.2 to 5.3

Absence of shrub removal disturbances over time coupled with inappropriate grazing management that promotes a reduction in perennial bunchgrasses and facilitates shrub dominance.

Pathway 5.3a
Community 5.3 to 5.1

Fire eliminates/decreases the overstory of sagebrush and allows for the understory perennial grasses to increase. Fires would typically be low severity resulting in a mosaic pattern due to low fine fuel loads. A fire following an unusually wet spring or change in management favoring an increase in fine fuels, may be more severe and reduce the shrub component to trace amounts. A severe infestation of Aroga moth would also cause a large decrease in sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs. Brush treatments with minimal soil disturbance would also decrease sagebrush and release the perennial understory. Annual non-native species respond well to fire and may increase post-burn.

Transition T1A
State 1 to 2

Trigger: This transition is caused by the introduction of non-native annual weeds, such as cheatgrass, mustards, bur buttercup and halogeton. Slow variables: Over time the annual non-native plants 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: Inappropriate, long-term grazing of perennial bunchgrasses during the growing season would favor sagebrush. Slow variables: Long term decrease in deep-rooted perennial grass density. 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: To Community Phase 4.1: Severe fire and/or soil disturbing treatments. To Community Phase 4.2: Inappropriate grazing management that favors shrubs in the presence of non-native species. 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.

Restoration pathway R3A
State 3 to 2

Brush management with minimal soil disturbance, coupled with seeding of deep rooted perennial native bunchgrasses.

Conservation practices

Brush Management
Range Planting

Transition T3A
State 3 to 4

Trigger: To Community Phase 4.1: Severe fire and/or soil disturbing treatments. To Community Phase 4.2: Inappropriate grazing management in the presence of annual non-native species. 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.

Restoration pathway R3B
State 3 to 5

Brush management with minimal soil disturbance, coupled with seeding of desired species, usually wheatgrasses (5.1 or 5.2).

Conservation practices

Brush Management
Range Planting

Restoration pathway R4A
State 4 to 5

Seeding of deep-rooted introduced bunchgrasses and other desired species; may be coupled with brush management and/or herbicide.

Transition T5A
State 5 to 4

Trigger: Fire Slow variables: Increased production and cover of non-native annual species Threshold: Cheatgrass or other non-native annuals dominate understory

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**			160–260	
	bluebunch wheatgrass	PSSPS	*Pseudoroegneria spicata ssp. spicata*	80–140	–
	Thurber's needlegrass	ACTH7	*Achnatherum thurberianum*	80–120	–
2	**Secondary Perennial Grasses**			8–40	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	2–12	–
	squirreltail	ELEL5	*Elymus elymoides*	2–12	–
	Idaho fescue	FEID	*Festuca idahoensis*	2–12	–
	basin wildrye	LECI4	*Leymus cinereus*	2–12	–
	Sandberg bluegrass	POSE	*Poa secunda*	2–12	–
Forb					
3	**Perennial Forbs**			20–60	
	arrowleaf balsamroot	BASA3	*Balsamorhiza sagittata*	2–12	–
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	2–12	–
	buckwheat	ERIOG	*Eriogonum*	2–12	–
	lupine	LUPIN	*Lupinus*	2–12	–
	phlox	PHLOX	*Phlox*	2–12	–
Shrub/Vine					
4	**Primary Shrubs**			60–100	
	big sagebrush	ARTR2	*Artemisia tridentata*	60–100	–
5	**Secondary Shrubs**			20–40	
	Utah serviceberry	AMUT	*Amelanchier utahensis*	4–12	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	4–12	–
	rubber rabbitbrush	ERNAN5	*Ericameria nauseosa ssp. nauseosa var. nauseosa*	4–12	–
	desert peach	PRAN2	*Prunus andersonii*	4–12	–

Animal community

Livestock Interpretations:
This site has value for livestock grazing. Grazing management should be keyed to palatable perennial dominant grass and forb production. Bluebunch wheatgrass is considered one of the most important forage grass species on western rangelands for livestock. Although bluebunch wheatgrass can be a crucial source of forage, it is not necessarily the most highly preferred species. Thurber's needlegrass species begin growth early in the year and remain green throughout a relatively long growing season. This pattern of development enables animals to use 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. Livestock browse Wyoming big sagebrush, but may use it only lightly when palatable herbaceous species are available. 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.

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:
Bluebunch wheatgrass is considered one of the most important forage grass species on western rangelands for wildlife. Bluebunch wheatgrass does not generally provide sufficient cover for ungulates, however, mule deer are frequently found in bluebunch-dominated grasslands. Thurber needlegrass is valuable forage for wildlife. Wyoming big sagebrush is preferred browse for wild ungulates. Pronghorn usually browse Wyoming big sagebrush heavily. 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.

Hydrological functions

Runoff is medium to high. Permeability is moderately slow to slow. Hydrologic soil groups are B, C, and D. Rills are typically none to rare. Rock fragments armor the soil surface. Water flow patterns are typically none but can rarely occur on steeper slopes (30% gradient) in areas recently subjected to intense summer convection storms or rapid snowmelt. Rock fragments armor the soil surface. Pedestals are none to rare. Gullies are none. 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.

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 hiking and has potential for upland and big game hunting.

Other products

Native Americans made tea from big sagebrush leaves. They used the tea as a tonic, an antiseptic, for treating colds, diarrhea, and sore eyes and as a rinse to ward off ticks. Big sagebrush seeds were eaten raw or made into meal. Native Americans used big sagebrush leaves and branches for medicinal teas, and the leaves as a fumigant. Bark was woven into mats, bags and clothing.

Other information

Wyoming big sagebrush is used for stabilizing slopes and gullies and for restoring degraded wildlife habitat, rangelands, mine spoils and other disturbed sites. It is particularly recommended on dry upland sites where other shrubs are difficult to establish.

Inventory data references

NASIS soil component data.

Type locality

Location 1: Lander County, NV	
Township/Range/Section	T31N R47E S18
UTM zone	N
UTM northing	4490046
UTM easting	523712
Latitude	40° 33′ 39″
Longitude	116° 43′ 11″

General legal description	SW¼ Approximately 4 miles east of Battle Mountain, Shoshone Mountains, Lander County, Nevada. This site also occurs in Humboldt County, Nevada.

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Contributors

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Approval

Kendra Moseley, 3/06/2025

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)	Patti Novak-Echenique
Contact for lead author	State Rangeland Management Specialist
Date	03/18/2010
Approved by	Kendra Moseley
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rills are typically none to rare. A few short rills (<1m) may occur on steeper slopes after summer convection storms or rapid snowmelt.

2. **Presence of water flow patterns:** Water flow patterns rarely occur on steeper slopes (30% gradient) in areas recently subjected to intense summer convection storms or rapid snowmelt. These are short (<2m) and meandering.

3. **Number and height of erosional pedestals or terracettes:** Pedestals are none to rare.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground 10-20%.

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 4 to 6 on most soil textures found on this site.

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Surface structure is thin to medium platy, massive, or granular. Soil surface colors are light brownish-grays or pale browns and soils are typified by an ochric epipedon. Organic matter of the surface 2 to 4 inches is typically less than 3 percent. 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, subangular blocky, or massive structure or subsoil argillic horizons are not to be interpreted as compacted layers.

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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

    Sub-dominant: Tall shrubs (big sagebrush) > associated shrubs > shallow-rooted, cool season, perennial grasses > deep-rooted, cool season, perennial forbs > fibrous, shallow-rooted, cool season, perennial and annual forbs

    Other: microbiotic crusts

    Additional: With an extended fire return interval, the shrub component becomes dominant at the expense of the herbaceous component.

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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 not uncommon and standing dead shrub canopy material may be as much as 20% of total woody canopy; some of the mature bunchgrasses (<10%) have dead centers.

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14. **Average percent litter cover (%) and depth (in):** Between plant interspaces (± 15%) and litter depth is ± 1/4 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) ± 400 lbs/ac. Favorable years ± 500 lbs/ac and unfavorable years ± 250 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, annual mustards, red-stem filaree and halogeton are

invaders on 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.
