

Ecological site R025XY032NV CLAYPAN 16+ 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 mountain sideslopes and mountain valley fans on all aspects. Slopes range from 2 to 30 percent, but slope gradients of 4 to 15 percent are most typical. Elevations are 7000 to 8500 feet. The average growing season is about 60 to 90 days.

The soils associated with this site are very deep, well drained soils that formed in alluvium and residuum derived from mixed rocks. An argillic horizon occurs from 18 to 79 cm. Clay content ranges from 30 to 40 percent. Permeability is very slow, and runoff is rapid. A mollic epipedon occurs from the soil surface to 36 cm.

The reference plant community is dominated by Idaho fescue and low sagebrush.

Associated sites

R025XY004NV	LOAMY SLOPE 16+ P.Z.
R025XY024NV	MOUNTAIN RIDGE
R025XY052NV	CEANOTHUS THICKET
R025XY056NV	LOAMY 14-16 P.Z.
R025XY071NV	MAHOGANY SAVANNA 14-16 P.Z.

Similar sites

R025XY054NV	CLAYEY 12-14 P.Z. ARARL dominant shrub
R025XY023NV	GRAVELLY CLAYPAN 12-16 P.Z. PUTR2-ARAR8 codominant shrubs; PSSPS-FEID codominant grasses
R025XY017NV	CLAYPAN 12-16 P.Z. PSSPS-FEID codominant grasses
R025XY024NV	MOUNTAIN RIDGE Very shallow soil; less productive site; occurs on ridgetops

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) <i>Artemisia arbuscula</i>
Herbaceous	(1) <i>Festuca idahoensis</i>

Physiographic features

This site occurs on mountain sideslopes and mountain valley fans on all aspects. Slopes range from 2 to 30 percent, but slope gradients of 4 to 15 percent are most typical. Elevations are 7000 to 8500 feet.

Table 2. Representative physiographic features

Landforms	(1) Mountain slope (2) Fan
Runoff class	Very high
Flooding frequency	None
Ponding frequency	None
Elevation	7,000–8,500 ft
Slope	2–30%
Water table depth	78 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 14 or more inches. Mean annual air temperature is typically <45 degrees F.

Mean annual precipitation across the range in which this ES occurs is 18.58".

Monthly mean precipitation: January 1.65"; February 1.68"; March 1.98"; April 2.43"; May 2.41"; June 1.62"; July 0.61"; August 0.63"; September 0.84"; October 1.41"; November 1.51"; December 1.79".

*The above data is averaged from the Jarbridge 4N and Lamoille PH WRCC climate stations.

Table 3. Representative climatic features

Frost-free period (average)	84 days
Freeze-free period (average)	114 days
Precipitation total (average)	19 in

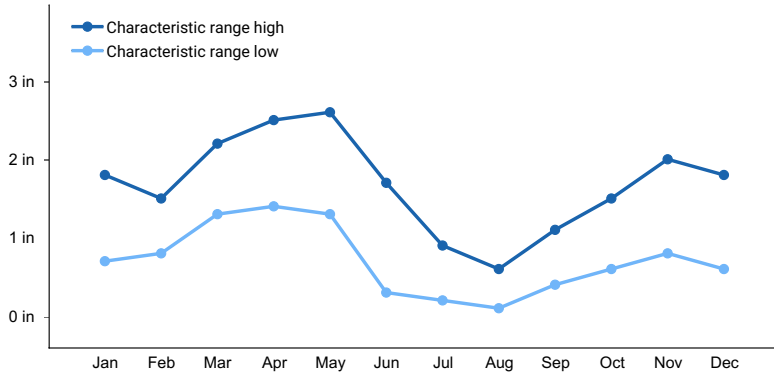


Figure 1. Monthly precipitation range

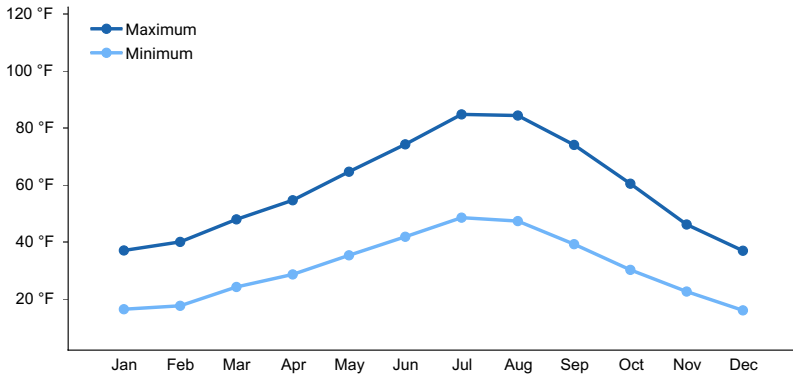


Figure 2. Monthly average minimum and maximum temperature

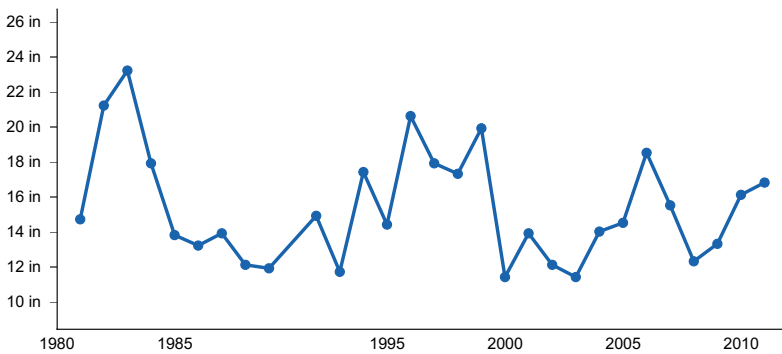


Figure 3. Annual precipitation pattern

Climate stations used

- (1) JARBIDGE 7 N [USC00264039], Jackpot, NV
- (2) LAMOILLE YOST [USC00264394], Spring Creek, 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 deep, well drained soils that formed in residuum or alluvium. Clay content ranges from 30 to 40 percent. Permeability is very slow, and runoff is rapid. A mollic epipedon occurs from the soil surface to 36 cm.

Soil series correlated with this site are: Ninemile and Drice.

Table 4. Representative soil features

Parent material	(1) Colluvium (2) Alluvium
Surface texture	(1) Gravelly loam (2) Very cobbly loam
Family particle size	(1) Clayey
Drainage class	Well drained
Permeability class	Very slow
Depth to restrictive layer	72–84 in
Soil depth	72–84 in
Surface fragment cover <=3"	25–40%
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
Soil reaction (1:1 water) (0-40in)	6.4–6.8
Subsurface fragment volume <=3" (Depth not specified)	15–25%
Subsurface fragment volume >3" (Depth not specified)	0–10%

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 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. Community types with low sagebrush as the dominant shrub were found to have soil depths (and thus available rooting depths) of 71 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 have 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 with the soil profile (Bates et al. 2006).

Low sagebrush is fairly drought tolerant but also tolerates periodic wetness during some portion of the growing season. Low sagebrush is also susceptible to the sagebrush defoliator Aroga moth. Aroga moth can partially or entirely kill individual plants or entire stands of big sagebrush (Furniss and Barr 1975), but the research is inconclusive of the damage sustained by low sagebrush populations.

The perennial bunchgrasses that are dominant on this site include Idaho fescue and bluebunch wheatgrass. 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 but taper off more rapidly. Differences in root depth distributions between grasses and shrubs result in resource partitioning in these shrub/grass systems.

The Great Basin sagebrush communities have high spatial and temporal variability in precipitation both among years and within growing seasons. Nutrient availability is typically low but increases with elevation and closely follows moisture availability. The 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). 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.

The perennial bunchgrasses that are dominant include Idaho fescue and bluebunch wheatgrass. 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.

As ecological condition declines, low sagebrush species and Douglas rabbitbrush become dominant with increases of bottlebrush squirreltail, Sandberg's bluegrass, and mat forming forbs in the understory. The potential invasive/noxious weeds are cheatgrass, rabbitbrush, snakeweed, and annual mustards.

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. Two possible alternative stable states have been identified for this ecological site.

Fire Ecology:

Prior to 1897, mean fire return intervals for low sagebrush communities have been estimated to be from 35 to over 100 years. Fire risk is greatest following a wet, productive year when there is greater production of fine fuels (Beardall and Sylvester 1976).

Low sagebrush is killed by fire and does not sprout (Tisdale and Hironaka 1984). Establishment after fire is from seed, generally blown in and not from the seed bank (Bradley et al. 1992). Fire return intervals have been estimated at 100-200 years in black sagebrush-dominated sites (Kitchen and McArthur 2007) and likely is similar in the low sagebrush ecosystem. Historically, however, fires were probably patchy due to the low productivity of these sites. Fine fuel loads generally average 100 to 400 pounds per acre (110- 450 kg/ha) but are occasionally as high as 600 pounds per acre (680 kg/ha) in low sagebrush habitat types (Bradley et al. 1992). Recovery time of low sagebrush following fire is variable (Young 1983). After fire, if regeneration conditions are favorable, low sagebrush recovers in 2 to 5 years; on harsh sites where cover is low to begin with and/or erosion occurs after fire, recovery may require more than 10 years (Young 1983). Slow regeneration may subsequently worsen erosion (Blaisdell et al. 1982).

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

Idaho fescue responds to fire variably depending on condition and size of the plant, season and severity of fire, and ecological conditions. Mature Idaho fescue plants are commonly reported to be severely damaged by fire in all

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

Cusick's bluegrass is unharmed to slightly harmed by light-severity fall fires. Cusick's bluegrass regenerates after fire from seed and by tillering.

Onespike oatgrass is most likely top killed by fire. Little information is available in the literature that addresses this species' adaptations to fire.

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

Thurber's needlegrass, a minor component on this site, is very susceptible to fire-caused mortality. Burning has been found to decrease the vegetative and reproductive vigor of Thurber's needlegrass (Uresk et al. 1976). Fire also reduces 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). Thurber's needlegrass often survives fire, however, and will continue growth when conditions are favorable (Koniak 1985). Thus, the initial condition of the bunchgrasses within the site along with seasonality and intensity of the fire are important factors in individual species' responses.

Sandberg bluegrass has been found to increase following fire likely due to its low stature and productivity (Daubenmire 1975) and may retard reestablishment of more deeply-rooted bunchgrasses

State and transition model

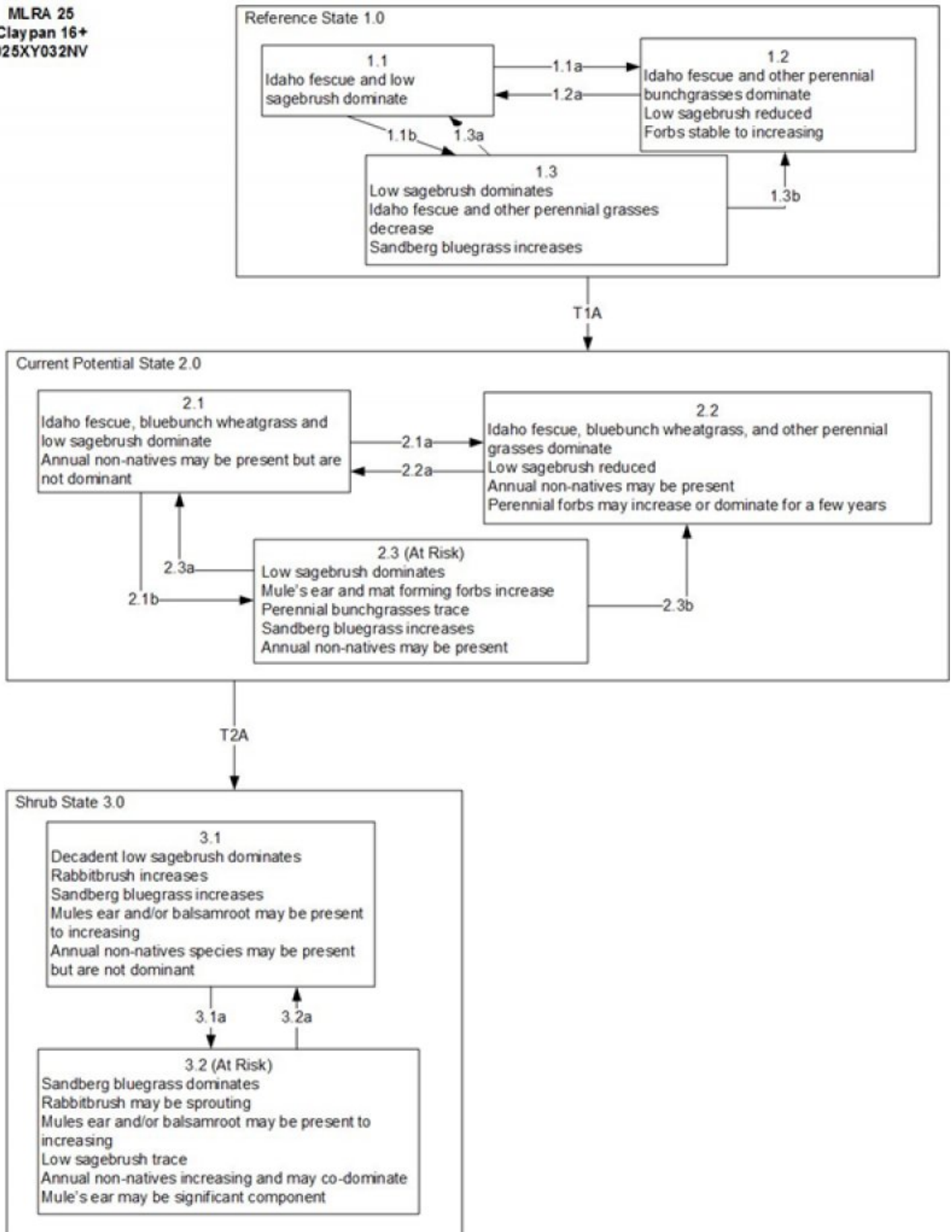


Figure 5. T. Stringham 2015

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. Excessive herbivory and/or long-term drought may also reduce perennial understory.
- 1.2a: Time and lack of disturbance allows for shrub regeneration.
- 1.3a: Low severity fire creates sagebrush/grass mosaic.
- 1.3b: High severity fire significantly reduces sagebrush cover leading to early/mid seral community.

Transition T1A: Introduction of non-native species

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.
- 2.1b: Time and lack of disturbance. Inappropriate grazing management and/or long-term drought may also reduce perennial understory.
- 2.2a: Time and lack of disturbance allows for shrub regeneration.
- 2.3a: Low severity fire creates sagebrush/grass mosaic. Brush treatments with minimal soil disturbance; late-fall/winter grazing causing mechanical damage to sagebrush would reduce the shrub overstory.
- 2.3b: High severity fire significantly reduces sagebrush cover leading to early/mid seral community.

Transition T2A: Grazing management favoring shrubs and/or Mule's ear/balsamroot.

Shrub State 3.0 Community Pathways

- 3.1a: Fire.
- 3.2a: Time without disturbance.

Figure 6. T. Stringham 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 Idaho fescue/low sagebrush

The reference plant community is dominated by Idaho fescue and low sagebrush. Potential vegetative composition is about 60 percent grasses, 15 percent forbs and 20 percent shrubs. Approximate ground cover (basal and crown) is 35 to 50 percent.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	260	390	520
Shrub/Vine	80	120	160
Forb	60	90	120
Total	400	600	800

Community 1.2 Herbaceous

This community phase is characteristic of a post-disturbance, early/mid-seral community. Idaho fescue, bluebunch wheatgrass, Thurber's needlegrass and other perennial bunchgrasses and forbs dominate. Depending on fire severity patches of intact sagebrush may remain. Rabbitbrush and other sprouting shrubs may be sprouting. Perennial forbs may be a significant component for a number of years following fire.

Community 1.3 Low sagebrush

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 will decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses and forbs to dominate the site. Fires will typically be low severity resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring 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 sagebrush to dominate the site.

Pathway 1.2a Community 1.2 to 1.1

Time and lack of disturbance will allow sagebrush to increase.

Pathway 1.3a Community 1.3 to 1.1

A low severity fire, herbivory or combinations will reduce the sagebrush overstory and create a sagebrush/grass mosaic.

Pathway 1.3b 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 may be high severity in this community phase due to the dominance of sagebrush resulting in removal of overstory shrub community.

State 2

Current Potential State

This state is similar to the Reference State 1.0, though an additional 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

Idaho fescue/low sagebrush/annual non-native species present

This community phase is compositionally similar to the Reference State Community Phase 1.1 with the presence non-native species in trace amounts. This community is dominated by Idaho fescue with a large component of low sagebrush. Bluegrass and antelope bitterbrush are common within the community. An assortment of perennial forbs is present and may comprise a significant portion of total production.

Community 2.2

Herbaceous

This community phase is characteristic of a post-disturbance, early to mid-seral community where annual non-native species are present. Sagebrush is present in trace amounts; perennial bunchgrasses and forbs dominate the site. Depending on fire severity patches of intact sagebrush may remain. Rabbitbrush may be sprouting or dominant in the community. Perennial forbs may be a significant component for a number of years following fire. Annual non-native species are stable or increasing within the community.

Community 2.3

Low sagebrush/perennial forbs/Sandberg bluegrass/annual non-native species present (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-dominant 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 inappropriate grazing management, 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 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.

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 2.3a

Community 2.3 to 2.1

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

Pathway 2.3b

Community 2.3 to 2.2

Fire eliminates/reduces the overstory of sagebrush and allows for the understory perennial grasses and forbs to increase. Fires may be high severity in this community phase due to the dominance of sagebrush resulting in removal of overstory shrub community. Annual non-native species respond well to fire and may increase post-burn.

State 3

Shrub State

This state has two community phases and is a product of many years of inappropriate grazing management during time periods harmful to perennial bunchgrasses. Sandberg bluegrass will increase with a reduction in deep rooted perennial bunchgrass competition and become the dominant grass. Sagebrush dominates the overstory and rabbitbrush may be a significant component. Sagebrush cover increases and may be decadent, reflecting stand maturity and lack of seedling establishment due to competition with mature plants. The shrub overstory and bluegrass understory dominate site resources such that soil water, nutrient capture, nutrient cycling and soil organic matter are temporally and spatially redistributed.

Community 3.1

Low sagebrush/Sandberg bluegrass/forbs/annual non-native species present

Decadent sagebrush dominates the overstory. Rabbitbrush may be a significant component. 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 is significant. Mule-ears, balsamroot and other perennial forbs may make up a significant component of the understory. Some excessive pedestalling of grasses may be seen. Bare ground may be increasing.

Community 3.2

Sandberg bluegrass/forbs/annual non-native species (at risk)

Bluegrass dominates the site; annual non-native species may be present but are not dominant. Rabbitbrush may be sprouting. Mule-ears, balsamroot and other perennial forbs may make up a significant component of the understory. Trace amounts of sagebrush may be present.

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.

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 establishment of low sagebrush can take many years.

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 grazing management will decrease or eliminate deep rooted perennial bunchgrasses, increase Sandberg bluegrass and muttongrass and favor shrub growth and establishment. To Community Phase 3.2: Severe fire in community phase 2.3 will remove sagebrush overstory, decrease perennial bunchgrasses and enhance Sandberg bluegrass and annual non-native species. Slow variables: Long term decrease in deep-rooted perennial grass density and reduction in organic matter. Threshold: Loss of deep-rooted perennial bunchgrasses changes nutrient cycling, nutrient redistribution, and reduces soil organic matter and results in decreased soil moisture.

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			294–474	
	Idaho fescue	FEID	<i>Festuca idahoensis</i>	240–300	–
	Cusick's bluegrass	POCU3	<i>Poa cusickii</i>	30–90	–
	onespike danthonia	DAUN	<i>Danthonia unispicata</i>	12–54	–
	bluebunch wheatgrass	PSSPS	<i>Pseudoroegneria spicata ssp. spicata</i>	12–30	–
2	Secondary Perennial Grasses			12–48	
	needlegrass	ACHNA	<i>Achnatherum</i>	3–12	–
	sedge	CAREX	<i>Carex</i>	3–12	–
	big squirreltail	ELMU3	<i>Elymus multisetus</i>	3–12	–
	spike fescue	LEKI2	<i>Leucopoa kingii</i>	3–12	–
	Sandberg bluegrass	POSE	<i>Poa secunda</i>	3–12	–
Forb					
3	Perennial			60–120	
	aster	ASTER	<i>Aster</i>	3–30	–
	milkvetch	ASTRA	<i>Astragalus</i>	3–30	–
	California balsamroot	BAMA3	<i>Balsamorhiza macrolepis</i>	3–30	–
	arrowleaf balsamroot	BASA3	<i>Balsamorhiza sagittata</i>	3–30	–
	tapertip hawksbeard	CRAC2	<i>Crepis acuminata</i>	3–30	–
	buckwheat	ERIOG	<i>Eriogonum</i>	3–30	–
	lupine	LUPIN	<i>Lupinus</i>	3–30	–
	phlox	PHLOX	<i>Phlox</i>	3–30	–
	clover	TRIFO	<i>Trifolium</i>	3–30	–
	mule-ears	WYAM	<i>Wyethia amplexicaulis</i>	3–30	–
Shrub/Vine					
4	Primary Shrubs			60–120	
	little sagebrush	ARAR8	<i>Artemisia arbuscula</i>	60–120	–
5	Secondary Shrubs			12–30	
	Utah serviceberry	AMUT	<i>Amelanchier utahensis</i>	3–12	–
	yellow rabbitbrush	CHV18	<i>Chrysothamnus viscidiflorus</i>	3–12	–
	antelope bitterbrush	PUTR2	<i>Purshia tridentata</i>	3–12	–
	mountain snowberry	SYOR2	<i>Symphoricarpos oreophilus</i>	3–12	–

Animal community

Livestock Interpretations:

This site is suited to 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.

In general, bunchgrasses best tolerate light grazing after seed formation. Britton and others (1979) observed the effects of harvest date on basal area of 5 bunchgrasses in eastern Oregon, including Idaho fescue, and found grazing from August to October (after seed set) has the least impact on these bunchgrasses. Therefore, abusive grazing during the growing season will reduce perennial bunchgrasses, with the exception of Sandberg bluegrass (Tisdale and Hironaka 1981). Abusive grazing by cattle or horses will likely increase low sagebrush, rabbitbrush and some forbs such as arrowleaf balsamroot. Annual non-native weedy species may invade, such as cheatgrass and mustards, and potentially medusahead.

Reduced bunchgrass vigor or density provides an opportunity for Sandberg bluegrass expansion and/or cheatgrass and other invasive species to occupy interspaces. Bluegrass is a widespread, palatable forage grass; Sandberg's bluegrass is one of the earliest grasses in the spring and is sought by domestic livestock and several wildlife species. Its production is closely tied to weather conditions; little forage is produced in drought years, making it a less dependable food source than other perennial bunchgrasses. Sandberg bluegrass increases under grazing pressure (Tisdale and Hironaka 1981) and is capable of co-existing with cheatgrass or other weedy species. Excessive sheep grazing favors Sandberg bluegrass; however, where cattle are the dominant grazers, cheatgrass often dominates (Daubenmire 1970). Thus, depending on the season of use, the grazer and site conditions, either Sandberg bluegrass or cheatgrass may become the dominant understory with inappropriate grazing management.

Though Cusick's bluegrass makes up only a small proportion of the biomass of the sagebrush communities in which it lives, it is often taken preferentially by cattle, especially early in the season.

Idaho fescue provides important forage for many types of domestic livestock. The foliage cures well and is preferred by livestock in late fall and winter. Idaho fescue tolerates light to moderate grazing (Ganskopp and Bedell 1980) and is moderately resistant to trampling (Cole 1987). Heavy grazing may lead to replacement of Idaho fescue with non-native species such as cheatgrass (Mueggler 1984).

Domestic sheep and, to a much lesser degree, cattle consume low sagebrush, particularly during the spring, fall, and winter (Sheehy and Winward 1981). Heavy dormant season grazing by sheep will reduce sagebrush cover and increase grass production (Laycock 1967). Severe trampling damage to supersaturated soils may occur if sites are used in early spring when there is abundant snowmelt. Trampling damage, particularly from cattle or horses, in low sagebrush habitat types is greatest when high clay content soils are wet. In drier areas that contain more gravelly soils, no serious trampling damage occurs, even when the soils are wet (Hironaka et al. 1983).

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

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:

Idaho fescue is an important source of forage for pronghorn and deer in ranges of northern Nevada.

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

Recreational uses

Aesthetic value is derived from the lush verdure of native grasses in the spring and early summer on this site. This site has rewarding opportunities for nature study and photography.

Other information

Low sagebrush can be successfully transplanted or seeded in restoration.

Inventory data references

Soils and Physiographic features were gathered from NASIS.

Type locality

Location 1: Elko County, NV	
General legal description	Occurs in Elko and Humboldt counties, Nevada.

Other references

- Anderson, E. W. and R. J. Scherzinger. 1975. Improving quality of winter forage for elk by cattle grazing. *Journal of Range Management* 28: 120-125.
- Baker, W. L. 2006. Fire and restoration of sagebrush ecosystems. *Wildlife Society Bulletin* 34: 177-185.
- Barnett, J. K. and J. A. Crawford. 1994. Pre-laying nutrition of sage grouse hens in Oregon. *Journal of Range Management* 47: 114-118.
- Barney, M. A. and N. C. Frischknecht. 1974. Vegetation changes following fire in the pinyon-juniper type of west-central Utah. *Journal of Range Management* 27 :91-96.
- Barrington, M., S. Bunting, and G. Wright. 1988. A fire management plan for Craters of the Moon National Monument. Cooperative Agreement CA-9000-8-0005. Moscow, ID: University of Idaho, Range Resources Department. 52 p. Draft.
- Bates, J. D., T. Svejcar, R. F. Miller, and R. A. Angell. 2006. The effects of precipitation timing on sagebrush steppe vegetation. *Journal of Arid Environments* 64: 670-697.
- Beardall, L. E. and V. E. Sylvester. 1976. Spring burning of removal of sagebrush competition in Nevada. In: Tall Timbers Fire Ecology conference and proceedings. Tall Timbers Research Station. 14: 539-547.
- Blaisdell, J. P., R. B. Murray, and E. D. McArthur. 1982. Managing intermountain rangelands - sagebrush-grass ranges. Gen. Tech. Rep. INT-134. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT. p. 41.
- Blaisdell, J. P. and W. F. Mueggler. 1956. Sprouting of bitterbrush (*Purshia tridentata*) following burning or top removal. *Ecology* 37:365-370.
- Blaisdell, J. P. and J. F. Pechanec. 1949. Effects of herbage removal at various dates on vigor of bluebunch wheatgrass and arrowleaf balsamroot. *Ecology* 30:298-305.
- Bradley, A. F., N. V. Noste, and W. C. Fischer. 1992. Fire ecology of forests and woodlands in Utah. Gen. Tech. Rep. INT-287. U.S. Department of Agriculture, Forest Service, Intermountain Research Station. P. 128.
- Britton, C.M., F.A. Sneva, and R.G. Clark. 1979. Effect of harvest date on five bunchgrasses of eastern Oregon. In: 1979 progress report: research in rangeland management. Special report 549. Corvallis, OR: Oregon State University, Agricultural Experiment Station: Pgs 16-19. In cooperation with: U.S. Department of Agriculture, SEA-AR.
- Britton, C. M., G. R. McPherson, and F. A. Sneva. 1990. Effects of burning and clipping on five bunchgrasses in eastern Oregon. *Great Basin Naturalist* 50:115-120.
- Bunting, S. 1994. Effects of fire on juniper woodland ecosystems in the Great Basin. In: S. Monsen, S. Kitchen [eds] Proceedings - Ecology and management of annual rangelands. Gen. Tech. Rep. INT-GTR-313. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT. p. 53-55.
- Busse, D., A. Simon, and M. Riegel. 2000. Tree-growth and understory responses to low-severity prescribed burning in thinned *Pinus ponderosa* forests of central Oregon. *Forest Science* 46:258-268.
- Busso, C. A. and J. H. Richards. 1995. Drought and clipping effects on tiller demography and growth of two tussock grasses in Utah. *Journal of Arid Environments* 29: 239-251.
- Caudle, D., J. DiBenedetto, M. Karl, H. Sanchez, and C. Talbot. 2013. Interagency Ecological Site Handbook for Rangelands. Available at: <http://jornada.nmsu.edu/sites/jornada.nmsu.edu/files/InteragencyEcolSiteHandbook.pdf>. Accessed 4 October 2013.

- Chambers, J., B. Bradley, C. Brown, C. D'Antonio, M. Germino, J. Grace, S. Hardegree, R. Miller, and D. Pyke. 2013. Resilience to stress and disturbance, and resistance to *Bromus tectorum* L. invasion in cold desert shrublands of western North America. *Ecosystems* 17:1-16.
- Chambers, J. C., B. A. Roundy, R. R. Blank, S. E. Meyer, and A. Whittaker. 2007. What makes Great Basin sagebrush ecosystems invasible by *Bromus tectorum*? *Ecological Monographs* 77:117-145.
- Clark, R. G., M. B. Carlton, and F. A. Sneva. 1982. Mortality of bitterbrush after burning and blipping in eastern Oregon. *Journal of Range Management* 35:711-714.
- Clements, C. D. and J. A. Young. 2002. Restoring antelope bitterbrush. *Rangelands* 24:3-6.
- Cole, D.N. 1987. Effects of three seasons of experimental trampling on five montane forest communities and a grassland in western Montana, USA. *Biological Conservation* 40:219-244.
- Comstock, J. P. and J. R. Ehleringer. 1992. Plant adaptation in the Great Basin and Colorado Plateau. *Western North American Naturalist* 52:195-215.
- Conrad, C. E. and C. E. Poulton. 1966. Effect of a wildfire on Idaho fescue and bluebunch wheatgrass. *Journal of Range Management* 19: 138-141.
- Cook, J. G., T. J. Hershey, and L. L. Irwin. 1994. Vegetative response to burning on Wyoming mountain-shrub big game ranges. *Journal of Range Management* 47: 296-302.
- Currie, P. O., D. W. Reichert, J. C. Malechek, and O. C. Wallmo. 1977. Forage selection comparisons for mule deer and cattle under managed ponderosa pine. *Journal of Range Management* 30: 352-356.
- Daubenmire, R. 1970. Steppe vegetation of Washington. Technical bulletin. Washington Agriculture Experiment Station. 131 pp.
- Daubenmire, R. 1975. Plant succession on abandoned fields, and fire influences in a steppe area in Southeastern Washington. *Northwest Science* 49: 36-48.
- Dayton, W. 1937. Range Plant Handbook. USDA, Forest Service. Bull.
- Dobrowolski, J. P., M. M. Caldwell, and J. H. Richards. 1990. Basin hydrology and plant root systems. In: C. B. Osmand, L. F. Pitelka, G. M. Hildy [eds]. *Plant biology of the basin and range*. *Ecological Studies*. 80: 243-292.
- Eckert, R. E., Jr. and J. S. Spencer. 1987. Growth and reproduction of grasses heavily grazed under rest-rotation management. *Journal of Range Management* 40: 156-159.
- Evans, R. A. and J. A. Young. 1978. Effectiveness of rehabilitation practices following wildfire in a degraded big sagebrush-downy brome community. *Journal of Range Management* 31: 185-188.
- Everett, R. L. and K. Ward. 1984. Early plant succession on pinyon-juniper controlled burns. *Northwest Science* 58: 57-68.
- Furniss, M. M. and W. F. Barr. 1975. Insects affecting important native shrubs of the northwestern United States. General Technical Report INT-19. Intermountain Forest and Range Experiment Station, U.S. Department of Agriculture, Forest Service. Ogden, UT. p. 68.
- Ganskopp, D. 1988. Defoliation of Thurber needlegrass: Herbage and root responses. *Journal of Range Management* 41:472-476.
- Garrison, G. A. 1953. Effects of clipping on some range shrubs. *Journal of Range Management* 6:309-317.
- Hironaka, M., M. A. Fosberg, and A. H. Winward. 1983. Sagebrush-grass habitat types of southern Idaho. Bulletin Number 35. University of Idaho, Forest, Wildlife and Range Experiment Station, Moscow, ID.

- Houghton, J.G., C.M. Sakamoto, and R.O. Gifford. 1975. Nevada's weather and climate, Special Publication 2. Nevada Bureau of Mines and Geology, Mackay School of Mines, University of Nevada, Reno, NV.
- Jensen, M.E. 1990. Interpretation of environmental gradients which influence sagebrush community distribution in northeastern Nevada. *J. of Range Management* 43:161-166.
- Johnson, C.G., Jr., R.R. Clausnitzer, P.J. Mehringer, and C. Oliver. 1994. Biotic and abiotic processes of eastside ecosystems: the effects of management on plant and community ecology and on stand and landscape vegetation dynamics. Gen. Tech. Rep. PNW-GTR-322. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 66 p.
- Kerns, B. K., W. G. Thies, and C. G. Niwa. 2006. Season and severity of prescribed burn in ponderosa pine forests: implications for understory native and exotic plants. *Ecoscience* 13: 44-55.
- Kindschy, R. R., C. S. Undstrom, and J. D. Yoakum. 1982. Wildlife habitats in managed rangelands - The Great Basin of southeastern Oregon: Pronghorns. Gen. Tech. Rep. PNW-GTR-145. Portland, OR. P. 18
- Kitchen, S. G. and E. D. McArthur. 2007. Big and black sagebrush landscapes. In: S. Hood, M. Miller [eds.]. Fire ecology and management of the major ecosystems of southern Utah. Gen. Tech. Rep. RMRMS-GTR-202. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO. P. 73-95.
- Koniak, S. 1985. Succession in pinyon-juniper woodlands following wildfire in the Great Basin. *The Great Basin Naturalist* 45:556-566.
- Kuntz, D.E. 1982. Plant response following spring burning in an *Artemisia tridentata* subsp. *vaseyana*/*Festuca idahoensis* habitat type. Moscow, ID: University of Idaho. 73 p. Thesis.
- Laycock, W. A. 1967. How heavy grazing and protection affect sagebrush-grass ranges. *Journal of Range Management* 20: 206-213.
- McConnell, B. R. and J. G. Smith. 1977. Influence of grazing on age-yield interactions in bitterbrush. *Journal of Range Management* 30: 91-93.
- Miller, R. F. and R. J. Tausch. 2000. The role of fire in pinyon and juniper woodlands: A descriptive analysis. In *Proceedings of the invasive species workshop: The role of fire in the control and spread of invasive species*. Fire conference. P. 15-30.
- Mueggler, W. F. 1975. Rate and pattern of vigor recovery in Idaho fescue and bluebunch wheatgrass. *Journal of Range Management* 28: 198-204.
- Mueggler, W. F. and J. P. Blaisdell. 1951. Replacing wyethia with desirable forage species. *Journal of Range Management* 4: 143-150.
- Murray, R. 1983. Response of antelope bitterbrush to burning and spraying in southeastern Idaho. In: Tiedemann, Arthur R.; Johnson, Kendall L., [eds.] *Research and management of bitterbrush and cliffrose in western North America*. General Technical Report INT-152. Ogden, UT: US Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station p. 142-152.
- National Oceanic and Atmospheric Administration. 2004. The North American Monsoon. Reports to the Nation. National Weather Service, Climate Prediction Center. Available online: <http://www.weather.gov>
- Richards, J. H. and M. M. Caldwell. 1987. Hydraulic lift: Substantial nocturnal water transport between soil layers by *Artemisia tridentata* roots. *Oecologia* 73:486-489.
- Robberecht, R. and G. Defossé. 1995. The relative sensitivity of two bunchgrass species to fire. *International Journal of Wildland Fire* 5:127-134.

- Sheehy, D. P. and A. H. Winward. 1981. Relative palatability of seven *Artemisia* taxa to mule deer and sheep. *Journal of Range Management* 34:397-399.
- Tausch, R. J. 1999. Historic pinyon and juniper woodland development. In: *Proceedings: Ecology and management of pinyon-juniper communities within the interior west RMRS-P-9*. Ogden, UT, USA: US Department of Agriculture, Forest Service, Rocky Mountain Research Station. P. 12-19.
- Tausch, R. J. and N. E. West. 1988. Differential establishment of pinyon and juniper following fire. *American Midland Naturalist* 119: 174-184.
- Tisdale, E. W. and M. Hironaka. 1981. *The sagebrush-grass region: A review of the ecological literature*. University of Idaho, Forest, Wildlife and Range Experiment Station. Moscow, ID. P. 31.
- Uresk, D. W., J. F. Cline, and W. H. Rickard. 1976. Impact of wildfire on three perennial grasses in south-central Washington. *Journal of Range Management* 29:309-310.
- Urness, P. J. 1965. *Influence of range improvement practices on composition, production, and utilization of Artemisia deer winter range in central Oregon*. Oregon State University.
- USDA-NRCS Plants Database (Online; <http://www.plants.usda.gov>).
- Vose, J. M. and A. S. White. 1991. Biomass response mechanisms of understory species the first year after prescribed burning in an Arizona ponderosa-pine community. *Forest Ecology and Management* 40: 175-187.
- Wood, M. K., Bruce A. Buchanan, & William Skeet. 1995. Shrub preference and utilization by big game on New Mexico reclaimed mine land. *Journal of Range Management* 48: 431-437.
- Wright, H. A. and J. O. Klemmedson. 1965. Effect of fire on bunchgrasses of the sagebrush-grass region in southern Idaho. *Ecology* 46: 680-688.
- Wright, H.A., L.F. Neuenschwander, and C.M. Britton. 1979. The role and use of fire in sagebrush-grass and pinyon-juniper plant communities: A state-of-the-art review. *Gen. Tech. Rep. INT-58*. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 48 p.
- Young, R.P. 1983. Fire as a vegetation management tool in rangelands of the intermountain region. In: Monsen, S.B. and N. Shaw (eds). *Managing intermountain rangelands — Improvement of range and wildlife habitats: Proceedings of symposia; 1981 September 15-17; Twin Falls, ID; 1982 June 22-24; Elko, NV*. *Gen. Tech. Rep. INT-157*. Ogden, UT. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. Pgs 18-31.

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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)	
Contact for lead author	
Date	04/26/2024
Approved by	Kendra Moseley
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

2. **Presence of water flow patterns:**

3. **Number and height of erosional pedestals or terracettes:**

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

5. **Number of gullies and erosion associated with gullies:**

6. **Extent of wind scoured, blowouts and/or depositional areas:**

7. **Amount of litter movement (describe size and distance expected to travel):**

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

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

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:

Sub-dominant:

Other:

Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**
-

14. **Average percent litter cover (%) and depth (in):**
-

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):**
-

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

17. **Perennial plant reproductive capability:**
-