Ecological site R025XY019NV
LOAMY 8-10 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

The Owyhee High Plateau, MLRA 25, lies within the Intermontane Plateaus physiographic province. The southern half is found in the Great Basin while the northern half is located in the Columbia Plateaus. The southern section of the Owyhee High Plateau 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 section forms the southern boundary of the extensive Columbia Plateau basalt flows. Deep, narrow canyons drain to the Snake River across the broad volcanic plain.

This MLRA is characteristically cooler and wetter than the neighboring MLRAs of the Great Basin. 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 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. Precipitation occurs mainly as snow in winter. The supply of water from precipitation and streamflow is small and unreliable, except along major rivers. Streamflow depends largely on accumulated snow in the mountains.

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, arid bordering on xeric, or xeric moisture regime. Most of the soils formed in mixed parent material. Volcanic ash and loess mantle the landscape. Surface soil textures are loam and silt loam, and have ashy texture modifiers in some cases. Argillic horizons occur on the more stable landforms.

Ecological site concept

This ecological site is associated with fan piedmont landscapes. It is typically on fan remnants or pediments. Slopes range from 4 to 30 percent with elevations of 4,500 to 6,000 feet (1,372 to 1,829 meters). Soils are very deep, well drained, characterized by high runoff and formed in mixed alluvium. Important abiotic factors contributing to this site include a light colored surface horizon (ochric epipedon), accumulation of clay (argillic horizon) 1.2 to 8.0 inches (3 to 20cm) from soil surface and a subsurface horizon strongly cemented with silica and calcium carbonates (duripan) between 20 to 39 inches (50 to 100cm). The reference plant community is dominated by Wyoming big sagebrush and Thurber's needlegrass.

Associated sites

F025XY059NV	**Gravelly Juniper**
R025XY006NV	**DRY MEADOW**
R025XY014NV	**LOAMY 10-12 P.Z.**
R025XY015NV	**SOUTH SLOPE 8-12 P.Z.**
R025XY018NV	**CLAYPAN 10-12 P.Z.**

R025XY025NV	**CHALKY KNOLL**

Similar sites

R025XY014NV	**LOAMY 10-12 P.Z.** More productive site; soils with a dark surface horizon (mollic)
R025XY066NV	**ASHY LOAM 10-12 P.Z.** More productive site; PONE3 and HECO26 important grasses; soils derived from volcanic ash with ashy textures throughout
R025XY021NV	**SHALLOW LOAM 8-12 P.Z.** Less productive site; soils 36-50cm to a duripan
R025XY015NV	**SOUTH SLOPE 8-12 P.Z.** PSSPS dominant plant; occurs on south facing slopes greater than 15 percent.
R025XY045NV	**ASHY LOAM 8-10 P.Z.** HECO26-ACHY codominant grasses; soils high in volcanic ash

Table 1. Dominant plant species

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

Physiographic features

This ecological site is associated with fan piedmont landscapes. It is typically on fan remnants or rock pediments. Slopes range from 4 to 30 percent with elevations of 4,500-6,000 feet (1,372 to 1,829 meters).

Table 2. Representative physiographic features

Landforms	(1) Fan piedmont > Fan remnant (2) Rock pediment
Runoff class	High to very high
Flooding frequency	None
Elevation	4,500–6,000 ft
Slope	4–30%
Water table depth	150 in
Aspect	Aspect is not a significant factor

Climatic features

The climate associated with this site is defined by hot dry summers and cold snowy winters. This site is characterized by an estimated 110 freeze-free days annually. Mean annual precipitation is 10 inches (25cm), with effective precipitation between 8 to 10 inches (20 to 25cm).

*The above data is averaged from the Pine Valley and Wells climate stations, NASIS and, the Western Regional Climate Center (wrcc.dri.edu).

Table 3. Representative climatic features

Frost-free period (characteristic range)	80-120 days
Freeze-free period (characteristic range)	100-145 days
Precipitation total (characteristic range)	7-12 in

Frost-free period (actual range)	80-120 days
Freeze-free period (actual range)	100-145 days
Precipitation total (actual range)	5-20 in
Frost-free period (average)	100 days
Freeze-free period (average)	110 days
Precipitation total (average)	10 in

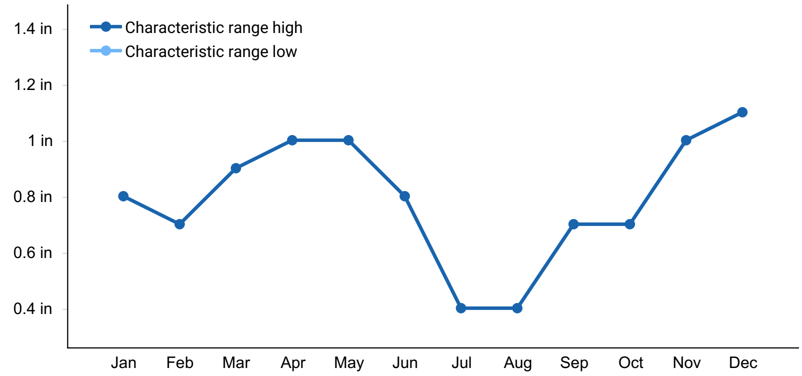


Figure 1. Monthly precipitation range

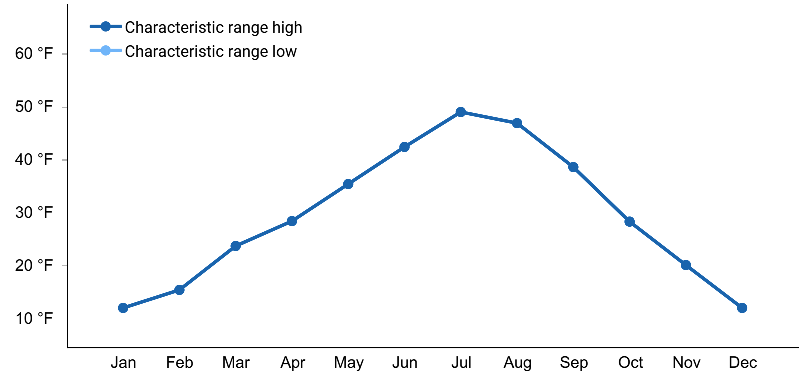


Figure 2. Monthly minimum temperature range

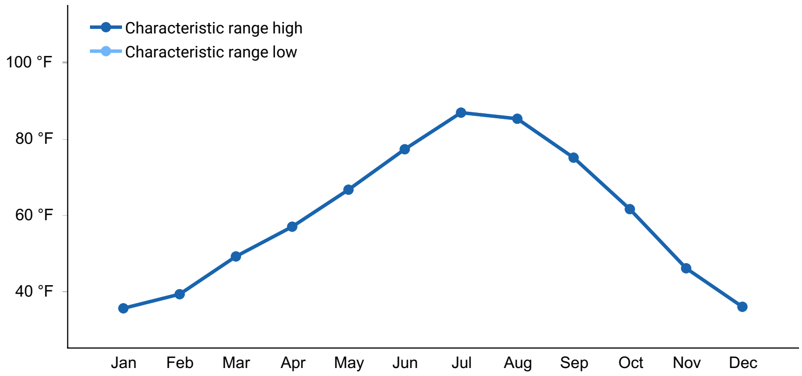


Figure 3. Monthly maximum temperature range

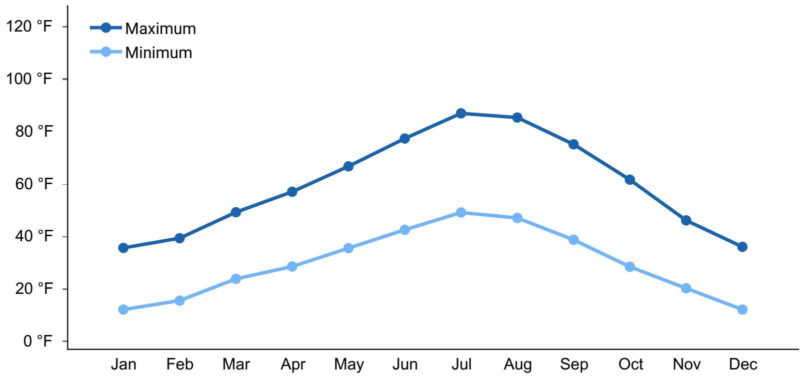


Figure 4. Monthly average minimum and maximum temperature

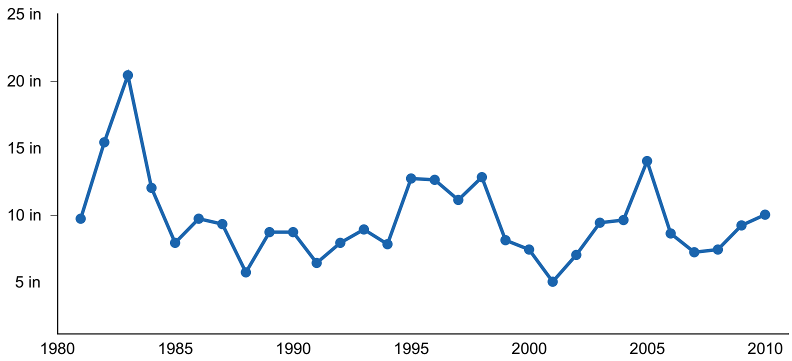


Figure 5. Annual precipitation pattern

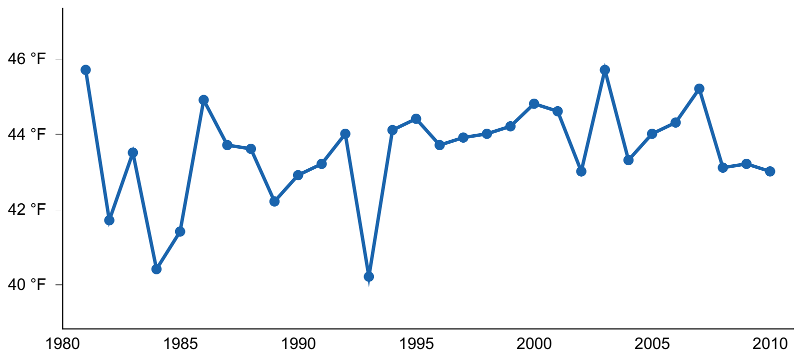


Figure 6. Annual average temperature pattern

Climate stations used

- (1) WELLS [USC00268988], Wells, NV

Influencing water features

Influencing water features are not associated with this site.

Soil features

These soils are formed in alluvium derived from mixed rocks with a component of loess and volcanic ash. Surface textures are loamy or gravely loam. The soil profile is characterized by a light-colored surface horizon, less than 20 percent rock fragments by volume, and greater than 35 percent clay in the particle size control section.
Soils are well drained and very deep. Soil reaction increases with soil depth and slight or moderate concentrations of salts (carbonate and gypsum) in the lower subsoil. Soils associated with this site have an accumulation of clay (argillic horizon) within 14 inches (35cm) of the soil surface and a subsurface horizon strongly cemented with silica and calcium carbonates (duripan) below 24 inches (60cm).

Representative soil components associated with this ecological site include Hunnton, Wieland, Enko, Dacker, Zevadez, Orovada and Kelk.

Where this site is correlated to shallow soils including Chiara, Dewar, Bartome, Yuko, Buffaram, Chuska, Tuffo and Shabliss full consideration should be given to recorrelating to a more appropriate site concept.

Table 4. Representative soil features

Parent material	(1) Alluvium–volcanic rock
Surface texture	(1) Loam (2) Gravelly loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Slow to moderate
Depth to restrictive layer	40–84 in
Soil depth	40–84 in
Surface fragment cover <=3"	8–26%
Surface fragment cover >3"	2–3%
Available water capacity (0-40in)	0–2 in
Soil reaction (1:1 water) (0-40in)	6.6–9
Subsurface fragment volume <=3" (Depth not specified)	12–25%
Subsurface fragment volume >3" (Depth not specified)	2–5%

Ecological dynamics

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

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

Variability in plant community composition and production depends on soil surface texture and depth. Thurber's needlegrass will increase on gravelly soils, whereas Indian ricegrass will increase with sandy soil surfaces, and bottlebrush squirreltail will increase with silty soil surfaces. A weak argillic horizon will promote production of bluebunch wheatgrass. Production generally increases with soil depth. The amount of sagebrush in the plant community is dependent upon disturbances like fire, Aroga moth infestations, and grazing. Sandberg bluegrass more easily dominates sites where surface soils are gravelly loams or when there is an increase in ash in the upper soil profile.

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

Native insect outbreaks are also important drivers of ecosystem dynamics in sagebrush communities. Climate is generally believed to influence the timing of insect outbreaks especially a sagebrush defoliator, Aroga moth (Aroga websteri). Aroga moth infestations have occurred in the Great Basin in the 1960s, early 1970s, and have been ongoing in Nevada since 2004 (Bentz, et al 2008). Thousands of acres of big sagebrush have been impacted, with partial to complete die-off observed. Aroga moth can partially or entirely kill individual plants or entire stands of big sagebrush (Furniss and Barr 1975).

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

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

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

At the upper elevational range of this site, there is potential for infilling by Utah juniper (*Juniperus osteosperma*) and/or singleleaf pinyon (*Pinus monophylla*). Infilling may also occur if the site is adjacent to woodland sites or other ecological sites with juniper present. Without disturbance in these areas, Utah juniper will eventually dominate the site and out-compete sagebrush for water and sunlight severely reducing both the shrub and herbaceous understory (Miller and Tausch 2000, Lett and Knapp 2005). The potential for soil erosion increases as the woodland matures and the understory plant community cover declines (Pierson et al. 2010).

This site has low resilience to disturbance and low resistance to invasion. Increased resilience increases with elevation, aspect, increased precipitation and increased nutrient availability. Five possible stable states have been identified for the Loamy 8-10” ecological site.

Fire Ecology:
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 (Young et al. 1979, West and Hassan 1985, Bunting et al. 1987). Davies et al. (2006) 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 to 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). 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 correlated to duration and intensity of heat which is related to culm density, culm-leaf morphology, size of plant and abundance of old growth (Wright 1971, Young 1983).

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. 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 influenced the response and mortality of Thurber's needlegrass, smaller bunch sizes were less likely to be damaged by fire (Wright and Klemmedson 1965). Reestablishment on burned sites has been found to be relatively slow due to low germination and 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).

Fire will remove aboveground biomass from bluebunch wheatgrass but plant mortality is generally low (Robberecht and Defossé 1995) because the buds are underground (Conrad and Poulton 1966) or protected by foliage. Uresk et al. (1976) reported burning increased vegetative and reproductive vigor of bluebunch wheatgrass. Thus, bluebunch wheatgrass is considered to experience slight damage to fire but is more susceptible in drought years (Young 1983). Plant response will vary depending on season, fire severity, fire intensity and post-fire soil moisture availability.

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

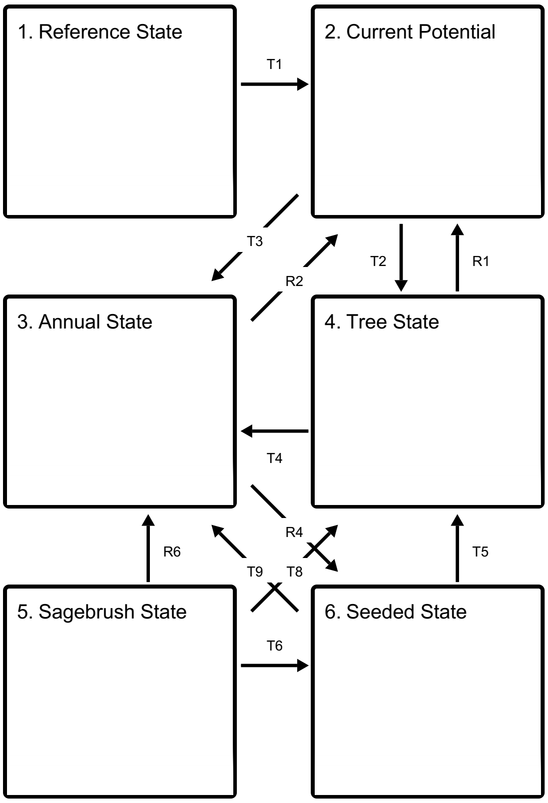
Sandberg bluegrass, a minor component of this ecological site, has been found to increase following fire likely due to its low stature and productivity (Daubenmire 1975). Sandberg bluegrass may retard reestablishment of deeper rooted bunchgrass. Reduced bunchgrass vigor or density provides an opportunity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

The range and density of Utah juniper and singleleaf pinyon has increased since the middle of the nineteenth century (Tausch 1999, Miller and Tausch 2000). Causes for expansion of trees into sagebrush ecosystems include wildfire suppression, historic livestock grazing, and climate change (Bunting 1994).

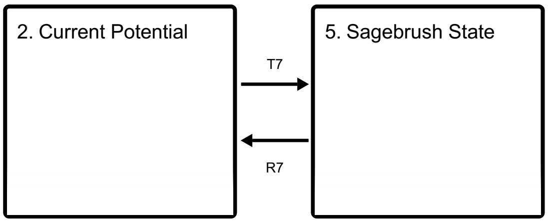
Depending on fire severity, rabbitbrush and horsebrush may increase after fire. Rubber rabbitbrush is top-killed by fire, but can resprout after fire and can also establish from seed (Young 1983). Yellow rabbitbrush is top-killed by fire, but sprouts vigorously after fire (Kuntz 1982, Akinsoji 1988). As cheatgrass increases, fire frequencies also increase to frequencies between 0.23 and 0.43 times a year; then even sprouting shrubs such as rabbitbrush will not survive (Whisenant 1990).

State and transition model

Ecosystem states



States 2 and 5 (additional transitions)



T1 - Introduction of annual non-native species.

T3 - Repeated, widespread and severe fire.

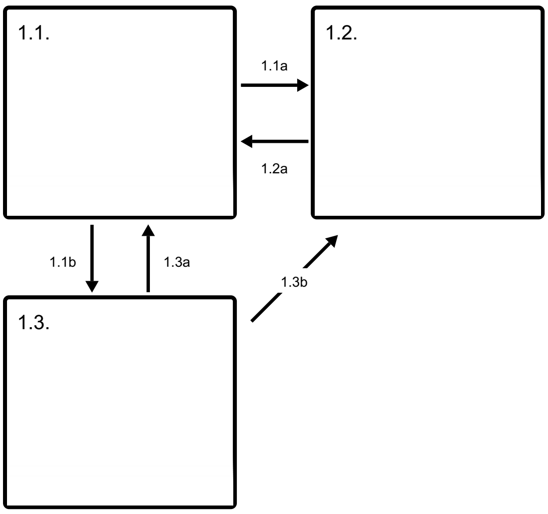
T2 - Wildfire Suppression

R2 - Seeding with native species/prescribed grazing

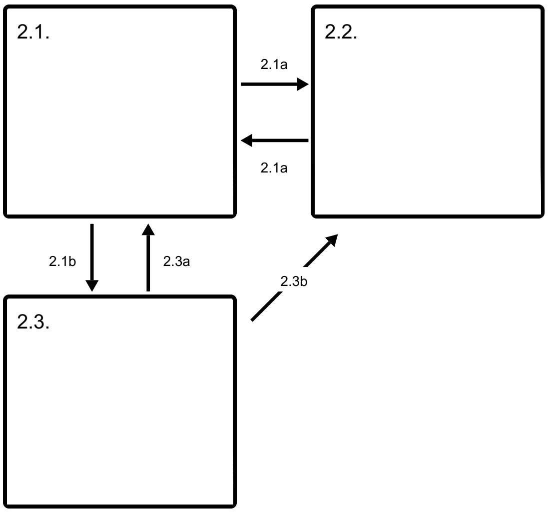
R1 - Tree Removal and seeding with native species

T4 - Catastrophic fire or a failed restoration attempt

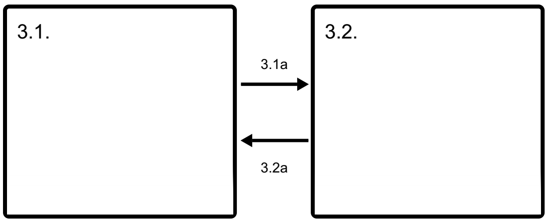
State 1 submodel, plant communities



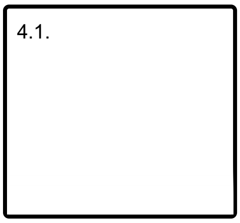
State 2 submodel, plant communities



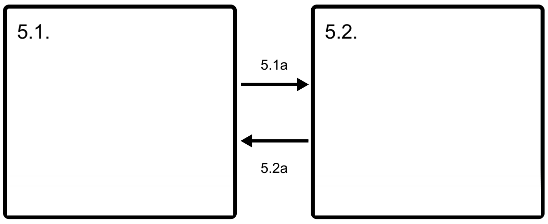
State 3 submodel, plant communities



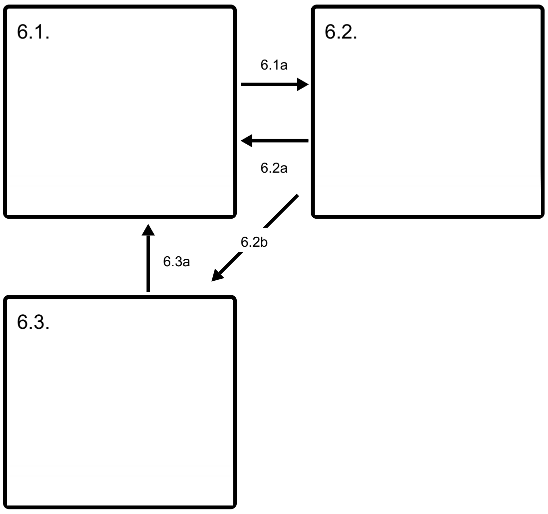
State 4 submodel, plant communities



State 5 submodel, plant communities



State 6 submodel, plant communities



State 1
Reference State

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

Dominant plant species

- little sagebrush (*Artemisia arbuscula ssp. arbuscula*), shrub
- Sandberg bluegrass (*Poa secunda*), grass
- bluebunch wheatgrass (*Pseudoroegneria spicata*), grass
- Idaho fescue (*Festuca idahoensis*), grass

Community 1.1

This community phase is characteristic of a mid-seral plant community and is dominated by Wyoming big sagebrush, bluebunch wheatgrass and Thurber's needlegrass. Potential vegetative composition by weight is about 65 percent grasses, 5 percent forbs and 30 percent shrubs. Total vegetative cover averages 20 to 30 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	120	180	240
Forb	20	30	40
Total	**400**	**600**	**800**

Community 1.2

This community phase is characterized by a post-disturbance, early seral, plant community. Sagebrush and other shrubs are reduced, or patchy. Perennial bunchgrasses and forbs dominate the visual aspect of the plant community. Disturbance tolerant shrubs such as rabbitbrush and antelope bitterbrush will sprout from the root-crown following low and medium intensity wildfire and may begin to dominate the plant community 2 to 5 years post-disturbance.

Community 1.3

Absence of disturbance allows sagebrush to mature and dominate the plant community. Perennial bunchgrasses and forbs are reduced in both vigor and productivity due to competition for light, moisture and nutrient resources. Juniper may also be increasing in cover and number of individual trees. Additional field work is need to determine the extent of juniper on this ecological site and determine if correlation to a more appropriate site is warranted.

Pathway 1.1a
Community 1.1 to 1.2

Wildfire. Low severity fire creates sagebrush/grass mosaic; higher intensity fires significantly reduce sagebrush cover and lead to early seral community dominated by grasses and forbs. Frequency and intensity of wildfire is primarily driven by cover and amount of herbaceous vegetation. Under pre-Eurosettlement conditions fire return interval is estimated to be between 20 and 50 years.

Pathway 1.1b
Community 1.1 to 1.3

Time, absence of disturbance and natural regeneration over time allows sagebrush to dominate site resources. This community phase pathway may be coupled with drought and/or herbivory further reducing herbaceous understory.

Pathway 1.2a
Community 1.2 to 1.1

Time, absence of disturbance and natural regeneration over time allows sagebrush to recover. Recovery of sagebrush depends on the availability of a local seed source (patches of mature shrubs) as well as precipitation patterns favorable for germination and seedling recruitment. Sagebrush seedlings are susceptible to less than favorable conditions for several years. Completion of this community phase pathways may take decades.

Pathway 1.3a
Community 1.3 to 1.1

Low intensity, patchy wildfire or insect infestation would reduce sagebrush overstory creating a mosaic on the landscape. Perennial bunchgrasses and forbs dominate disturbed patches due to an increase in light, moisture and nutrient resources.

Pathway 1.3b
Community 1.3 to 1.2

Wide spread wildfire removes sagebrush and allows perennial bunchgrasses and forbs to dominate.

State 2
Current Potential

This state is similar to the Reference State 1.0. Ecological function has not changed, however the resiliency of the state has been reduced by the presence of invasive weeds. This state has the same three general community phases. 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 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. Management would be to maintain high diversity of desired species to promote organic matter inputs and prevent the dispersal and seed production of the non-native invasive species.

Dominant plant species

- little sagebrush (*Artemisia arbuscula*), shrub
- cheatgrass (*Bromus tectorum*), grass
- Idaho fescue (*Festuca idahoensis*), grass
- bluebunch wheatgrass (*Pseudoroegneria spicata*), grass

Community 2.1

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

Resilience management. The presence of non-native annuals has reduced site resilience. Management actions should focus on maintaining the presence of all functional and structural groups and minimizing wildfire and soil disturbing practices.

Community 2.2

This community phase is characteristic of a post-disturbance, early seral community where annual non-native species are present. Perennial bunchgrasses and forbs recover rapidly following wildfire. Annual non-native species are stable or increasing within the community. Disturbance tolerant shrubs typically recover 2 to 5 years post fire and may dominate the sites for many years.

Community 2.3

This community phase is characterized by decadent sagebrush, reduced perennial bunchgrass and increasing bare ground. Annual non-natives species are stable or increasing due to lack of competition from perennial bunchgrasses. Sandberg bluegrass may increase and become co-dominate with remaining deep-rooted bunchgrasses. Juniper may also be increasing in cover and number of individual trees. Additional field work is need to determine the extent of juniper on this ecological site and determine if correlation to a more appropriate site is warranted.

Pathway 2.1a
Community 2.1 to 2.2

Fire reduces the shrub overstory and allows for perennial bunchgrasses to dominate the site. Fire may be patchy resulting in a mosaic pattern with patches of mature sagebrush remaining. 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. Mature sagebrush is controlling the spatial and temporal distribution of moisture, nutrient and light resources. Native perennial bunchgrasses are reduced due to competition for these resources. Non-native annuals are stable to increasing.

Pathway 2.1a
Community 2.2 to 2.1

Time, lack of disturbance and natural regeneration of sagebrush. The establishment of little sagebrush depends on presence of seed source and favorable weather patterns. It may take decades for sagebrush to recover to pre-disturbance levels.

Pathway 2.3a
Community 2.3 to 2.1

Low intensity wildfire, insect infestation, or brush management with minimal soil disturbance reduces sagebrush overstory and releases herbaceous understory.

Pathway 2.3b
Community 2.3 to 2.2

Fire reduces or eliminates the overstory of sagebrush and allows for the understory perennial grasses and forbs to increase. Annual non-native species respond well to fire and may increase post-burn.

State 3
Annual State

Annual non-natives dominated site productivity and site resources. The dominance of non-native annuals control the spatial and temporal distribution of soil moisture, soil nutrients and energy resources. Remaining patches of sagebrush and/or perennial bunchgrass suffer from increased competition and narrowed fire return intervals.

Characteristics and indicators. This state experiences frequent fire due to increased cover and continuity of fine fuels. Fire is frequent enough to prevent the recovery of long-lived native perennials like mountain big sagebrush. Disturbance tolerant shrubs may be present or increasing depending on time since disturbance.

Dominant plant species

- cheatgrass (*Bromus tectorum*), grass

- tansymustard (*Descurainia*), grass
- medusahead (*Taeniatherum*), grass
- fescue (*Vulpia*), grass
- bulbous bluegrass (*Poa bulbosa*), grass

Community 3.1

This community phase in dominated by annual non-native plants such as medusahead or cheatgrass and shallow-rooted perennial grasses like Sandberg bluegrass. Sprouting shrubs such as rabbitbrush may also common. Patches of mature sagebrush may or may not be present.

Community 3.2

This community phase is characteristic of a post-wildfire community where annual non-natives are controlling site resources. Depending on season and/or intensity of fire the visually aspect of the site in dominated annual non-natives and bare ground. Site may be experiencing soil loss.

Resilience management. This community phases is high susceptible to frequent and repeated wildfire. Best management practices prevent sites from reaching this community phase. Management options are extremely limited.

Pathway 3.1a
Community 3.1 to 3.2

Fire reduces or eliminates the overstory shrubs and shallow-rooted perennials and allows for annual non-natives to increase

Pathway 3.2a
Community 3.2 to 3.1

Time and lack of fire allows for sagebrush/rabbitbrush to establish. Probability of sagebrush establishment is very unlikely and dependent on a near-by seed source from unburned patches of sagebrush.

State 4
Tree State

This state is characterized by a dominance of Utah juniper. Sagebrush and perennial bunchgrasses may still be present, but they are no longer controlling site resources. Soil moisture, soil nutrients and soil organic matter distribution and nutrient cycling have been spatially and temporally altered. This state is relatively stable due to rapid growth rate and long life span of juniper.

Dominant plant species

- Utah juniper (*Juniperus osteosperma*), tree

Community 4.1

Juniper dominates overstory and site resources. Trees are actively growing and seedlings may be present. The shrub and grass understory is reduced. Sagebrush is stressed and dying. Trace amounts Sandberg bluegrass and forbs may be found in the interspaces. Annual non-native species are present under tree canopies. Bare ground areas are large and connected.

State 5
Sagebrush State

Wyoming big sagebrush and rabbitbrush dominate.

Community 5.1

Wyoming big sagebrush and rabbitbrush dominate overstory. Bluegrass dominates understory with annuals present. Junipers could be present with a sparse understory.

Community 5.2

Bluegrass dominates with annuals present. Sagebrush or rabbitbrush may be present.

Pathway 5.1a
Community 5.1 to 5.2

Wildfire or insect infestation.

Pathway 5.2a
Community 5.2 to 5.1

Lack of disturbance and time.

State 6
Seeded State

Forage for livestock is planted.

Community 6.1

Crested wheatgrass or other forage species dominates. Wyoming big sagebrush and other annuals may be present.

Community 6.2

Wyoming big sagebrush dominates overstory while crested wheatgrass dominates understory. Annual species are present.

Community 6.3

Wyoming big sagebrush is increasing while crested wheatgrass is decreasing. Annuals are increasing and juniper could be present.

Pathway 6.1a
Community 6.1 to 6.2

Time and lack of disturbance favor sagebrush establishment.

Pathway 6.2a
Community 6.2 to 6.1

Sagebrush management or insect infestation.

Pathway 6.2b
Community 6.2 to 6.3

Increasing grazing pressure decreases bunchgrass understory.

Pathway 6.3a
Community 6.3 to 6.1

Frequent, severe wildfire with planting.

Transition T1
State 1 to 2

Trigger: Introduction of annual non-native species Slow variable: Over time the annual non-native plants 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 T3
State 2 to 3

Trigger: Repeated, widespread and severe fire. Slow variables: Increased production and cover of non-native annual species over time. Threshold: Loss of deep-rooted perennial bunchgrasses and shrubs truncates, spatially and temporally, nutrient capture and cycling within the community.

Transition T2
State 2 to 4

Trigger: Presence of juniper Slow variables: Encroachment of juniper is primarily driven by lack of fire. This may also be coupled with prolonged drought and poor grazing management. Threshold: Juniper is now controlling energy, moisture and nutrient resources Dominance of juniper results in decreased infiltration and increased runoff, reducing soil moisture and nutrient cycling. Sagebrush and perennial bunchgrass are reduced both vigor and reproductive capacity.

Transition T7
State 2 to 5

Wildfire will reduce the dominance of shrubs and will provide resources and area for grasses to establish and grow.

Restoration pathway R2
State 3 to 2

Seeding with native species followed by prescribed grazing Minimize soil disturbance and maximize non-native annual plant biomass removal during early spring. Combine prescribed grazing with seeding of native species. Continue to protect site from wildfire. Probability of success is extremely low.

Restoration pathway R4
State 3 to 6

Severe, frequent wildfire or herbicide treatment will allow planted seeds to compete with the annuals that currently dominate the site.

Restoration pathway R1
State 4 to 2

Brush management/tree removal with minimal soil disturbance, coupled with seeding of native species. Probability of success very low.

Restoration pathway T4
State 4 to 3

Trigger: Catastrophic fire causing a stand replacing event. Or a failed restoration attempt including inappropriate tree removal or rangeland seeding using soil disturbing practices. Slow variables: Increased production and cover of non-native annual species under tree canopies. Threshold: Closed tree canopy with non-native annual species in the understory changes the intensity, size and spatial variability of wildfires. Changes in community composition are driven by temporal changes in energy capture, soil moisture and nutrient cycling and result in the loss of perennial bunchgrasses and sagebrush.

Restoration pathway R7
State 5 to 2

Inappropriate grazing management will lead to a decrease of native grasses and will allow more resources for brush species.

Restoration pathway R6
State 5 to 3

Brush management and seeding of grass species.

Transition T8
State 5 to 4

Time and wildfire suppression will favor tree species.

Transition T6
State 5 to 6

Brush management and seeding will allow planted grasses to become dominant due to greater availability of resources and lack of competition.

Transition T9
State 6 to 3

Wyoming big sagebrush and crested are eliminated on the site by severe, frequent wildfire. This will create sites where annuals can begin to dominate the landscape due to the availability of resources and little competition.

Transition T5
State 6 to 4

Time and wildfire suppression will allow juniper trees to develop and outcompete grasses for available resources.

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				260–520	
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	150–300	–
	Thurber's needlegrass	ACTH7	*Achnatherum thurberianum*	90–180	–
	Sandberg bluegrass	POSE	*Poa secunda*	10–20	–
	squirreltail	ELEL5	*Elymus elymoides*	2–4	–
	basin wildrye	LECI4	*Leymus cinereus*	2–4	–
	Webber needlegrass	ACWE3	*Achnatherum webberi*	2–4	–
	tufted wheatgrass	ELMA7	*Elymus macrourus*	2–4	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	2–4	–
Forb					
2				20–40	
	globemallow	SPHAE	*Sphaeralcea*	20–40	–
Shrub/Vine					
3				120–240	
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	100–200	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	5–10	–
	spiny hopsage	GRSP	*Grayia spinosa*	5–10	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	5–10	–
	antelope bitterbrush	PUTR2	*Purshia tridentata*	5–10	–

Animal community

Livestock Interpretations:
This site is suited for livestock grazing. Considerations for grazing management include timing, duration and intensity of grazing. Overgrazing leads to an increase in sagebrush and a decline in understory plants like bluebunch wheatgrass and Thurber’s needlegrass. Squirreltail or Sandberg bluegrass will increase temporarily with further degradation. Invasion of annual weedy forbs and cheatgrass could occur with further grazing degradation, leading to a decline in squirreltail and bluegrass and an increase in bare ground. A combination of overgrazing and prolonged drought leads to soil erosion, increased bare ground and a loss in plant production. 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. Although trees are not part of the site concept, Utah juniper and/or singleleaf pinyon can also invade and eventually dominate this site.

Thurber's needlegrass is an important forage source for livestock and wildlife in the arid regions of the West (Ganskopp 1988). Although the seeds are apparently not injurious, grazing animals avoid them when they begin to mature. Sheep, however, have been observed to graze the leaves closely, leaving stems untouched (Eckert and Spencer 1987). Heavy grazing during the growing season has been shown to reduce the basal area of Thurber’s needlegrass (Eckert and Spencer 1987), suggesting that both seasonality and utilization are important factors in management of this plant. A single defoliation, particularly during the boot stage, was found to reduce herbage production and root mass thus potentially lowering the competitive ability of this needlegrass (Ganskopp 1988).

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

Reduced bunchgrass vigor or density provides an opportunity for Sandberg bluegrass expansion and/or cheatgrass and other invasive species such as halogeton (Halogeton glomeratus), bur buttercup (Ceratocephala testiculata) and annual mustards to occupy interspaces. 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.

Wildlife Interpretations:
Many wildlife species are dependent on the sagebrush ecosystem including the greater sage grouse, sage sparrow, pygmy rabbit and the sagebrush vole. Dobkin and Sauder (2004) identified 61 species, including 24 mammals and 37 birds, associated with the shrub-steppe habitats of the Intermountain West. Wyoming big sagebrush is important to wildlife for both food and cover. Mountain big sagebrush is highly preferred and nutritious winter forage for mule deer, elk and pronghorn. Elk (Alces alces) and pronghorn antelope (Antilocapra americana) prefer mountain big sagebrush over basin and Wyoming sagebrush (Beale and Smith 1970, Wambolt 1996). A study by Brown (1977) determined that desert bighorn sheep (Ovis canadensis nelisoni) preferred big sagebrush over other shrub types; however, the variety was not noted. Welch and Wagstaff (1992) noted in a study near Provo, Utah, big sagebrush was highly preferred winter forage of mule deer (Odocoileus hemionus) over other available forage. Furthermore, wildlife use a variety of associated understory plants and soils that occur in big sagebrush habitat. For example: Sage grouse (Centrocercus urophasianus), sagebrush vole (Lemmiscus curtatus), Merriam’s shrew (Sorex merriami) and Preble’s shrew (Sorex preblei) use the grasses that occur with big sagebrush for nesting, cover and forage. Big sagebrush sandy soil sites provide burrowing opportunities and protection from predators for burrowing owls (Athene cunicularia), dark and pale kangaroo mice (Microdipodops megacephalus and Microdipodops pallidus, respectively). Several reptiles and amphibians are distributed throughout the sagebrush steppe in the west in Nevada, where basin big sagebrush is known to grow (Bernard and Brown 1977). Reptile species including: eastern racers (Coluber constrictor), ringneck snakes (Diadophis punctatus), night snakes (Hypsiglena torquata), Sonoran mountain kingsnakes (Lampropeltis pyromelana), striped whipsnakes (Masticophis taeniatus), gopher snakes (Pituophis catenifer), long-nosed snakes (Rhinoceheilus lecontei), wandering garter snakes (Thamnophis elegans vagrans), Great Basin rattlesnakes (Crotalus oreganus lutosus), Great Basin collared lizard (Crotaphytus bicinctores), long-nosed leopard lizard (Gambelia wislizenii), short-horned lizard (Phrynosoma douglassi), desert-horned lizard (Phrynosoma platyrhinos), sagebrush lizards (Sceloporus graciosus), western fence lizards (Sceloporus occidentalis), northern side-blotched lizards (Uta uta stansburiana), western skinks (Plestiodon skiltonianus), and Great Basin whiptails (Aspidoscelis tigris) occur in areas where sagebrush is dominant. Similarly, amphibians such as: western toads (Anaxyrus boreas), Woodhouse’s toads (Anaxyrus woodhousii), northern leopard frogs (Lithobates pipiens), Columbia spotted frogs (Rana luteiventris), bullfrogs (Lithobates catesbeianus), and Great Basin spadefoots (Spea intermontana) also occur throughout the Great Basin in areas sagebrush species are dominant (Hamilton 2004). Studies have not determined if reptiles and amphibians prefer certain species of sagebrush; however, researchers agree that maintaining habitat where basin big sagebrush and reptiles and amphibians occur is important. In fact, wildlife biologists have noticed declines in reptiles where sagebrush steppe habitat has been seeded with introduced grasses (West 1999 and ref. therein).

Sagebrush communities are important for maintaining lagomorph and rodent populations. Pygmy rabbits, sagebrush obligates, use sites with big sagebrush at a higher intensity than low sagebrush sites (Heady and Laundre 2005). A study by Larrison and Johnson (1973) captured more deer mice in big sagebrush communities than in any other plant community. Although specific varieties of big sagebrush are not mentioned in these studies, thus, suggests that deer mice prefer big sagebrush plant communities where mountain big sagebrush are present, for cover over other plant communities.

It should also be noted that sagebrush-grassland communities provide critical sage-grouse (Centrocercus urophaianus) 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 low to very high. The potential for sheet and rill erosion is moderate to high depending on slope. Pedestals are rare. Occurrence is usually limited to areas of water flow patterns. Fine litter (foliage from grasses and annual and perennial forbs)is expected to move the distance of slope length during intense summer convection storms or rapid snowmelt events. Persistent litter (large woody material) will remain in place except during large rainfall events. Perennial herbaceous plants (especially deep-rooted bunchgrasses) slow runoff and increase infiltration. Shrub canopy and associated litter break raindrop impact and provide opportunity for snow catch and accumulation on this site.

Recreational uses

Aesthetic value is derived from the colorful flowering of numerous flowering forbs in the spring and early summer. The diverse floral and faunal populations offer rewarding opportunities to photographers and for nature study. This site has potential for deer, antelope and upland game hunting. It has limited potential for camping, picnicking and hiking.

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.

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

Old SS Manuscripts, Range Site Descriptions, etc.

Type locality

Location 1: Elko County, NV	
Township/Range/Section	T42N R60E S16
General legal description	S½ Section 16, T42N. R60E. MDBM. About ½ mile west of O'Neil Basin Road, along south side of entrance road to Mary's River Ranch, Elko County, Nevada.

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Approval

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Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	GK BRACKLEY/P.NOVAK-ECHENIQUE
Contact for lead author	State Rangeland Management Specialist
Date	06/22/2006
Approved by	Kendra Moseley
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rills are rare. A few rills can be expected on steeper slopes in areas subjected to summer convection storms or rapid spring snowmelt. Rills are short (<2m), stable and not connected.

2. **Presence of water flow patterns:** Water flow patterns are rare but can be expected in areas subjected to summer convection storms or rapid snowmelt. Flow paths are short (<2m), meandering and interrupted by plant bases.

3. **Number and height of erosional pedestals or terracettes:** Pedestals are none to rare. Occurrence is usually limited to areas of water flow patterns. Terracettes are rare but may occur on steeper slopes, typically short (<1m).

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare Ground 15-30%, depending on amount of surface rock fragments.

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

6. **Extent of wind scoured, blowouts and/or depositional areas:** Typically none. Severe wind scouring may occur after a wildfire that removes all vegetation.

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

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 with canopy and 2 to 3 in the interspaces.

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Surface structure is typically thin to thick platy. Soil surface colors are light browns or grays and the soils are typified by an ochric epipedon. Surface textures are typically loams. Organic matter of the surface 2 to 3 inches is typically 1 to 1.5 percent dropping off quickly below. Organic matter content can be more or less depending on micro-topography.

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

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** Compacted layers are none. Platy or massive sub-surface horizons, subsoil

argillic horizons or duripans 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 State: Deep-rooted, cool season, perennial bunchgrasses>>tall shrubs (Wyoming big sagebrush). (By above ground production)

    Sub-dominant: Associated shrubs>shallow-rooted, cool season, perennial grasses>deep-rooted, cool season, perennial forbs=fibrous, shallow-rooted, cool season, annual and perennial forbs. (By above ground production)

    Other: microbiotic crusts

    Additional: With an extended fire return interval, the shrub component will increase at the expense of the herbaceous component. Utah juniper may invade and eventually dominate this site resulting in a severe reduction of the understory.

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Dead branches within individual shrubs are common and standing dead shrub canopy material may be as much as 35% of total woody canopy; some of the mature bunchgrasses (<20%) have dead centers.

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14. **Average percent litter cover (%) and depth (in):** Between plant interspaces (20-30%) and litter depth is approximately 0.25 inches.

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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) ± 600 lbs/ac; Spring moisture significantly affects total production. Favorable years ± 800 lbs/ac and unfavorable years ± 400 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 on this site include cheatgrass, halogeton, Russian thistle, annual mustards and Utah juniper. Utah juniper may increase and eventually dominate this site. After wildfire, cheatgrass and annual mustards are most likely to invade.

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