Ecological site R024XY028NV
SOUTH SLOPE 8-12 P.Z.

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General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

MLRA notes

Major Land Resource Area (MLRA): 024X–Humboldt Basin and Range Area

Major land resource area (MLRA) 24, the Humboldt Area, covers an area of approximately 8,115,200 acres (12,680 sq. mi.). It is found in the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. Elevations range from 3,950 to 5,900 feet (1,205 to 1,800 meters) in most of the area, some mountain peaks are more than 8,850 feet (2,700 meters).

A series of widely spaced north-south trending mountain ranges are separated by broad valleys filled with alluvium washed in from adjacent mountain ranges. Most valleys are drained by tributaries to the Humboldt River. However, playas occur in lower elevation valleys with closed drainage systems. Isolated ranges are dissected, uplifted fault-block mountains. Geology is comprised of Mesozoic and Paleozoic volcanic rock and marine and continental sediments. Occasional young andesite and basalt flows (6 to 17 million years old) occur at the margins of the mountains. Dominant soil orders include Aridisols, Entisols, Inceptisols and Mollisols. Soils of the area are generally characterized by a mesic soil temperature regime, an aridic soil moisture regime and mixed geology. They are generally well drained, loamy and very deep.

Approximately 75 percent of MLRA 24 is federally owned, the remainder is primarily used for farming, ranching and mining. Irrigated land makes up about 3 percent of the area; the majority of irrigation water is from surface water sources, such as the Humboldt River and Rye Patch Reservoir. Annual precipitation ranges from 6 to 12 inches (15 to 30 cm) for most of the area, but can be as much as 40 inches (101 cm) in the mountain ranges. The majority of annual precipitation occurs as snow in the winter. Rainfall occurs as high-intensity, convective thunderstorms in the spring and fall.

Ecological site concept

This ecological site is found on south facing side slopes of hills and mountains, with slopes greater than 30 percent. Soils associated with this site are mod-deep, well drained and formed in residuum and colluvium derived from mixed parent material. The soil profile is characterized by a light-colored surface (ochric epipedon), a horizon of clay accumulation (argillic horizon) approximately 20cm from the soil surface, and greater than 35 percent rock fragments by volume throughout the soil profile.

Important abiotic factors contributing to the presence of this site include south-facing aspect and grater than 35 percent clay in the particle size control section. These characteristics contribute to increased water holding capacity and warmer soil temperatures allowing Wyoming big sagebrush to co-dominate with mountain big sagebrush.

Associated sites

R024XY021NV	**Loamy Slope 12-14 P.Z.** Mountain Big sagebrush (ARTRV) dominant shrub; soils are moderately deep, formed in residuum/colluvium, and have a dark colored (mollic epipedon) surface horizon

R024XY005NV	**LOAMY 8-10 P.Z.** Important abiotic factors contributing to the presence of this ecological site include limited precipitation and the presence of the argillic horizon that helps retain soil moisture. The fine-textured/clay rich horizons, lying beneath the coarser-textured horizons become impermeable as the swelling matrix closes following wetting.
R024XY013NV	**LOAMY 10-12 P.Z.** This ecological site is on hills and mountains. Soils are deep, well drained, and formed in residuum and colluvium derived from mixed parent material. The soil profile is characterized by a mollic epipedon, a mesic soil temperature regime and aridic bordering on xeric soil moisture regime. The sagebrush found on this site is primarily basin big sagebrush, with Wyoming sagebrush confined to the transitions. The mixing of sagebrush species and the presence of the mollic epipedon are indicative of greater than 10 in (25 cm) of precipitation this site is receiving.
R024XY018NV	**Claypan 10-12 P.Z.** This site is on summits and side slopes of low mountains, hills and upper piedmont slopes. Soils associated with this site are well drained and formed in residuum derived from mixed parent material. The soil profile is characterized by an ochric epipedon and an abrupt boundary to layer of clay accumulation (argillic horizon) 30cm (11in) or less from the soil surface. Important abiotic factors contributing to the presence of this ecological site include wet non-satiated conditions in the spring, shallow depth to an abrupt boundary, and very dry soil conditions in the summer and fall.
R024XY030NV	**SHALLOW CALCAREOUS LOAM 8-10 P.Z.** This site is on fan remnants. The soils are shallow to a duripan, well drained and formed in loess with a component of volcanic ash and alluvium derived from mixed parent material. The soil profile is characterized by an ochric epipedon, effervescence throughout the profile and less than 35 percent rock fragments by volume. Important abiotic factors contributing to the presence of this site include shallow depth, low available water holding capacity

Similar sites

R024XY029NV	**SOUTH SLOPE 12-16 P.Z.** Mountain bis sagebrush (ARTRV) dominant shrub; Wyoming big sagebrush (ARTRW8) rare to absent; more productive site
R024XY013NV	**LOAMY 10-12 P.Z.** Slope gradients less than 30 percent
R024XY035NV	**SHALLOW LOAM 10-14 P.Z.** Less productive site; Thurber's needlegrass (ACTH7)- Bluebunch wheatgrass (PSSPS) codominant grasses

Table 1. Dominant plant species

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

Physiographic features

This ecological site is found on side-slopes of hills and mountains. Aspects are typically southeast, south, southwest or west facing. Slopes range from 30 to 50 percent but may extend from 15 to 75 percent in some areas. Elevations range from 5,500 to 7,000 feet (1,676 to 2,134 m) but can be found between 5,200 and 8,000 feet (1,585 to 2,438 m) in some locations. Runoff on this site is high to very high.

Table 2. Representative physiographic features

Landforms	(1) Mountain range > Mountain slope
Runoff class	High to very high

Elevation	1,676–2,134 m
Slope	30–50%
Aspect	W, SE, S, SW

Climatic features

The climate associated with this site is semiarid, characterized by cold, moist winters and warm, dry summers. Average annual precipitation is estimated to be between 8 to 12 inches (20 to 31 cm). Mean annual air temperature is 42 to 47 degrees F. The average growing season is about 80 to 110 days. Representative weather stations are not available for this site.

Table 3. Representative climatic features

Frost-free period (characteristic range)	80-110 days
Freeze-free period (characteristic range)	70-90 days
Precipitation total (characteristic range)	203-305 mm
Frost-free period (actual range)	70-120 days
Freeze-free period (actual range)	60-100 days
Precipitation total (actual range)	178-330 mm
Frost-free period (average)	100 days
Freeze-free period (average)	80 days
Precipitation total (average)	254 mm

Influencing water features

Influencing water features are not associated with this site.

Wetland description

N/A

Soil features

The soils associated with this site are moderately deep to hard un-weathered bedrock, well drained, and formed in residuum and colluvium derived from volcanic and sedimentary rock. These soils are characterized by a light-colored surface (ochric epipedon), a layer of clay accumulation (argillic horizon) starting at 20cm (8 in), and 35 to 60 percent rock fragments distributed throughout the soil profile. The soil profile has greater than 35 percent clay in the particle size control section, subsoil textures are very cobbly or very channery clay or clay loam. Surface soil textures include loam and its stony, cobbly, and gravelly counterparts.
Representative soil components associated with this site include: Roca, Vanwyper, Bucan, Burrita, Gol, and Midraw.

Table 4. Representative soil features

Parent material	(1) Residuum–volcanic rock (2) Colluvium–volcanic rock (3) Residuum–shale (4) Colluvium–shale
Surface texture	(1) Very cobbly loam (2) Very stony loam (3) Very gravelly loam
Family particle size	(1) Loamy

Drainage class	Well drained
Permeability class	Slow to very slow
Soil depth	51–99 cm
Surface fragment cover <=3"	6–18%
Surface fragment cover >3"	19–33%
Available water capacity (0-101.6cm)	6.86–8.64 cm
Soil reaction (1:1 water) (0-101.6cm)	6.1–7.8
Subsurface fragment volume <=3" (Depth not specified)	23–32%
Subsurface fragment volume >3" (Depth not specified)	5–11%

Ecological dynamics

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

The plant communities of this site are dynamic in response to changing weather patterns and disturbance regimes. The reference plant community is dominated by Wyoming big sagebrush (*Artemisia tridentata* subsp. wyomingensis) and deep-rooted cool season perennial bunchgrasses such as bluebunch wheatgrass (Pseudorogeneria spicata). Thurber's needlegrass (*Achnatherum thurberianum*) and mountain big sagebrush (*A. tridentata* subsp. vaseyana) represent minor but important part of this plant community.

Sagebrush species are 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 sagebrush seedlings is dependent on adequate moisture conditions. Young plants are susceptible to less than desirable conditions for several years following germination. Density and age of sagebrush and other woody perennials in the community is largely dependent upon fire frequency.

It is well know that sagebrush species naturally hybridize (McArthur et al., 1988, Richardson et al., 2012, and others). Natural hybridization has been important in the differentiation and success of sagebrush as a landscape dominant (McArthur et al. 1988). The sagebrush found on this site is most likely a hybrid. At this time, research is lacking regarding the ecological potential of all possible hybridized sagebrush species/subspecies. The suspected hybrid dominating this ecological site is found in the same elevation zone and precipitation zone and on the same landscape position and soils as Wyoming big sagebrush, therefore making it appropriate to existing literature about Wyoming big sagebrush to describe ecological dynamics of the site. Updates and revisions will be made as more information is available.

Wyoming big sagebrush is the most drought-tolerant of the three major big sagebrush subspecies. The root system is deep and well-developed with many laterals and one or more taproots. The majority of the roots are in the upper foot of soil with tap roots extending up to 6 feet in depth. The roots are inoculated with the vesicular-arbuscular mycorrhizae (VAM) Glomus microcarpus and Gigaspora spp., which help to mitigate nutrient and moisture limitations. Mycorrhizas or ‘fungus-roots’ are the result of a symbiotic relationship between specialized soil organisms and plant roots. Beneficial changes in the water relations of plants inoculated with (VAM) include altered rates of water uptake, hydraulic conductivity, leaf and stem water potentials, stomatal resistance and transpiration rates (Stahl 1998). Dominant perennial bunchgrass, bluebunch wheatgrass, tolerates droughty conditions found on this ecological site by extending its root system into subsoil horizons maximizing water uptake.

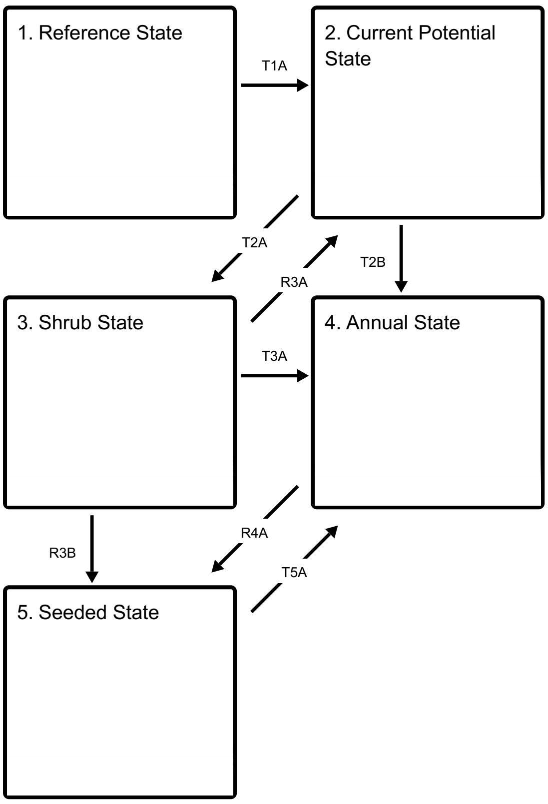
Vegetative cover of perennial plants on this ecological site is generally sparse, even under reference conditions. However, soil space not occupied by living plants is usually covered in biological soil crusts. In Wyoming big sagebrush communities of southeastern Idaho, biological soil crust were found to occupy between 40-60 percent of the soil surface in an undisturbed setting (Memmott et al. 1998, Kaltenecker et al. 1999). Biological soil crusts are formed by living organisms, cyanobacteria, green algae, lichens, mosses, microfungi, etc., and their by-products, creating a crust of soil particles bound together by organic materials. In rangelands they have several important functions including; helping to retain soil moisture, reducing wind and water erosion, fixing atmospheric nitrogen and contributing to soil organic matter (USDI-BLM 2001). Soil crusts are also good indicators of physical disturbance. Disturbances such as off-road vehicles and trampling by humans and livestock destroy the physical structure of soil crusts. Once destroyed the pieces of crust are blown or washed away, reducing soil stability and fertility (Belnap 2003). Extent of impact is determined by severity, frequency, size and timing of disturbance. Recovery of biological crust may take decades to hundreds of years. Therefore, it is important to prevent degradation.

This site inherently has low resistance to invasion by non-natives, and low resilience following invasion by non-natives. In Great Basin ecosystems, inherent resilience typically increases with elevation due to higher levels of water, nutrients and annual biomass production. Wyoming sagebrush ecosystems are least resistant to cheatgrass (*Bromus tectorum*) invasion due to the combination of low resilience to disturbances, such as fire (Chambers et al. 2012). Management activities should be prioritized based on the relative resilience and resistance of a specific ecological site.

Inappropriate management; grazing recreation, etc., on this site can lead to an increase in sagebrush and a decrease in herbaceous species, namely bluebunch wheatgrass and Thurber's needlegrass. Reoccurring disturbances, natural or anthropogenic, will result in decreased sagebrush cover and increased cover of disturbance-tolerant shrubs and non-natives. A combination of inappropriate management and prolonged drought often leads to an increase in bare ground and a decrease in plant production, all contributing to increased soil erosion. The loss of structural and functional groups affects ecosystem functioning and can result in soil surface instability and soil loss.

State and transition model

Ecosystem states



T1A - Introduction of non-native species

T2A - Loss of deep-rooted perennial bunchgrass

T2B - Severe repeated wildfire or soil disturbance

R3A - Seeding with native species

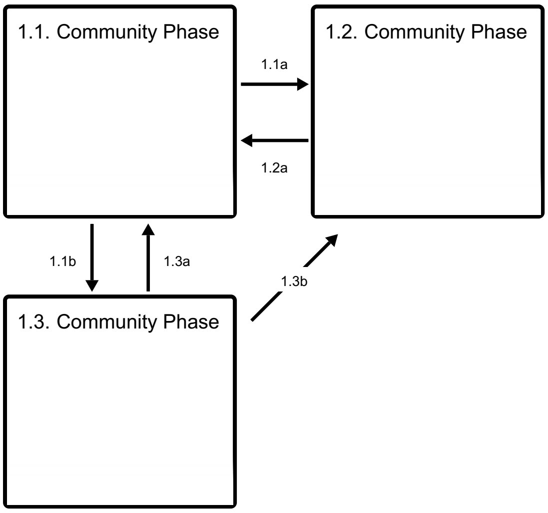
T3A - Repeated/severe wildfire and/or failed restoration attempt

R3B - Brush management, seeding, low success probability

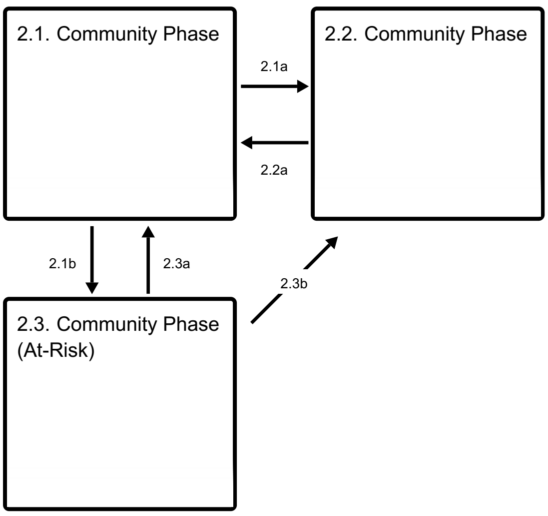
R4A - Seeding, management techniques, low probability success

T5A - Increased size and frequency of wildfires

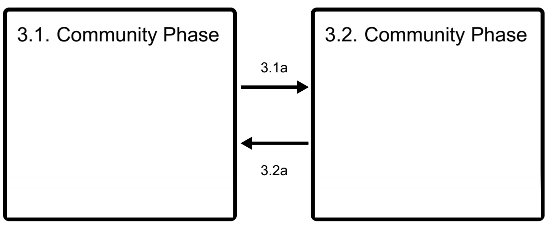
State 1 submodel, plant communities



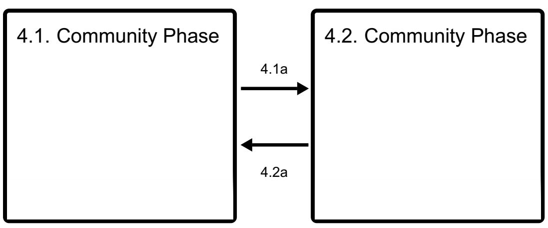
State 2 submodel, plant communities



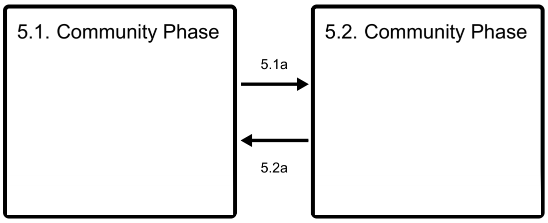
State 3 submodel, plant communities



State 4 submodel, plant communities



State 5 submodel, plant communities



State 1
Reference State

The Reference State 1.0 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.

Characteristics and indicators. Fire is the principal means of renewal of decadent stands of Wyoming big sagebrush. Wyoming big sagebrush communities historically had low fuel loads, and patchy fires that burned in a mosaic pattern were common at 10 to 70 year return intervals (West and Hassan 1985, Bunting et al. 1987). (Davies et al 2007) suggest fire return intervals in Wyoming big sagebrush communities were around 50 to 100 years. Wyoming big sagebrush is killed by fire and only regenerates from seed. Recovery time for Wyoming big sagebrush may require 50 to 120 or more years (Baker 2006). Post-fire hydrologic recovery and resilience is primarily influenced by pre-fire site conditions, fire severity, and post-fire weather and land use that relate to vegetation recovery.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*), shrub
- bluebunch wheatgrass (*Pseudoroegneria spicata*), grass
- Thurber's needlegrass (*Achnatherum thurberianum*), grass

Community 1.1
Community Phase

This community phase is characteristic of a mid-seral plant community and is dominated by big sagebrush and bluebunch wheatgrass. Thurber’s needlegrass and basin wildrye are also common. Forbs are present but not abundant. Under natural conditions potential vegetative composition is approximately 65% grasses, 10% forbs and 25% shrubs by weight.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	364	510	729
Shrub/Vine	140	196	280
Forb	56	78	112
Total	**560**	**784**	**1121**

Community 1.2
Community Phase

This community phase is characteristic of a post-disturbance, early seral plant community Bluebunch wheatgras, Thurber’s needlegrass and other perennial natives increase post-wildfire. Plant response will vary depending on season, fire severity, fire intensity and post-fire soil moisture availability. Depending on fire severity or intensity of Aroga moth infestation, patches of intact sagebrush may remain.

Resilience management. The effect of fire on bunchgrasses relates to culm density, culm-leaf morphology, and the size of the plant. The initial condition of bunchgrasses within the site along with seasonality and intensity of the fire all factor into the individual species response. For most forbs and grasses the growing points are located at or below the soil surface providing relative protection from disturbances which decrease above ground biomass, such as grazing or fire. Thus, fire mortality is more related to duration and intensity of heat which is related to culm density, culm-leaf morphology, size of plant and abundance of old growth (Young 1983).

Community 1.3
Community Phase

This community phase is characteristics of a late-seral plant community. Decadent sagebrush dominates the overstory and the deep-rooted perennial bunchgrasses are reduced either from competition with shrubs and/or from herbivory. Big sagebrush is long-lived and increases in cover and density in the absence of disturbance. Bare ground exceeds the site concept and this site is at-risk of crossing an ecological threshold.

Pathway 1.1a
Community 1.1 to 1.2

Fire reduces or eliminates overstory of sagebrush and allows perennial bunchgrasses to dominate the site. Big sagebrush communities historically had low fuel loads, and patchy fires that burned in a mosaic pattern were common at 10 to 70 year return intervals (West and Hassan 1985, Bunting et al. 1987).

Context dependence. A fire following an unusually wet spring or a change in management may be more severe and reduce sagebrush cover to trace amounts. A severe infestation of Aroga moth could also cause a large decrease in sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs.

Pathway 1.1b
Community 1.1 to 1.3

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

Pathway 1.2a
Community 1.2 to 1.1

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

Context dependence. Recovery time for Wyoming big sagebrush may require 50 to 120 or more years (Baker 2006). Post-fire hydrologic recovery and resilience is primarily influenced by pre-fire site conditions, fire severity, and post-fire weather and land use that relate to vegetation recovery. Survival of sagebrush seedlings is dependent on adequate moisture conditions. Young plants are susceptible to less than desirable conditions for several years following germination.

Pathway 1.3a
Community 1.3 to 1.1

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

Pathway 1.3b
Community 1.3 to 1.2

Fire reduces or eliminates overstory of sagebrush and allow for perennial bunchgrasses to dominate. Fires may be more severity due to decadent sagebrush overstory resulting in complete removal of mature sagebrush.

Context dependence. A fire following an unusually wet spring or a change in management favoring an increase in fine fuels, may be more severe and reduce sagebrush cover to trace amounts. A severe infestation of Aroga moth could also cause a large decrease in sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs.

State 2
Current Potential State

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

Dominant plant species

- mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*), shrub
- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- bluebunch wheatgrass (*Pseudoroegneria spicata*), grass

Community 2.1
Community Phase

This community phase is characteristic of a mid-seral plant community and is dominated by big sagebrush and bluebunch wheatgrass. Thurber's needlegrass and basin wildrye are also common. Forbs are present but not abundant. Non-native annual species are present., but do not dominate.

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
Community Phase

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.

Resilience management. 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). Cheatgrass has been found to be a highly successful competitor with seedlings of Thurber's needlegrass and may preclude reestablishment (Evans and Young 1978).

Community 2.3
Community Phase (At-Risk)

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. Rabbitbrush may be a significant component. Sandberg bluegrass may increase and become co-dominate with deep-rooted bunchgrasses. Annual non-natives species may be stable or increasing due to lack of competition with perennial bunchgrasses. This site is susceptible to further degradation from grazing, drought, and fire.

Pathway 2.1a
Community 2.1 to 2.2

Fire reduces the shrub overstory and allows for perennial bunchgrasses to dominate the site. Fires are typically low severity resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring or a change in management favoring an increase in fine fuels, may be more severe and reduce sagebrush cover to trace amounts. A severe infestation of Aroga moth could also cause a large decrease in sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs. Annual non-native species are likely to increase after fire.

Pathway 2.1b
Community 2.1 to 2.3

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

Pathway 2.2a
Community 2.2 to 2.1

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

Pathway 2.3a
Community 2.3 to 2.1

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

Pathway 2.3b
Community 2.3 to 2.2

Fire would decrease or eliminate the overstory of sagebrush and allow for the perennial bunchgrasses to dominate the site. Fires would typically be small and patchy due to low fuel loads. A fire following an unusually wet spring or a change in management may be more severe and reduce sagebrush cover to trace amounts. A severe infestation of Aroga moth could also cause a large decrease in sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs.

State 3
Shrub State

This state is a product of the absence of wildfire, prolonged drought, combined with many years of heavy grazing during time periods harmful to perennial bunchgrasses. Sandberg bluegrass increases with a reduction in deep-rooted perennial bunchgrass competition and may become the dominate grass. The loss of structural and functional groups affects ecosystem functioning and can result in soil surface instability and soil loss. Sagebrush dominates the overstory and exceeds site concept. It may be decadent, reflecting stand maturity and lack of seedling establishment due to competition with mature plants. Spiny hopsage and/or rabbitbrush may be a significant component of this state. The shrub overstory dominates site resources such that soil water, nutrient capture, nutrient cycling and soil organic matter are temporally and spatially redistributed. Bare ground exceeds the site concept and soil and precipitation are being redistributed off site.

Dominant plant species

- Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), shrub
- mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*), shrub
- bluegrass (*Poa*), grass

Community 3.1
Community Phase

Figure 2. South Slope 8-12 P.Z. Community Phase 3.1

This community phase is characterized by the dominance of big sagebrush. Spiny hopsage and/or rabbitbrush may be a significant component. Deep-rooted perennial bunchgrasses are significantly reduced or absent and Sandberg's bluegrass is the dominant perennial grass. Annual non-native species are stable or increasing. Bare ground is significant.

Resilience management. A combination of inappropriate management and prolonged drought often leads to an increase in bare ground and a decrease in plant production, all contributing to increased soil erosion. The loss of structural and functional groups affects ecosystem functioning and can result in soil surface instability and soil loss.

Community 3.2
Community Phase

Bluegrass dominates the site; annual non-native species may be present but are not dominant. Trace amounts of sagebrush may be present, depending on fire severity. Sprouting shrubs such as spiny hopsage or rabbitbrush may initially increase following disturbance.

Resilience management. Sandberg bluegrass has been found to increase following fire likely due to its low stature and productivity (Daubenmire 1975). Reduced bunchgrass vigor or density provides an opportunity for Sandberg bluegrass expansion and/or cheatgrass and other invasive species to occupy interspaces, leading to increased fire frequency and potentially an annual plant community. Repeated frequent fire in this community will eliminate big sagebrush and severely decrease or eliminate the deep rooted perennial bunchgrasses from the site and facilitate the establishment of an annual weed community with varying amounts of Sandberg bluegrass and rabbitbrush.

Pathway 3.1a
Community 3.1 to 3.2

Fire and heavy fall grazing causes 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 re-establishment of Wyoming big sagebrush can take many years. With the dominance of bluegrass this pathway is unlikely to occur.

State 4
Annual State

This community is characterized by the dominance of annual non-native species and a narrowed fire return interval. Sprouting shrubs such as rabbitbrush, shadscale, broom snakeweed and Spiny hopsage may be common, depending on time since disturbance.

Dominant plant species

- cheatgrass (*Bromus tectorum*), grass

Community 4.1
Community Phase

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 site is dominated by annual non-natives and bare ground. Site may be experiencing soil loss.

Community 4.2
Community Phase

This community phase is characterized by the recovery of sprouting shrubs. Disturbance tolerant shrubs such as spiny hopsage and rabbitbrush along with broom snakeweed may dominate overstory. Trace amounts of big sagebrush may be present, depending on fire severity. Annual non-native species are dominant, fine fuels are continuous and risk of wildfire is high. Trace amounts of desirable bunchgrasses may be present. Bare ground is significant.

Pathway 4.1a
Community 4.1 to 4.2

Absence of wildfire and natural regeneration over time favors the establishment and growth of long lived perennials. Probability of sagebrush establishment is extremely low.

Pathway 4.2a
Community 4.2 to 4.1

Repeated and severe wildfire is driven by the dominance of annual non-native species has significantly altered disturbance regimes from their historic range of variation.

State 5
Seeded State

This state is characterized by the dominance of introduced wheatgrass species. Forage kochia and other desired seeded species including. Wyoming big sagebrush and native and non-native forbs may be also be present. Seeded perennials are long-lived and persistent and are capable of outcompeting native perennials and prohibit the return of pre-disturbance plant diversity. Soil nutrients , soil moisture, and organic matter distribution and cycling are primarily driven by introduced bunchgrasses.

Dominant plant species

- crested wheatgrass (*Agropyron cristatum*), grass

Community 5.1
Community Phase

This community phase is characteristic of a successful restoration attempt. Seeded perennials like crested wheatgrass, forage kochia, or other introduced forage species dominate. Trace amounts of big sagebrush may be present, especially if seeded. Annual non-natives present and may be increasing, but do not dominate.

Community 5.2
Community Phase

This community phase is characterized by an increase in big sagebrush. Seeded wheatgrass species are the dominant herbaceous species. Crested wheatgrass remains productive for more than 30 years. Stand mortality is virtually unknown, except in cases of extreme drought. Annual non-native species are stable to increasing. Sagebrush recovery is dependent on available seed source and seedlings are susceptible to less than favorable conditions for several years.

Pathway 5.1a
Community 5.1 to 5.2

Absence of wildfire and natural regeneration over time allows sagebrush to increase. This community phase pathway may be coupled with heavy grazing during the growing season. Herbivory helps to reduce dominance of seeded wheatgrasses.

Pathway 5.2a
Community 5.2 to 5.1

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

Transition T1A
State 1 to 2

Trigger: This transition is caused by the introduction of non-native annual weeds, such as cheatgrass, mustards, bur buttercup and halogeton. Slow variables: Over time the annual non-native plants will increase within the community. Threshold: Any amount of introduced non-native species causes an immediate decrease in the resilience of the site. Annual non-native species cannot be easily removed from the system and have the potential to significantly alter disturbance regimes from their historic range of variation.

Transition T2A
State 2 to 3

Trigger: Absence of wildfire, prolonged drought, and/or excessive, long-term, herbivory during periods harmful to perennial bunchgrasses, or a combination of all. Slow variables: Long term reduction in deep-rooted perennial grass density, reproduction, and vigor. Threshold: Loss of deep-rooted perennial bunchgrasses results in spatial and temporal nutrient changes to nutrient cycling, water infiltration and redistribution. This reduces soil organic matter and soil moisture storage.

Transition T2B
State 2 to 4

Trigger: Multiple severe wildfires and/or soil disturbing treatments that removes deep-rooted native perennials Slow variables: Increased seed production and cover of annual non-native species. Threshold: Increased, continuous fine fuels modify the fire regime by changing frequency, intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture and impact the temporal and spatial aspects of nutrient cycling and distribution.

Restoration pathway R3A
State 3 to 2

Brush management with minimal soil disturbance, coupled with seeding of deep-rooted perennial native bunchgrasses. Probability of success very low.

Transition T3A
State 3 to 4

Trigger: Repeated/severe wildfire and/or failed restoration attempt using soil disturbing practices Slow variables: Increased production and cover of non-native annual species and loss of native perennials. Threshold: Increased, continuous fine fuels modify the fire regime by changing intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture spatially and temporally thus impacting nutrient cycling and distribution.

Restoration pathway R3B
State 3 to 5

Brush management with minimal soil disturbance, coupled with seeding of desired species, usually introduced wheatgrasses. Restoration attempts causing soil disturbance will likely initiate a transition to an annual state. Probability of success very low.

Restoration pathway R4A
State 4 to 5

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

Transition T5A
State 5 to 4

Trigger: Multiple severe wildfires and/or soil disturbing treatments that removes deep-rooted perennials. Slow variables: Increased production and cover of non-native annual species Threshold: Increased, continuous fine fuels modify the fire regime by changing frequency, intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture and impact the temporal and spatial aspects of nutrient cycling and distribution.

Additional community tables

Table 6. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Primary Perennial Grasses**			424–690	
	bluebunch wheatgrass	PSSPS	*Pseudoroegneria spicata ssp. spicata*	353–471	–
	Thurber's needlegrass	ACTH7	*Achnatherum thurberianum*	39–118	–
	bluegrass	POA	*Poa*	16–63	–
	basin wildrye	LECI4	*Leymus cinereus*	16–39	–
2	**Secondary Perennial Grasses**			16–63	
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	4–24	–
	Webber needlegrass	ACWE3	*Achnatherum webberi*	4–24	–
	squirreltail	ELEL5	*Elymus elymoides*	4–24	–
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	4–24	–
	needle and thread	HECO26	*Hesperostipa comata*	4–24	–
Forb					
3	**Primary Perennial Forbs**			31–78	
	arrowleaf balsamroot	BASA3	*Balsamorhiza sagittata*	16–39	–
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	16–39	–
4	**Secondary Perennial Forbs**			16–39	
	buckwheat	ERIOG	*Eriogonum*	4–16	–
	lupine	LUPIN	*Lupinus*	4–16	–
	phlox	PHLOX	*Phlox*	4–16	–
Shrub/Vine					
5	**Primary Shrubs**			196–275	
	big sagebrush	ARTR2	*Artemisia tridentata*	196–275	–
6	**Secondary Shrubs**			16–63	
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	8–24	–
	mormon tea	EPVI	*Ephedra viridis*	8–24	–
	rubber rabbitbrush	ERNAN5	*Ericameria nauseosa ssp. nauseosa var. nauseosa*	8–24	–
	spiny hopsage	GRSP	*Grayia spinosa*	8–24	–
	desert peach	PRAN2	*Prunus andersonii*	8–24	–

Animal community

Livestock Interpretations:
This site has limited value for livestock grazing, due to steep slopes. Grazing management should be keyed to dominant grasses production. Bluebunch wheatgrass is considered one of the most important forage grass species on western rangelands for livestock. Although bluebunch wheatgrass can be a crucial source of forage, it is not necessarily the most highly preferred species. Thurber’s needlegrass species begin growth early in the year and remain green throughout a relatively long growing season. This pattern of development enables animals to use Thurber’s needlegrass when many other grasses are unavailable. Cattle prefer Thurber’s needlegrass in early spring before fruits have developed as it becomes less palatable when mature. Thurber’s needlegrasses are grazed

in the fall only if the fruits are softened by rain. Bluegrass is a widespread forage grass. It is one of the earliest grasses in the spring and is sought by domestic livestock and several wildlife species. The early growth and abundant production of basin wildrye make it a valuable source of forage for livestock. It is important forage for cattle and is readily grazed by cattle and horses in early spring and fall. Though coarse-textured during the winter, basin wildrye may be utilized more frequently by livestock and wildlife when snow has covered low shrubs and other grasses. Livestock browse big sagebrush, but may use it only lightly when palatable herbaceous species are available.

Stocking rates vary over time depending upon season of use, climate variations, site, and previous and current management goals. A safe starting stocking rate is an estimated stocking rate that is fine tuned by the client by adaptive management through the year and from year to year.

Wildlife Interpretations:
Bluebunch wheatgrass is considered one of the most important forage grass species on western rangelands for wildlife. Bluebunch wheatgrass does not generally provide sufficient cover for ungulates, however, mule deer are frequently found in bluebunch-dominated grasslands. Thurber needlegrass is valuable forage for wildlife. Basin wildrye provides winter forage for mule deer, though use is often low compared to other native grasses. Basin wildrye provides summer forage for black-tailed jackrabbits. Because basin wildrye remains green throughout early summer, it remains available for small mammal forage for longer time than other grasses. Wyoming Big sagebrush is preferred browse for wild ungulates. Sagebrush-grassland communities provide critical sage-grouse breeding and nesting habitats. Meadows surrounded by sagebrush may be used as feeding and strutting grounds. Sagebrush is a crucial component of their diet year-round, and sage-grouse select sagebrush almost exclusively for cover. Sage-grouse prefer mountain big sagebrush and Wyoming big sagebrush communities to basin big sagebrush communities.

Hydrological functions

Runoff is high to very high. Permeability is very slow to moderately slow. Hydrologic soil groups are C and D. Rills are none to rare. A few rills can be expected on steeper slopes in areas subjected to summer convection storms or rapid spring snowmelt. Water flow patterns are few and can be expected on steeper slopes in areas subjected to summer convection storms or rapid snowmelt. Pedestals are none to rare. Occurrence is usually limited to areas of water flow patterns. Frost heaving of shallow rooted plants should not be considered a "normal" condition. Gullies are none to rare. Perennial herbaceous plants (especially deep-rooted bunchgrasses [i.e., bluebunch wheatgrass]) slow runoff and increase infiltration. Shrub canopy and associated litter break raindrop impact and provide opportunity for snow catch and accumulation on site.

Recreational uses

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

Other products

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

Other information

Basin wildrye is useful in mine reclamation, fire rehabilitation and stabilizing disturbed areas. Its usefulness in range seeding, however, may be limited by initially weak stand establishment. 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

NV-ECS-1 - 12 records

Type locality

Location 1: Eureka County, NV	
Township/Range/Section	T24N R54E S23
UTM zone	N
UTM northing	4422591
UTM easting	597308
Latitude	39° 56′ 52″
Longitude	115° 51′ 39″
General legal description	NE¼ Judd Canyon area, east side of Diamond Mountains, Eureka County, Nevada. Site also occurs in Humboldt, Lander, and Pershing Counties, Nevada.

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Contributors

CP/GKB
T. Strnigham
P. NovakEchenique
E. Hourihan
A.Argullin

Approval

Kendra Moseley, 3/07/2025

Rangeland health reference sheet

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

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

Indicators

1. **Number and extent of rills:** Rills are none to rare. A few rills (short <1m) can be expected on steeper slopes in areas subjected to summer convection storms or rapid spring snowmelt. These will begin to heal during the following growing season.

2. **Presence of water flow patterns:** Water flow patterns are few and can be expected on steeper slopes in areas subjected to summer convection storms or rapid snowmelt. These are typically short (<1m), meandering and disconnected.

3. **Number and height of erosional pedestals or terracettes:** Pedestals are none to rare. Occurrence is usually limited to areas of water flow patterns. Frost heaving of shallow rooted plants should not be considered a "normal" condition.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare Ground 15-35 percent, depending on amount of rock fragments.

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

6. **Extent of wind scoured, blowouts and/or depositional areas:** Typically none. Wind scouring may occur after severe wildfire that removes all vegetative cover.

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

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil stability values should be 3 to 6 on most soil textures found on this site. (To be field tested.)

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Surface structure is typically thin to thick platy. Soil surface colors are light and some soils are typified by a mollic epipedon. Organic matter of the surface 2 to 4 inches is typically 1.25 to 3 percent dropping off quickly below. Organic matter content can be more or less depending on micro-topography.

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

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** Compacted layers are none. Platy, subangular blocky, prismatic, or massive sub-surface horizons or subsoil argillic horizons are not to be interpreted as compacted.

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: Deep-rooted, cool season, perennial bunchgrasses > tall shrubs (big sagebrush)

    Sub-dominant: associated shrubs > shallow-rooted, cool season, perennial bunchgrasses > deep-rooted, cool season, perennial forbs > fibrous, shallow-rooted, cool season, perennial and annual forbs

Other: succulents, microbiotic crusts

Additional: with an extended fire return interval the shrub component will increase at the expense of the herbaceous component.

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Dead branches within individual shrubs common and standing dead shrub canopy material may be as much as 25 percent of total woody canopy; some of the mature bunchgrasses (<20 percent) have dead centers.

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14. **Average percent litter cover (%) and depth (in):** Between plant interspaces (± 20-35%) and litter depth is ± ½ inch.

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** For normal or average growing season (through mid-June) ± 700 lbs/ac; Spring moisture significantly affects total production. Favorable years ± 1000 lbs/ac and unfavorable years 500 lbs/ac.

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