Ecological site R024XY005NV
LOAMY 8-10 P.Z.

Accessed: 05/06/2024

General information

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

MLRA notes

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

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

Classification relationships

National Vegetation Classification (USNVC): 3 Semi-Desert, 3.B Cool Semi-Desert Scrub and Grassland, 3.B.1 Cool Semi-Desert Scrub and Grassland, D040 Western North American Cool Semi-Desert Scrub and Grassland, M169 Great Basin and Intermountain Tall Sagebrush Shrubland and Steppe, G303 Intermountain Dry Tall Sagebrush Shrubland Group, CEGL001052 *Artemisia tridentata* ssp. wyomingensis/ Achnatherum thurberianum Shrubland.

Ecological site concept

This ecological site is found on alluvial fans on all exposures. Soils associated with this site are deep, well drained and formed in alluvium derived from mixed parent material. Representative soil features include an ochric epipedon and an argillic horizon lacking an abrupt boundary.

Vegetative cover is less than 35% and is dominated by cool season, deep-rooted, perennial bunchgrasses and evergreen shrubs. Dominant species include Thurber's needlegrass and Wyoming big sagebrush. The soil temperature regime is mesic and the soil moisture regime is aridic bordering on xeric.
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. This results in a

temporary increase in plant available water above the fine-textured horizon, especially during spring snowmelt. This moisture is important for deep-rooted perennial bunchgrasses, such as Thurber's needlegrass (Achnatherum thurberianum) found on this site. This contributes greatly to the higher herbaceous productivity on this ecological site than what the precipitation zone alone would indicate.

Associated sites

R024XY013NV	**LOAMY 10-12 P.Z.** Found on similar landforms at slightly higher elevation. Includes basin big and mountain big sagebrush in addition to Wyoming big sagebrush, bluebunch wheatgrass is the dominant grass.
R024XY020NV	**DROUGHTY LOAM 8-10 P.Z.** Found on similar landforms at slightly lower elevation. Soils are not characterized by an argillic horizon. Spiny hopsage and bud sagebrush are important associated shrubs and bluebunch wheatgrass is not associated with the plant community.
R024XY030NV	**SHALLOW CALCAREOUS LOAM 8-10 P.Z.** Found on similar landforms at similar elevation. Dominated by black sagebrush.

Similar sites

R024XY045NV	**ERODED SLOPE 6-10 P.Z.** Less productive site. Indian ricegrass is the dominant grass.
R024XY013NV	**LOAMY 10-12 P.Z.** More productive site. Basin big sagebrush and mountain big sagebrush are present in plant community. Bluebunch wheatgrass is the dominant grass.
R024XY026NV	**STONY SLOPE 8-10 P.Z.** Wyoming big sagebrush and shadscale are co-dominant shrubs. Squirreltail is the dominant grass.
R024XY020NV	**DROUGHTY LOAM 8-10 P.Z.** Spiny hopsage, bud sagebrush and shadscale are important associated shrubs and bluebunch wheatgrass is absent. Soils lack an agrillic horizon.
R024XY058NV	**SANDY LOAM 8-10 P.Z.** More productive site, commonly found on north aspects. Indian ricegrass and needleandthread are co-dominant.
R024XY047NV	**SHALLOW LOAM 8-10 P.Z.** Less productive site, mostly found on south aspects.

Table 1. Dominant plant species

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

Physiographic features

This site is found on alluvial fans on all exposures. Slopes range from 0 to 50 percent, but slope gradients of 2 to 30 percent are most typical. This site most commonly occurs between elevations from 4500 to 7000 feet, but can be found between 4000 and 7500 feet in some locations.

Table 2. Representative physiographic features

Landforms	(1) Fan remnant (2) Alluvial fan
Flooding duration	Extremely brief (0.1 to 4 hours)
Flooding frequency	None to rare
Ponding frequency	None

Elevation	4,500–7,000 ft
Slope	2–30%
Aspect	Aspect is not a significant factor

Climatic features

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

Mean precipitation by month: Jan 1.0; Feb 0.89; Mar 0.92; Apr 1.04; May 1.09; Jun 0.86; Jul 0.24; Aug 0.26; Sept 0.43; Oct 0.78; Nov 0.88; Dec 0.97. *The above data is averaged from the Winnemucca AP and the Orovada 3W climate station.

Table 3. Representative climatic features

Frost-free period (average)	88 days
Freeze-free period (average)	122 days
Precipitation total (average)	9 in

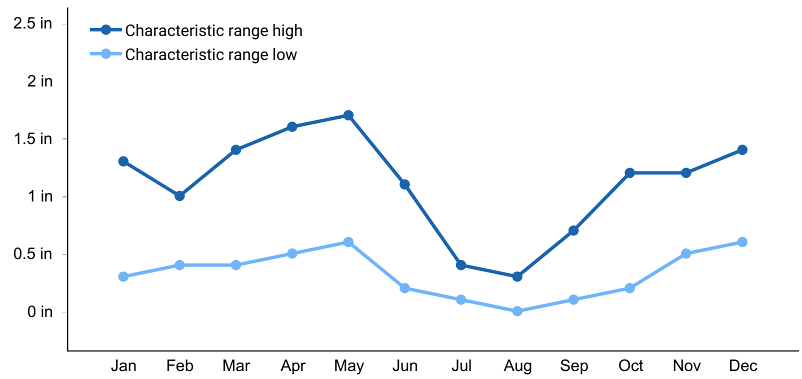


Figure 1. Monthly precipitation range

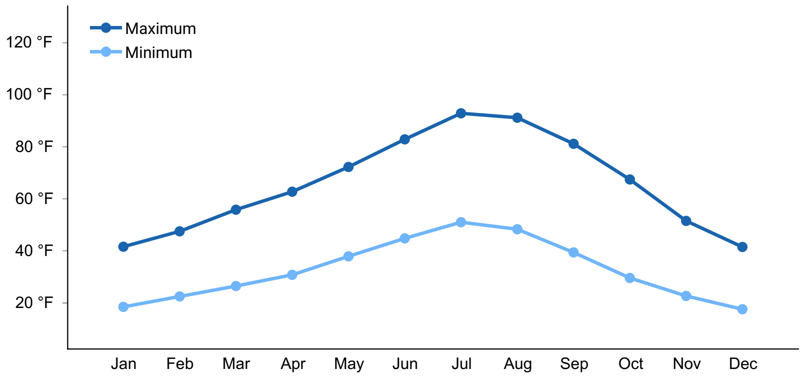


Figure 2. Monthly average minimum and maximum temperature

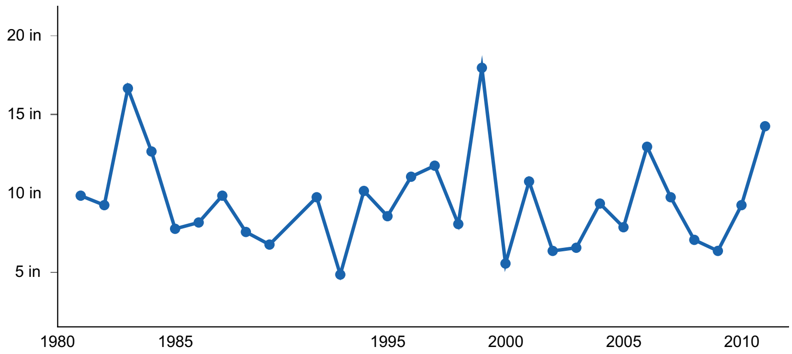


Figure 3. Annual precipitation pattern

Climate stations used

- (1) WINNEMUCCA MUNI AP [USW00024128], Winnemucca, NV
- (2) OROVADA 3 W [USC00265818], Orovada, NV

Influencing water features

Influencing water features are not associated with this site.

Soil features

Soils associated with this site are deep, well drained and formed in alluvium derived from mixed parent material. The soils are characterized by an ochric epipedon, an argillic horizon and 5-25% rock fragments distributed throughout the profile. Soil moisture regime is aridic bordering on xeric and the soil temperature regime is mesic. Secondary calcium carbonate occurs in the lower part of the subsoil.

The representative series for this site is Hunnton, classified as a fine, smectitic, mesic Xeric Argidurid.

Additional soil series correlated to this ecological site include: Trunk, Snapp, Bliss, Wieland, Cherry Spring, Boulflat, Alley, Zevadez, Allker, Allor, Snowmore, Goosel, Pineval, Tomera, Nevador, Dacker, Berning, Vanwyper, Spasprey and Schamp.

Occurrences of this site on soils that formed in residuum/colluvium and are 40” deep or less will be considered for recorrelation to Shallow Loam 8-10" PZ (024XY047NV) or Shallow Loam 10-14" PZ (024XY035NV). Series include: Burrita, Chiara, Dewar, Old Camp, Shabliss, Soughe, Locane, tumtum, Boger, Brock, Buffaran, Midraw, Genaw, Reina, Locane, Bucan, and Humdun.

Where this site is correlated to soils lacking an argillic horizon components will be field checked and correlated to Droughty Loam 8-10" (024XY020NV) or other ecological site as appropriate including Orovada, McConnel, Enko, Colbar, Flue, Zineb, Connel, Bioya, Dugchip, Rad, Cortez, Pocan, Tulase, Minat, Rebel, Midas, Clurde, Kodra, Rasille, Veta, Newpass.

Table 4. Representative soil features

Surface texture	(1) Loam (2) Silt loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Slow to very slow
Soil depth	40–60 in
Surface fragment cover <=3"	0–15%
Surface fragment cover >3"	0–5%

Available water capacity (0-40in)	3.3–4.9 in
Calcium carbonate equivalent (0-40in)	0–5%
Electrical conductivity (0-40in)	0–8 mmhos/cm
Sodium adsorption ratio (0-40in)	0–30
Soil reaction (1:1 water) (0-40in)	7.4–9
Subsurface fragment volume <=3" (Depth not specified)	5–20%
Subsurface fragment volume >3" (Depth not specified)	0–5%

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

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

Variability in plant community composition and production depends on soil surface texture and depth. Indian ricegrass increases with sandy soil surfaces. The amount of sagebrush in the plant community is dependent upon disturbances such as fire, Aroga moth infestations and grazing. Sandberg bluegrass more easily dominates sites where surface soils are gravelly loams than those where surface soils are silt loams.

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

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

The Great Basin sagebrush communities have high spatial and temporal variability in precipitation both among

years and within growing seasons. Nutrient availability is typically low but increases with elevation and closely follows moisture availability. The moisture resource supporting the greatest amount of plant growth is usually the water stored in the soil profile during the winter. The invasibility of plant communities is often linked to resource availability. Disturbance can decrease resource uptake due to damage or mortality of the native species and depressed competition or can increase resource pools by the decomposition of dead plant material following disturbance. The invasion of sagebrush communities by cheatgrass has been linked to disturbances (fire, abusive grazing) that have resulted in fluctuations in resources (Chambers et al 2007).
The introduction of annual weedy species, like cheatgrass, may cause an increase in fire frequency and eventually lead to an annual state. Conversely, as fire frequency decreases, sagebrush will increase and with inappropriate grazing management the perennial bunchgrasses and forbs may be reduced.
The ecological sites in this DRG have low resilience to disturbance and low resistance to invasion. Resilience increases with elevation, aspect, increased precipitation and increased nutrient availability. Five possible alternative stable states have been identified for this DRG.

Fire Ecology:
Fire is the principal means of renewal of decadent stands of Wyoming big sagebrush. Wyoming big sagebrush communities historically had low fuel loads, and patchy fires that burned in a mosaic pattern were common at 10 to 70 year return intervals (West and Hassan 1985, Bunting et al. 1987). Davies et al. (2007) suggest fire return intervals in Wyoming big sagebrush communities were around 50 to 100 years. More recently, Baker (2011) estimates fire rotation to be 200-350 years in Wyoming big sagebrush communities. Wyoming big sagebrush is killed by fire and only regenerates from seed. Recovery time for Wyoming big sagebrush may require 50 to 120 or more years (Baker 2006). Post-fire hydrologic recovery and resilience is primarily influenced by pre-fire site conditions, fire severity, and post-fire weather and land use that relate to vegetation recovery. Sites with low abundances of native perennial grasses and forbs typically have reduced resiliency following disturbance and are less resistant to invasion or increases in cheatgrass (Miller et al 2013). However, the introduction and expansion of cheatgrass has dramatically altered the fire regime (Balch et al. 2013) and restoration potential of Wyoming big sagebrush communities.
The effect of fire on bunchgrasses relates to culm density, culm-leaf morphology, and the size of the plant. The initial condition of bunchgrasses within the site along with seasonality and intensity of the fire all factor into the individual species response. For most forbs and grasses the growing points are located at or below the soil surface providing relative protection from disturbances which decrease above ground biomass, such as grazing or fire. Thus, fire mortality is more related to duration and intensity of heat which is related to culm density, culm-leaf morphology, size of plant and abundance of old growth (Young 1983, Wright 1971).
Burning has been found to decrease the vegetative and reproductive vigor of Thurber’s needlegrass (Uresk et al. 1976). Fire can cause high mortality, in addition to reducing basal area and yield of Thurber’s needlegrass (Britton et al. 1990a). The fine leaves and densely tufted growth form make this grass susceptible to subsurface charring of the crowns (Wright and Klemmedson 1965). Although timing of fire highly influenced the response and mortality of Thurber’s needlegrass, smaller bunch sizes were less likely to be damaged by fire (Wright and Klemmedson 1965). Thurber’s needlegrass often survives fire and will continue growth or regenerate from tillers when conditions are favorable (Koniak 1985, Britton et al. 1990a). Reestablishment on burned sites has been found to be relatively slow due to low germination and competitive ability (Koniak 1985). Cheatgrass has been found to be a highly successful competitor with seedlings of this needlegrass and may preclude reestablishment (Evans and Young 1978).
Indian ricegrass is fairly fire tolerant (Wright 1985), which is likely due to its low culm density and below-ground root crowns. Vallentine (1989) cites several studies in the sagebrush zone that classified Indian ricegrass as being slightly damaged from late summer burning. Indian ricegrass has also been found to reestablish on burned sites through seed dispersed from adjacent unburned areas (Young 1983, West 1994). Thus the presence of surviving, seed producing plants facilitates the reestablishment of Indian ricegrass. Grazing management following fire to promote seed production and establishment of seedlings is important.
Squirreltail is considered more fire tolerant than Indian ricegrass due to its small size, coarse stems, broad leaves and generally sparse leafy material (Wright 1971, Britton et al. 1990). Postfire regeneration occurs from surviving root crowns and from on-and off-site seed sources. Bottlebrush squirreltail has the ability to produce large numbers of highly germinable seeds, with relatively rapid germination (Young and Evans 1977) when exposed to the correct environmental cues. Early spring growth and ability to grow at low temperatures contribute to the persistence of bottle brush squirreltail among cheatgrass dominated ranges (Hironaka and Tisdale 1972).
Sandberg bluegrass, a minor component of this ecological site, has been found to increase following fire likely due to its low stature and productivity (Daubenmire 1975). Reduced bunchgrass vigor or density provides an opportunity for Sandberg bluegrass expansion and/or cheatgrass and other invasive species to occupy interspaces, leading to increased fire frequency and potentially an annual plant community. Sandberg bluegrass increases under grazing

pressure (Tisdale and Hironaka 1981) and is capable of co-existing with cheatgrass. Excessive sheep grazing favors Sandberg bluegrass; however, where cattle are the dominant grazers, cheatgrass often dominates (Daubenmire 1970). Thus, depending on the season of use, the grazer and site conditions, either Sandberg bluegrass or cheatgrass may become the dominant understory with inappropriate grazing management. Repeated frequent fire in this community will eliminate big sagebrush and severely decrease or eliminate the deep rooted perennial bunchgrasses from the site and facilitate the establishment of an annual weed community with varying amounts of Sandberg bluegrass and rabbitbrush.
Fire will remove aboveground biomass from bluebunch wheatgrass but plant mortality is generally low (Robberecht and Defossé 1995) because the buds are underground (Conrad and Poulton 1966) or protected by foliage. Uresk et al. (1976) reported burning increased vegetative and reproductive vigor of bluebunch wheatgrass. Thus, bluebunch wheatgrass is considered to experience slight damage to fire but is more susceptible in drought years (Young 1983). Plant response will vary depending on season, fire severity, fire intensity and post-fire soil moisture availability.
Wildfire in sites with cheatgrass present could transition to cheatgrass dominated communities. Without management cheatgrass and annual forbs are likely to invade and dominate the site, especially after fire.

Ecological dynamics:
The plant communities of this site are dynamic in response to changing weather patterns and disturbance regimes. The reference community phase is dominated by big sagebrush (*Artemisia tridentata*) and deep-rooted, cool season perennial bunchgrasses such as Thurber's needlegrass and bluebunch wheatgrass. Indian ricegrass (*Achnatherum hymenoides*) and spiny hopsage (*Grayia spinosa*) are always found on this site, but at low percentages.

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 known 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. It frequently displays intermediate morphological characteristics between basin big sagebrush (*A. tridentata* spp. tridentata) and Wyoming big sagebrush (*A. tridentata* spp. wyomingesis) including mature plant height, growth form, and leaf shape (B. Perryman, personal communication, May 19, 2014).
Following this discussion of hybridization you will find references to Wyoming big sagebrush throughout the document. 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, maximizing water uptake. The majority of the roots are in the upper foot of soil with tap roots extending up to 6 feet in depth (Howard 1999). The combination of deep and shallow roots also provides excellent soil stabilization. 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 bunchgrasses, Thurber's needlegrass and bluebunch wheatgrass, tolerate droughty conditions found on this ecological site by extending their root system into subsoil horizons maximizing water uptake. The rooting depth of Thurber's needlegrass associated with sagebrush in Idaho is reported to be 24" (Archer 2000). The maximum rooting depth of bluebunch wheatgrass in Colorado is reported to be 52", with the highest concentration of roots around 18" (Zlatnik 1999). The fine textured argillic horizon found in typical soils associated to this ecological site is located between 14” and 28” increasing available moisture in the prime rooting depth for these perennial grasses. Ecological significance of deep roots in arid environments helps to extend growth into the dry season and increases survival.

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% 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, due to a combination of factors such as disturbance history, relatively low elevation, and the semi-arid climate. 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 the most vulnerable to cheatgrass (*Bromus tectorum*) invasion due to the combination of low resilience to disturbances such as fire and low resistance to cheatgrass invasion (Chambers et al. 2012). Management activities should be prioritized based on the relative resilience and resistance of a specific ecological site.

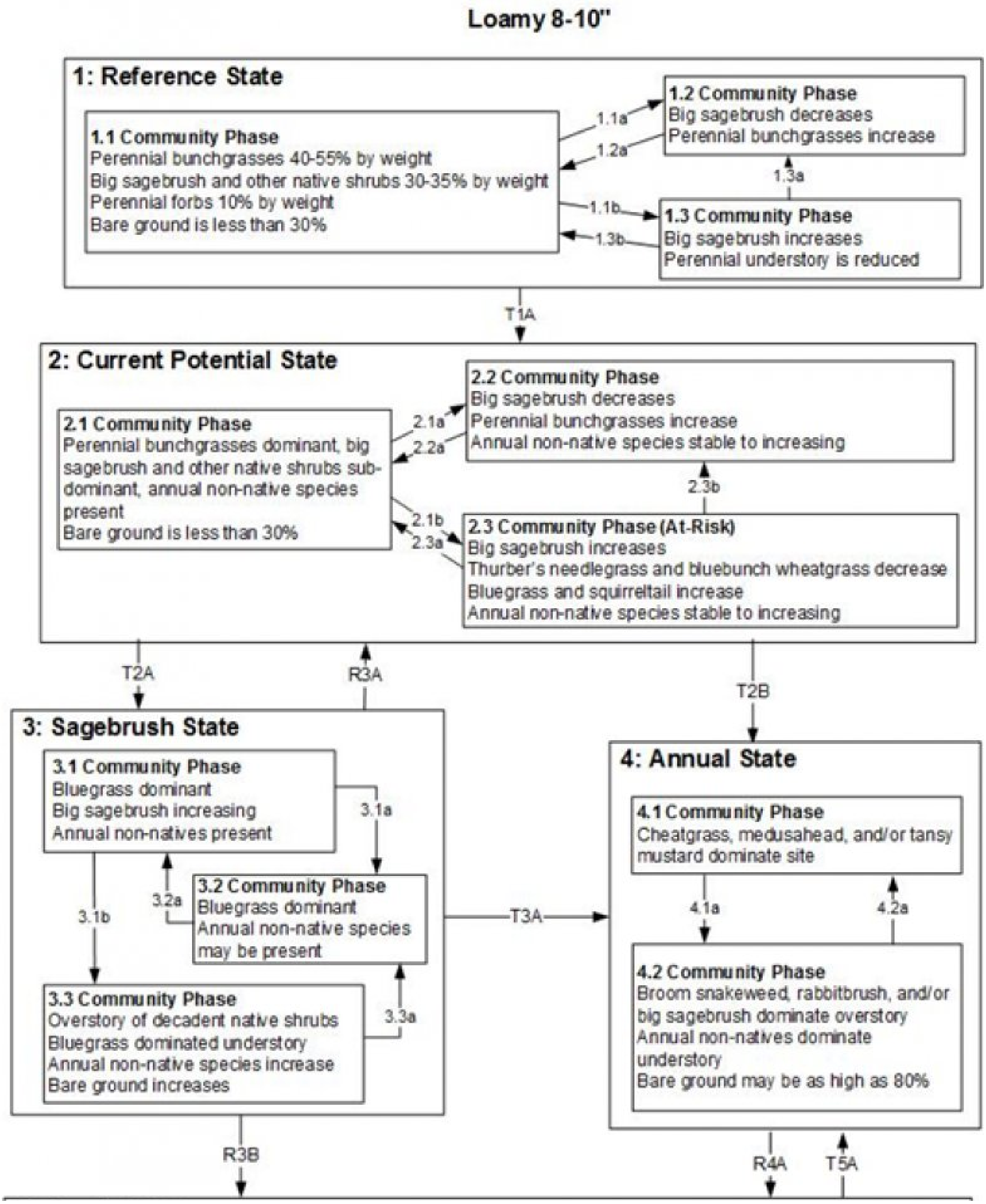
Inappropriate management; grazing, recreation, etc., on this site can lead to an increase in sagebrush and a decline in herbaceous species, namely Thurber’s needlegrass and other deep rooted perennial bunchgrasses. Reoccurring disturbances, natural or anthropogenic, will result in decreased sagebrush 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. Additional discussion regarding how functional groups and disturbance impact the hydrologic functions of this ecological site can be found in the Ecological Site Interpretations under Hydrology Functions.

Disturbance Ecology:
Prior to Euro-American settlement, Wyoming big sagebrush communities historically had low fuel loads, and patchy fires that burned in a mosaic pattern were common (Young et al. 1979, West and Hassan 1985, and Bunting et al. 1987). Estimates of pre Euro-American settlement fire return intervals in Wyoming big sagebrush communities vary widely; 10 to 40 years (Young and Evans 1981), 50 to 100 years (Davies et al. 2007), 100 to 240 years (Baker 2006). Actual fire return intervals were largely dependent on landscape position and year to year variation in herbaceous fuel loading. There is, however, general agreement among authors that infrequent fire probably maintained Wyoming big sagebrush communities as open, seral stands of sagebrush with productive herbaceous understories. The introduction and expansion of cheatgrass has dramatically altered the fire return intervals and restoration potential of Wyoming big sagebrush communities.

Fire is the principal means of renewal for decadent stands of Wyoming big sagebrush. Wyoming big sagebrush plants of all ages are killed by fire. Depending on site conditions prior to wildfire, perennial grasses and forbs will dominate initially after wildfire. Wyoming big sagebrush establishes afterwards from seed stored in the soil and from seed produced by remnant plants that escaped fire. Prolific seed production from nearby unburned plants coupled with high germination and survival rates is required to ensure establishment following fire. The VAM upon which Wyoming big sagebrush depends on for healthy growth are usually harmed by fire and may take several years to recover. Typically, fewer VAM are killed by low-intensity wildfire than by more severe fire intensities (Howard 1999).

This ecological site can also be impacted by the native sagebrush defoliating insect the aroga moth (Aroga websteri). Individual plants are partially or entirely killed through defoliation under low to moderate moth population densities. Under high population densities, entire stands involving thousands of acres can be eliminated (Furniss and Barr 1975). Adult moths lay eggs in the late summer/early fall on small cracks in the bark or on the leaves of sagebrush plants. After approximately two weeks larvae hatch and mine into the leaves and remain there through the winter. The following spring larvae resume work mining the leaves. Leaves are cut off the plant and used to build cocoons. In the later part of June or July larvae go in to the pupil stage and adult moths emerge in approximately two weeks (Gates 1964). The aroga moth is a native insect and therefore has native predators. It is impacted by 20 or more species of parasites. The moth and the larvae are also preyed upon by two species of beetles (Furniss and Barr 1975).

State and transition model



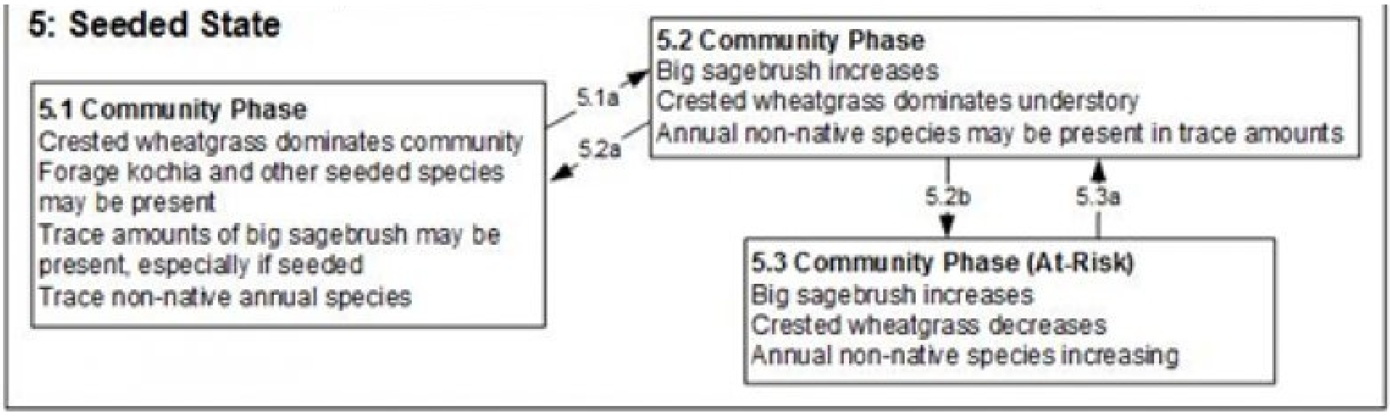


Figure 5. R024XY005NV Loamy 8-10" PZ

State 1
Reference State

The Reference State 1.0 is a representative of the natural range of variability under pristine conditions. The reference state has three general community phases; a shrub-grass dominant phase, a perennial grass dominant phase and a shrub dominant phase. State dynamics are maintained by interactions between climatic patterns and disturbance regimes. Negative feedbacks enhance ecosystem resilience and contribute to the stability of the state. These include the presence of all structural and functional groups, low fine fuel loads, and retention of organic matter and nutrients. Plant community phase changes are primarily driven by fire, periodic drought and/or insect or disease attack.

Community 1.1
Reference Community Phase

Wyoming big sagebrush and Thurber's needlegrass dominate the site. Indian ricegrass, bluebunch wheatgrass, Sandberg bluegrass and squirreltail are also common. Forbs are present but not abundant.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	220	330	440
Shrub/Vine	140	220	300
Forb	40	50	60
Total	**400**	**600**	**800**

Community 1.2
Community Phase

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

Community 1.3
Community Phase

Wyoming big sagebrush increases in the absence of disturbance. Decadent sagebrush dominates the overstory and the deep-rooted perennial bunchgrasses in the understory are reduced either from competition with shrubs, drought and/or herbivory.

Pathway 1.1a
Community 1.1 to 1.2

Reduction of sagebrush overstory allows for perennial bunchgrasses to dominate the site. Fires would typically be small and patchy due to low fuel loads. 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 sagebrush killing disturbance such as fire allows shrubs tp increase and become decadent. Long-term drought, herbivory, competition from shrubs, or combinations of these would cause a decline in perennial bunchgrasses and fine fuels and lead to a reduced fire frequency allowing big sagebrush to dominate the site.

Pathway 1.2a
Community 1.2 to 1.1

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

Pathway 1.3a
Community 1.3 to 1.1

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

Pathway 1.3b
Community 1.3 to 1.2

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

State 2
Current Potential State

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

Community 2.1
Community Phase

Figure 7. Loamy 8-10 Community Phase 2.1 NV777 MU530 Shabliss Soil T. Stringham April 2010

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

Table 6. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	–	–	–
>0.5 <= 1	–	2-5%	2-5%	5-20%
>1 <= 2	–	10-15%	2-5%	–
>2 <= 4.5	–	5-10%	–	–
>4.5 <= 13	–	–	–	–
>13 <= 40	–	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Community 2.2
Community Phase

Figure 8. Loamy 8-10 Community Phase 2.2 NV777 MU530 Shabliss Soil T. Stringham April 2010

This community phase is characteristic of a post-disturbance, early seral community phase. Thurber's needlegrass and other perennial grasses dominate. Wyoming big sagebrush is present in trace amounts. Depending on fire severity or intensity of Aroga moth infestations, patches of intact sagebrush may remain. Rabbitbrush may be sprouting. Forbs may increase post-fire but will likely return to pre-burn levels within a few years. Annual non-native species generally respond well after fire and may be stable or increasing within the community.

Community 2.3
Community Phase (At-Risk)

Figure 9. Loamy 8-10 Community Phase 2.2 NV777 MU530 Shabliss Soil T. Stringham April 2010

Figure 10. Loamy 8-10 Community Phase 2.2 NV777 MU530 Shabliss Soil T. Stringham April 2010

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

Pathway 2.1a
Community 2.1 to 2.2

Community Phase

Community Phase

Fire reduces the shrub overstory and allows 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.

Conservation practices

Prescribed Grazing

Pathway 2.1b
Community 2.1 to 2.3

Community Phase

Community Phase (At-Risk)

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.

Conservation practices

Prescribed Grazing

Pathway 2.2a
Community 2.2 to 2.1

Community Phase

Community Phase

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

Community Phase (At-Risk)

Community Phase

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

Community Phase (At-Risk)

Community Phase

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

State 3
Shrub State

This state is a product of many years of heavy grazing during time periods harmful to perennial bunchgrasses. Sandberg bluegrass may increase with a reduction in deep rooted perennial bunchgrass competition and may become the dominate grass or the herbaceous understory may be completely eliminated. Sagebrush dominates the overstory and spiny hopsage and/or rabbitbrush may be a significant component. Sagebrush cover exceeds site concept and may be decadent, reflecting stand maturity and lack of seedling establishment due to competition with mature plants. The shrub overstory dominates site resources such that soil water, nutrient capture, nutrient cycling and soil organic matter are temporally and spatially redistributed. Bare ground may be significant with soil redistribution occurring between interspace and canopy locations.

Community 3.1
Community Phase

This community phase is dominated by Wyoming big sagebrush and Sandberg bluegrass. Non-native annuals are present throughout the site, but do not dominate. Sandberg bluegrass generally increases under heavy grazing pressure as most palatable bunchgrass decline in vigor and productivity. It is self-fertile, shallow-rooted and regenerates by tillering and by seed, easily dominating site resources. Once established Wyoming big sagebrush easily competes with Sandberg bluegrass. However, sagebrush seedling establishment will take longer than normal on a site once dominated by Sandberg bluegrass. Bare ground ranges from <20 to 60 percent depending on the amount of rock fragments on the soil surface.

Table 7. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	20-35%
Grass/grasslike foliar cover	6-20%
Forb foliar cover	1-5%
Non-vascular plants	0-5%
Biological crusts	0-5%
Litter	5-20%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0-15%
Bedrock	0%
Water	0%
Bare ground	10-40%

Community 3.2
Community Phase

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

Community 3.3
Community Phase

Mature stands of sagebrush dominate this community phase. Understory species, perennial grasses and forbs, are severely reduced do to completion for light, nutrients and water. Non-natives species are present and common throughout the plant community.

Pathway 3.1a
Community 3.1 to 3.2

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

Pathway 3.1b
Community 3.1 to 3.3

Absence of disturbance and natural regeneration over time allows for shrub dominance.

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.

Pathway 3.3a
Community 3.3 to 3.2

Low severity fire or other disturbance that removes sagebrush canopy without extensive soil disturbance.

State 4
Annual State

This community is characterized by the dominance of annual non-native species such as cheatgrass and tansy mustard in the understory. Sprouting shrubs such as rabbitbrush, shadscale, broom snakeweed and spiny hopsage may dominate the overstory.

Community 4.1
Community Phase

Figure 11. Cheatgrass and fiddleneck

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

Community 4.2
Community Phase

Sprouting shrubs such as spiny hopsage and Rabbitbrush along with broom snakeweed dominate overstory. Wyoming big sagebrush may be a minor component. Annual non-native species dominate understory. Trace amounts of desirable bunchgrasses may be present. Bare ground is significant.

Pathway 4.1a
Community 4.1 to 4.2

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

Pathway 4.2a
Community 4.2 to 4.1

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

State 5
Seeded State

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

Community 5.1
Community Phase

Figure 12. Loamy 8-10 P.Z. Community Phase 5.1

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

Community 5.2
Community Phase

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

Community 5.3
Community Phase (At-Risk)

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

Pathway 5.1a
Community 5.1 to 5.2

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

Pathway 5.2a
Community 5.2 to 5.1

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

Pathway 5.2b
Community 5.2 to 5.3

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

Pathway 5.3a
Community 5.3 to 5.1

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

Transition T1A
State 1 to 2

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

Transition T2A
State 2 to 3

Trigger: Inappropriate, long-term grazing of perennial bunchgrasses during the growing season would favor sagebrush. Slow variables: Long term decrease in deep-rooted perennial grass density. Threshold: Loss of deep-rooted perennial bunchgrasses changes spatial and temporal nutrient cycling and nutrient redistribution, and reduces soil organic matter.

Transition T2B
State 2 to 4

Trigger: To Community Phase 4.1: Severe fire and/or soil disturbing treatments. To Community Phase 4.2: Inappropriate grazing management that favors shrubs in the presence of non-native species. Slow variables: Increased production and cover of non-native annual species. Threshold: Loss of deep-rooted perennial bunchgrasses and shrubs truncates, spatially and temporally, nutrient capture and cycling within the community. Increased, continuous fine fuels from annual non-native plants modify the fire regime by changing intensity, size and spatial variability of fires.

Restoration pathway R3A
State 3 to 2

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

Conservation practices

Brush Management
Range Planting
Enhancement - Habitat Management
Herbaceous Weed Control

Transition T3A
State 3 to 4

Trigger: To Community Phase 4.1: Severe fire and/or soil disturbing treatments. To Community Phase 4.2: Inappropriate grazing management in the presence of annual non-native species. Slow variables: Increased production and cover of non-native annual species. Threshold: Increased, continuous fine fuels modify the fire regime by changing intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture spatially and temporally thus impacting nutrient cycling and distribution.

Restoration pathway R3B
State 3 to 5

Brush management with minimal soil disturbance, coupled with seeding of desired species, usually wheatgrasses (5.1 or 5.2). Restoration attempts causing soil disturbance will likely initiate a transition to an annual state. Probability of success very low.

Conservation practices

Range Planting
Prescribed Grazing
Herbaceous Weed Control

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.

Conservation practices

Range Planting
Prescribed Grazing
Herbaceous Weed Control

Transition T5A
State 5 to 4

Trigger: Catastrophic wildfire. Catastrophic wildfire can be considered a wildfire long, hot and/or frequent enough to remove all vegetation, kill below ground biomass, damage biological crust and volatilize organic matter. Slow variables: Increase in reproduction and cover of non-native annuals. Reduced reproduction of seeded perennial species. Changes in the plant community the amount and type of organic matter inputs reduce soil water and soil nutrient availability. Threshold: Continuous bed of fine fuels provided by non-native annuals results in a modified fire regime (changes in fire frequency, intensity, size and spatial variability).

Transition T5A
State 5 to 4

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

Additional community tables

Table 8. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Primary Perennial Grasses**			220–408	
	Thurber's needlegrass	ACTH7	*Achnatherum thurberianum*	240–300	–
	bluebunch wheatgrass	PSSPS	*Pseudoroegneria spicata ssp. spicata*	12–60	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	12–48	–
2	**Secondary Perennial Grasses**			12–60	
	Webber needlegrass	ACWE3	*Achnatherum webberi*	3–18	–
	squirreltail	ELEL5	*Elymus elymoides*	3–18	–
	needle and thread	HECO26	*Hesperostipa comata*	3–18	–
	basin wildrye	LECI4	*Leymus cinereus*	3–18	–
	Sandberg bluegrass	POSE	*Poa secunda*	3–18	–
Forb					
3	**Perennial forbs**			30–80	
	milkvetch	ASTRA	*Astragalus*	3–12	–
	arrowleaf balsamroot	BASA3	*Balsamorhiza sagittata*	3–12	–
	tapertip hawksbeard	CRAC2	*Crepis acuminata*	3–12	–
	buckwheat	ERIOG	*Eriogonum*	3–12	–
	desertparsley	LOMAT	*Lomatium*	3–12	–
	silvery lupine	LUAR3	*Lupinus argenteus*	3–12	–
	beardtongue	PENST	*Penstemon*	3–12	–
	phlox	PHLOX	*Phlox*	3–12	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	3–12	–
	deathcamas	ZIGAD	*Zigadenus*	1–8	–
	cryptantha	CRYPT	*Cryptantha*	1–8	–
	larkspur	DELPH	*Delphinium*	1–8	–
	castilla	CASTI	*Castilla*	1–8	–
Shrub/Vine					
4	**Primary Shrubs**			140–215	
	big sagebrush	ARTR2	*Artemisia tridentata*	120–180	–
	spiny hopsage	GRSP	*Grayia spinosa*	12–30	–
5	**Secondary Shrubs**			12–60	
	fourwing saltbush	ATCA2	*Atriplex canescens*	6–12	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	6–12	–
	Nevada jointfir	EPNE	*Ephedra nevadensis*	6–12	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	6–12	–
	pricklypear	OPUNT	*Opuntia*	6–12	–
	horsebrush	TETRA3	*Tetradymia*	6–12	–

Animal community

Livestock Interpretations:
This site has value for livestock grazing. Grazing management considerations include timing, duration, frequency,

and intensity of grazing. Livestock browse big sagebrush, but may use it only lightly when palatable herbaceous species are available. Spiny hopsage provides a palatable and nutritious food source for livestock, particularly late winter through spring. Domestic sheep browse the succulent new growth of spiny hopsage in late winter and early spring.
Thurber’s needlegrass species begin growth early in the year and remains green throughout the 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 needlegrass is grazed in the fall only if the fruits are softened by rain. Thurber’s needlegrass is sensitive to defoliation, especially during the boot stage (Ganskopp 1988).
Bluebunch wheatgrass is considered one of the most important forage grass species on western rangelands for livestock. 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, Britton et al. 1990). Although an important forage species, it is not always the preferred species by livestock and wildlife.
Indian ricegrass is highly palatable to all classes of livestock in both green and cured condition. This species is heavily utilized in winter because it cures well. It is also utilized in early spring, being a source of green feed before most other perennial grasses have produced new growth (Quinones 1981). Heavy grazing will reduce seed production and may reduce density and basal area of these plants. Additionally, heavy early spring grazing reduces plant vigor and stand density (Stubbendieck et al. 1985).
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 rate, fine-tuned by the client’s adaptive management throughout current and future years.

Wildlife Interpretations:
A large compliment of wildlife species, including many bird, small and large mammals, and reptile species, depend on or at least partially utilize this ecological site. Large mammals common to this ecological site include mule deer (Odocoileus hemionus) and pronghorn antelope (Antilocarpa americana). Desert bighorn sheep (Ovis canadensis sierra) and Rocky Mountain elk (Cervus elaphus nelsonii canadensis) may occasionally use this ecological site; especially when in search of green forage in the late-winter and early-spring months. Wyoming big sagebrush is preferred browse for wild ungulates. Pronghorn usually browse Wyoming big sagebrush heavily. Spiny hopsage provides a palatable and nutritious food source for big game, particularly during late winter through spring. Thurber’s needlegrass is valuable forage for wildlife. 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. Indian ricegrass is eaten by pronghorn in moderate amounts whenever available. In Nevada Indian ricegrass is consumed by desert bighorns.
Sagebrush-grassland communities provide critical sage-grouse (Centrocercus urophasianus) breeding and nesting habitats. Sagebrush is a crucial component of their diet year-round, and sage-grouse select sagebrush almost exclusively for cover. Widespread natural hybridization of big sagebrush species, such as is suspected on this site, has important implications for wildlife management especially sage-grouse. Sage-grouse select Wyoming big sagebrush communities for wintering and nesting habitat. The growth form of Wyoming big sagebrush provides suitable nesting and other habitat requirements for sage-grouse (Goodrich 2005). Favorable morphological characteristics for sage-grouse habitat include plant heights ranging from 16-36inches (40-90cm) and a dense spreading crown, with the lower part of the crown in proximity to the ground, but not so close that it obstructs sage-grouse nesting (Goodrich 2005). Stands of big sagebrush with a less spreading and more upright branching pattern, when compared to pure Wyoming big sagebrush, will not be preferred for nesting habitat. Big sagebrush is generally palatable to sage-grouse, though its palatability is highly variable (Rosentreter 2005). Palatability of hybrid sagebrush species is also highly variable. In addition to sage-grouse; California quail (Callipepla californica), chukar (Alectoris chukar), mourning dove (Zenaida macroura), Brewers sparrow (Spizella breweri), gray flycatcher (Empidonax wrightii), lark sparrow (Chondestes grammacus), sage sparrow (Amphispiza belli), sage thrasher (Oreoscoptes montanus), and Vesper’s sparrow (Pooecetes gramineus) utilize this ecological site. Indian ricegrass seed provides food for many species of birds. Doves, for example, eat large amounts of shattered Indian ricegrass seed lying on the ground.
This sagebrush-grassland ecological site also provides habitat for small mammals such as: black-tailed (Lepus californicus) and white-tailed jackrabbit (L. townsendii), mountain cottontail (Sylvilagus nuttallii), pygmy rabbit (Brachylagus idahoensis), dark kangaroo mouse (Microdipodops megacephalus), Great Basin ground squirrel (Sermophilus mollis), Great Basin pocket mouse (Perognathus parvus), little pocket mouse (P. longimembris), Merriam’s shrew (Sorex merriami), Northern grasshopper mouse (Onychomys leucogaster), Ord’s kangaroo rat (Dipodomys ordii), sagebrush vole (Lemmiscus curtatus), Western jumping mouse (Zapus princeps), and Wyoming

ground squirrel (Urocitellus elegans). A number of heteromyid rodents inhabiting desert rangelands show preference for seed of Indian ricegrass. Indian ricegrass is an important component of jackrabbit diets in spring and summer. In Nevada, Indian ricegrass may dominate jackrabbit diets during the spring through the early summer months. Spiny hopsage is a major food source for black-tailed jackrabbits. The seedlings of spiny hopsage are eaten by a variety of small mammals; including rabbits and mice. This ecological site may also provide a significant insect foraging resource for bats.
A variety of predatory bird, mammal, and reptile species utilize this ecological site. Common mammalian predators to this site are the American badger (Taxidea taxus), bobcat (Lynx rufus), coyote (Canis latrans), kit fox (Vulpes macrotis), cougar or mountain lion (Puma concolor), short-tailed weasel (Mustela ermine) and long-tailed weasel (M. frenata). All of which utilize wildlife species in the area as sources of prey. Predatory reptiles utilizing habitat in this ecological site to catch prey are common sagebrush lizard (Sceloporus graciosus), Great Basin spadefoot (Spea intermontana), Great Basin collared lizard (Crotaphytus bicinctores), long-nosed leopard lizard (Gambelia wislizenii), Western skink (Plestiodon skiltonianus), Great Basin whiptail (Aspidoscelis tigris tigris), Great Basin gopher snake (Pituophis catenifer deserticola), Great Basin rattle snake (Crotalus oreganus lutosus). Avian predators present in the site are the American kestrel (Falco sparverius), common raven (Corvus corax), golden eagle (Aquila chrysaetos), loggerhead shrike (Lanius ludovicianus), Western burrowing owl (Athene cunicularia), Ferruginous Hawk (Buteo regalis), Swainson’s hawk (B. swainsoni), and Prairie falcon (Falco mexicanus).
Changes in dynamic soil properties, plant community composition, precipitation, and fire frequency associated with this ecological site could affect the distribution and presence of wildlife species.

Hydrological functions

The accumulation and decomposition of litter under sagebrush shrub canopies and the breakdown of aging roots contributes to organic matter and nutrient cycling in the sagebrush system. Soil organic matter is important to soil function because it binds soil particles together into stable aggregates, improving porosity, infiltration and root penetration and reducing runoff and erosion (USDA-NRCS 2001). Soil aggregate stability is the ability of the aggregates to resist degradation. Soils with stable aggregates at the surface are more resistant to wind and water erosion than other soils. Where organic matter inputs are reduced, unstable aggregates disperse during rainstorms resulting in soil loss and possible formation of a hard physical crust when the soil dries (USDA-NRCS 2001). Mature, properly functioning, sagebrush communities, have higher infiltration rates, less runoff, and lower sediment production than their degraded counterparts.
Permeability is moderately slow and runoff is medium to high on this ecological site. Non-typical runoff; i.e. slow to moderate, may occur on areas with less surface rock fragments, sandy surface textures and low slope gradients. Rills are none to rare. A few can be expected on steeper slopes in areas subjected to summer convection storms or rapid spring snowmelt. Water flow patterns are none to rare. Pedestals are none to rare. Frost heaving of shallow-rooted plants should not be considered a normal condition. Gullies are none. Perennial herbaceous plants (especially deep-rooted bunchgrasses [i.e., Thurbers needlegrass]) slow runoff and increase infiltration. Shrub canopy and associated litter break raindrop impact and provide opportunity for snow catch and accumulation on site. Fire alters runoff and erosion rates by decreasing resistance to surface flow. Surface soil susceptibility to erosion is a function of ground cover, surface roughness, soil erodibility, soil water repellency, and slope (Miller et al. 2013).
In alternative states hydrology functions may change. Consult rangeland health reference sheet for reference conditions.

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 has potential for upland bird and big game hunting.

Other products

Traditional uses:
This site supports many plant species traditionally used and in some instances still utilized by Northern Paiute American Indians. Traditional plants that can be found in association with this ecological site include: sagebrush, balsamroot, Indian ricegrass, basin wildrye, saltbush, and rabbitbrush. These plants and others are addressed in various publications including Couture et al. (1986). Native Americans made tea from big sagebrush leaves. They used the tea as a tonic, an antiseptic, for treating colds, diarrhea, sore eyes and as a rinse to ward off ticks. Big

sagebrush seeds were eaten raw or made into meal. Some American peoples traditionally ground parched seeds of spiny hopsage to make pinole flour. The Northern Paiutes used Indian ricegrass seed as a reserve food source. This ecological site was part of the aboriginal home territory of American Indians currently residing on the Burns Indian Reservation, Oregon. In Nevada, Indian groups residing on the Summit Lake Indian Reservation, the Fort McDermitt Indian Reservation, the Winnemucca Indian Colony and Te-Moak groups residing on the Battle Mountain Indian Colony consider this their aboriginal territory. The eastern edge of the site represents an ethnographic boundary between Northern Paiute and Shoshonean American Indians and some Shoshonean groups may also consider their home territory.

Other information

Restoration: Range planting in combination with herbicide treatment or targeted grazing of non-native species may be necessary in order to restore Wyoming big sagebrush communities. Minimizing soil disturbing practices, applying seed immediately before a period of high-precipitation or using high-moisture microsites may improve success. Plant establishment in the Great Basin is highly dependent upon precipitation and available moisture; which is highly variable among years. Determination of seeding success is best delayed until the end of the second growing season. Seeding failures should be reseeded before complete seedbed preparation is required. Many rangeland seedings are only marginally successful and can be improved by means of natural or secondary seeding and plant establishment if given extra time and protection (USDA-SCS 1993).

Other projects: Wyoming big sagebrush can be 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. Spiny hopsage has moderate potential for erosion control and low to high potential for long-term re-vegetation projects. It can improve forage, control wind erosion, and increase soil stability on gentle to moderate slopes. Spiny hopsage is suitable for highway plantings on dry sites in Nevada.

Type locality

Location 1: Humboldt County, NV	
Township/Range/Section	T43N R39E S36
UTM zone	N
UTM northing	455865
UTM easting	4601342
Latitude	41° 33′ 50″
Longitude	117° 31′ 45″
General legal description	Approximately 2 miles North of Paradise Valley, near Mullinix Creek, Humbolt County, Nevada. SSA NV777, MU1173.

Location 2: Humboldt County, NV	
Township/Range/Section	T36N R39E S29
UTM zone	N
UTM northing	448216
UTM easting	4535641
Latitude	40° 58′ 13″
Longitude	117° 36′ 55″
General legal description	SSA NV777, MU592

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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)	Winnemucca Rangeland Health Class (May 12-15, 2005)
Contact for lead author	State Rangeland Management Specialist
Date	05/20/2005
Approved by	P. Novak-Echenique
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Minimal on less than 10% slopes and increasing slightly as slopes increase up to 50%. Rills spaced 15-50 ft. apart when present on slopes of 10-50%. After wildfires, high levels of natural herbivory or extended drought or combinations of these disturbances, rills may double in numbers on slopes from 10-50% after high

intensity summer thunderstorms.

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2. **Presence of water flow patterns:** Generally up to 20 ft. apart and short (<10 ft. long) with numerous obstructions that alter the water flow path. On slopes of 10-50%, flow patterns increase in number and length. Flow pattern length and numbers may double after wildfires, high levels of natural herbivory, extended drought, or combinations of these disturbances if high intensity summer thunderstorms occur.

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3. **Number and height of erosional pedestals or terracettes:** Wind caused pedestals are rare and only would occur after wildfires, high levels of natural herbivory, extended drought, or combinations of these disturbances. Pedestals of Sandberg bluegrass outside of water flow patterns are generally caused by frost heaving, not erosion.

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground 10-20% depending on amount of rock fragments. Lower slopes are expected to have less bare ground than steeper slopes. Upper end of precip range (10") will also have less bare ground. Bare ground would be expected to increase to 80% or more the first year following wildfire but to decrease to pre-fire levels within 2-5 years depending on climate and other disturbances. Multi-year droughts can also cause bare ground to increase to around 30%.

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

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6. **Extent of wind scoured, blowouts and/or depositional areas:** Wind erosion is minimal. Moderate to severe wind erosion can occur when disturbances such as severe wildfires, high levels of natural herbivory, extended drought, or combinations of these disturbances. After rain events, exposed soil surfaces form a physical crust that tends to reduce wind erosion.

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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 (1-3 ft on 2-15% slopes, 4-6 ft. on 15-30% slopes, and 7-10 ft. on 30-50% slopes) during intense summer convection storms or rapid snowmelt events. Persistent litter (large woody material) will remain in place except during large rainfall events.

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Values will range from 4 to 6 under canopy and in interspaces.

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Surface structure is moderate granular. Soil surface colors are light brownish grays and soils are typified by an ochric epipedon. 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. Loss of several millimeters of soil may occur immediately after a high intensity wildfire, high levels of natural herbivory, extended drought, or combinations of these disturbances.

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial**

distribution on infiltration and runoff: Perennial plants and especially sagebrush capture snow, increasing soil water availability in the spring. High bunchgrass density (especially deep-rooted bunchgrasses [i.e., Thurbers needlegrass] slow runoff and increase infiltration. Loss of sagebrush after a high intensity wildfire reduces snow accumulation in the winter, reducing the depth of soil water recharge negatively affecting recovery and growth and reproduction of deep-rooted perennial forbs and grasses.

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11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** Compacted layers are none. These are soil profile features, such as massive sub-surface structure, subsoil argillic horizons, or duripans that would be mistaken for a management induced soil compaction layer. Silica accumulations can cause denser horizons; however these horizons can be distinguished from compaction by their brittleness and "shiny" material in the horizon. These silica accumulations will increase the hardness of the soil, but should not be considered compaction.

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

    Dominant: Reference Plant Community: Deep-rooted, cool season, perennial bunchgrasses > Wyoming 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, annual and perennial forbs, biological crust up to 10-15%

    Additional: After wildfires, the functional/structural dominance changes to the herbaceous components with a slow 10-20 year recovery of the non-resprouting shrubs (big sagebrush). Resprouting shrubs (spiny hopsage, rabbitbrush) tend to increase until the sagebrush reestablishes. High levels of natural herbivory, extended drought, or combinations of these factors can increase shrub functional/structural groups at the expense of the herbaceous groups and biological crust.

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

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14. **Average percent litter cover (%) and depth (in):** Within plant interspaces (± 20%) and depth of litter is 0.25 inch. After wildfires, high levels of natural herbivory, extended drought, or combinations of these disturbances, litter cover and depth decreases to none. Depending on climate and vegetation recovery, litter will increase to pre-fire amounts in one to five growing seasons.

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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 (end of June) ± 600 lbs/ac; Favorable years ± 800 lbs/ac and unfavorable years ± 400 lbs/ac. Spring moisture significantly affects total production. After wildfires, high levels of natural herbivory, extended drought, or combinations of these disturbances, can cause production to be significantly reduced (100-200 lbs/ac the first growing season following wildfire) and recovery is slow under below average precipitation regimes.

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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, halogeton, Russian thistle, bassia, annual mustards, and knapweeds. Cheatgrass is the greatest threat to dominate this site after disturbance (primarily wildfires). Exotic mustards and Russian thistle may dominate soon after disturbance but are eventually replaced by cheatgrass.

17. **Perennial plant reproductive capability:** All functional groups should reproduce in average (or normal) and above average growing season years. Only limitations to reproductive capability are weather-related, natural disease or herbivory, insect infestations or combinations of these disturbances.