USDA Natural Resources Conservation Service

Ecological site R028AY073NV
ASPEN THICKET

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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): 028A–Ancient Lake Bonneville

MLRA 28A occurs in Utah (82%), Nevada (16%), and Idaho (2%). It makes up about 36,775 square miles. A large area west and southwest of Great Salt Lake is a salty playa. This area is the farthest eastern extent of the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. It is an area of nearly level basins between widely separated mountain ranges trending north to south. The basins are bordered by long, gently sloping alluvial fans. The mountains are uplifted fault blocks with steep side slopes. They are not well dissected because of low rainfall in the MLRA. Most of the valleys are closed basins containing sinks or playa lakes. Elevation ranges from 3,950 to 6,560 ft. in the basins and from 6,560 to 11,150 ft. in the mountains. Most of this area has alluvial valley fill and playa lakebed deposits at the surface. Great Salt Lake is all that remains of glacial Lake Bonneville. A level line on some mountain slopes indicates the former extent of this glacial lake. Most of the mountains in the interior of this area consist of tilted blocks of marine sediments from Cambrian to Mississippian age. Scattered outcrops of Tertiary continental sediments and volcanic rocks are throughout the area. The average annual precipitation is 5 to 12 ins. in the valleys and is as much as 49 ins. in the mountains. Most of the rainfall occurs as high-intensity, convective thunderstorms during the growing season. The driest period is from midsummer to early autumn. Precipitation in winter typically occurs as snow. The average annual temperature is 39 to 53 °F. The freeze-free period averages 165 days and ranges from 110 to 215 days, decreasing in length with elevation. The dominant soil orders in this MLRA are Aridisols, Entisols, and Mollisols. The soils in the area dominantly have a mesic or frigid soil temperature regime, an aridic or xeric soil moisture regime, and mixed mineralogy. They generally are well drained, loamy or loamy-skeletal, and very deep.

Ecological site concept

This site occurs on smooth to usually concave mountain shoulders with northerly exposures. Slopes range from 8 to 75 percent, but slopes of 30 to 75 are most typical. Elevations are 7200 to over 8800 feet.

Average annual precipitation ranges from 16 to over 20 inches in some areas. Mean annual air temperature is 40 to 43 degrees F. The average growing season is about 50 to 70 days.

The soils associated with this site are moderately deep to very deep and well drained. The soils are formed in alluvium and colluvium derived from quartzite and/or limestone. These soils are often modified with large rock fragments through their profile. Stones may interfere with the lateral spread of shallow roots and restrict the reproductive ability of aspen.

The reference state is dominated by low-growing quaking aspen. Locally known as "snowbank" aspen, these trees have a stunted growth form and are usually not more than 15 feet tall at maturity. Each site normally represents a single clone of aspen with a common genetic makeup having uniform phenological and physiological characteristics. Mountain brome and nodding brome, slender wheatgrass, meadowrue and snowberry are important understory species associated with this site, and are most prevalent about the periphery of the aspen overstory. Total overstory canopy cover exceeds 60 percent. Understory vegetation comprises about 20% of the total site production. Production ranges from 100 to 400 pounds per acre understory.

Table 1. Dominant plant species

Tree	(1) *Populus tremuloides*
Shrub	Not specified
Herbaceous	(1) *Bromus marginatus* (2) *Bromus anomalus*

Physiographic features

This site occurs on smooth to usually concave mountain shoulders with northerly exposures. Slopes range from 8 to 75 percent, but slopes of 30 to 75 are most typical. Elevations are 7200 to over 8800 feet.

Table 2. Representative physiographic features

Landforms	(1) Mountain
Flooding duration	Brief (2 to 7 days)
Flooding frequency	Occasional

Elevation	2,195–2,682 m
Slope	8–75%
Aspect	N

Climatic features

Nevada's climate is predominantly arid, with large daily ranges of temperature, infrequent severe storms, heavy snowfall in the higher mountains, and great location variations with elevation. Three basic geographical factors largely influence Nevada's climate: continentality, latitude, and elevation. Continentality is the most important factor. The strong continental effect is expressed in the form of both dryness and large temperature variations. Nevada lies on the eastern, lee side of the Sierra Nevada Range, a massive mountain barrier that markedly influences the climate of the State. The prevailing winds are from the west, and as the warm moist air from the Pacific Ocean ascend the western slopes of the Sierra Range, the air cools, condensation occurs and most of the moisture falls as precipitation. As the air descends the eastern slope, it is warmed by compression, and very little precipitation occurs. The effects of this mountain barrier are felt not only in the West but throughout the state, with the result that the lowlands of Nevada are largely desert or steppes. The temperature regime is also affected by the blocking of the inland-moving maritime air. Nevada sheltered from maritime winds, has a continental climate with well-developed seasons and the terrain responds quickly to changes in solar heating. Nevada lies within the mid-latitude belt of prevailing westerly winds which occur most of the year. These winds bring frequent changes in weather during the late fall, winter and spring months, when most of the precipitation occurs. To the south of the mid-latitude westerlies, lies a zone of high pressure in subtropical latitudes, with a center over the Pacific Ocean. In the summer, this high-pressure belt shifts northward over the latitudes of Nevada, blocking storms from the ocean. The resulting weather is mostly clear and dry during the summer and early fall, with scattered thundershowers. The eastern portion of the state receives significant summer thunderstorms generated from monsoonal moisture pushed up from the Gulf of California, known as the North American monsoon. The monsoon system peaks in August and by October the monsoon high over the Western U.S. begins to weaken and the precipitation retreats southward towards the tropics (NOAA 2004).

Average annual precipitation ranges from 16 to over 20 inches in some areas. Mean annual air temperature is 37 to 43 degrees F. The average growing season is about 15 to 80 days.

Mean annual preciptation at Spring Valley State Park Climate Station(267750) is 11.89 in. Monthly mean precipitation is: January 0.87;
February 1.21; March 1.32; April 0.92; May 1.07; June 0.42; July 0.88; August 1.29; September 1.23; October 1.2; November 0.66; December 0.82.

Table 3. Representative climatic features

Frost-free period (average)	47 days
Freeze-free period (average)	
Precipitation total (average)	457 mm

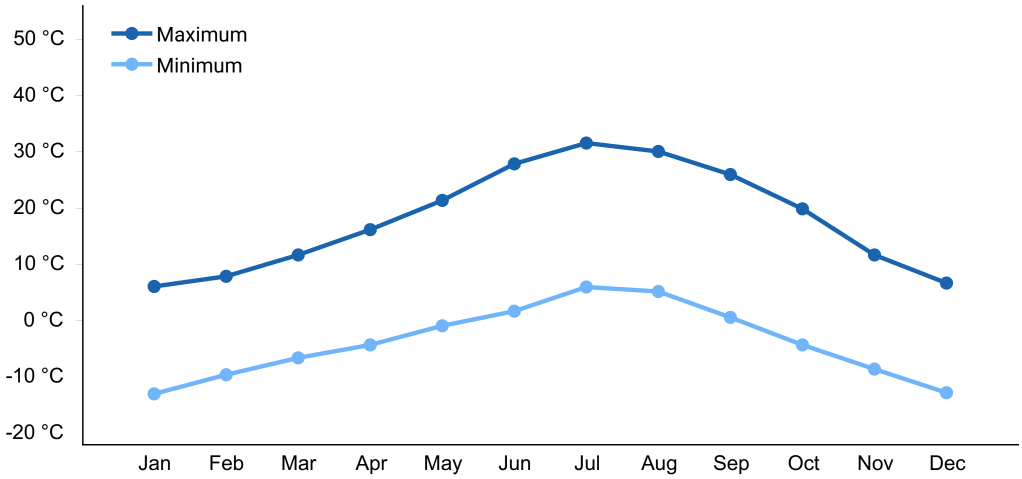


Figure 1. Monthly average minimum and maximum temperature

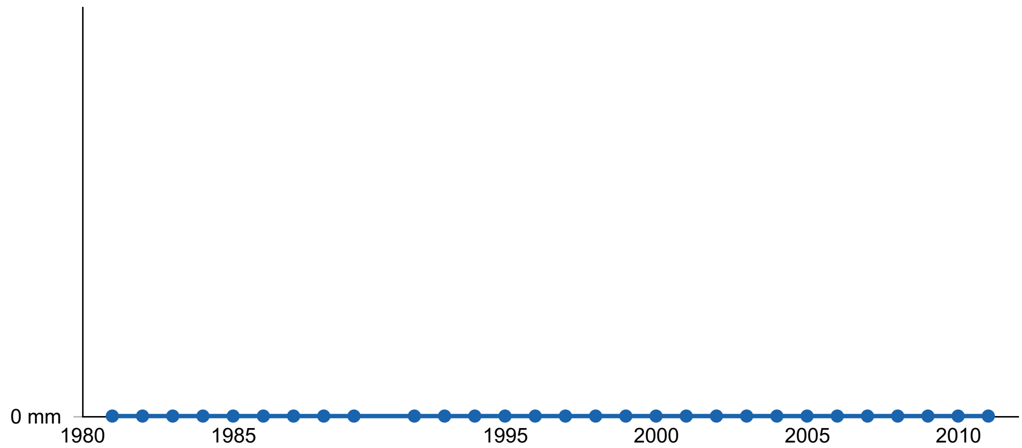


Figure 2. Annual precipitation pattern

Influencing water features

Heavy snow accumulation on this site persists late into spring and early summer when the soil is not frozen. Snow, slowly melting during this period, is added to the soil moisture supply and is available to plants during the growing season.

Soil features

The soils associated with this site are moderately deep to very deep and well drained. The soils are formed in alluvium and colluvium derived from quartzite and/or limestone. These soils are often modified with large rock fragments through their profile. Stones may interfere with the lateral spread of shallow roots and restrict the reproductive ability of aspen. This site provides a cool, moist environment for plant growth. Heavy snow accumulation on this site persists late into spring and early summer when the soil is not frozen. Snow, slowly melting during this period, is added to the soil moisture supply and is available to plants during the growing season. The soil series associated with this site include: Timmercrek.

The representative soil component is Timmercrek (NV708, MU5410) classified as a Loamy-skeletal, mixed, superactive Xeric Haplocryolls. Diagnostic horizons include a mollic epipedon from 3 to 33 cm, an albic horizon with albic materials from 33 to about 112 cm, and a cambic horizon from 33 to 56 cm. Clay content in the particle control section averages 12 to 18 percent. Rock fragments range from 65 to 85 percent, dominantly pebbles. Reaction is moderately acid or slightly acid. Effervescence is none. Lithology consists of glacial till dominantly from quartzite, with local admixtures of shale or argillite.

Table 4. Representative soil features

Parent material	(1) Alluvium–quartzite (2) Colluvium–limestone
Surface texture	(1) Very stony loam (2) Gravelly silt loam (3) Very gravelly loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Moderate
Soil depth	114–152 cm
Surface fragment cover <=3"	0–25%
Surface fragment cover >3"	0–10%
Available water capacity (0-101.6cm)	10.41–13.46 cm
Calcium carbonate equivalent (0-101.6cm)	0–5%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	6.2–6.8
Subsurface fragment volume <=3" (Depth not specified)	15–50%
Subsurface fragment volume >3" (Depth not specified)	5–30%

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 influence resilience include site productivity, species composition and structure, and population regulation and regeneration (Chambers et al. 2013).

Common disturbances in aspen stands include fire, insect and disease outbreaks, wind storms and avalanches. Aspen stands have also shown some sensitivity to drought (Hogg et al 2008). Quaking aspen is considered one of the most widely distributed forest plants in North America (Potter 1998). Mature aspen stands (80 to 100 years) can reach heights up to 100 feet depending on the site. Most stands contain a variety of medium-high shrubs and tall herbs in the understory (DeByle and Winokur 1985). Wildfire maintained the dynamics of these communities, but with fire suppression mature aspen stands can be susceptible to stand decline. Typically as stands begin to decline aspen suckers and saplings are able to regenerate the stand. As aspen trees mature and tree canopy begins to close the perennial understory becomes dominated by shade tolerant species. Conifers, when present, can eventually increase and overtop the aspen trees. The increase in conifers can be attributed to both fire suppression and grazing pressure by both livestock and wildlife (Potter 2005, Strand et al. 2009, Bartos and Campbell 1998). Using a habitat model Strand et al. 2009 computed aspen occurrence probability across the landscape of the Owyhee Plateau. They visited 41 sites where they modeled aspen occurrence; 37% they found dead aspen stems with no aspen regeneration, 51% had scattered aspen ramets and aspen was regenerating in forest gaps, and 12% there was no evidence that aspen had ever occurred on or near the site. Their aspen successional model theorized that non-producing aspen stands can be permanently converted to a conifer stand and the aspen clone can be lost. They estimated that over 60% of aspen woodlands have been or are in the process of converting to conifer woodlands within 80-200 years. Whether or not these stands can be converted back to aspen with disturbance is inconclusive.

An additional threat to aspen sustainability is limited aspen regeneration due to the shading by conifer trees or herbivory. Overstory clearing, whether in small gaps or in large openings, provides the needed light for aspen suckers to sprout (Shepperd et al 2006). A limited aspen root system resulting from previous conifer dominance and/or persistent shading from surrounding uncut trees may require additional disturbance to initiate suckering. Additional management actions such as root ripping may be needed to stimulate root suckering (Shepperd et al 2006). Continuous browsing by livestock or wildlife may also limit aspen regeneration. Herbivory can reduce community resilience and alter future aspen cover (Rogers et al 2013).

There are many environmental factors that can contribute to stand decline or die-off. The major underlying cause can be attributed to tree and/or stand stress. Drought, low soil oxygen, and cold soil temperatures all limit soil water uptake and can contribute to xylem

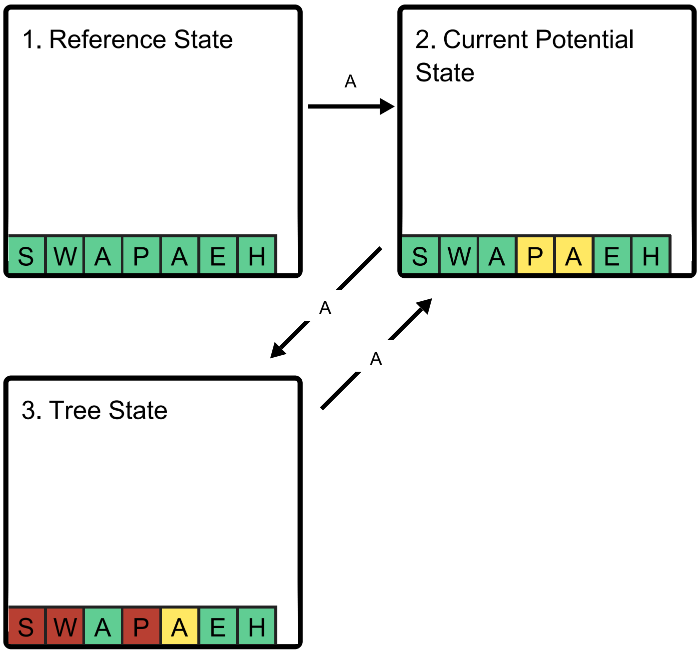
cavitation. Cavitation causes much of the aspen die-off but the created stress can also leave the stand open to secondary factors such as wood boring insects and fungal pathogens (Frey et al. 2004). Drought has been attributed to the decline and death of aspen trees, but also contributes to secondary factors such as insects (Frey et al. 2004).
Aspen stands possess three characteristics that provide suitable sites for invasive plants: 1) deep, rich soils, 2) proximity to moist meadows and riparian areas with open water, 3) their dependency on disturbance and open light. This site has moderate resilience to disturbance and resistance to invasion. Human disturbance associated with recreation and animal (domestic and wildlife) disturbance may lead to the spread of invasive species such as Kentucky bluegrass (*Poa pratensis*), common dandelion (*Taraxacum officinale*) and thistles (Cirsium sp.). Additionally, the ecological site is moderately resilient and resistant due to productive soils, additional soil moisture and aspens ability to sprout following fire or other stand or tree removal processes. Three stable states have been identified for this site, a reference state, current potential state and a third state where conifers have encroached and dominated the site. The research is inconclusive if these conifer dominated aspen stands can regenerate with fire.
Fire Ecology:
Wildfire is recognized as a natural disturbance that influenced the structure and composition of the historic climax vegetation of this woodland site. It is hypothesized that many of the fires that maintained these communities were set by the Native population, who used fire to manage plant communities for human benefit (Kay 1997). Specific fire intervals are dependent upon surrounding vegetation communities. Intense fires that kill the aspen overstory usually stimulate abundant suckering (DeByle and Winokur 1985). Although aspen stands rely on fire for successful regeneration, aspen stands don’t readily carry fire (Fechner and Barrows 1976, Debyle and Winokur 1985, Debyle et al. 1987). The tree itself is extremely fire sensitive (Baker 1925); with its thin bark most aspens are killed by fire, and those left with scarring are usually killed within the next growing season from rot and disease (Bradley et al. 1992,Davidson et al. 1959, Meinecke 1929). Periodic wildfires prevent over-mature aspen stands and maintain a naturally stratified mosaic of even-aged aspen communities in various stages of successional development. Uneven-aged stands form under stable conditions where the overstory gradually disintegrates with disease or age, and is replaced by aspen suckers. Historic heavy grazing has been attributed to the reduction of fine fuels within stands; without the fuels to burn fires seldom occur within aspen forests (DeByle and Winokur 1985).
Mountain big sagebrush is killed by fire (Neuenschwander 1980, Blaisdell et al. 1982), and does not resprout (Blaisdell 1953). Post fire regeneration occurs from seed and will vary depending on site characteristics, seed source, and fire characteristics. Mountain big sagebrush seedlings can grow rapidly and may reach reproductive maturity within 3 to 5 years (Bunting et al. 1987). Mountain big sagebrush may return to pre-burn density and cover within 15-20 years following fire, but establishment after severe fires may proceed more slowly and can take up to 50 years (Bunting et al. 1987, Ziegenhagen 2003, Miller and Heyerdahl 2008, Ziegenhagen and Miller 2009).
Mountain snowberry is top-killed by fire, but resprouts after fire from rhizomes (Leege and Hickey 1971, Noste and Bushey 1987). Snowberry has been noted to regenerate well and exceed pre-burn biomass in the third season after fire (Merrill et al. 1982). Was currant, a

minor component of this site, is known as a weak sprouter from the root crown but usually regenerates from soil stored seeds after fire. It is susceptible to fire kill and rarely survives fire (Crane and Fischer 1986). If balsamroot or mules ear is common before fire, these plants will increase after fire or with heavy grazing (Wright 1985).

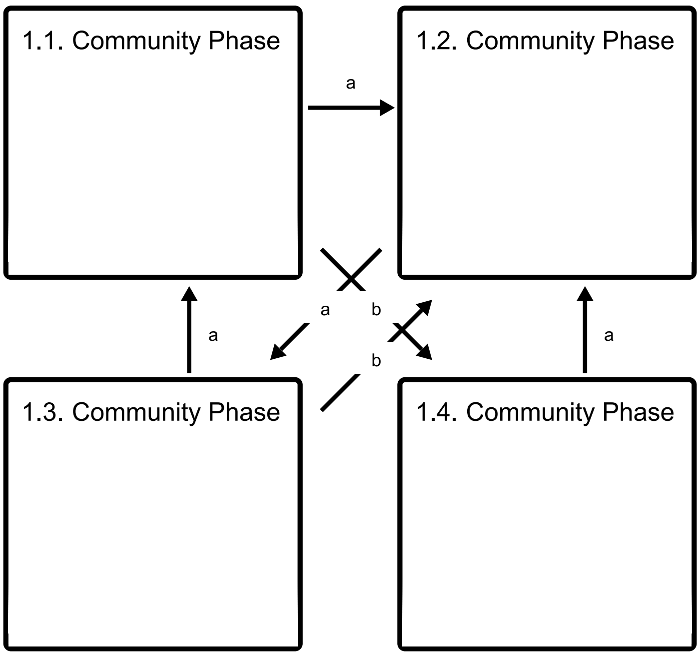
The effect of fire on bunchgrasses relates to culm density, culm-leaf morphology, and the size of the plant. The initial condition of bunchgrasses within the site along with seasonality and intensity of the fire all factor into the individual species response. For most forbs and grasses the growing points are located at or below the soil surface providing relative protection from disturbances which decrease above ground biomass, such as grazing or fire. Thus, fire mortality is more correlated to duration and intensity of heat which is related to culm density, culm-leaf morphology, size of plant and abundance of old growth (Wright 1971, Young 1983).
Mountain brome the dominate grass found on this site is a robust, coarse-stemmed, short lived perennial bunchgrass that can grow from 1 to 5 feet in height (Dayton 1937, Tilley et al. 2004). It is commonly seeded after wildfires due to its ability to establish quickly and reduce erosion (Tilley et al. 2004). Mountain brome significantly decreases after burning (Nimir and Payne 1978). Slender wheatgrass, a sub-dominate grass on this site, may increase after fire. In a study by Nimir and Payne (1978) slender wheatgrass increased significantly in burned than in non-burned sites, although the species did not appear in measurable quantities until mid-July.
Sandberg bluegrass (*Poa secunda*), a minor component of this ecological site, has been found to increase following fire likely due to its low stature and productivity (Daubenmire 1975). Sandberg bluegrass may retard reestablishment of deeper rooted bunchgrasses.
Mutton grass (*Poa fendleriana*), also a minor component on this site, is top killed by fire but will resprout after low to moderate severity fires. A study by Vose and White (1991) in an open sawtimber site, found minimal difference in overall effect of burning on mutton grass.

State and transition model

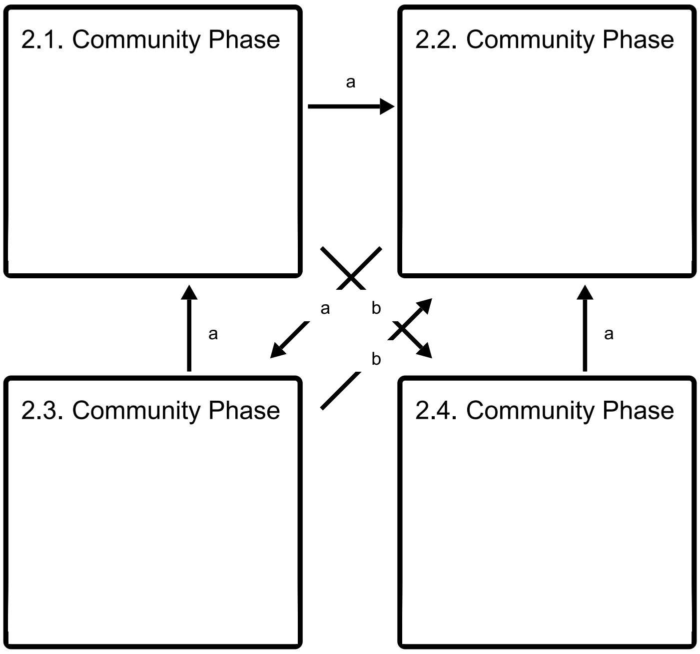
Ecosystem states



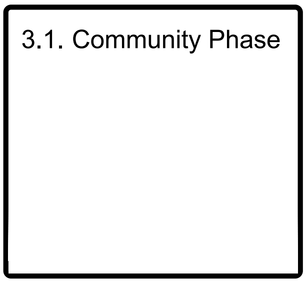
State 1 submodel, plant communities



State 2 submodel, plant communities



State 3 submodel, plant communities



State 1
Reference State

The Reference State 1.0 is a representative of the natural range of variability under pristine conditions. This site has four general community phases; a mature woodland phase, a sucker/sapling phase, an immature woodland phase and an over mature woodland/conifer 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, 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
Community Phase

The visual aspect and vegetal structure are dominated by single-storied aspen that have reached or are near maximal heights for the site. Tree heights range from 60 to 80 feet, depending upon site. Tree canopy cover ranges from 25 to about 35 percent. Despite considerable understory forage production, the overstory trees compete with the undergrowth plants for moisture, light, nutrients, and space. Vegetative shoots and/or saplings of aspen occur in the understory, but they are inconspicuous and have a high mortality rate. Engelmann's spruce, Rocky Mountain fir, and other conifers may be present to increasing in the understory, because of their shade tolerance these trees can multiply and eventually dominate the site.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Tree	897	1121	1569
Grass/Grasslike	50	151	202
Shrub/Vine	34	101	135
Forb	28	84	112
Total	**1009**	**1457**	**2018**

Community 1.2
Community Phase

Herbaceous vegetation dominates the site. Quaking aspen suckers are evident. If the aspen stand is healthy, this stage will only last from one to two years. However, if competing brush and herbaceous plants grow for a full season before aspen suckers emerge, or with excessive herbivory from large ungulates such as elk, a reduction in growth and survival of aspen suckers may occur. Early growth of quaking aspen suckers ranges from less than 1 foot to more than 3 feet per year for shoots having good competitive position. In the absence of disturbance, suckers develop into saplings (to 4½ feet in height) with a range in canopy cover of about 5 to 15 percent. Vegetation consists of grasses, forbs and a few shrubs in association with tree saplings.

Community 1.3
Community Phase

This stage is characterized by rapid growth of the aspen trees, both in height and canopy cover. Aspen stands are self-thinning, especially at young ages. After the canopy closes, trees stratify into crown classes quickly, despite genetic uniformity within clones. The visual aspect and vegetal structure are dominated by aspen ranging from about 10 to 20 feet in height, and having a diameter at breast height of about 2 to 4 inches. Understory vegetation is moderately influenced by a tree overstory canopy of about 40 to over 60 percent. Growth of the aspen begins to slow and there is a fairly continual adjustment of trees to growing space. As competition becomes intense enough to affect the diameter growth of dominants, mortality quickly reduces the number of trees in the lower crown classes. There are periodic surges in mortality, with a large number of trees dying within a short time. The visual aspect and vegetal structure are dominated by aspen mostly greater than 25 feet in height. Understory vegetation is moderately influenced by a tree overstory canopy of about 25 to 40 percent.

Community 1.4
Community Phase

In the absence of wildfire or other naturally occurring disturbances, the tree canopy on this site can become very dense. This stage is normally dominated by aspen and/or conifers that have reached maximal heights for the site. Engelmann's spruce, Rocky Mountain fir, and other conifers may dominate the overstory canopy in over-mature, aspen stands. Aspen trees may be decadent. In the absence of disturbance, over-mature, even-aged aspen stands slowly die. Tree canopy cover is commonly more than 50 percent. Understory production is strongly influenced by the overstory, as is species composition. Shade tolerant forbs and a few grasses will dominate the understory.

Pathway a
Community 1.1 to 1.2

Fire would reduce the mature aspen and allow for the suckers, saplings and the herbaceous understory to increase.

Pathway b
Community 1.1 to 1.4

Time and lack of disturbance will allow for the conifer trees in the understory to mature and dominate the site.

Pathway a
Community 1.2 to 1.3

Time and lack of disturbance, release from herbivory will allow for the aspen suckers to mature

Pathway a
Community 1.3 to 1.1

Time and lack of disturbance, release from herbivory will allow for the aspen trees to mature.

Pathway b
Community 1.3 to 1.2

Fire, insects, disease or wind damage can reduce the aspen canopy and the subsequent competition with the understory allowing the understory herbaceous community to increase. Excessive herbivory while trees are still within reach to browse may also reduce aspen growth.

Pathway a
Community 1.4 to 1.2

Fire would decrease the conifer canopy and allow for the aspen suckers to increase.

State 2
Current Potential State

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

Community 2.1
Community Phase

This community phase is similar to the Reference State Community Phase 1.1, with the presence of non-native species in trace amounts such as common dandelion and cheatgrass. The visual aspect and vegetal structure are dominated by single-storied aspen that have reached or are near maximal heights for the site. Tree heights range from 60 to 80 feet, depending upon site. Tree canopy cover ranges from 25 to about 35 percent. Despite considerable understory forage production, the overstory trees do compete with the undergrowth plants for moisture, light, nutrients, and space. Vegetative shoots and/or saplings of aspen occur in the understory, but they are inconspicuous and have a high mortality rate.

Community 2.2
Community Phase

Herbaceous vegetation dominates the site. Quaking aspen suckers are evident. If the aspen stand is healthy, these first two stages will only last from one to two years. However, if competing brush and herbaceous plants grow for a full season before aspen suckers emerge sucker survival and growth may be reduced. With excessive grazing from large ungulates such as elk and cattle, a reduction in growth and survival of aspen suckers may occur, this may last until season of grazing is changed, or grazing is reduced/excluded. Early growth of quaking aspen suckers ranges from less than 1 foot to more than 3 feet per year for shoots having good competitive position. In the absence of disturbance, suckers develop into saplings (to 4½ feet in height) with a range in canopy cover of about 5 to 15 percent. Vegetation consists of grasses, forbs and a few shrubs in association with tree saplings. Annual non-native species are stable to increasing within the community.

Community 2.3
Community Phase

This stage is characterized by rapid growth of the aspen trees, both in height and canopy cover. Aspen stands are self-thinning, especially at young ages. After the canopy closes, trees stratify into crown classes quickly, despite genetic uniformity within clones. The visual aspect and vegetal structure are dominated by aspen ranging from about 10 to 20 feet in height, and having a diameter at breast height of about 2 to 4 inches. Understory vegetation is moderately influenced by a tree overstory canopy of about 40 to over 60 percent. Growth of the aspen begins to slow and there is a fairly continual adjustment of trees to growing space. As competition becomes intense enough to affect the diameter growth of dominants, mortality quickly reduces the number of trees in the lower crown classes. There are periodic surges in mortality, with a large number of trees dying within a short time. The visual aspect and vegetal structure are dominated by aspen mostly greater than 25 feet in height. Understory vegetation is moderately influenced by a tree overstory canopy of about 25 to 40 percent.

Community 2.4
Community Phase

In the absence of wildfire or other naturally occurring disturbances, the tree canopy on this site can become very dense. This stage is normally dominated by aspen that have reached maximal heights for the site. Engelmann's spruce, Rocky mountain fir, and other conifers may comprise as much as 50 percent of the total tree canopy in stable, over-mature, aspen stands. Aspen trees have straight, clear stems with short, high-rounded crowns. In the absence of disturbance, over-mature, even-aged aspen stands slowly die. The aspen canopy opens up, and otherwise inconspicuous aspen suckers survive and grow in the openings not shaded by the remaining conifers. These suckers typically arise over a period of several years; the resulting stand is broadly even-aged. If broadly even-aged stands reach old age without disturbance, their deterioration is likely to extend over a longer period than before because of the range of tree ages. That, in turn, will result in a longer regeneration period and a new stand with an even greater range of ages. If this continues over several generations, all-aged stands will result. Tree canopy cover is commonly more than 50 percent. Understory production is strongly influenced by the overstory, as is species composition. Shade tolerant forbs and a few grasses will dominate the understory.

Pathway a
Community 2.1 to 2.2

Fire would reduce the mature aspen and allow for the suckers, saplings and the herbaceous understory to increase. Annual non-natives are likely to increase after fire.

Pathway b
Community 2.1 to 2.4

Time and lack of disturbance will allow for the conifers in the understory to mature and dominate the site.

Pathway a
Community 2.2 to 2.3

Time and lack of disturbance, changing of grazing season or grazing reduction/exclusion will allow for the aspen suckers to mature.

Pathway a
Community 2.3 to 2.1

Time and lack of disturbance and/or release from browsing, will allow for the aspen trees to mature.

Pathway b
Community 2.3 to 2.2

Fire, insects, disease or wind damage can reduce the aspen canopy and the subsequent competition with the understory allowing the understory herbaceous community to increase. Inappropriate grazing especially by sheep, and/or herbivory by large ungulates while trees are still within reach to browse may also reduce aspen growth.

Pathway a
Community 2.4 to 2.2

Fire, or equivalent such as clearcutting/harvesting of the conifers would allow for the aspen suckers to increase and the understory plant community to increase of shrubs and grasses to increase.

State 3
Tree State

This state is characterized by one community phase dominated by Rocky Mountain fir and Engelmann's spruce. Aspen may be present in trace amounts however trees are decadent and little to no regeneration is present. Understory vegetation is sparse. Negative feedbacks enhance ecosystem resilience and contribute to the stability of the state. These feedbacks include the dense canopy cover of conifer creating a shade rich environment that facilitates the germination and establishment of conifers and retards the growth and suckering of aspen. Positive feedbacks decrease ecosystem resilience and stability of the state. These include high fuel loads from canopy closure and dead and down wood leading to the potential for stand replacing fire.

Community 3.1
Community Phase

This community phase is dominated by Rocky Mountain fir and Engelmann’s spruce. Aspen trees may be present but show decadence and are significantly reduced. Understory vegetation is reduced due to competition of the overstory canopy. Annual non-native species may be present.

Transition A
State 1 to 2

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

Transition A
State 2 to 3

Trigger: Time and a lack of disturbance allow conifer trees to establish, grow and mature grown in understory. Slow variables: Over time the abundance and size of trees will increase. Threshold: Conifer canopy cover is greater than 60% of the stand and conifer height exceeds aspen height. Aspen are decadent and dying with little to no regeneration. Little understory vegetation remains due to competition with trees for site resources.

Restoration pathway A
State 3 to 2

Prescribed fire or mechanical removal of trees potentially coupled with root ripping to stimulate suckering.

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 G			57–151	

1	**Primary Perennial Grasses**			57–151	
	slender wheatgrass	ELTR7	*Elymus trachycaulus*	17–50	–
	nodding brome	BRAN	*Bromus anomalus*	17–34	–
	mountain brome	BRMA4	*Bromus marginatus*	17–34	–
	Letterman's needlegrass	ACLE9	*Achnatherum lettermanii*	2–11	–
	Dore's needlegrass	ACNED	*Achnatherum nelsonii ssp. dorei*	2–11	–
	western needlegrass	ACOCO	*Achnatherum occidentale ssp. occidentale*	2–11	–
2	**Secondary Perennial Grasses**			17–50	
	sedge	CAREX	*Carex*	2–10	–
	big squirreltail	ELMU3	*Elymus multisetus*	2–10	–
	bluegrass	POA	*Poa*	2–10	–
	spike trisetum	TRSP2	*Trisetum spicatum*	2–10	–
Forb					
3	**Perennial**			67–118	
	heartleaf arnica	ARCO9	*Arnica cordifolia*	2–10	–
	aster	ASTER	*Aster*	2–10	–
	fleabane	ERIGE2	*Erigeron*	2–10	–
	carrotleaf biscuitroot	LODIM	*Lomatium dissectum var. multifidum*	2–10	–
	Clayton's sweetroot	OSCL	*Osmorhiza claytonii*	2–10	–
	cinquefoil	POTEN	*Potentilla*	2–10	–
	meadow-rue	THALI2	*Thalictrum*	2–10	–
	violet	VIOLA	*Viola*	2–10	–
Shrub/Vine					
4	**Primary Shrubs**			50–151	
	mountain snowberry	SYOR2	*Symphoricarpos oreophilus*	34–84	–
	mountain big sagebrush	ARTRV	*Artemisia tridentata ssp. vaseyana*	17–67	–
5	**Secondary Shrubs**			17–50	
	greenleaf manzanita	ARPA6	*Arctostaphylos patula*	3–17	–
	currant	RIBES	*Ribes*	3–17	–

	Woods' rose	ROWO	*Rosa woodsii*	3–17	–
	willow	SALIX	*Salix*	3–17	–
Tree					
6	**Deciduous**			1020–1239	
	quaking aspen	POTR5	*Populus tremuloides*	1020–1239	–
7	**Evergreen**			73–219	
	Rocky Mountain juniper	JUSC2	*Juniperus scopulorum*	8–29	–

Animal community

Livestock Interpretations:
This site has value for livestock grazing because of its shade and quality of forage that is consistently found in the aspen understory. Adaptive management will be necessary to successfully establish aspen suckers and retain biodiversity. Grazing management considerations include timing, intensity, frequency, and duration of grazing. Early season grazing may cause more intense soil compaction, thereby limiting growth in many species. Domestic livestock consume aspen with increasing pressure through summer and early fall as preferred forage decreases in volume and nutritional quality (DeByle 1985, Fitzgerald et al 1986).
Mountain brome increases with grazing (Leege et al. 1981). A study by Mueggler (1967), found that with clipping, mountain brome increased in herbage production when clipped in June. When clipped in July mountain brome increased due to reduced competition from forb species. The study also found that after three successive years of clipping mountain brome started to show adverse effects. Mountain brome is ranked as highly valuable as elk winter forage (Kufeld 1973).
Slender wheatgrass is a perennial bunchgrass that tends to be short lived, however it spreads well by natural reseeding (Monsen et al. 2004). It is widely used in restoration seedings (Monsen et al. 2004). Slender wheatgrass tends to persists for a longer time than other perennial grasses when subjected to heavy grazing (Monsen et al. 1996, Monsen et al. 2004). Slender wheatgrass is palatable and nutritious for livestock.
Wildlife Interpretations:
This site provides valuable habitat for a variety of wildlife species. Domestic livestock, wild ungulates, rodents and hares utilize aspen stands and can have a measurable impact. A study by Krebill (1972) found that the majority of aspen decline within their study area was due to a combination of pathogenic fungi and insects which invade aspen trees damaged by big game (Krebill 1972). Browsing during the sapling stage reduces aspen growth, vigor and numbers (DeByle and Winokur 1985). Heavy browsing on aspen suckers may result in lower clone vigor to the point that suckering no longer takes place. Browsing pressure may allow aspen to regenerate but prevent the development of trees, and the aspen will grow instead as a dense shrub (Bradley et al. 1992). Because aspen stands are grazed by cattle and/or sheep and also have a significant population of wild ungulates, grazing management and game management are important for the health of aspen

communities. Removal of forage, as well as disruption of nesting site cover, can have negative effects on both large and small mammals (Kie et al 1991).
Quaking aspen is important forage for large mammals. Elk (Alces alces) browse the bark, branches and sprouts of quaking aspen year-round throughout the West (Beck and Peek 2000, DeByle 1979, Howard 1996). Mule deer (Odocoileus hemionus) use quaking aspen year round especially if winters are mild, browsing leaves, buds, twigs, bark, and sprouts. New growth, after burns or clearcuts, are readily consumed by mule deer (Robin 2013). Moose (Alces americanus) occasionally occur in Nevada but will feed on the bark of quaking aspen in winter, the saplings in spring, and leaves and branches the rest of the year (Sheppard at al. 2006). Black bear (Ursus americanus), will eat stems and leaves of quaking aspen; however, forbs and other plants found in quaking aspen understory are preferred (Ulev 2007, Wildlife Action Plan 2012).

Several lagamorphs use quaking aspen habitat. Although aspen groves are at elevations where desert cottontail (Sylvilagus audubonii) are not normally found; desert cottontail may use aspen habitat where aspen groves occur at lower elevation with sagebrush and shrubland (DeByle 1979). Snowshoe hares (Lepus americanus) feed on quaking aspen in summer and spring and snowshoe hares will continue to use quaking habitat year round, particularly if the there is substantial conifer components provided (Debyle 1979). A threatened species, the American Pika (Ochotona princeps) will utilize quaking aspen stands in higher elevation habitat and have been documented to feed on quaking aspen buds, twigs, and bark (Wildlife Action Plan 2012, Howard 1996).
Rodents utilize aspen habitat for food and cover. Pocket gophers, (Thomomys monticola) a fossorial rodent favor quaking aspen stands (Linzey and Hammerson 2008). Aspen soils rarely freeze which are ideal for borrowing pocket gophers. Forbs and aspen sprouts also provide forage in the spring and summer (DeByle 1979). Rodents including deer mice (Peromyscous maniculatus) and least chipmunks (Tamias minimus) occupy quaking aspen habitat (Debyle 1979). The deer mouse was trapped more than any other rodent, consistently throughout several years, in quaking aspen stands according to Andersen et al. (1980). The least chipmunk has been trapped at near equal density as the deer mouse in aspen habitat (DeByle 1979, Anderson et al. 1980). The Inyo shrew (Sorex tenellus), Merriam's shrew (Sorex merriami), montane shrew (Sorex monticolus), and Western jumping mouse (Zapus princeps) use the shrub and herbaceous cover within quaking aspen habitat for foraging and cover (Wildlife Action Plan 2012). The flying squirrel (Glaucomys sabrinus), although rarely seen because of its nocturnal habit, is estimated to be one of the most common mammal species found in aspen type forests (Debyle 1979). Larger rodents, such as the North American porcupine (Erethizon dorsatum) will eat quaking aspen in winter and spring months. In winter, porcupine eat the smooth outer bark of the upper trunk and branches, in spring they eat the buds and twigs (Howard 1996, Debyle 1979).
Beaver (Castor canadensis) use a large amount of aspen for building material to construct their dams. It is estimated that as many as 200 quaking aspen stems are required to support one beaver for a 1-year period. Beaver prefer the inner bark of aspen to that of other trees as food (Lanner 1984). They will consume the leaves, bark, twigs, and any diameters of quaking aspen branches (Innes 2013). Previous research has estimated that

an individual beaver consumes 2 to 4 pounds (1-2 kg) of quaking aspen bark daily (DeByle 1985).
Quaking aspen provide feed and cover for a variety of bird species in Nevada. The northern goshawk (Accipiter gentilis) and flammulated owl (Psiloscops flammeolus) use mature overstory for nesting (Nevada Wildlife Action Plan 2012). Bird species including orange-crowned and yellow-rumped warblers (Vermivora celata and Dendroica coronata, respectively), broad-tailed hummingbirds (Selasphorus platycercus), robins (Turdus migratorius), house wrens (Troglodytes aedon), pewees (Contopus sordidulus), juncos (Junco hyemalis), and thrushes (Catharus ustulatus) nest and forage aspen stands. Dead trees are used by downy woodpeckers (Picoides pubescens), flickers (Colaptes auratus) and Lewis's woodpeckers (Melanerpes lewis). (Lanner 1984, Wildlife Action Plan 2012). Birds such as the mountain bluebird (Sialia currucoides), tree swallow (Tachycineta bicolor), pine siskin, (Spinus pinus), and black-headed grosbeak (Pheucticus melanocephalus) can be found at the edges of aspen communities (Innes 2013 and references therein). Even duck species, including, Wood duck (Aix sponsa), common and barrow's goldeneye (Bucephala clangula and Bucephala islandica, respectively), bufflehead (Bucephala albeola), hooded and common merganser (Lophodytes cucullatus and Mergus merganserall, respectively) utilize aspen habitat (DeByle et al. 1985). Dusky grouse (Dendragapus obscurus), sooty grouse (Dendragapus fuliginosus), mountain quail (Oreotoryz pictus) and rufous hummingbird (Selasphorus rufus) utilize the shrub and herbaceous cover provided by quaking aspen forests (Nevada Wildlife Action Plan 2012).
Several bat species occur within subalpine habitat, adding to the community's diversity. The fringed myotis (Myotis thysanodes), Long-eared myotis (myotis evotis), hoary bat (Lasiurus cinereus), Silver-haired bat (Lasionycteris noctivagans), little brown myotis (Myotis lucifugus), and western small-footed myotis (Myotis ciliolabrum) all are documented as occurring in quaking aspen forests and meadows above 9000 feet (Keinath 2003, Arroyo-Calbrales and Alvares-Castneda 2008, Warner and Czaplewski 1984, Armstrong 2007, Sullivan 2009, Great Basin National Park, Listing Sensitive and Extirpated Species 2006, Wildlife Action Plan 2012).
Habitat distribution of reptiles and amphibians is not as widely studied as other animals and few reptiles and amphibians are found at such elevations where quaking aspen trees occur. However; the Columbia spotted frog (Rana luteiventris) and northern rubber boa (Charina bottae) favor downed quaking aspen trees as well as stored ground moisture maintained from dead, decomposing logs (Wildlife Action Plan 2012).

Hydrological functions

Runoff is low to high. Permeability is moderate. Hydrologic soil groups are A and B.

Recreational uses

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

Other products

Native Americans 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

Quaking aspens is used to stabilize soil and watersheds. The trees produce abundant litter that contains more nitrogen, phosphorus, potash and calcium than leaf litter of most other hardwoods. The litter decays rapidly, forming nutrient-rich humus that may amount to 25 tons per acre (oven-dry basis). The humus reduces runoff and aids in percolation and recharge of ground water. Mountain snowberry is useful for establishing cover on bare sites and has done well when planted onto roadbanks. Mountain brome is an excellent native bunchgrass for seeding alone or in mixtures in disturbed areas, including depleted rangelands, burned areas, roadways, mined lands, and degraded riparian zones. Slender wheatgrass is widely used for revegetating disturbed lands. Slender wheatgrass is a short-lived perennial with good seedling vigor. It germinates and establishes quickly when seeded making it a good choice for quick cover on disturbed sites. It persists long enough for other, slower developing species to establish. It has been used for rehabilitating mine spoils, livestock ranges, and wildlife habitat and watershed areas. Letterman's needlegrass has been used successfully in revegetating mine spoils. This species also has good potential for erosion control.

Type locality

Location 1: White Pine County, NV	
Township/Range/Section	T11N R69E S4
Latitude	38° 51′ 16″
Longitude	114° 14′ 0″
General legal description	Approximately 1 mile west of Lexington Creek mining area, Great Basin National Park, Snake Range, White Pine County, Nevada

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Contributors

DBP/GKB

Rangeland health reference sheet

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

Author(s)/participant(s)	
Contact for lead author	
Date	03/16/2026

Approved by	Kendra Moseley
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

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

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

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

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

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

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

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

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

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

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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):**

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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:

    Sub-dominant:

    Other:

    Additional:

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

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

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

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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:**

17. **Perennial plant reproductive capability:**