Ecological site F028BY025NV
Mountain Stream Terrace

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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): 028B–Central Nevada Basin and Range

MLRA 28B occurs entirely in Nevada and comprises about 23,555 square miles (61,035 square kilometers). More than nine-tenths of this MLRA is federally owned. This area is in the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. It is an area of nearly level, aggraded desert basins and valleys between a series of mountain ranges trending north to south. The basins are bordered by long, gently sloping to strongly sloping alluvial fans. The mountains are uplifted fault blocks with steep sideslopes. Many of the valleys are closed basins containing sinks or playas. Elevation ranges from 4,900 to 6,550 feet (1,495 to 1,995 meters) in the valleys and basins and from 6,550 to 11,900 feet (1,995 to 3,630 meters) in the mountains.
The mountains in the southern half are dominated by andesite and basalt rocks that were formed in the Miocene and Oligocene. Paleozoic and older carbonate rocks are prominent in the mountains to the north. Scattered outcrops of older Tertiary intrusives and very young tuffaceous sediments are throughout this area. The valleys consist mostly of alluvial fill, but lake deposits are at the lowest elevations in the closed basins. The alluvial valley fill consists of cobbles, gravel, and coarse sand near the mountains in the apex of the alluvial fans. Sands, silts, and clays are on the distal ends of the fans.
The average annual precipitation ranges from 4 to 12 inches (100 to 305 millimeters) in most areas on the valley floors. Average annual precipitation in the mountains ranges from 8 to 36 inches (205 to 915 millimeters) depending on elevation. The driest period is from midsummer to midautumn. The average annual temperature is 34 to 52 degrees F (1 to 11 degrees C). The freeze-free period averages 125 days and ranges from 80 to 170 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 soil temperature regime, an aridic or xeric soil moisture regime, and mixed or carbonatic mineralogy. They generally are well drained, loamy or loamyskeletal, and shallow to very deep.
Nevada’s climate is predominantly arid, with large daily ranges of temperature, infrequent severe storms and heavy snowfall in the higher mountains. Three basic geographical factors largely influence Nevada’s climate: continentality, latitude, and elevation. 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, as a result 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 midlatitude 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

occasional thundershowers. The eastern portion of the state receives noteworthy 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).

Ecological site concept

The Mountain Stream Terrace occurs along mountain stream terraces and flood plains. Soils are very deep, have a mollic epipedon, moderately well drained and formed in alluvium derived from quartzite and glacial outwash. This ecological site experiences occasional brief flooding and endosaturation between 76 to 100cm during the spring time.

The reference state is dominated by one to several quaking aspen clones, each with a common genetic makeup and individual phenological and physiological characteristics. Overstory tree canopy is 100 percent quaking aspen. Slender wheatgrass, sedges, Nevada bluegrass, Columbia needlegrass, yarrow, meadowrue, groundsel, willows, and Woods rose are common understory species associated with this site.

The Mountain Stream Terrace site was previously named POTR5/ELTR7-PONE.

Associated sites

R028AY029NV	**LIMESTONE HILL** Occurs on well drained stream terraces.
F028AY080NV	**ABCOC-PSMEG (White Fir-Douglas Fir)** Occurs on well drained backslopes or moraines.
R028AY072NV	**WET MEADOW** Occurs on poorly drained stream terraces.

Similar sites

F028BY055NV	**POTR5-ABCO/LEKI2-BRMA4-ELTR7** ABCOC codominant tree; LEKI2-BRMA4 codominant grasses
F028BY067NV	**POTR5/SYOR2/BRMA4-ELTR7** SYMPH dominant shrub; BRMA4 codominant grass; lower site quality

Table 1. Dominant plant species

Tree	(1) *Populus tremuloides*
Shrub	(1) *Rosa woodsii* (2) *Salix*
Herbaceous	(1) *Elymus trachycaulus* (2) *Poa nevadensis*

Physiographic features

The Mountain Stream Terrace occurs on along mountain stream terraces and floodplains. Slopes are less than 30 percent. Elevations are 7000 to 9000 feet.

Table 2. Representative physiographic features

Landforms	(1) Stream terrace (2) Flood plain
Runoff class	Medium to high
Flooding duration	Brief (2 to 7 days)
Flooding frequency	None to occasional

Ponding frequency	None
Elevation	2,134–2,743 m
Slope	2–30%
Water table depth	61–102 cm
Aspect	Aspect is not a significant factor

Climatic features

Average annual precipitation is 14 to over 22 inches. Mean annual air temperature is 40 to 43 degrees and the average growing season is 50 to 90 days.
There are no representative weather stations available for this ecological site.

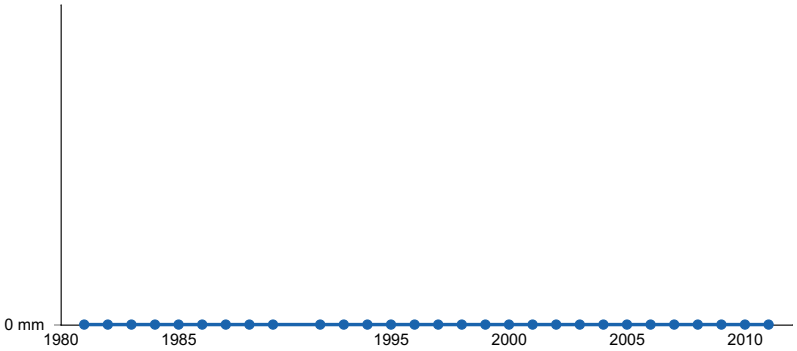


Figure 1. Annual precipitation pattern

Influencing water features

This ecological site is associated with perennial streams. Adjacent streams are responsible for a water table between 60 and 100 centimeters during the spring time.

Soil features

The soils are generally very deep and moderately well drained. They have a thick, dark surface horizon called a mollic epipedon and a seasonally high water table within 100 centimeters of the surface. Available water holding capacity is very low and surface runoff is high depending on slope. The soils are susceptible to gullying which intercepts normal overflow patterns causing site degradation.
The soil series associated with this site include Brokit, an Aquic Cumulic Haplocryoll. Diagnostic features include a mollic epipedon from the surface to 41cm and endosaturation between 76 to 100 centimeters at certain times of the year. Soil reaction is neutral to slightly acid. Redoximorphic concentrations occur as few or common masses of iron.

Table 3. Representative soil features

Parent material	(1) Alluvium–quartzite
Surface texture	(1) Very stony, peaty loam
Family particle size	(1) Loamy
Drainage class	Somewhat poorly drained
Permeability class	Moderate
Soil depth	152–213 cm
Surface fragment cover <=3"	30–40%
Surface fragment cover >3"	5–10%
Available water capacity (0-101.6cm)	0–6.1 cm

Electrical conductivity (0-101.6cm)	4–8 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	1–5
Soil reaction (1:1 water) (0-101.6cm)	7.9–8.4
Subsurface fragment volume <=3" (Depth not specified)	10–20%
Subsurface fragment volume >3" (Depth not specified)	30–60%

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).

Quaking aspen is considered one of the most widely distributed forest plants in North America (Potter 2005). 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 percent they found dead aspen stems with no aspen regeneration, 51 percent had scattered aspen ramets and aspen was regenerating in forest gaps, and 12 percent 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 percent of aspen woodlands have been or are in the process of converting to conifer woodlands within 80 to 200 years. Whether or not these stands can be converted back to aspen with disturbance is inconclusive.

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).

Two stable states have been identified for this site, a third state may be possible where conifers have encroached and dominated the site. The research is inconclusive if these conifer dominated aspen stands can regenerate with fire.

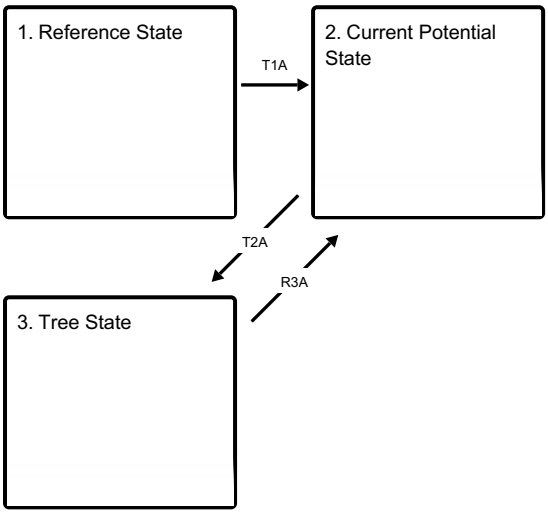
Fire Ecology:
Wildfire is recognized as a natural disturbance that influenced the structure and composition of the historic climax vegetation of this woodland site. It is hypothesized that many of the fires that maintained these communities were set by the Native population, who used fire to manage plant 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).

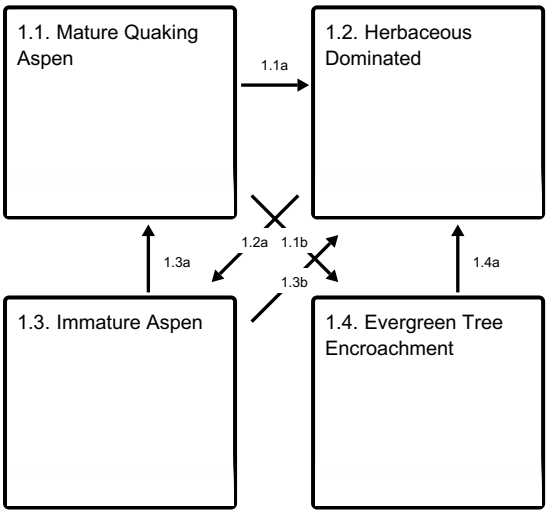
The effect of fire on bunchgrasses relates to culm density, culm-leaf morphology, and the size of the plant. The initial condition of bunchgrasses within the site along with seasonality and intensity of the fire all factor into the individual species response. For most forbs and grasses the growing points 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).

State and transition model

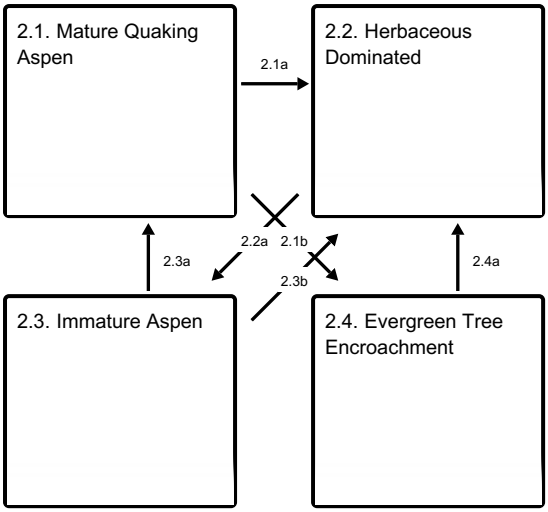
Ecosystem states



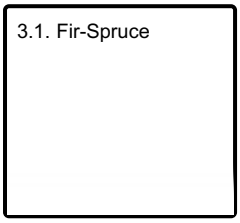
State 1 submodel, plant communities



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
Mature Quaking Aspen

Figure 3. POTR5/ELTR7-PONE (F28BY025NV)

The reference plant community is dominated by one to several quaking aspen clones, each with a common genetic makeup and individual phenological and physiological characteristics. An overstory canopy of about 35 percent is representative of tree dominance on this site in the natural environment. Overstory tree canopy is 100 percent quaking aspen. Slender wheatgrass, sedges, Nevada bluegrass, Columbia needlegrass, yarrow, meadowrue,

groundsel, willows, and Woods rose are common understory species associated with this site.

Forest overstory. MATURE FORESTLAND: The growth of the aspen continues during this stage, though not as fast as during the pole stage. Diameter growth shows strong recovery with reduced competition. 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 30 to 50 feet, depending upon site and clonal genotype. Tree canopy cover ranges from 25 to 40 percent. Trees have developed tall, straight, clear stems with short, narrow dome-like crowns that develop greater at the edge of the stand. Despite considerable forage production in most aspen communities, the overstory trees do compete with the undergrowth plants for moisture, light, nutrients and space. Consequently, adjacent vegetation types lacking such overstory competition will normally produce more forage than the understory of the aspen forest. Vegetative shoots and/or saplings of aspen occur in the understory, but they are inconspicuous and have a high mortality rate.

Forest understory. Understory vegetative composition is about 40 percent grasses, 30 percent forbs and 30 percent shrubs and young trees when the average overstory canopy is medium (25 to 40 percent). Average understory production ranges from 1,000 to 1,600 pounds per acre with a medium canopy cover. Understory production includes the total annual production of all species within 4½ feet of the ground surface.

Table 4. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	448	583	717
Forb	336	437	538
Shrub/Vine	258	335	412
Tree	78	102	126
Total	**1120**	**1457**	**1793**

Community 1.2
Herbaceous Dominated

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.

Forest overstory. Following a major disturbance, the root system gives rise to many root suckers, assuming the root system remains and is healthy. Herbaceous vegetation and woody shrubs, including aspen suckers, dominate the site. Early sucker growth ranges from less than 1 foot to more than 3 feet per year for shoots having good competitive position. 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 arise, a reduction in sprouting and the eventual growth and survival of the aspen suckers may occur. In this case, it may take more than five years for the stand to reach the sapling stage.

In the absence of disturbance, the tree vegetative shoots develop into saplings (20 inches to 4½ feet in height) with a range in tree canopy cover of about 15 to 35 percent. Rapid extension of lateral shoots on suckers more than 1 year old accompanies leader growth and results in early crown closure.

Forest understory. Vegetation consists of grasses, forbs and shrubs in association with tree saplings. Understory production ranges from 1200 to 1800 pounds per acre.

Community 1.3
Immature Aspen

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.

Forest overstory. Growth of the aspen slows somewhat during this stage. There is a fairly continual adjustment of trees to growing space, and a loss in competitive position of many trees making up the codominant, intermediate, and overtopped classes. When competition becomes intense enough to appreciably 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 disproportionate number of trees, mostly those overtopped, dying within a short time. The visual aspect and vegetal structure are dominated by aspen mostly greater than 25 feet in height.

Forest understory. Understory vegetation is moderately influenced. Understory production ranges from 800 to 1300 pounds per acre.

Community 1.4
Evergreen Tree Encroachment

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.

Forest overstory. In the absence of wildfire or other naturally occurring disturbances, the tree canopy on this site can become somewhat dense. In most forest types, the more tree overstory there is, the fewer herbs and shrubs there are. This generalization applies to aspen forests that are rapidly seral to conifers, but usually not to aspen communities that are stable. This stage is normally dominated by aspen that have reached maximal heights for the site. Trees have straight, clear stems with short, high-rounded crowns.In the absence of disturbance, over-mature, even-aged aspen stands slowly die. The canopy opens up, and otherwise inconspicuous aspen suckers survive and grow in the openings. 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 will range from 40 to over 50 percent.

Forest understory. Understory production is influenced by the overstory, as is composition. Shade tolerant forbs and a few grasses will dominate the understory, and the grasses and shrubs that dominate in the adjacent rangeland will occur in lesser amounts. Understory production ranges from 800 to 1300 pounds per acre.

Pathway 1.1a
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 1.1b
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 1.2a
Community 1.2 to 1.3

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

Pathway 1.3a
Community 1.3 to 1.1

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

Pathway 1.3b
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 1.4a
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
Mature Quaking Aspen

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.

Forest overstory. MATURE FORESTLAND: The growth of the aspen continues during this stage, though not as fast as during the pole stage. Diameter growth shows strong recovery with reduced competition. 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 30 to 50 feet, depending upon site and clonal genotype. Tree canopy cover ranges from 25 to 40 percent. Trees have developed tall, straight, clear stems with short, narrow dome-like crowns that develop greater at the edge of the stand. Despite considerable forage production in most aspen communities, the overstory trees do compete with the undergrowth plants for moisture, light, nutrients and space. Consequently, adjacent vegetation types lacking such overstory competition will normally produce more forage than the understory of the aspen forest. Vegetative shoots and/or saplings of aspen occur in the understory, but they are inconspicuous and have a high mortality rate.

Forest understory. Understory vegetative composition is about 40 percent grasses, 30 percent forbs and 30

percent shrubs and young trees when the average overstory canopy is medium (25 to 40 percent). Average understory production ranges from 1,000 to 1,600 pounds per acre with a medium canopy cover. Understory production includes the total annual production of all species within 4½ feet of the ground surface.

Community 2.2
Herbaceous Dominated

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.

Forest overstory. Following a major disturbance, the root system gives rise to many root suckers, assuming the root system remains and is healthy. Herbaceous vegetation and woody shrubs, including aspen suckers, dominate the site. Early sucker growth ranges from less than 1 foot to more than 3 feet per year for shoots having good competitive position. 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 arise, a reduction in sprouting and the eventual growth and survival of the aspen suckers may occur. In this case, it may take more than five years for the stand to reach the sapling stage.

In the absence of disturbance, the tree vegetative shoots develop into saplings (20 inches to 4½ feet in height) with a range in tree canopy cover of about 15 to 35 percent. Rapid extension of lateral shoots on suckers more than 1 year old accompanies leader growth and results in early crown closure.

Forest understory. Vegetation consists of grasses, forbs and shrubs in association with tree saplings. Understory production ranges from 1200 to 1800 pounds per acre.

Community 2.3
Immature Aspen

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.

Forest overstory. Growth of the aspen slows somewhat during this stage. There is a fairly continual adjustment of trees to growing space, and a loss in competitive position of many trees making up the codominant, intermediate, and overtopped classes. When competition becomes intense enough to appreciably 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 disproportionate number of trees, mostly those overtopped, dying within a short time. The visual aspect and vegetal structure are dominated by aspen mostly greater than 25 feet in height.

Forest understory. Understory vegetation is moderately influenced. Understory production ranges from 800 to 1300 pounds per acre.

Community 2.4

Evergreen Tree Encroachment

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.

Forest overstory. In the absence of wildfire or other naturally occurring disturbances, the tree canopy on this site can become somewhat dense. In most forest types, the more tree overstory there is, the fewer herbs and shrubs there are. This generalization applies to aspen forests that are rapidly seral to conifers, but usually not to aspen communities that are stable. This stage is normally dominated by aspen that have reached maximal heights for the site. Trees have straight, clear stems with short, high-rounded crowns.In the absence of disturbance, over-mature, even-aged aspen stands slowly die. The canopy opens up, and otherwise inconspicuous aspen suckers survive and grow in the openings. 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 will range from 40 to over 50 percent.

Forest understory. Understory production is influenced by the overstory, as is composition. Shade tolerant forbs and a few grasses will dominate the understory, and the grasses and shrubs that dominate in the adjacent rangeland will occur in lesser amounts. Understory production ranges from 800 to 1300 pounds per acre.

Pathway 2.1a
Community 2.1 to 2.2

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

Pathway 2.1b
Community 2.1 to 2.4

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

Pathway 2.2a
Community 2.2 to 2.3

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

Pathway 2.3a
Community 2.3 to 2.1

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

Pathway 2.3b
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. Excessive herbivory while trees are still within reach to browse may also reduce aspen growth.

Pathway 2.4a
Community 2.4 to 2.2

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

State 3
Tree State

The Tree 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
Fir-Spruce

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.

Forest overstory. In the absence of wildfire or other naturally occurring disturbances, the tree canopy on this site can become somewhat dense. In most forest types, the more tree overstory there is, the fewer herbs and shrubs there are. This generalization applies to aspen forests that are rapidly seral to conifers, but usually not to aspen communities that are stable. This stage is normally dominated by aspen that have reached maximal heights for the site. Trees have straight, clear stems with short, high-rounded crowns.In the absence of disturbance, over-mature, even-aged aspen stands slowly die. The canopy opens up, and otherwise inconspicuous aspen suckers survive and grow in the openings. 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 will range from 40 to over 50 percent.

Forest understory. Understory production is influenced by the overstory, as is composition. Shade tolerant forbs and a few grasses will dominate the understory, and the grasses and shrubs that dominate in the adjacent rangeland will occur in lesser amounts. Understory production ranges from 800 to 1300 pounds per acre.

Transition T1A
State 1 to 2

Establishment of non-native plants.

Transition T2A
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 R3A
State 3 to 2

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

Additional community tables

Table 5. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Primary Perennial Grasses/Grasslikes**			364–656	
	Columbia needlegrass	ACNE9	*Achnatherum nelsonii*	73–131	–
	sedge	CAREX	*Carex*	73–131	–
	slender wheatgrass	ELTR7	*Elymus trachycaulus*	73–131	–
	rush	JUNCU	*Juncus*	73–131	–
2	**Secondary Perennial Grasses**			31–58	
	bentgrass	AGROS2	*Agrostis*	8–15	–
	mountain brome	BRMA4	*Bromus marginatus*	8–15	–
	basin wildrye	LECI4	*Leymus cinereus*	8–15	–
	beardless wildrye	LETR5	*Leymus triticoides*	8–15	–
Forb					
3	**Perennial**			219–393	
	yarrow	ACHIL	*Achillea*	73–131	–
	ragwort	SENEC	*Senecio*	73–131	–
	meadow-rue	THALI2	*Thalictrum*	73–131	–
Shrub/Vine					
4	**Primary Shrubs**			73–131	
	Woods' rose	ROWO	*Rosa woodsii*	73–131	–
5	**Secondary Shrubs**			15–73	
	currant	RIBES	*Ribes*	15–73	–
Tree					
6	**Deciduous**			73–131	
	quaking aspen	POTR5	*Populus tremuloides*	73–131	–

Animal community

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.

Fecal samples from ungulates in Montana showed that bighorn sheep, mule deer, and elk all consumed mountain big sagebrush in small amounts in winter, while cattle had no sign of sagebrush use. This same study found that juniper (mostly Juniperus horizontalis) constituted half of the diet of mule deer and approximately 1/6 of the late winter diets of elk and bighorn sheep (Kasworm et al. 1984).

Livestock Interpretations:

This site is suited to cattle and sheep grazing during the summer and early fall. Livestock use aspen types for forage and shade. Cattle select for Nevada bluegrass, slender wheatgrass, and forage grasses while sheep select for meadowrue, groundsel and other forbs. Browsing has a direct impact on aspen. Through the early sapling stage,

browsing reduces aspen growth, vigor and numbers. Heavy browsing by sheep or deer can eliminate aspen sucker regeneration. Suckers can be drastically reduced or eliminated by big game browsing on winter ranges. Sheep browse the aspen with increasing pressure through late summer and early fall. Browsing is incidental to grazing by cattle. If grazing is light to moderate, the effect on aspen will be also. This, however, is less true for sheep and wild ungulates. Grazing management should allow aspen saplings to attain a minimum height of 55 to 60 inches before use to prevent destructive browsing by livestock. Harvesting trees under a sound management program can open up the tree canopy to allow increased production of understory species desirable for grazing and browsing.

Stocking rates vary with such factors as kind and class of grazing animal, season of use and fluctuations in climate. Actual use records for individual sites, a determination of the degree to which the sites have been grazed, and an evaluation of trend in site condition offer the most reliable basis for developing initial stocking rates.

Selection of initial stocking rates for given grazing units is a planning decision. This decision should be made ONLY after careful consideration of the total resources available, evaluation of alternatives for use and treatment, and establishment of objectives by the decisionmaker.

The forage value rating is not an ecological evaluation of the understory as is the Similarity Index rating for rangeland. The forage value rating is a utilitarian rating of the existing understory plants for use by specific kinds of grazing animals.

Wildlife Interpretations:
The aspen community is important habitat for many species of birds and mammals, especially where it is associated with free flowing streams. Mule deer and elk use aspen woodlands mostly in summer and fall for browse, thermal and hiding cover. Commonly associated birds using aspen during breeding season include the Western tanager, common nighthawk, mourning dove, Swainson's hawk and various species of bluebird, thrush and flycatcher. Those using aspen during the wintering season include the Ruby-crowned kinglet, Townsend's solitaire, rough-legged hawk, Cooper's hawk, sharp-shinned hawk and various species of finch and waxwing. Those using aspen yearlong or as migrants include the American robin, American kestrel, mountain chickadee, scrub jay, yellow-bellied sapsucker, long-eared owl, screech owl, great-horned owl, California quail, red-tailed hawk, golden eagle, and various species of sparrow, nuthatch and woodpecker. Commonly associated mammals using the aspen community type include various species of shrew, myotis, bat, mouse and vole. Some very common species include deer mouse, Nuttall's cottontail, least chipmunk, Western gray squirrel, bushy-tailed woodrat, raccoon, long-tailed weasel and the North American porcupine. The mountain lion and bobcat use edges and sometimes the interior of the aspen community for hunting.

Hydrological functions

A well stocked aspen stand provides excellent watershed protection. A mixture of herbaceous and woody root systems penetrate and anchor the soil. Erosion producing overland flow is almost non-existent. An undesirable characteristic of the quaking aspen stand is their heavy drain on available water in the soil.

Recreational uses

Aesthetic value is derived from the rich hues and textures of the aspen trees, particularly in the fall. The diverse flora and fauna, and the colorful wildflowers in the summer enhance the beauty of this site. The site offers rewarding opportunities to photographers and for nature study. It has high value for hunting, camping, picnicking, cross country skiing and family wood gathering. Management of the aspen woodland should include small, irregularly shaped clearcuts that blend into the natural landscape. Harvesting plans should include a mix of even-aged aspen patches in all size classes. Quaking aspen fits well into management for dispersed recreation activities, but does not tolerate concentrated use, as found in established campgrounds. Encouraging concentrated recreation or developing campgrounds within aspen stands can lead to serious damage, including carving on trees, vandalism, destruction or removal of young suckers and trampling and disturbance of the soil.

Wood products

Historically quaking aspen has been used for mine props, posts, bridge planking, flooring, furniture and fuelwood. It makes excellent pulp, excelsior, door corestock, paper, particleboard, matchsticks, structural flakeboard, lumber products and boxwood.

PRODUCTIVE CAPACITY

This site has a low site quality for tree production. Site index ranges from 45 to 55.
Productivity Class: 2

CMAI*: 20 to 28 cu ft/ac/yr;
1.4 to 2.0 cu m/hr/yr.
Culmination is estimated to be at 100 years.
*CMAI: is the culmination of mean annual increment or highest average growth rate of the stand in the units specified.

Fuelwood Production: 8 to 10 cords per acre. There are about 203,000 gross British Thermal Units (BTUs) heat content per cubic foot of quaking aspen wood. Firewood is commonly measured by cord, or a stacked unit equivalent to 128 cubic feet. Solid wood volume in a cord varies, but assuming an average of 75 cubic feet of solid wood per cord, there are about 15 million BTUs of heat value in a cord of quaking aspen.

Saw timber: 200 to 300 board-feet per acre.

MANAGEMENT GUIDES AND INTERPRETATIONS

1. LIMITATIONS AND CONSIDERATIONS
a. Potential for sheet and rill erosion is moderate to severe depending on slope.
b. Moderate to severe equipment limitations on steeper slopes.
c. Proper spacing is the key to a well managed, multiple use and multi-product aspen woodland.
d. To begin short rotation management, older stands with larger trees will have to be utilized.
e. Cut residual unmerchantable trees to stimulate maximum sucker regeneration and rapid development of a replacement stand.
f. Soil compaction and erosion hazards are greatest if logging is done with heavy equipment when soils are saturated in late spring. Logging at this time is most damaging to aspen roots, which can reduce suckering. Because root carbohydrate reserves are lowest in spring, harvesting at this time can further reduce sprouting.

2. ESSENTIAL REQUIREMENTS
a. Adequately protect from high intensity wildfire.
b. Protect soils from accelerated erosion.
c. Apply proper grazing management.

3. SILVICULTURAL PRACTICES
a. Harvest Cutting: Selectively harvest surplus trees to achieve desired spacing. Harvest stands in small blocks of 1/5 to 1/2 acre with slash left in place to shelter emerging aspen suckers from browsing.
1) Clearcutting - Clearcutting is appropriate when the primary management objective is sustained production of forest products, either saw timber or fiber. Cutting submerchantable stems along with the merchantable ones will maximize sucker production, will minimize the presence of diseased or defective growing stock in the new stand, and will avoid suppression of the new crop by residual overstory stems.
2) Partial cutting - Partial cutting is feasible in some uneven-aged stands where management objectives require vertical canopy diversity or retention of some overstory; partial cutting may result in enough sprouting to adequately regenerate stands. Individual tree or group selection cutting methods can be applied. Extreme care is necessary to avoid injury to residual stems during logging. Partial cutting is not worthwhile in deteriorated aspen clones where root system dieback has reduced suckering.
3) Selective Harvest – selectively remove trees on suitable sites to enhance forage production and manage site reproduction.
b. Thinning - Ordinarily, only stands on saw timber sites should be thinned. The low productivity of this site would not justify thinning costs.
c. Protection from disease - There are no proven forest stand treatments that successfully prevent or control disease in aspen. Maintenance of well-stocked stands, minimizing wounding of stems, control of damaging agents, and harvesting at the proper rotation age are advised for avoiding disease.
d. Protection from insects - Direct control of insects in aspen forests has not been practical. Maintenance of a well-stocked stand and protection from wounding is advised for coping with insects.

e. Protection from mammals - Domestic livestock, wild ungulates, porcupines, rodents and hares utilize aspen as food and can have measurable impacts on some stands. Most animal damage can be prevented by careful husbandry of domestic livestock and by population control of wild game.
f. Fire management - Fire is a natural feature in much of the aspen ecosystem. Fire is considered responsible for the abundance of aspen in the west, and for the even-aged structure of many stands. Without human intervention, fire appears to be necessary for the continued well-being of aspen on sites where natural degeneration of the clone occurs, or where insects or pests are especially harmful to the stand. Aspen forests, particularly in riparian zones, do not readily burn. The conditions suitable for fire are infrequent in these aspen stands. Although aspen forests do not burn readily, aspen trees are extremely sensitive to fire. Very light fires will kill aspen, because the bark is thin and green, and lacks protective corky layers. Even with adequate fuels, the flammability of adjacent grasslands may make prescribed burning risky. Where fire can be used with reasonable safety, it is an inexpensive and effective way to naturally regenerate the aspen forest. Moderate intensity fire that kills most or all the overstory will stimulate adequate suckering and will have the least effect on subsequent sucker growth. If fire occurs at infrequent intervals and is moderately intense to kill most or all of the aspen overstory, most aspen sites will remain viable. Frequent fires may adversely affect site quality.

Other information

Quaking aspens are 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. Slender wheatgrass is widely used for revegetating disturbed lands. It has been used for rehabilitating mine spoils, livestock ranges, and wildlife habitat and watershed areas. Slender wheatgrass is used for rehabilitating alpine meadows and other high elevation habitats. 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 is especially valuable for use in saline soils.

Table 6. Representative site productivity

Common Name	Symbol	Site Index Low	Site Index High	CMAI Low	CMAI High	Age Of CMAI	Site Index Curve Code	Site Index Curve Basis	Citation
quaking aspen	*POTR5*	45	55	20	28	–	–	–	

Inventory data references

NASIS soil component data.

Type locality

Location 1: Elko County, NV	
General legal description	This site is found in Elko, Eureka, and White Pine Counties, Nevada.

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Contributors

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Approval

Kendra Moseley, 2/19/2025

Rangeland health reference sheet

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

Author(s)/participant(s)	
Contact for lead author	
Date	05/11/2025
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):**

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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:

---

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

---

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

---

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

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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:**

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17. **Perennial plant reproductive capability:**
