Ecological site R025XY002NV
ASPEN THICKET

Last updated: 4/24/2024
Accessed: 05/14/2025

General information

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

MLRA notes

Major Land Resource Area (MLRA): 025X–Owyhee High Plateau

MLRA Notes 25—Owyhee High Plateau
This area is in Nevada (56 percent), Idaho (30 percent), Oregon (12 percent), and Utah (2 percent). It makes up about 27,443 square miles. MLRA 25 is characteristically cooler and wetter than the neighboring MLRAs of the Great Basin. The western boundary is marked by a gradual transition to the lower and warmer basins of MLRA 24. The boundary to the south-southeast, with MLRA 28B, is marked by gradual changes in geology marked by an increased dominance of singleleaf pinyon and Utah juniper and a reduced presence of Idaho fescue. The boundary to the north, with MLRA 11, is a rapid transition from the lava plateau topography to the lower elevation Snake River Plain.
Physiography:
All of this area lies within the Intermontane Plateaus. The southern half is in the Great Basin section of the Basin and Range province. This part of the MLRA is characterized by isolated, uplifted fault-block mountain ranges separated by narrow, aggraded desert plains. This geologically older terrain has been dissected by numerous streams draining to the Humboldt River.
The northern half of the area lies within the Columbia Plateaus province. This part of the MLRA forms the southern boundary of the extensive Columbia Plateau basalt flows. Most of the northern half is in the Payette section, but the northeast corner is in the Snake River Plain section. Deep, narrow canyons draining into the Snake River have been incised into this broad basalt plain. Elevation ranges from 3,000 to 7,550 feet on rolling plateaus and in gently sloping basins. It is more than 9,840 feet on some steep mountains. The Humboldt River crosses the southern half of this area
Geology:
The dominant rock types in this MLRA are volcanic. They include andesite, basalt, tuff, and rhyolite. In the north and west parts of the area, Cretaceous granitic rocks are exposed among Miocene volcanic rocks in mountains. A Mesozoic igneous and metamorphic rock complex dominates the south and east parts of the area. Upper and Lower Paleozoic calcareous sediments, including oceanic deposits, are exposed with limited extent in the mountains. Alluvial fan and basin fill sediments occur in the valleys.
Climate:
The average annual precipitation in most of this area is typically 11 to 22 inches. It increases to as much as 49 inches at the higher elevations. Rainfall occurs in spring and sporadically in summer. Precipitation occurs mainly as snow in winter. The precipitation is distributed fairly evenly throughout fall, winter, and spring. The amount of precipitation is lowest from midsummer to early autumn. The average annual temperature is 33 to 51 degrees F. The freeze-free period averages 130 days and ranges from 65 to 190 days, decreasing in length with elevation. It is typically less than 70 days in the mountains.
Water:
The supply of water from precipitation and streamflow is small and unreliable, except along the Owyhee, Bruneau, and Humboldt Rivers. Streamflow depends largely on accumulated snow in the mountains. Surface water from mountain runoff is generally of excellent quality and suitable for all uses. The basin fill sediments in the narrow alluvial valleys between the mountain ranges provide some ground water for irrigation. The alluvial deposits along the large streams have the most ground water. Based on measurements of water quality in similar deposits in

adjacent areas, the basin fill deposits probably contain moderately hard water. The water is suitable for almost all uses. The carbonate rocks in this area are considered aquifers, but they are little used. Springs are common along the edges of the limestone outcrops.
Soils:
The dominant soil orders in this MLRA are Aridisols and Mollisols. The soils in the area dominantly have a mesic or frigid temperature regime and an aridic, aridic bordering on xeric, or xeric moisture regime. Soils with aquic moisture regimes are limited to drainage or spring areas, where moisture originates or runs on and through. These soils are of a very limited extent throughout the MLRA. They generally are well drained, clayey or loamy, and shallow or moderately deep. Most of the soils formed in mixed parent material. Volcanic ash and loess mantle the landscape. Surface soil textures are loam and silt loam with ashy texture modifiers in some areas. Argillic horizons occur on the more stable landforms. They are exposed nearer the soil surface on convex landforms, where ash and loess deposits are more likely to erode. Soils that formed in carbonatic parent material in areas that receive less than 12 inches of precipitation are characterized by calcic horizons throughout the profile, while soils in areas that receive more than 12 inches of precipitation do not have calcic horizons in the upper part of the profile. Soils that formed on stable landforms at the lower elevations are dominated by ochric horizons. Soils that formed at the middle and upper elevations are characterized by mollic epipedons. Soils in drainage areas at all elevations that receive moisture running on or through them are characterized by thicker mollic epipedons.
Biological Resources:
This MLRA supports shrub-grass vegetation. Lower elevations are characterized by Wyoming big sagebrush associated with bluebunch wheatgrass, western wheatgrass, and Thurber’s needlegrass. Other important plants include bluegrass, squirreltail, penstemon, phlox, milkvetch, lupine, Indian paintbrush, aster, and rabbitbrush. Black sagebrush occurs but is less extensive. Singleleaf pinyon and Utah juniper occur in limited areas. With increasing elevation and precipitation, vast areas characterized by mountain big sagebrush or low sagebrush/early sagebrush in association with Idaho fescue, bluebunch wheatgrass, needlegrasses, and bluegrass become common. Snowberry, curl-leaf mountain mahogany, ceanothus, and juniper also occur. Mountains at the highest elevations support whitebark pine, Douglas-fir, limber pine, Engelmann spruce, subalpine fir, aspen, and curl-leaf mountain mahogany.
Major wildlife species include mule deer, bighorn sheep, pronghorn, mountain lion, coyote, bobcat, badger, river otter, mink, weasel, golden eagle, red-tailed hawk, ferruginous hawk, Swainson’s hawk, northern harrier, prairie falcon, kestrel, great horned owl, short-eared owl, long-eared owl, burrowing owl, pheasant, sage grouse, chukar, gray partridge, and California quail. Reptiles and amphibians include western racer, gopher snake, western rattlesnake, side-blotched lizard, western toad, and spotted frog. Fish species include bull, red band, and rainbow trout.

Ecological site concept

This ecological site is on concave shoulders of mountains and plateaus on northerly aspects or on snow-blown plateau and mountain summits. Slopes range from 15 to 75 percent. Elevations range from 6,600 to 8,500 feet (2,011 to 2,591 meters). The average growing season is 50 to 70 days.

The soils associated with this ecological site are moderately deep to very deep and are well drained. These soils have a thick, dark, medium textured surface soil. The underlying material is medium textured and is slightly acidic. The soils have large rock fragments throughout the profile. The soils have either a mollic or umbric epipedon. Stones may interfere with the lateral spread of shallow roots and could restrict the reproductive ability of aspen.

The representative plant community is dominated by dense stands of low-growing quaking aspen, generally less than 15-feet (4 meters) tall at maturity (locally known as "snowbank" aspen). Each site normally represents a single clone of aspen with a common genetic makeup having uniform phenological and physiological characteristics. A variety of forbs, mountain brome, needlegrass, slender wheatgrass, and snowberry are important understory species. These species are most prevalent on the periphery of the aspen overstory.

Associated sites

F025XY065NV	**Backslope Aspen**
R025XY004NV	**LOAMY SLOPE 16+ P.Z.**
R025XY010NV	**STEEP NORTH SLOPE**

Similar sites

F025XY064NV	**Streambank Aspen** POTR5 woodland; occurs along riparian zone of perennial streams
F025XY065NV	**Backslope Aspen** POTR5 woodland; mature POTR5 greater than 30 feet tall.

Table 1. Dominant plant species

Tree	(1) *Populus tremuloides*
Shrub	(1) *Gaultheria*
Herbaceous	(1) *Bromus marginatus* (2) *Elymus trachycaulus*

Physiographic features

The Aspen Thicket ecological site is on concave shoulders of mountains and plateaus on northerly aspects or on snow-blown plateau and mountain summits. Slopes range from 15 to 75 percent, with the most common slopes between 15 and 50 percent. Elevations range from 6,600 to 8,500 feet (2,012 to 2,591 meters).

Table 2. Representative physiographic features

Landforms	(1) Mountains > Mountain slope (2) Plateau > Plateau
Runoff class	Medium to high
Flooding frequency	None
Ponding frequency	None
Elevation	2,012–2,591 m
Slope	15–50%
Water table depth	183 cm
Aspect	NW, N, NE

Table 3. Representative physiographic features (actual ranges)

Runoff class	Not specified
Flooding frequency	Not specified
Ponding frequency	Not specified
Elevation	Not specified
Slope	15–75%
Water table depth	Not specified

Climatic features

The climate is semiarid, characterized by cold, moist winters and hot, dry summers.

The average annual precipitation ranges from 14 to 17 inches (36 to 43cm). Average annual air temperature is around 44 Degrees F.

Frost free period for this site is 54 days while the freeze free period is 92 days.

Monthly mean precipitation in inches: January 1.3 (3.3cm); February 1.2 (3cm); March 1.9 (4.8cm); April 2.1 (5cm); May 2.0 (5cm); June 1.2 (3cm); July 0.6 (1.5cm); August 0.5 (1.2cm); September 0.9 (2.3cm); October 1.0 (2.5cm); November 1.45 (3.7cm); December 1.3 (3.3cm).

Monthly average high temperature: January 37 Degrees F; February 40 Degrees F; March 48 Degrees F; April 55 Degrees F; May 65 Degrees F; June 74 Degrees F; July 85 Degrees F; August 84 Degrees F; September 74 Degrees F; October 60 Degrees F; November 46 Degrees F; December 37 Degrees F.

Monthly average low temperature: January 16 Degrees F; February 18 Degrees F; March 24 Degrees F; April 29 Degrees F; May 35 Degrees F; June 42 Degrees F; July 48 Degrees F; August 47 Degrees F; September 39 Degrees F; October 30 Degrees F; November 23 Degrees F; December 16 Degrees F.

Average snowfall is 106 inches.

*The above data is averaged from the Jarbridge 4N and Lamoille PH WRCC climate stations and NASIS.

Table 4. Representative climatic features

Frost-free period (characteristic range)	50-90 days
Freeze-free period (characteristic range)	50-170 days
Precipitation total (characteristic range)	356-635 mm
Frost-free period (actual range)	50-90 days
Freeze-free period (actual range)	50-170 days
Precipitation total (actual range)	356-635 mm
Frost-free period (average)	54 days
Freeze-free period (average)	92 days
Precipitation total (average)	381 mm

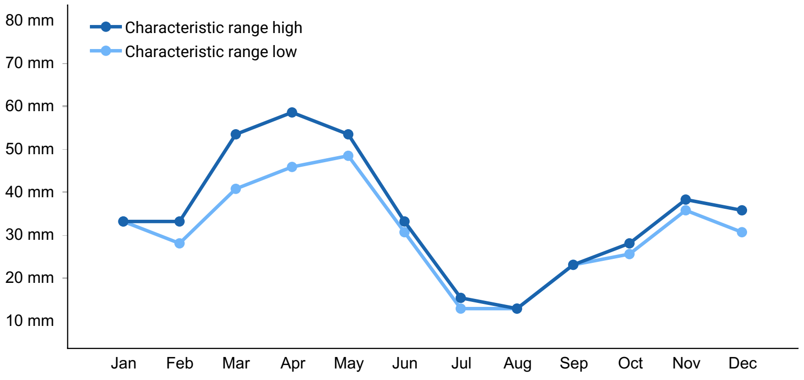

Figure 1. Monthly precipitation range

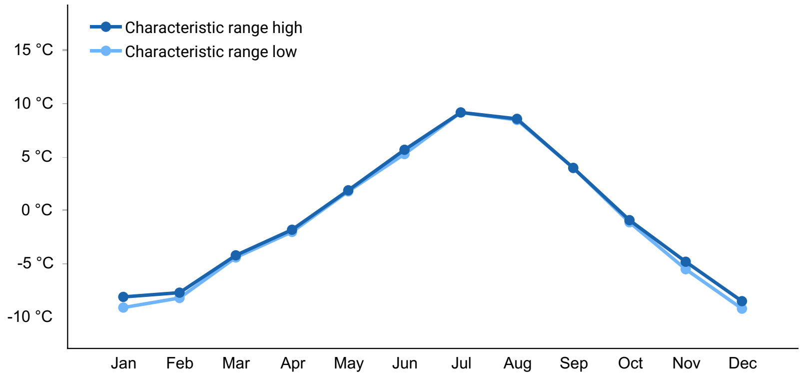

Figure 2. Monthly minimum temperature range

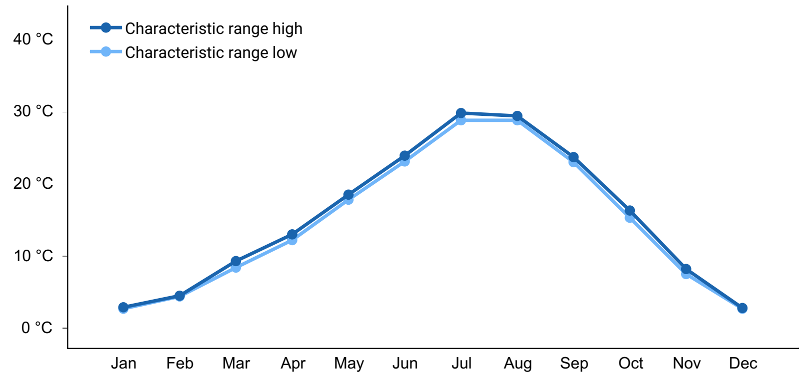

Figure 3. Monthly maximum temperature range

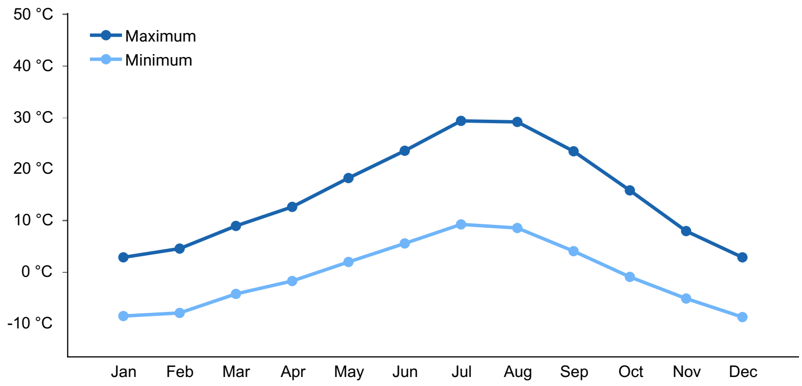

Figure 4. Monthly average minimum and maximum temperature

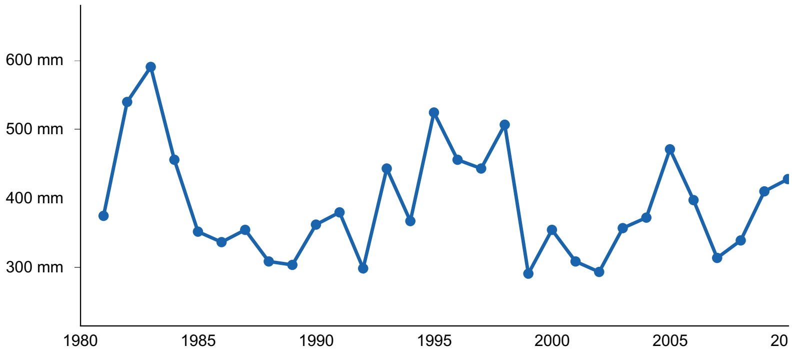

Figure 5. Annual precipitation pattern

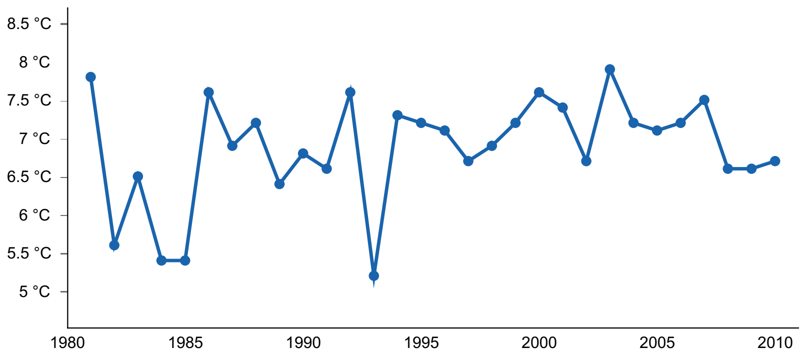

Figure 6. Annual average temperature pattern

Climate stations used

- (1) LAMOILLE YOST [USC00264394], Spring Creek, NV
- (2) JARBIDGE 7 N [USC00264039], Jackpot, NV

Influencing water features

Snowmelt provides moisture to this site throughout the spring and early summer.

Soil features

The soils associated with this ecological site are moderately deep to very deep and are well drained. These soils have a thick, dark, medium textured surface soil. The underlying material is medium textured and is slightly acidic. The soils have large rock fragments throughout the profile. The soils have either a mollic or umbric epipedon. Stones may interfere with the lateral spread of shallow roots and could restrict the reproductive ability of aspen. Snow accumulation on this site persists late into early summer and provides moisture in the soil that is available to plants during the growing season. The soil series associated with this site are Hapgood and Inpendence.

A representative soil series is Inpendence, classified as a loamy-skeletal, mixed, superactive Typic Humicryept. This soil is very deep, moderately well drained and formed in colluvium derived from welded tuff, chert, shale, and quartzite. The reaction is very strongly acid to slightly acid, usually remaining relatively constant throughout the profile. Diagnostic horizons include an umbric epipedon that occurs from the mineral soil surface to 28 inches (71cm). Clay content in the particle-size control section is between 10 to 18 percent. Rock fragments average 40 to 60 percent, mainly gravel. 0 to 15 percent cobbles or stones usually occur below 8 inches (20cm).

Table 5. Representative soil features

Parent material	(1) Colluvium
Surface texture	(1) Extremely gravelly loam (2) Gravelly loam (3) Very stony silt loam
Family particle size	(1) Loamy-skeletal
Drainage class	Moderately well drained to well drained
Permeability class	Moderate
Depth to restrictive layer	183 cm
Soil depth	102–183 cm
Surface fragment cover <=3"	30–40%
Surface fragment cover >3"	0–10%
Available water capacity (0-101.6cm)	7.62–11.94 cm
Calcium carbonate equivalent (0-101.6cm)	0–2%
Electrical conductivity (0-101.6cm)	0 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	4.5–7.3
Subsurface fragment volume <=3" (Depth not specified)	11–38%
Subsurface fragment volume >3" (Depth not specified)	7–46%

Ecological dynamics

An ecological site is the product of all the environmental factors responsible for its development. Each ecological site has a set of key characteristics that influence a site's resistance and resilience. Key characteristics include 1) climate (precipitation and temperature), 2) topography (aspect, slope, elevation, and landform), 3) hydrology (infiltration and runoff), 4) soils (depth, texture, structure, and organic matter), 5) plant communities (functional groups and productivity), and 6) natural disturbance regime (fire, herbivory, etc.) (Caudle 2013). Biotic factors that influence resilience include site productivity, species composition, population regulation, and population 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 maintains the dynamics of these communities, but with fire suppression mature aspen stands can begin to 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; in 37 percent of these sites, they found dead aspen stems with no aspen regeneration. 51percent contained scattered aspen remnants and observed regeneration of aspen in forest gaps. 12 percent of the sites showed 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, permanently removing the aspen clone.

Additional threats to aspen sustainability is limited aspen regeneration due to shading by conifer trees (see 028BY067NV; Stringham et al. 2015) and 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, and 3) dependency on disturbance and open light.

As ecological condition deteriorates, the aspen overstory is thinned out and permanent openings in the canopy are often created. If aspen sucker reproduction is inadequate plant species such as snowberry, big sagebrush and other shrubs, grasses, and forbs increase in the understory and eventually become dominant on the site. Some of the current combinations of species in aspen communities might be considered relatively stable. Some aspen communities are no longer able to return to their reference state due to changes caused by abusive grazing and dominance of invader species.

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*), cheat grass (Bromus techtorum), common dandelion (*Taraxacum officinale*) and thistles (Cirsium sp.).

Fire Ecology:
The most important agent of disturbance in aspen forests before 1900 was fire, although other natural disturbances were locally important including windthrow, snow damage, hail, lightning, fungal diseases and insect damage. Most aspen forests in the West are seral and have been dependent upon fire for their perpetuation. If fire occurs at infrequent intervals (e.g. 50-150 years) and is intense enough to kill most of the aspen and competing conifers, most aspen sites in the West will retain viable stands of aspen. 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. Although aspen forests do not burn readily, aspen trees are extremely sensitive to fire. A severe fire will top-kill the aspen overstory and will stimulate abundant suckering. Frequent fires have a detrimental effect on site quality and can eliminate aspen from a site. Aspen is highly competitive on burned sites and has several adaptations to fire including the following: a) the thin bark has little heat resistance, and aspen is easily top-killed by fire, b) root systems of top-killed stems send up a profusion of sprouts for several years after fire, c) sprouts grow rapidly by extracting water, nutrients, and photosynthate from an extant root system, and may outcompete other woody vegetation, d) following fire, a new, even-aged quaking aspen stand can develop within a decade, and e) aspen is self-thinning and a mature forest of healthy trees can develop from dense sprouts.

Mountain snowberry is top-killed by fire and will sprout after fire from rhizomes (Leege and Hickey 1971, Noste and Bushey 1987). It has also been noted to regenerate well and exceed pre-burn biomass in the third season after fire (Merrill et al. 1982). Currant, a minor component of this site, is known as a weak reproducer from the root crown but usually regenerates from seeds that were stored in the soil before the burn. If mule-ears or balsamroot is common before fire, these plants will increase after fire or with heavy grazing disturbance (Wright 1985).

Mountain big sagebrush, a minor component on these sites, is killed by fire (Neuenschwander 1980, Blaisdell et al. 1982), and is eliminated from the site (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 to 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).

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 species response. For most forbs and grasses, the growing points are located at or below the soil surface and provides relative protection from disturbances which decrease above ground biomass, such as grazing or fire. Thus, fire mortality is more correlated to the duration and intensity of heat produced during the burning period. (Wright 1971, Young 1983).

Mountain brome, the dominant 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 by land managers following wildfires because of its ability to quickly establish and reduce erosion (Tilley et al. 2004). Mountain brome density significantly decreases after burning (Nimir and Payne 1978).

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.

State and transition model

MLRA 25
Aspen Thicket
025XY002NV

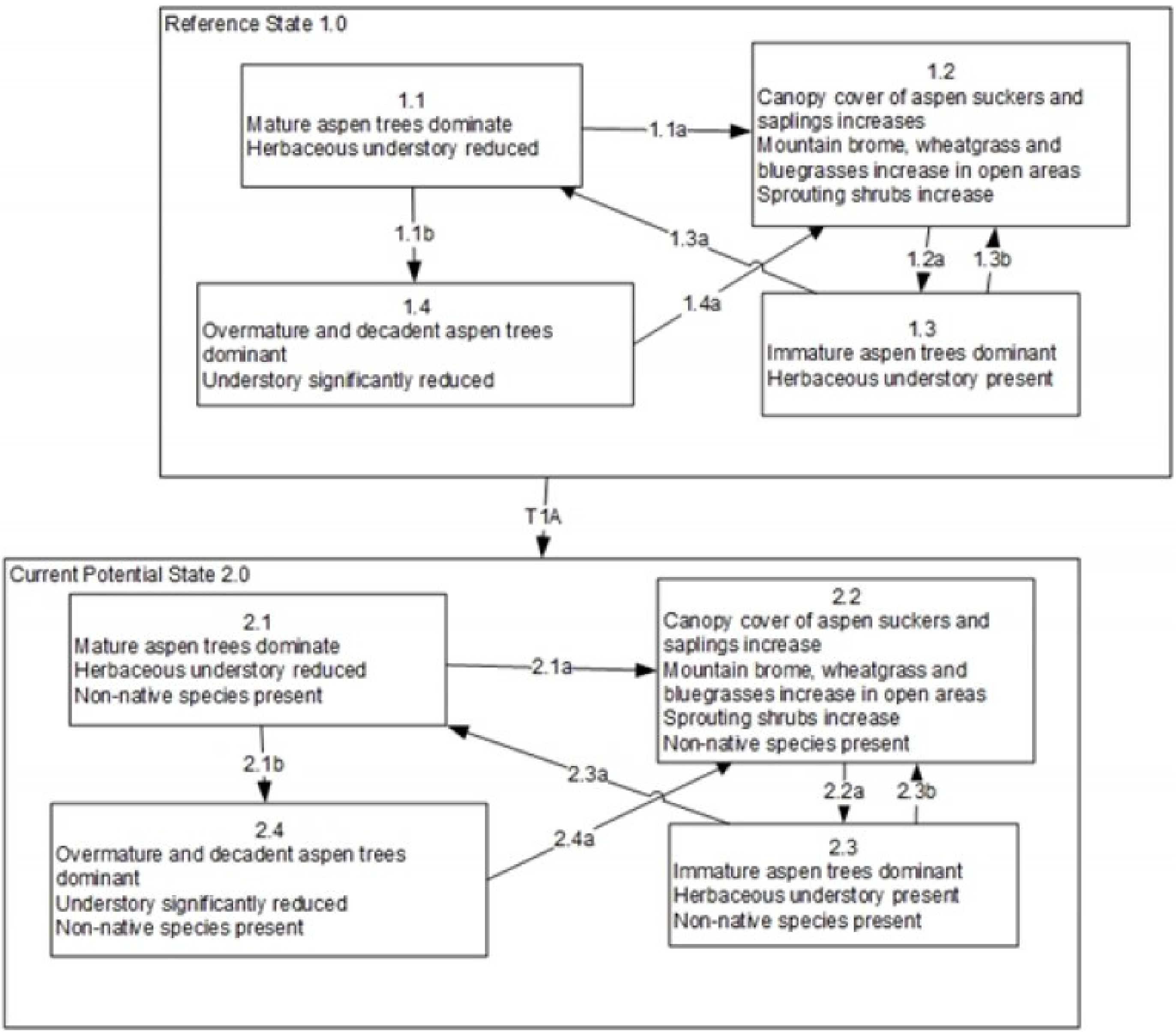

Figure 7. T. Stringham 3/2015

MLRA 25
Aspen Thicket
025XY002NV

Reference State 1.0
1.1a: Fire, insects, disease, wind
1.1b: Time and lack of disturbance
1.2a: Time and lack of disturbance, release from herbivory
1.3a: Time and lack of disturbance, release from herbivory
1.3b: Fire, insects, disease, wind, herbivory when young trees are within browsing reach
1.4a: Fire

T1A: Introduction of non-native species (ex: Kentucky bluegrass, dandelion, thistles)

Current Potential State 2.0
2.1a: Fire, insects, disease, wind or equivalent via harvesting/cutting
2.1b: Time and lack of disturbance
2.2a: Time and lack of disturbance, and/or release from browsing/grazing
2.3a: Time and lack of disturbance, and/or release from browsing/grazing
2.3b: Fire, insects, disease, wind or equivalent via harvesting/cutting, or grazing when young trees are within reach
2.4a: Fire or equivalent via harvesting/cutting

Notes: Fire intervals are dependent upon surrounding vegetation communities. Open areas/localized aspen death can occur from disease, insects, heavy snow loading, windfall, etc.

Figure 8. Legend

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 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 long-term drought and/or insect or disease attack.

Community 1.1
Mature Aspen

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. This site is dominated by quaking aspen and overstory tree canopy composition is typically 100 percent quaking aspen.). Average understory production ranges from 600 to 1200 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 6. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Tree	504	729	1009
Grass/Grasslike	202	291	404
Forb	202	291	404
Shrub/Vine	101	146	202
Total	**1009**	**1457**	**2019**

Community 1.2
Herbaceous

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
Young Aspen

Figure 10. Aspen Thicket (R025XY002NV) Phase 1.3 T. K. Stringham, August 2012

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
Old Aspen

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. 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 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 aspen trees to mature and become decadent.

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 canopy and allow for the aspen suckers to increase.

State 2
Current Potential

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 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.

Community 2.2
Herbaceous

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
Young 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 15 to over 40 percent.

Community 2.4
Old Aspen

Figure 11. Aspen Thicket (R025XY002NV) Phase 2.4 T. K. Stringham, August 2011

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. 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 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.

Annual non-natives are likely to increase after fire.

Pathway 2.1b
Community 2.1 to 2.4

Time and lack of disturbance will allow for the aspen trees to mature and become decadent.

Pathway 2.2a
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 2.3a
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 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. 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 2.4a
Community 2.4 to 2.2

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

Transition T1A
State 1 to 2

Introduction of non-native species (such as Kentucky bluegrass, dandelion, thistles).

Additional community tables

Table 7. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Primary Perennial Grasses**			146–179	
	mountain brome	BRMA4	*Bromus marginatus*	73–146	–
	slender wheatgrass	ELTR7	*Elymus trachycaulus*	73–146	–
2	**Secondary Perennial Grasses**			73–146	
	Letterman's needlegrass	ACLE9	*Achnatherum lettermanii*	3–34	–
	Columbia needlegrass	ACNE9	*Achnatherum nelsonii*	3–34	–
	California needlegrass	ACOCC	*Achnatherum occidentale ssp. californicum*	3–34	–
	western needlegrass	ACOCO	*Achnatherum occidentale ssp. occidentale*	3–34	–
	sedge	CAREX	*Carex*	3–34	–

	Idaho fescue	FEID	*Festuca idahoensis*	3–34	–
	melicgrass	MELIC	*Melica*	3–34	–
	bluegrass	POA	*Poa*	3–34	–
	bluebunch wheatgrass	PSSPS	*Pseudoroegneria spicata ssp. spicata*	3–34	–
Forb					
3	**Perennial**			146–364	
	melicgrass	MELIC	*Melica*	3–34	–
	nettleleaf giant hyssop	AGUR	*Agastache urticifolia*	3–20	–
	fleabane	ERIGE2	*Erigeron*	3–20	–
	geranium	GERAN	*Geranium*	3–20	–
	carrotleaf biscuitroot	LODIM	*Lomatium dissectum var. multifidum*	3–20	–
	lupine	LUPIN	*Lupinus*	3–20	–
	bluebells	MERTE	*Mertensia*	3–20	–
	Clayton's sweetroot	OSCL	*Osmorhiza claytonii*	3–20	–
	ragwort	SENEC	*Senecio*	3–20	–
	meadow-rue	THALI2	*Thalictrum*	3–20	–
	violet	VIOLA	*Viola*	3–20	–
Tree					
4	**Deciduous**			729–947	
	quaking aspen	POTR5	*Populus tremuloides*	729–947	–
	willow	SALIX	*Salix*	29–291	–
	nettleleaf giant hyssop	AGUR	*Agastache urticifolia*	3–20	–
	fleabane	ERIGE2	*Erigeron*	3–20	–
	geranium	GERAN	*Geranium*	3–20	–
	carrotleaf biscuitroot	LODIM	*Lomatium dissectum var. multifidum*	3–20	–
	lupine	LUPIN	*Lupinus*	3–20	–
	bluebells	MERTE	*Mertensia*	3–20	–
	Clayton's sweetroot	OSCL	*Osmorhiza claytonii*	3–20	–
	ragwort	SENEC	*Senecio*	3–20	–
	meadow-rue	THALI2	*Thalictrum*	3–20	–
	violet	VIOLA	*Viola*	3–20	–
Shrub/Vine					
5	**Primary Shrubs**			29–291	
	willow	SALIX	*Salix*	29–291	–
	snowberry	SYMPH	*Symphoricarpos*	3–13	–
	Utah serviceberry	AMUT	*Amelanchier utahensis*	3–13	–
	bitter cherry	PREME	*Prunus emarginata var. emarginata*	3–13	–
	black chokecherry	PRVIM	*Prunus virginiana var. melanocarpa*	3–13	–
	currant	RIBES	*Ribes*	3–13	–
6	**Secondary Shrubs**			29–146	
	Utah serviceberry	AMUT	*Amelanchier utahensis*	3–13	–
	mountain big sagebrush	ARTRV	*Artemisia tridentata ssp. vaseyana*	3–13	–

	sagebrush				
	bitter cherry	PREME	*Prunus emarginata var. emarginata*	3–13	–
	black chokecherry	PRVIM	*Prunus virginiana var. melanocarpa*	3–13	–
	currant	RIBES	*Ribes*	3–13	–
	snowberry	SYMPH	*Symphoricarpos*	3–13	–

Animal community

Livestock Interpretations:
This site is suited for livestock grazing. Considerations for grazing management include timing, frequency, intensity and duration of grazing.

Domestic livestock, wild ungulates, rodents and hares utilize aspen stands and can have a measurable direct impact upon them. 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 instead grow as a dense shrub (Bradley et al. 1992). Because aspen stands are grazed by cattle and/or sheep and have a significant population of wild ungulates, grazing management and game management are important for the health of aspen communities.

Mountain brome is ranked as excellent forage for both cattle and horses and good for domestic sheep, though domestic animals will graze mountain brome only when it is fairly succulent. 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, however, mountain brome started to exhibit adverse effects.

Slender wheatgrass is a perennial bunchgrass that tends to be short lived though 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 persist longer 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:
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. Birds 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. Birds that use aspen either 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.

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 (DeByle 1979, Howard 1996). Mule deer (Odocoileus hemionus) use quaking aspen year-round, particularly if winters are mild, by browsing leaves, buds, twigs, bark, and sprouts. New growth after burns or clearcuts is 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 bears (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 Team 2012). A study by Krebill (1972) found 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).

Several lagamorphs use quaking aspen habitat. Although aspen groves are at elevations where desert cottontail (Sylvilagus audubonii) are not normally found, they may utilize aspen habitat where groves occur at lower elevations with sagebrush and shrubland (DeByle and Winokur 1985). Snowshoe hares (Lepus americanus) feed on quaking aspen in summer and spring and will continue to use quaking aspen habitat year round, but are more common in the associated coniferous forests (DeByle and Winokur 1985). 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 Team 2012, Howard 1996).

Rodents utilize aspen habitat for food and cover. Pocket gophers (Thomomys monticola), a fossorial rodent, favors quaking aspen stands (Linzey and Hammerson 2008). Aspen soils rarely freeze and thus are ideal for borrowing. Forbs and aspen sprouts provide forage in the spring and summer (DeByle and Winokur 1985). 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 and Winokur 1985, 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 Team 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 and Winokur 1985). 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 and Winokur 1985)

Beavers (Castor canadensis) use a large amount of aspen for building material to construct their dams. In fact, as many as 200 quaking aspen stems are required to support one beaver for a 1-year period. Beavers 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 and Winokur 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 (Wildlife Action Plan Team 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. Furthermore, dead trees are used by downy woodpeckers (Picoides pubescens), flickers (Colaptes auratus) and Lewis’s woodpeckers (Melanerpes lewis) (Lanner 1984, Wildlife Action Plan Team 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 the wood duck (Aix sponsa), common and barrow’s goldeneye (Bucephala clangula and Bucephala islandica, respectively), bufflehead (Bucephala albeola), and the 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 hummingbirds (Selasphorus rufus) utilize the shrub and herbaceous cover provided by quaking aspen forests (Wildlife Action Plan Team 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) have been documented in quaking aspen forests and meadows above 9,000 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 Team 2012).

While habitat distribution of reptiles and amphibians is not as widely studied and few reptiles and amphibians are found at such elevations where quaking aspen trees occur, 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 2006).

Hydrological functions

Runoff from this site is medium to very high and the potential for surface erosion is moderate to high.

Recreational uses

Aesthetic value is derived from the diverse floral and faunal composition and the colorful flowering of wildflowers during the growing season. Steep slopes and dense tree spacing limit most forms of recreation. This site offers rewarding opportunities to photographers and for nature study. There is good potential for deer hunting on this site.

Wood products

Quaking aspen wood is little used in the West, except in Colorado, where it is used for pulp and particleboard. Specialty products from quaking aspen wood include excelsior, matchsticks, and tongue depressors. Quaking aspen pellets are used for fuel.

Other products

Native Americans used the leaves of willows to treat mosquito bites, bee stings and stomach aches and used to stems for implements such as baskets, arrow shafts, scoops and fish traps.

Other information

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. 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. 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. Willow is useful in stabilizing streambanks and providing erosion control on severely disturbed sites. It is valuable in revegetating disturbed riparian sites having high water tables and low elevations.

Inventory data references

Soils and Physiographic features were gathered from the NASIS database.

Type locality

Location 1: Elko County, NV	
Township/Range/Section	T37N R51E S18
General legal description	About 2 miles west of Beaver Peak at head of Torro Canyon, Elko County, Nevada. This site also occurs in Humboldt County, Nevada.

Other references

Airola, D. A. 1980. Northeast Interior Zone: Vol. III - Birds & Vol. IV - Mammals. U.S. Gov. Printing Off.: 1980-690-082/26.

Alexander R.R. 1987. Ecology, silviculture, and management of the Engelmann spruce-subalpine fir type in the central and southern Rocky Mtns. Ag Hndbk No. 659. Rky Mtn For & Rng Exp Sta, USDA-FS.

Baker, F. S. 1925. Aspen in the central Rocky Mountain Region. USDA Technical Bulletin 1291.
Cryer, D.H. and Murray, J.E. 1988.

Aspen Regeneration and Soils. USDA, Bulletin 1291, 47 p. Washington D.C.

DeByle, N. V., and R.P. Winokur, editors. 1985. Aspen: ecology and management in the western United States. General Technical Report RM-119, Rocky Mtn For & Rng Exp Sta, FS, USDA.

DeByle, N.V., P.J. Urness, and D.L. Blank. 1989. Forage quality in burned and un-burned aspen communities. Research Paper INT-404. Inter. Res. Sta., FS, USDA.

Edminster, C., et al. 1982. Volume tables and point-sampling factors for aspen in Colorado. Res Paper RM-232, Rocky Mtn For & Rng Exp Sta. USDA-FS.

Eyre, F.H. (editor). 1980. Forest cover types of the United States and Canada. Society of American Foresters, Washington, D.C.

Fire Effects Information System [Online]. http://www.fs.fed.us/feis

Houghton, J.G., C.M. Sakamoto, and R.O. Gifford. 1975. Nevada's weather and climate, special publication 2. Nevada Bureau of Mines and Geology, Mackay School of Mines, University of Nevada, Reno, NV.

Howard, Janet L. 1996. Populus tremuloides. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/ [2015, January 30].

Innes, Robin J. 2013. Odocoileus hemionus. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/ [2015, January 30].

Kasworm, W. F., L. R. Irby, and H. B. I. Pac. 1984. Diets of ungulates using winter ranges in northcentral Montana. Journal of Range Management 37: 67-71.

Kay, C.E. 1997. Is aspen doomed? Aspen bibliography. Paper 1478. http://digitalcommons.usu.edu/aspen_bib/1478

Keinath, D.A. 2003. Species assessment for fringed Myotis (Myotis thysanodes) in Wyoming. United States Department of the Interior, Bureau of Land Management. Cheyenne, WY.

Kiiskila, J. 2014. Mephitis mephitis, striped skunk. http://animaldiversity.org/ accounts/Mephitis_mephitis/. Accessed 23 January 2015.

Krebill, R. G. 1972. Mortality of aspen on the Gros Ventre elk winter range. Aspen Bibliography. Paper 5398. http://digitalcommons.usu.edu/aspen_bib/5398

Kufeld, R. C. 1973. Foods eaten by the Rocky Mountain elk. Journal of Range Management 26: 106-113.

Laacke, Robert J. 1990. Abies concolor (Gord. & Glend.) Lindl. ex Hildebr. White Fir. In: Burns, Russell M.; Honkala, Barbara H., technical coordinators. Silvics of North America. Volume 1. Conifers. Agric. Handb. 654. Washington, DC: U.S. Department of Agriculture, Forest Service: 36-46. 0 p.

Lanner, R.M. 1984. Trees of the Great Basin: A Natural History. Reno: University of Nevada Press.

Leege, T. A., D. J. Herman, and B. Zamora. 1981. Effects of cattle grazing on mountain meadows in Idaho. Journal of Range Management 34:324-328.

Leege, T. A. and W. O. Hickey. 1971. Sprouting of northern Idaho shrubs after prescribed burning. The Journal of Wildlife Management 35:508-515.

Lindsdale, J.M. 1940. Amphibians and reptiles in Nevada. Proceedings of the American Academy of Arts and Sciences. 73:197-257.

Linzey, A.V. & Hammerson, G. 2008. Marmota flaviventris. The IUCN Red List of Threatened Species. Version 2014.3. www.iucnredlist.org. Downloaded on 23 January 2015.

Linzey, A.V. & Hammerson, G. 2008. Thomomys monticola. The IUCN Red List of Threatened Species. Version 2014.3.
www.iucnredlist.org. Downloaded on 03 February 2015.

Logan, Jesse A.; Powell, James A. 2001. Ghost Forests, Global Warming, and the Mountain Pine Beetle (Coleoptera: Scolytidae). American Entomologist. 47(3): 160-173.

McKell, Cyrus M. 1950. A study of plant succession in the oak brush(Quercus gambelli) zone after fire. Thesis. Salt Lake City, UT: University of Utah. 79p.

Meinecke, E. P. 1929. Quaking aspen: A study in applied forest pathology. U.S. Department of Agriculture, Technical Bulletin 155. Washington D.C. p. 34.

Merrill, E. H., H. Mayland, and J. Peek. 1982. Shrub responses after fire in an Idaho ponderosa pine community. The Journal of Wildlife Management 46: 496-502.

Miller, R. F. and E. K. Heyerdahl. 2008. Fine-scale variation of historical fire regimes in sagebrush-steppe and juniper woodland: An example from California, USA. International Journal of Wildland Fire 17:245-254.

Monsen, S. B., R. Stevens, S. C. Walker, and N. E. West. 1996. The competitive influence of seeded smooth brome (Bromus inermis) and intermediate wheatgrass (Thinopyron intermedium) within aspen-mountain brush communities of central Utah. In: Rangelands in a sustainable biosphere: Proceedings of the fifth international rangeland congress, Salt Lake City, Utah, USA, 23-28 July, 1995. Volume 1.

Monsen, S. B., R. Stevens, and N. L. Shaw. 2004. Grasses. Pp. 295-424 In: S.B. Monsen, R. Stevens [eds.] Restoring western ranges and wildlands, vol. 2. Gen. Tech. Rep. RMRS-GTR-136-vol-2. USDA: Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Mueggler, W. F. 1967. Response of mountain grassland vegetation to clipping in southwestern Montana. Ecology 48:942-949.

National Oceanic and Atmospheric Administration. 2004. The North American Monsoon. Reports to the Nation. National Weather Service, Climate Prediction Center. Available online: http://www.weather.gov/

Neuenschwander, L. 1980. Broadcast burning of sagebrush in the winter. Journal of Range Management 33:233-236.

Nevada Division of Forestry. Fir engraver beetle (Scolytus vetralis). http://forestry.nv.gov /forestry-resources/forest-health/fir-engraver-beetle/. Accessed 27 January 2015.

Nimir, M. B. and G. F. Payne. 1978. Effects of spring burning on a mountain range. Journal of Range Management 31:259-263.

Noste, N. V. and C. L. Bushey. 1987. Fire response of shrubs of dry forest habitat types in Montana and Idaho. Gen. Tech. Rep. INT-239.

Potter, Donald A. 1998. Forested communities of the upper montane in the central and southern Sierra Nevada. Gen. Tech. Rep. PSW-GTR-169. Albany, CA: Pacific Southwest Research
Station, Forest Service, U.S. Department of Agriculture. 319 p.

Rogers, P.C., C., Eisenberg, S. St. Clair. 2013. Resilience in quaking aspen: recent advances and future needs. Forest Ecology and Management. http://dx.doi.org/10.1016/j.foreco.2012.11.008.

Shepperd, W.D., P.C. Rogers, D. Burton, and D.L. Bartos. 2006. Ecology, biodiversity, management, and restoration of aspen in the Sierra Nevada. United States Department of Agriculture Forest Service Rocky Mountain Research Station General Technical Report RMRS-GTR-178.

Stanton, Frank. 1973. Wildlife guidelines for range fire rehabilitation. Tech. Note 6712. Denver, CO. U.S. Department of the Interior, Bureau of Land Management. 90p.

Stuever, Mary C.; Hayden, John S. 1996. Plant associations (habitat types) of the forests and woodlands of Arizona and New Mexico. Final report: Contract R3-95-27. Placitas, NM: Seldom Seen Expeditions, Inc. 52.

Strand, Eva K., L. A. Vierling, S. C. Bunting, P. E. Gessler. 2009. Quantifying successional rates in western aspen woodlands: Current conditions, future predictions. Forest Ecology and Management 257: 1705-1715.

Stringham, T.K., P. Novak-Echenique, P. Blackburn, C. Coombs, D. Snyder, and A. Wartgow. 2015. Final Report for USDA Ecological Site Description State-and-Transition Models, Major Land Resource
Area 28A and 28B Nevada. University of Nevada Reno, Nevada Agricultural Experiment Station
Research Report 2015-01. p. 1524.

Sullivan, J. 2009. Corynorhinus townsendii: Townsend's Big-eared Bat. http://animaldiversity.org /accounts/Corynorhinus_townsendii/. Accessed 23 January 2015.

Tilley, D. J., D. Ogle, L. St. John, L. Holzworth, W. Crowder, and M. Majerus. 2004. Mountain Brome. USDA NRCS Plant Guide. USDA NRCS Plant Materials Center. USDA NRCS Idaho State Office, Idaho. p. 5.

Tisdale, E. W. and M. Hironaka. 1981. The sagebrush-grass region: A review of the ecological literature. University of Idaho, Forest, Wildlife and Range Experiment Station.

Vose, J. M. and A. S. White. 1991. Biomass response mechanisms of understory species the first year after prescribed burning in an Arizona ponderosa-pine community. Forest Ecology and Management 40: 175-187.

Warner, R.M. and N.J. Czaplewski. 1984. Mammalian Species No. 224: Myotis volans. The American Society of Mammalogists. 224:1-4

Waters, J.R. and C.J. Zabel. 1995. Northern flying squirrel densities in fir forests of northeastern California. Journal of Range Management. 59: 858-866.

Wildlife Action Plan Team 2012. Nevada Wildlife Action Plan. Nevada Department of Wildlife, Reno, NV.

Wright, H. A. 1971. Why squirreltail is more tolerant to burning than needle-and-thread. Journal of Range Management 24: 277-284.

Wright, H. A. 1985. Effects of fire on grasses and forbs in sagebrush-grass communities. Pages 12-21 In K. Sanders, J. Durham [eds.] Rangeland fire effects; A symposium: Boise, ID, USDI-BLM.

Young, R. P. 1983. Fire as a vegetation management tool in rangelands of the intermountain region. In S.B. Monsen, N. Shaw [eds.] Proceedings: Managing intermountain rangelands - Improvement of range and wildlife abitats. U.S. Department of Agriculture, Forest Service. Gen. Tech. Rep. INT-GTR-157. p. 18-31.

Zevit, P. 2012. BC's coast region: Species & ecosystems of conservation concern
Long-tailed Weasel altifrontalis Subspecies(Mustela frenata altifrontalis).
http://ibis.geog.ubc.ca/biodiversity/factsheets/pdf/Mustela_frenata_altifrontalis.pdf. Accessed 23 January 2015.

Ziegenhagen, L. L. 2003. Shrub reestablishment following fire in the mountain big sagebrush (Artemisia tridentata Nutt. ssp. vaseyana (Rydb.) Beetle) alliance. Thesis. Oregon State University.

Ziegenhagen, L. L. and R. F. Miller. 2009. Postfire recovery of two shrubs in the interiors are large burns in the intermountain west, USA. Western North American Naturalist 69:195-205.

Contributors

RK/GKB
T. Stringham
P NovakEchenique
Trevor Crandall

Approval

Kendra Moseley, 4/24/2024

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	05/14/2025
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):**

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

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

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):**

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:**