Ecological site R028BY042NV
MAHOGANY THICKET

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General information

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

MLRA notes

Major Land Resource Area (MLRA): 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

This site occurs on concave mountain sideslopes. Slopes gradients of 15 to 50 percent are typical. Elevations range from 8000 to 10,000 feet.

The soils associated with this site are deep to bedrock, well drained, and formed in residuum and colluvium derived from limestone and dolomite. These soils have a mollic epipedon from the surface to bedrock and carbonate minerology. The profile is modified with >35% rock fragments throughout. Soil temperature regime ranges from frigid to cryic and the soil moisture regime is xeric.

The reference state is dominated by curlleaf mountain mahogany, but other tree species occasionally occur in trace amounts in the overstory. The understory is sparse and patchy but common plants include mountain big sagebrush, snowberry, bluebunch wheatgrass and needlegrass species. Total overstory canopy cover exceeds 45 percent.

Understory vegetation comprises less than 10% of the total site production. Average annual understory production ranges from 150 to 500 pounds per acre understory.

Associated sites

F028BY062NV	**PIMO-JUOS/ARTRV/PSSPS-ACTH7**
F028BY063NV	**ABCOC-PIFL2-PILO/ARTRV/LEKI2**
F028BY076NV	**Cobbly Mountain Slopes 12-16 PZ**
R028BY029NV	**LOAMY 16+ P.Z.**
R028BY070NV	**MOUNTAIN LOAM 16+ P.Z.**
R028BY085NV	**CALCAREOUS LOAM 16+ P.Z.**
R028BY088NV	**CALCAREOUS LOAM 14-16 P.Z.**

Similar sites

R028BY032NV	**STONY MAHOGANY SAVANNA** Overstory canopy of CELE3 less than 35 percent; less productive site; soils shallow or very shallow

Table 1. Dominant plant species

Tree	(1) *Cercocarpus ledifolius*
Shrub	(1) *Artemisia tridentata subsp. vaseyana*
Herbaceous	(1) *Pseudoroegneria spicata subsp. spicata* (2) *Achnatherum thurberianum*

Physiographic features

This site occurs on concave mountain sideslopes. Slopes range from 4 to 75 percent, but slope gradients of 15 to 50 percent are most typical. Elevations generally range from 8000 to 10,000 feet. Elevations may be lower than expected on some occurrences due to aspect or topographic differences.

Table 2. Representative physiographic features

Landforms	(1) Mountain slope
Flooding frequency	None
Ponding frequency	None

Elevation	8,000–10,000 ft
Slope	15–50%
Aspect	Aspect is not a significant factor

Climatic features

The climate associated with this site is semiarid, characterized by cold, moist winters and warm, dry summers.

Average annual precipitation ranges from 14 to over 20 inches. Mean annual air temperature is about 40 to 43 degrees F. The average growing season is about 50 to 70 days. Weather stations with a long term data record are currently not available for this ecological site. Associated climate data will be updated when information becomes available.

Table 3. Representative climatic features

Frost-free period (average)	50 days
Freeze-free period (average)	70 days
Precipitation total (average)	16 in

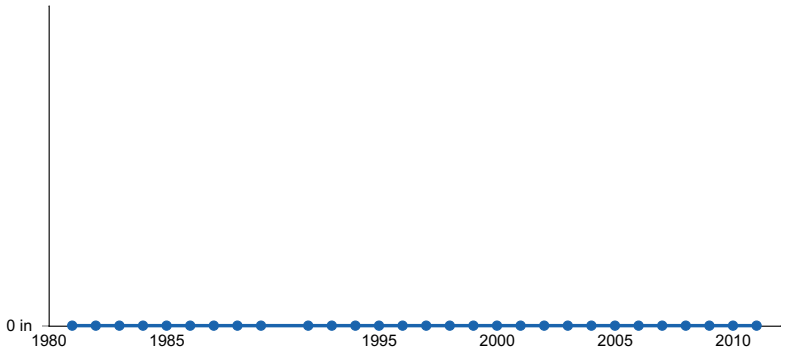


Figure 1. Annual precipitation pattern

Influencing water features

Influencing water features are not associated with this site.

Soil features

The soils associated with this site are deep to bedrock, well drained and formed in residuum and colluvium derived from limestone and dolomite. These soils have a pachic mollic epipedon from the surface to bedrock and carbonate minerology. The profile is modified with >35% rock fragments throughout. Soil temperature regime ranges from frigid to cryic and the soil moisture regime is xeric.
Soil series associated with this site include: Agassiz, Foxmount and Hardol.
The representative soil series is Hardol, a Loamy-skeletal, carbonatic Pachic Calcicryolls. Diagnostic horizons include a mollic epipedon from the soil surface to 152cm and a calcic horizon from 84 to 152cm. Clay content in the particle size control section average 20-27 percent. Rock fragments range from 60-85 percent, mainly gravel with some cobbles and stones. Reaction is slightly alkaline or moderately alkaline. Soils are slightly to strongly effervescent and derived from limestone or dolomite.
Occurrences of this site on any soil expect Hardol will be field checked for recorrelation.

Table 4. Representative soil features

Parent material	(1) Colluvium–limestone (2) Residuum–dolomite

Surface texture	(1) Very gravelly silt loam (2) Very cobbly silt loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Very slow to moderate
Soil depth	10–60 in
Surface fragment cover <=3"	20–30%
Surface fragment cover >3"	10–20%
Available water capacity (0-40in)	0.6–4.1 in
Calcium carbonate equivalent (0-40in)	0–50%
Electrical conductivity (0-40in)	0–2 mmhos/cm
Sodium adsorption ratio (0-40in)	0
Soil reaction (1:1 water) (0-40in)	6.8–8
Subsurface fragment volume <=3" (Depth not specified)	35–60%
Subsurface fragment volume >3" (Depth not specified)	20–25%

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).
The ecological sites in this DRG are dominated by the long-lived mountain mahogany, deep-rooted cool season perennial bunchgrasses, and long-lived shrubs (50+ years) with high root to shoot ratios. As tree canopy increases, bluebunch wheatgrass and needlegrasses will decline while muttongrass – the more shade tolerant grass – will increase. The dominant shrubs usually root to the full depth of the winter-spring soil moisture recharge, which ranges from 1.0 to over 3.0 m. (Comstock and Ehleringer 1992). Root length of mature sagebrush plants was measured to a depth of 2 meters in alluvial soils in Utah (Richards and Caldwell 1987). These shrubs have a flexible generalized root system with development of both deep taproots and laterals near the surface (Comstock and Ehleringer 1992). The perennial bunchgrasses generally have somewhat shallower root systems than the shrubs, but root densities are often as high as or higher than those of shrubs in the upper 0.5 meters. General differences in root depth distributions between grasses and shrubs results in resource partitioning in this system.
Curlleaf mountain mahogany is a multi-branched, evergreen shrub or tree extending from 3 to over 20 feet in height. The rooting of mountain mahogany is spreading and limited by the depth to bedrock. Youngberg and Hu (1972) reported in an Oregon study that curl-leaf mountain mahogany produces nitrogen-fixing root nodules. They also reported that nodulated plants had the highest amounts of nitrogen in the leaves. It is the most widely distributed species of Cercocarpus and is the only species of the genus that extends as far north and west as Washington. Most often curlleaf mountain mahogany stands occur on warm, dry, rocky ridges or outcrops where fire would be an infrequent occurrence (USDA 1937). Dealy (1975) and Scheldt (1969) found that mahogany trees were larger and older on fire-resistant rocky sites and were the seed source if fire destroyed the non-rocky portion of the site.

Curlleaf mahogany plants are long-lived and can reach 1,300+ years of age (Schultz 1987, Schultz et al. 1990). As mahogany stands increase in average age, average canopy volume and height of the individuals present also

increases. As average canopy height and volume increase, stand density declines (Schultz et al 1991). Stands with a closed, or nearly closed canopy often have few or no young curl-leaf mahogany (i.e., recruitment) in the understory (Schultz et al. 1990, 1991), despite high seed density beneath trees (Russell and Schupp 1998, Ibanez and Schupp 2002). Intraspecific competition reduces the growth rates of all age classes below the potential growth rates for the species. Competition may also increase mortality in the younger plants.
Curlleaf mahogany plants are very self-compatible for pollination and most developing seed matures and is viable (Russell et al. 1998). The deep litter throughout stands with high canopy cover appears to facilitate seed germination but retard seedling survival due to poor contact between the root and the soil (Schultz et al. 1996, Ibanez and Schupp 2001). Reproduction in large stands with high canopy cover occurs most often in either canopy gaps where a tree has died and increased exposure of bare ground or around the perimeter of the stand under sagebrush plants, where litter cover is less and seldom deep (Schultz 1987, Schultz et al. 1991).
Mahogany seeds require bare mineral soil to germinate; litter depths over 0.25 inches can impede recruitment (Gruell 1985, Schultz et al. 1991, Ibáñez et al. 1998, Ibáñez 2002). Cheatgrass thus affects mahogany growth by competing for water resources and reducing the amount of bare soil in an area (Ross 1999). Multiple sources (Schultz et al. 1996, Ibáñez et al. 1998) found that mahogany seedlings germinate abundantly under the canopy of adult plants but rarely successfully establish there due to shading and higher litter amounts. In addition, Schultz et al. (1996) found that seedlings had significantly higher long term success in areas dominated by sagebrush canopy than in areas under mahogany canopy or in interspaces. Some hypothesize that the light shading and hydraulic lift provided by sagebrush may create a microsite facilitating mahogany recruitment (Gruell 1985, Ibáñez et al. 1998).
Mountain big sagebrush is generally long-lived; therefore it is not necessary for new individuals to recruit every year for perpetuation of the stand. Infrequent large recruitment events and simultaneous low, continuous recruitment is the foundation of population maintenance (Noy-Meir 1973). Survival of the seedlings is dependent on adequate moisture conditions.
The perennial bunchgrasses present on this site include bluebunch wheatgrass, needlegrass, and muttongrass. These species generally have somewhat shallower root systems than the shrubs, but root densities are often as high as or higher than those of shrubs in the upper 0.5 m but taper off more rapidly than shrubs. Differences in root depth distributions between grasses and shrubs result in resource partitioning in these shrub/grass systems. Muttongrass may be more shade tolerant than other perennial bunchgrasses and will persist in the understory as the canopy closes (Erdman 1970).
Mahogany stands are susceptible to drought, frost, and invasion by non-native species, especially cheatgrass (*Bromus tectorum*). Cheatgrass affects mahogany seedling growth by competing for water resources and nutrients in an area (Ross 1999).

Infilling by singleleaf pinyon (*Pinus monophylla*) may also occur with an extended fire return interval. Eventually, singleleaf pinyon will dominate the site and the understory of mountain big sagebrush and grasses will be severely reduced. Muttongrass may remain underneath trees on north-facing slopes.

This ecological site has moderate to high resilience to disturbance and resistance to invasion. Resilience increases with elevation, aspect, precipitation, and nutrient availability. Long-term disturbance response may be influenced by small differences in landscape topography. Concave areas receive run-in from adjacent landscapes and consequently retain more moisture to support the growth of deep-rooted perennial grasses (i.e. bluebunch wheatgrass) whereas convex areas where runoff occurs are slightly less resilient and may have more shallow-rooted perennial grasses (i.e. muttongrass). North slopes are also more resilient than south slopes because lower soil surface temperatures operate to keep moisture content higher on northern exposures. Two possible alternative stable states have been identified for this site.

Fire Ecology:
The fire return interval in curlleaf mountain mahogany dominated sites is not well documented, however a study by Arno and Wilson (1986) suggested sites of curl-leaf mountain mahogany with ponderosa pine had fire return intervals of 13-22 years before 1900. Fire frequency most likely depends on surrounding vegetation. Mahogany will persist longest in rocky areas where it is protected from fire. Because of their thicker bark, mature trees can often survive low-severity fires (Gruell 1985). Curl-leaf mountain mahogany is considered a weak sprouter after fire. It is usually moderately to severely damaged by severe fires and the recovery time of these sites is variable; some measurements show that stands lack recruitment for up to 30 years post-fire (Gruell 1985).
Mountain big sagebrush is killed by fire (Neuenschwander 1980, Blaisdell et al. 1982) and does not resprout (Blaisdell 1953). Post fire regeneration occurs from seed and will vary depending on site characteristics, seed source, and fire characteristics. Mountain big sagebrush seedlings can grow rapidly and may reach reproductive maturity within 3 to 5 years (Bunting et al. 1987). Mountain big sagebrush may return to pre-burn density and cover

within 15-20 years following fire, but establishment after severe fires may proceed more slowly (Bunting et al. 1987). Depending on fire severity, mountain snowberry may increase after fire. Snowberry is top-killed by fire but resprouts after fire from rhizomes (Leege and Hickey 1971, Noste and Bushey 1987). Snowberry has been noted to be fire tolerant (Miller et al 2013); it regenerates well and may exceed pre-burn biomass in the third season after a fire (Merrill et al. 1982). Creeping barberry is resistant to low-intensity fire (Armour et al 1984). Creeping barberry is rhizomatous, thus it is capable of sprouting after fire and increasing in abundance after fire (Brown and Norbert 1989).

Fire will remove aboveground biomass from bluebunch wheatgrass but plant mortality is generally low (Robberecht and Defossé 1995) because the buds are underground (Conrad and Poulton 1966) or protected by foliage. Uresk et al. (1976) reported burning increased vegetative and reproductive vigor of bluebunch wheatgrass. Thus, bluebunch wheatgrass is considered to experience slight damage to fire but is more susceptible in drought years (Young 1983). Plant response will vary depending on season, fire severity, fire intensity and post-fire soil moisture availability.
Columbia needlegrass is common on this site. Perennial needlegrasses tend to be among the least fire resistant bunchgrasses, due partially, to their densely tufted stems. Columbia needlegrass is generally top-killed by fire. Particularly severe fires with soil heating caused by combustion of fine leaves at the soil surface may further damages the plant (Zouhar 2000).
Muttongrass, a minor component on this site, is top killed by fire but will resprout after low to moderate severity fires. A study by Vose and White (1991) in an open sawtimber site, found a minimal effect of burning on muttongrass.

State and transition model

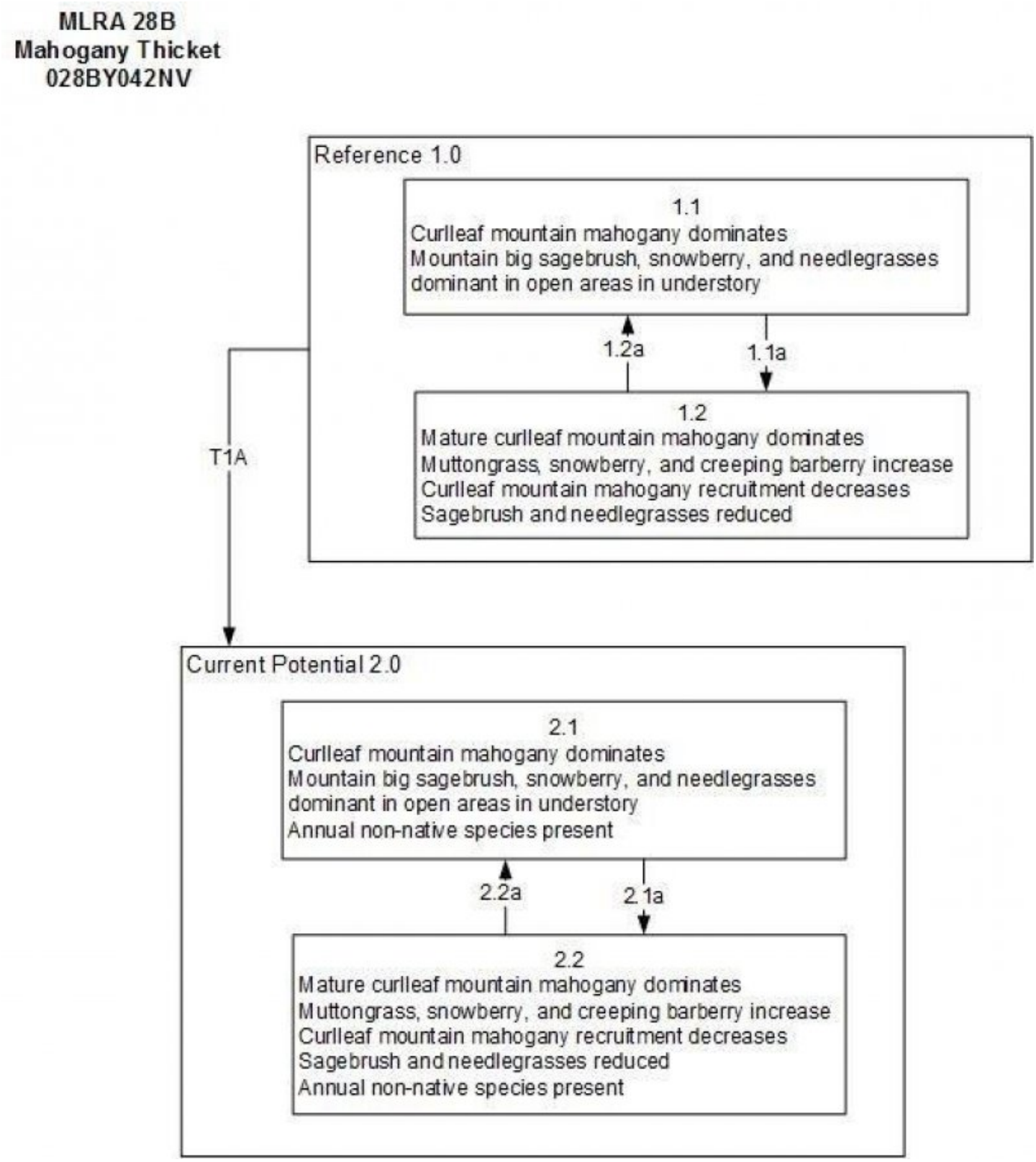


Figure 3. State and Transition Model

State 1
Reference State

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

Community 1.1
Community Phase

Figure 4. Mahogany Thicket (R028BY042NV) Community Phase 1.1 P.Novak-Echenique September 2013

The plant community is dominated by curlleaf mountain mahogany but trees such as singleleaf pinyon, juniper, white fir and limber pine may occur sporadically in the overstory canopy. Mountain big sagebrush and snowberry are the principal understory shrubs. Bluebunch wheatgrass and needlegrass are the most prevalent understory grasses. Total overstory canopy cover exceeds 45 percent (often = 50%). Understory vegetation comprises less than 10% of the total site production. Potential vegetative composition for the understory is about 55% grasses, 10% forbs and 35% shrubs. The overstory of curlleaf mountainmahogany is about 85% of the total site production. Approximate ground cover (basal and crown) is 50 to 75 percent. Mountain mahogany canopy is not closed in this phase. Small disturbances that damage or kill individual trees open up areas in the canopy.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Tree	2720	3400	4250
Grass/Grasslike	264	330	413
Shrub/Vine	168	210	262
Forb	48	60	75
Total	**3200**	**4000**	**5000**

Community 1.2
Community Phase

Figure 6. Mahogany Thicket (R028BY042NV) T.Stringham July 2013

Mahogany density increases in the absence of disturbance. Shrubs and deep-rooted perennial bunchgrasses are

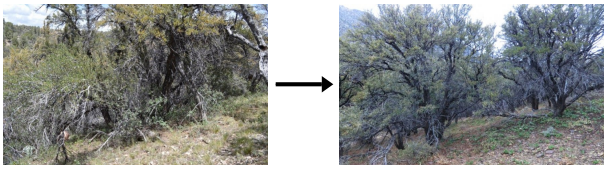
shaded out by the dense mahogany. Muttongrass is more shade tolerant, however, and is still found in the understory. Mountain big sagebrush is reduced or eliminated. Snowberry and creeping barberry are the dominant shrubs in the understory. Mahogany in dense stands will lose lower branches due to shading and/or herbivory, resulting in a more tree-like appearance. Singleleaf pinyon, juniper, white fir, and/or limber pine are described in the site concept and may or may not be present.

Pathway a
Community 1.1 to 1.2

Community Phase | Community Phase

Time and lack of disturbance such as fire allows the mountain mahogany to increase. The shrub and herbaceous understory components decline due to increased shading from the trees. Muttongrass and other shade-tolerant species increase.

Pathway a
Community 1.2 to 1.1



Community Phase | Community Phase

Snow loading, lightning, or insect damage will decrease the overstory and allow for the shrubs and herbaceous plants in the understory to increase.

State 2
Current Potential State

This state is similar to the Reference State 1.0. This state has the same two general community phases. Ecological function has not changed, however the resiliency of the state has been reduced by the presence of invasive weeds. 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 include the presence of all structural and functional groups, low fine fuel loads, and retention of organic matter and nutrients. Positive feedbacks decrease ecosystem resilience and stability of the state. These include the non-natives' high seed output, persistent seed bank, rapid growth rate, ability to cross pollinate, and adaptations for seed dispersal.

Community 2.1
Community Phase

This community phase is similar to the Reference State Community Phase 1.1, with the presence of non-native species in trace amounts. This community is dominated by curlleaf mountain mahogany. Small disturbances that damage or kill individual trees open up areas in the canopy. Mountain big sagebrush and mountain snowberry make up the shrub components of the understory. Bluebunch wheatgrass and Thurber's needlegrass make up the perennial bunchgrasses. Forbs and other grasses are a small component of the understory. Singleleaf pinyon, juniper, white fir, and/or limber pine may be present.

Community 2.2
Community Phase

Curl-leaf mountain mahogany dominates the overstory. Mountain big sagebrush is reduced or eliminated. Snowberry and creeping barberry are the dominant shrubs in the understory. The understory of bluebunch

wheatgrass and needlegrasses is reduced while the shade-tolerant muttongrass increases in the understory and may be the dominant grass on the site. Annual non-native species are stable to increasing. Bare ground may be increasing. Mahogany in dense stands will lose lower branches due to shading and/or herbivory, resulting in a more tree-like appearance Singleleaf pinyon, juniper, white fir, and/or limber pine may be present.

Pathway a
Community 2.1 to 2.2

Time and lack of disturbance allows the mountain mahogany component to increase. The shrub and herbaceous understory components decline due to increased shading from the trees.

Pathway a
Community 2.2 to 2.1

Snow loading, lightning, or insect damage will reduce the overstory and allow for the shrubs and herbaceous plants in the understory to increase. Fires may be likely following an unusually wet spring or a change in management favoring an increase in fine fuels. Annual non-native species generally respond well after fire and may be stable or increasing within the community.

Transition A
State 1 to 2

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

Additional community tables

Table 6. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Primary Perennial Grasses**			75–204	
	bluebunch wheatgrass	PSSPS	*Pseudoroegneria spicata ssp. spicata*	30–75	–
	Columbia needlegrass	ACNE9	*Achnatherum nelsonii*	10–25	–
	western needlegrass	ACOC3	*Achnatherum occidentale*	10–25	–
	pine needlegrass	ACPI2	*Achnatherum pinetorum*	10–25	–
	bluegrass	POA	*Poa*	6–24	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	6–15	–
	squirreltail	ELEL5	*Elymus elymoides*	6–15	–
2	**Secondary Perennial Grasses**			6–15	
	basin wildrye	LECI4	*Leymus cinereus*	2–6	–
	muttongrass	POFE	*Poa fendleriana*	2–6	–
Forb					
3	**Perennial**			15–45	
	yarrow	ACHIL	*Achillea*	2–9	–
	arrowleaf balsamroot	BASA3	*Balsamorhiza sagittata*	2–9	–
	hawksbeard	CREPI	*Crepis*	2–9	–
	western stoneseed	LIRU4	*Lithospermum ruderale*	2–9	–
	lupine	LUPIN	*Lupinus*	2–9	–
Shrub/Vine					
4	**Primary Shrubs**			45–105	
	mountain big sagebrush	ARTRV	*Artemisia tridentata ssp. vaseyana*	30–60	–
	snowberry	SYMPH	*Symphoricarpos*	15–45	–
5	**Secondary Shrubs**			1–15	
	antelope bitterbrush	PUTR2	*Purshia tridentata*	3–6	–
Tree					
6	**Evergreen**			3201–3920	
	curl-leaf mountain mahogany	CELE3	*Cercocarpus ledifolius*	3200–3800	–
	Rocky Mountain juniper	JUSC2	*Juniperus scopulorum*	20–80	–
	limber pine	PIFL2	*Pinus flexilis*	20–80	–
	singleleaf pinyon	PIMO	*Pinus monophylla*	20–80	–
	white fir	ABCO	*Abies concolor*	20–80	–

Animal community

Livestock Interpretations:
This site has value for livestock grazing. Grazing management considerations include duration, timing and intensity of grazing. Sampson and Jesperson (1963) state that domestic livestock will browse curlleaf mountain mahogany to varying degrees in all seasons except summer. Columbia needlegrass provides valuable forage for many species of wildlife and all classes of livestock. It is especially valuable to cattle and horses on summer ranges and to domestic sheep (Zouhar 2000). Most needlegrasses cure well on the ground and can be used during the fall and winter. However, the awns and/or callus of many species of needlegrasses can, however, cause injury to grazing animals. Because of this Columbia needlegrass and other speices should avoided from the time of seed maturation until the

ripe seed falls to the ground (Zouhar 2000). Bluebunch wheatgrass is moderately grazing tolerant and is very sensitive to defoliation during the active growth period (Blaisdell and Pechanec 1949, Laycock 1967, Anderson and Scherzinger 1975, Britton et al. 1990). Herbage and flower stalk production was reduced with clipping at all times during the growing season; however, clipping was most harmful during the boot stage (Blaisdell and Pechanec 1949). Tiller production and growth of bluebunch was greatly reduced when clipping was coupled with drought (Busso and Richards 1995). Mueggler (1975) estimated that low vigor bluebunch wheatgrass may need up to 8 years rest to recover. Although an important forage species, it is not always the preferred species by livestock and wildlife. Muttongrass, a minor component on this ecological site, is relatively grazing tolerant. It is palatable and nutritional forage for livestock and wildlife when it is in the early stages of growth. It rates as excellent forage for cattle and horses, and good for sheep, elk and deer (Dayton 1937).
Bluegrass is a widespread forage grass. It is one of the earliest grasses in the spring and is sought by domestic livestock and several wildlife species. Bluegrass is a palatable species, but its production is closely tied to weather conditions. It produces little forage in drought years, making it a less dependable food source than other perennial bunchgrasses. Bottlebrush squirreltail is very palatable winter forage for domestic sheep of Intermountain ranges. Domestic sheep relish the green foliage. Overall, bottlebrush squirreltail is considered moderately palatable to livestock. Indian ricegrass is highly palatable to all classes of livestock in both green and cured condition. It supplies a source of green feed before most other native grasses have produced much new growth. Some livestock (domestic goats, sheep, and cattle) use it in spring, fall, and/or winter but rarely in the summer. Despite low palatability, mountain big sagebrush is eaten by sheep, cattle, goats, and horses. Chemical analysis indicates that the leaves of big sagebrush equal alfalfa meal in protein, have a higher carbohydrate content, and yield twelvefold more fat (USDA-Forest Service 1937). Snowberry is poor to fair browse for cattle but may be heavily used by domestic livestock on overgrazed ranges (Morris et al 1962). It plays a critical role in permitting cattle to meet their protein requirements during the latter half of the growing season. Domestic sheep also utilize common snowberry for browse and it is considered fair to good forage. It is has no forage value for horses.
Stocking rates vary over time depending upon season of use, climate variations, site, and previous and current management goals. A safe starting stocking rate is an estimated stocking rate that is fine-tuned by the client by adaptive management through the year and from year to year.

Wildlife Interpretations:
Curlleaf mountain mahogany provides food and cover for a variety of wildlife species. Curlleaf mountainmahogany is highly palatable to deer. Curlleaf mountain mahogany habitat type has been documented as important browse and cover for elk (Cervus canadensis), pronghorn antelope (Antilocarpra americana) and even feral horses. A variety of small mammals consume curlleaf mountainmahogany seeds. Mountain mahogany is an important cover and browse species for big game such as elk, mule deer, and bighorn sheep (Furniss et al 1988, Lanner 1983). Sampson and Jesperson (1963) state that curlleaf mountain mahogany is excellent browse for deer. It is not uncommon for these trees to develop a “hedged” appearance after years of regular browsing by wildlife. According to Olsen (1992) curlleaf mountain mahogany is consumed widely by mule deer throughout the year. In fact, mule deer fecal pellets were observed to contain curlleaf mountain mahogany year-round, with the highest frequency of leaves found in winter (Gucker 2006). Mule deer will use curlleaf mountain mahogany for cover as well (Steel et al. 1981).
Mountain big sagebrush is highly preferred and nutritious winter forage for mule deer and elk. Common snowberry is considered important browse for many types of wildlife. Bighorn sheep use common snowberry regularly during the summer. Forage value to elk is fair. Snowberry is an important forage plant for sheep, deer, elk and bighorn sheep (Guillon 1964). Common snowberry is also important as both cover and food for bird and small mammal populations. These include sharp-tailed, ruffed, and blue grouse, wild turkey and, several non-game species of bird including the kingbird, western flycatcher, and western bluebird. Among small mammals that rely on common snowberry are fox squirrels, desert cottontails, and pocket gopher. Bluebunch wheatgrass is considered one of the most important forage grass species on western rangelands for wildlife. Bluebunch wheatgrass does not generally provide sufficient cover for ungulates, however, mule deer are frequently found in bluebunch-dominated grasslands. Needlegrasses have been found to be a significant component in the diet of many wildlife species, ranging from mule deer to pocket gophers. Bottlebrush squirreltail may provide forage for mule deer and pronghorn. Indian ricegrass is eaten by pronghorn in "moderate" amounts whenever available. In Nevada it is consumed by desert bighorns. A number of heteromyid rodents inhabiting desert rangelands show preference for seed of Indian ricegrass. Indian ricegrass is an important component of jackrabbit diets in spring and summer. Indian ricegrass seed provides food for many species of birds. Doves, for example, eat large amounts of shattered Indian ricegrass seed lying on the ground.
This site also provides breeding and hunting grounds for mountain lions, Puma concolor (Steele et al. 1981, (Gucker 2006). Lions used curl-leaf mountain mahogany vegetation as an important site for caching kills. Loagan

and Irwin (1985) noted of 52 mountain lion caches, 33 percent were located in curl-leaf mountain mahogany vegetation (Gucker 2006 and ref. therein).
A variety of small mammals consume curl-leaf mountain mahogany seeds (Gucker 2006, Wildlife Action Plan Team 2012). Curl-leaf mountain mahogany leaves and fruits have also been found in bushy-tailed woodrat (Neotoma cinerea) middens (Gucker 2006).

Bird species utilize mountain mahogany habitat types heavily. Virginia's warblers (Oreothylypis virginae) were recorded in their second highest densities in the state in mountain mahogany habitats. This habitat type also provides important nesting sites for dusky flycatchers (Empidonax oberholseri), rock wrens (Salpinctes obsoletus), and American kestrels (Falco sparverius) (Wildlife Action Plan Team 2012).

Hydrological functions

Runoff is high to very high. Permeability is very slow to moderate. Rills are rare to few. Occurrence of rills may be more frequent as canopy cover increases and on steeper slopes. Water flow patterns are none to rare with occurrence increasing as canopy cover increases. Pedestals are rare to few. Occurrence is usually limited to areas of water flow patterns. Gullies are none. Perennial herbaceous plants (especially deep-rooted bunchgrasses [i.e., needlegrasses] slow runoff and increase infiltration. Curl-leaf mountain mahogany and understory shrubs break raindrop impact and provide opportunity for snow catch and accumulation on site.

Recreational uses

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

Other products

Native peoples used big sagebrush leaves and branches for medicinal teas, and the leaves as a fumigant. Bark was woven into mats, bags and clothing. Indian ricegrass was traditionally eaten by some Native Americans. The Paiutes used the seed as a reserve food source. Common snowberry fruits were eaten fresh and also dried for winter use. It was also used on hair as soap, and the fruits and leaves mashed and applied to cuts or skin sores as a poultice and to soothe sore, runny eyes. Tea from the bark was used as a remedy for tuberculosis and sexually transmitted diseases. A brew made from the entire plant was used as a physic tonic. Arrowshafts and pipestems were made from the stems.

Other information

Curlleaf mountain mahogany may be planted to help stabilize soil in disturbed areas such as roadcuts and mine spoils. Bottlebrush squirreltail is tolerant of disturbance and is a suitable species for revegetation.

Type locality

Location 1: White Pine County, NV	
Township/Range/Section	T12N R64E S13
Latitude	38° 54′ 12″
Longitude	114° 44′ 5″
General legal description	Basque Canyon area, Schell Creek range, White Pine County, Nevada. Also occurs in Elko and Eureka Counties, Nevada.

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Rangeland health reference sheet

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

Author(s)/participant(s)	P. Novak-Echenique
Contact for lead author	State Rangeland Management Specialist
Date	11/18/2009
Approved by	PNovak-Echenique
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rills are rare to few. Occurrence of rills may be more frequent as canopy cover increases and on steeper slopes after summer convection storms and rapid snowmelt. These are typically short (<2m) and stable.

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2. **Presence of water flow patterns:** Water flow patterns are none to rare with occurrence increasing as canopy cover increases and on steeper slopes after summer convection storms or rapid snowmelt. Flow patterns are short (<2m), meandering and interrupted by plant bases and rock fragments.

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3. **Number and height of erosional pedestals or terracettes:** Pedestals are rare to few. Occurrence is usually limited to areas of water flow patterns.

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare Ground 5-15% depending on amount of surface rock fragments and overstory canopy.

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

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6. **Extent of wind scoured, blowouts and/or depositional areas:** None - rock fragments armor the surface

7. **Amount of litter movement (describe size and distance expected to travel):** Fine litter (foliage from grasses and annual & perennial forbs) expected to move distance of slope length during intense summer convection storms or rapid snowmelt events. Persistent litter (large woody material) will remain in place except during large rainfall events. Mat of accumulating leaf litter under mature trees is very stable and shows no obvious movement.

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

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Surface structure is fine subangular blocky or medium granular. Soil surface colors are dark grayish browns or dark browns and soils are typified by a mollic epipedon. Surface textures are loams or silt loams. Organic matter of the surface 2 to 4 inches is typically 1 to 4 percent, dropping off quickly below. Organic matter content can be more or less depending on micro-topography.

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

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

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

    Dominant: Reference State: Curlleaf mountain mahogany

    Sub-dominant: deep-rooted, cool season, perennial bunchgrasses > deep-rooted, cool season, perennial grasses > understory shrubs > shallow-rooted, cool season, perennial forbs = fibrous, shallow-rooted, cool season, perennial forbs = annual forbs

    Other: evergreen trees

    Additional: With an extended fire return interval, the shrub and tree canopy will increase at the expense of the herbaceous component.

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Overstory trees have little mortality. Dead branches within understory shrubs are common and standing dead shrub canopy material may be as much as 35% of total shrub canopy; mature bunchgrasses (<25%) may have dead centers.

14. **Average percent litter cover (%) and depth (in):** Herbaceous, or non-persistent, litter within curl-leaf mountain mahogany canopy interspaces (± 25%) and litter depth is ±½ inch. Leaf litter forms a mat 1 to 2 inches thick under the drip line of mature mountain mahogany. Large, persistent, litter from trees (limbs, etc.) variable to 5%.

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** Total for all trees, shrubs and herbaceous plants, irrespective of plant height for normal or average growing season (through June)±4000 lbs/ac, favorable years ±5000 lbs/ac, unfavorable years ±3200 lbs/ac. For understory vegetation to 4½ feet and normal or average growing season (through June) ± 300 lbs/ac, favorable years ±500 lbs/ac, unfavorable years ±150 lbs/ac.

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

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17. **Perennial plant reproductive capability:** All functional groups should reproduce in average (or normal) and above average growing season years. Reduced growth and reproduction occur during extreme or extended drought periods.
