

Ecological site R028AY130NV

ERODED SLOPE 8-12 P.Z.

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General information

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

MLRA notes

Major Land Resource Area (MLRA): 028A–Ancient Lake Bonneville

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

Ecological site concept

This site occurs on eroded fan remnants on all exposures. Slopes range from 15 to 75 percent, but slope gradients of 30 to 50 percent are typical. Elevations are 6000 to about 7000 feet. The climate associated with this site is semiarid, characterized by cold, moist winters and warm, dry summers. Average annual precipitation is 8 to 12 inches. Moisture from intermittent convection storms provides an important source of precipitation from July through September. Mean annual air temperature is 45 to 50 degrees F. The average growing season is about 90 to 110 days. Soils associated with this site are very shallow and well drained. Surface soils are medium textured and normally less than 6 to 10 inches thick to underlying material, commonly lacustrine deposits. Because of steep slopes and sparse vegetation, the soils of this site are subject to sheet and rill erosion. The available water capacity is low. Runoff is very high. Soils correlated to this ecological site are classified as Xeric Torriorthents. The reference state is dominated by antelope bitterbrush, black sagebrush, Indian ricegrass, and bottlebrush squirreltail. Production ranges from 100 to 250 pounds per acre.

Associated sites

R028AY013NV	SHALLOW CALCAREOUS LOAM 8-10 P.Z.
R028AY015NV	LOAMY 8-10 P.Z.
R028AY031NV	LOAMY FAN 8-10 P.Z.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) <i>Purshia tridentata</i> (2) <i>Artemisia nova</i>
Herbaceous	(1) <i>Achnatherum hymenoides</i>

Physiographic features

This site occurs on eroded fan remnants on all exposures. Slopes range from 15 to 75 percent, but slope gradients of 30 to 50 percent are typical. Elevations are 6000 to about 7000 feet.

Table 2. Representative physiographic features

Landforms	(1) Fan remnant
Elevation	1,830 – 2,130 m
Slope	20 – 80 %

Climatic features

Nevada's climate is predominantly arid, with large daily ranges of temperature, infrequent severe storms, heavy snowfall in the higher mountains, and great location variations with elevation. Three basic geographical factors largely influence Nevada's climate: continentality, latitude, and elevation. Continentality is the most important factor. The strong continental effect is expressed in the form of both dryness and large temperature variations. Nevada lies on the eastern, lee side of the Sierra Nevada Range, a massive mountain barrier that markedly influences the climate of the State. The prevailing winds are from the west, and as the warm moist air from the Pacific Ocean ascend the western slopes of the Sierra Range, the air cools, condensation occurs and most of the moisture falls as precipitation. As the air descends the eastern slope, it is warmed by compression, and very little precipitation occurs. The effects of this mountain barrier are felt not only in the West but throughout the state, with the result that the lowlands of Nevada are largely desert or steppes. The temperature regime is also affected by the blocking of the inland-moving maritime air. Nevada sheltered from maritime winds, has a continental climate with well-developed seasons and the terrain responds quickly to changes in solar heating.

Nevada lies within the mid-latitude belt of prevailing westerly winds which occur most of the year. These winds bring frequent changes in weather during the late fall, winter and spring months, when most of the precipitation occurs. To the south of the mid-latitude westerlies, lies a zone of high pressure in subtropical latitudes, with a center over the Pacific Ocean. In the summer, this high-pressure belt shifts northward over the latitudes of Nevada, blocking storms from the ocean. The resulting weather is mostly clear and dry during the summer and early fall, with scattered thundershowers. The eastern portion of the state receives significant summer thunderstorms generated from monsoonal moisture pushed up from the Gulf of California, known as the North American monsoon. The monsoon system peaks in August and by October the monsoon high over the Western U.S. begins to weaken and the precipitation retreats southward towards the tropics (NOAA 2004).

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Mean annual precipitation at Spring Valley State Park Climate Station(267750) is 11.89 in.

Monthly mean precipitation is: January 0.87;

February 1.21; March 1.32; April 0.92; May 1.07; June 0.42; July 0.88; August 1.29; September 1.23; October 1.2; November 0.66; December 0.82.

Table 3 Representative climatic features

Frost-free period (average)	100 days
Freeze-free period (average)	
Precipitation total (average)	250 mm

Influencing water features

There are no influencing water features associated with this site.

Soil features

Soils associated with this site are very shallow and well drained. Surface soils are medium textured and normally less than 6 to 10 inches thick to underlying material, commonly lacustrine deposits. Because of steep slopes and sparse vegetation, the soils of this site are subject to sheet and rill erosion. The available water capacity is low. Runoff is very high. Soils correlated to this ecological site are classified as Xeric Torriorthents.

Table 4. Representative soil features

Surface texture	(1) Fine sandy loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Moderately rapid
Soil depth	180 – 210 cm
Surface fragment cover <=3"	Not specified
Surface fragment cover >3"	Not specified
Available water capacity (0-101.6cm)	1.27 – 1.52 cm
Calcium carbonate equivalent (0-101.6cm)	0 – 20 %
Electrical conductivity (0-101.6cm)	0 – 10 mmhos/cm

Sodium adsorption ratio (0-101.6cm)	Not specified
Soil reaction (1:1 water) (0-101.6cm)	7.9 – 8.4
Subsurface fragment volume <=3" (Depth not specified)	Not specified
Subsurface fragment volume >3" (Depth not specified)	Not specified

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 site is dominated by deep-rooted cool season, perennial bunchgrasses and long-lived shrubs (50+ years) with high root to shoot ratios. The dominant shrubs usually root to the full depth of the winter-spring soil moisture recharge, which ranges from 1.0 to over 3.0 m (Dobrowolski et al. 1990). Root length of mature sagebrush plants was measured to a depth of 2 meters in alluvial soils in Utah (Richards and Caldwell 1987). However, community types with black sagebrush as the dominant shrub were found to have soil depths and thus available rooting depths of 77 to 81 cm in a study in northeast Nevada (Jensen 1990). These shrubs have a flexible generalized root system with development of both deep taproots and laterals near the surface (Comstock and Ehleringer 1992).

Periodic drought regularly influences sagebrush ecosystems and drought duration and severity has increased throughout the 20th century in much of the Intermountain West. Major shifts away from historical precipitation patterns have the greatest potential to alter ecosystem function and productivity. Species composition and productivity can be altered by the timing of precipitation and water availability within the soil profile (Bates et al 2006).

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

Black 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 that are co-dominant with the shrubs include Indian ricegrass and squirreltail. 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 of the soil profile. General differences in root depth distributions between grasses and shrubs results in resource partitioning in these shrub/grass systems.

The Great Basin sagebrush communities have high spatial and temporal variability in precipitation both among years and within growing seasons. Nutrient availability is typically low but increases with elevation and closely follows moisture availability. The invasibility of plant communities is often linked to resource availability. Disturbance can decrease resource uptake due to damage or mortality of the native species and depressed competition or can increase resource pools by the decomposition of dead plant material following disturbance. The invasion of sagebrush communities by cheatgrass has been linked to disturbances (fire, abusive grazing) that have resulted in fluctuations in resources (Chambers et al 2007).

The range and density of Utah juniper has increased since the middle of the nineteenth century (Tausch 1999, Miller and Tausch 2000). Causes for expansion of Utah juniper into sagebrush ecosystems include wildfire suppression, historic livestock grazing, and climate change (Bunting 1994). Mean fire return intervals prior to European settlement in black sagebrush ecosystems were greater than 100 years, however frequent enough to inhibit the encroachment of Utah juniper into these low productive sagebrush cover types (Kitchen and McArthur 2007). Thus, trees were isolated to fire-safe areas such as rocky outcroppings and areas with low-productivity. An increase in crown density causes a decrease in understory perennial vegetation and an increase in bare ground. This allows for the invasion of non-native annual species such as cheatgrass. With annual species in the understory wildfire can become more frequent and increase in intensity. With frequent wildfires these plant communities can convert to annual species with a sprouting shrub and juvenile tree overstory.

The ecological site has low to moderate resilience to disturbance and resistance to invasion. Increased resilience increases with elevation, aspect, increased precipitation and increased nutrient availability.

Fire Ecology:

Fire is not a major disturbance of these community types (Winward 2001), and would be infrequent. Historic fire return intervals have been estimated at 100 to 200 years (Kitchen and McArthur 2007); however, fires were probably patchy and very infrequent due to the low productivity of these sites. Black sagebrush plants have no morphological adaptations for surviving fire and must reestablish from seed following fire (Wright et al. 1979). The ability of black sagebrush to establish after fire is mostly dependent on the amount of seed deposited in the seed bank the year before the fire. Seeds typically do not persist in the soil for more than 1 growing season (Beetle 1960). A few seeds may remain viable in soil for 2 years (Meyer 2008); however, even in dry storage, black sagebrush seed viability has been found to drop rapidly over time, from 81% to 1% viability after 2 and 10 years of storage, respectively (Stevens et al. 1981). Thus, repeated frequent fires can eliminate black sagebrush from a site, however black sagebrush in zones receiving 12 to 16 inches of annual precipitation have been found to have greater fire survival (Boltz 1994). In lower precipitation zones, spiny hopsage and/or shadscale may become the dominant shrub species following fire. Douglas' rabbitbrush and ephedra can also sprout after fire and become a dominant shrub on this site often with an understory of galleta, Sandberg bluegrass and/or cheatgrass and other weedy species.

The effect of fire on bunchgrasses relates to culm density, culm-leaf morphology, and the size of the plant. The initial condition of bunchgrasses within the site along with seasonality and intensity of the fire all factor into the individual species response. Indian ricegrass is fairly fire tolerant (Wright 1985), which is likely due to its low culm density and below ground plant crowns. Indian ricegrass has been found to reestablish on burned sites through seed dispersed from adjacent unburned areas (Young 1983, West 1994). Thus the presence of surviving, seed producing plants is necessary for reestablishment of Indian ricegrass. Grazing management following fire to promote seed production and establishment of seedlings is important.

Sandberg bluegrass, another minor component of this site has also been found to increase following fire likely due to its low stature and productivity (Daubenmire 1975). This grass species may retard reestablishment of deeper rooted bunchgrasses. Repeated frequent fire in this community will eliminate black sagebrush, significantly decrease bunchgrass density on the site and facilitate the establishment of an annual weed community with varying amounts of Sandberg bluegrass and rabbitbrush.

Utah juniper is usually killed by fire, and is most vulnerable to fire when it is under four feet tall (Bradley et al. 1992). Larger trees, because they have foliage farther from the ground and thicker bark, can survive low severity fires but mortality does occur when 60% or more of the crown is scorched (Bradley et al. 1992). With the low production of the understory vegetation, high severity fires within this plant community were not likely and rarely became crown fires (Bradley et al. 1992, Miller and Tausch 2000). Tree density on this site increases with grazing management that favors the removal of fine fuels and management focused on fire suppression. With an increase of cheatgrass in the understory, fire severity is likely to increase. Utah juniper reestablishes by seed from nearby seed source or surviving seeds. Utah juniper begins to produce seed at about 30 years old (Bradley et al. 1992). Seeds establish best through the use of a nurse plant such as sagebrush and rabbitbrush (Everett and Ward 1984,Tausch and West 1988, Bradley et al. 1992). Utah juniper woodlands reach mature stage between 85 to 150 years after fire (Barney and Frischknecht 1974, Tausch and West 1988).

State and transition model

Additional community tables

Table 5. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
Grass/Grasslike					
1	Primary Perennial Grasses			18-34	
	Indian ricegrass	ACHY	<i>Achnatherum hymenoides</i>	9-17	–
	squirreltail	ELELE	<i>Elymus elymoides ssp. elymoides</i>	9-17	–
2	Secondary Perennial Grasses			3-9	
	muttongrass	POFE	<i>Poa fendleriana</i>	1-6	–
	Sandberg bluegrass	POSE	<i>Poa secunda</i>	1-6	–

Forb					
3	Perennial			9-17	
	buckwheat	ERIOG	<i>Eriogonum</i>	1-3	—
	scarlet gilia	IPAG	<i>Ipomopsis aggregata</i>	1-3	—
	beardtongue	PENST	<i>Penstemon</i>	1-3	—
	phlox	PHLOX	<i>Phlox</i>	1-3	—
	ragwort	SENEC	<i>Senecio</i>	1-3	—
4	Annual			2-4	
Shrub/Vine					
5	Primary Shrubs			93-135	
	antelope bitterbrush	PUTR2	<i>Purshia tridentata</i>	59-84	—
	black sagebrush	ARNO4	<i>Artemisia nova</i>	34-50	—
6	Secondary Shrubs			9-17	
	yellow rabbitbrush	CHVI8	<i>Chrysothamnus viscidiflorus</i>	2-3	—
	Stansbury cliffrose	PUST	<i>Purshia stansburiana</i>	2-3	—
Tree					
7	Evergreen			2-7	
	Utah juniper	JUOS	<i>Juniperus osteosperma</i>	1-3	—
	singleleaf pinyon	PIMO	<i>Pinus monophylla</i>	1-3	—

Table 6. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 7. Community 1.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 8. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 9. Community 2.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 10. Community 2.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 11. Community 3.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 12. Community 3.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Animal community

Livestock/Wildlife Grazing Interpretations: Black sagebrush palatability has been rated as moderate to high depending on the ungulate and the season of use (Horton 1989, Wambolt 1996). The palatability of black sagebrush increases the potential negative impacts on remaining black sagebrush plants from grazing or browsing pressure following fire (Wambolt 1996). Pronghorn utilize black sagebrush heavily (Beale and Smith 1970). On the Desert Experiment Range, black sagebrush was found to comprise 68% of pronghorn diet even though it was only the third most common plant. Fawns were found to prefer black sagebrush utilizing it more than all other forage species combined (Beale and Smith 1970). Domestic livestock will also utilize black sagebrush. The domestic sheep industry that emerged in the Great Basin in the early 1900s was largely based on wintering domestic sheep in black sagebrush communities (Mozingo 1987). Domestic sheep will browse black sagebrush during all seasons of the year depending on the availability of other forage species,

with greater amounts being consumed in fall and winter. Black sagebrush is generally less palatable to cattle than to domestic sheep and wild ungulates (McArthur et al. 1979); however, cattle use of black sagebrush has also been shown to be greatest in fall and winter (Schultz and McAdoo 2002), with only trace amounts being consumed in summer (Van Vuren 1984). Dormant season use of black sagebrush can reduce sagebrush density and increase the density of bunchgrasses such as Indian ricegrass. Inappropriate grazing management during the growing season will cause a decline in understory plants such as needleandthread and Indian ricegrass. Growing season grazing by cattle may initially cause a decrease in the bunchgrass component and give a competitive advantage to shrub species including black sagebrush (Eckert et al. 1972). Specifically, needleandthread grass is most commonly found on warm/dry soils (Miller et al. 2013) and is not grazing tolerant and will be one of the first grasses to decrease under heavy grazing pressure (Smoliak et al. 1972, Tueller and Blackburn 1974). Heavy grazing is likely to reduce basal area of these plants (Smoliak et al. 1972). With the reduction in competition from deep rooted perennial bunchgrasses, the rhizomatous galleta grass and short-statured Sandberg bluegrass will likely increase (Jameson 1962, Smoliak et al. 1972) Indian ricegrass is a deep-rooted, cool season perennial bunchgrass that is adapted primarily to coarse textured soils. Indian ricegrass is a preferred forage species for livestock and wildlife (Cook 1962, Booth et al. 2006). This species is often heavily utilized in winter because it cures well (Booth et al. 2006). It is also readily utilized in early spring, being a source of green feed before most other perennial grasses have produced new growth (Quinones 1981). Booth et al. (2006) note that the plant does well when utilized in winter and spring. Cook and Child (1971), however, found that repeated heavy grazing reduced crown cover, which may reduce seed production, density, and basal area of these plants. Additionally, heavy early spring grazing reduces plant vigor and stand density (Stubbendieck et al. 1985). In eastern Idaho, productivity of Indian ricegrass was at least 10 times greater in undisturbed plots than in heavily grazed ones (Pearson 1976). Cook and Child (1971) found significant reduction in plant cover after seven years of rest from heavy (90%) and moderate (60%) spring use. The seed crop may be reduced where grazing is heavy (Bich et al. 1995). Tolerance to grazing increases after May, thus spring deferment may be necessary for stand enhancement (Pearson 1964, Cook and Child 1971); however, utilization of less than 60% is recommended. In summary, adaptive management is required to manage this bunchgrass well. Reduced bunchgrass vigor or density provides an opportunity for galleta and/or Sandberg bluegrass expansion and/or cheatgrass and other invasive species such as halogeton to occupy interspaces. Increased cheatgrass cover leads to increased fire frequency and potentially an annual plant community. Galleta and/or Sandberg bluegrass increases under grazing pressure (Jameson 1962, Tisdale and Hironaka 1981) and is capable of co-existing with cheatgrass. Excessive sheep grazing favors galleta or Sandberg bluegrass; however, where cattle are the dominant grazers, cheatgrass often dominates (Daubenmire 1970). Thus, depending on the season of use, the type of grazing animal, and site conditions, either galleta or Sandberg bluegrass or cheatgrass may become the dominant understory with inappropriate grazing management.

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 camping and hiking and has potential for upland and big game hunting.

Other products

Antelope bitterbrush has been used extensively in land reclamation. Antelope bitterbrush enhances succession by retaining soil and depositing organic material and in some habitats and with some ecotypes, by fixing nitrogen. Indian ricegrass was traditionally eaten by some Native Americans. The Paiutes used the seed as a reserve food source.

Other information

Black sagebrush is an excellent species to establish on sites where management objectives include restoration or improvement of domestic sheep, pronghorn, or mule deer winter range. Bottlebrush squirreltail is tolerant of disturbance and is a suitable species for revegetation.

Type locality

Location 1: Lincoln County, NV	
Township/Range/Section	T4N R70E S32
UTM zone	N
UTM northing	749177

UTM easting	4227276
Latitude	38° 9'32"
Longitude	114° 9'21"
General legal description	Approximately 1 mile north of White Rock seeding well, White Rock Wash, Lincoln County, Nevada.

Other references

Akinsoji, A. 1988. Postfire vegetation dynamics in a sagebrush steppe in southeastern Idaho, USA. *Vegetatio* 78:151-155.

Bates, J.D., T. Svejcar, R.F. Miller and R.A. Angell. 2006. The effects of precipitation timing on sagebrush steppe vegetation. *Journal of Arid Environments* 64 (2006): 670-697.

Beale, D.M. and A.D. Smith. 1970. Forage use, water consumption, and productivity of pronghorn antelope in western Utah. *Journal of Wildlife Management* 34(3):570-582.

Beetle, A.A. 1960. A study of sagebrush: The section *Tridentatae* of *Artemisia*. Bulletin 368. Laramie, WY: University of Wyoming, Agricultural Experiment Station. 83 p.

Bentz, B., D. Alston, and T. Evans. 2008. Great Basin Insect Outbreaks. In: Chambers, Jeanne C.; Devoe, Nora; Evenden, Angela, eds. Collaborative management and research in the Great Basin - examining the issues and developing a framework for action. Gen. Tech. Rep. RMRS-GTR-204. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 45-48.

Bich, B.S., J.L. Butler, and C.A. Schmidt. 1995. Effects of differential livestock use of key plant species and rodent populations within selected *Oryzopsis hymenoides*/*Hilaria jamesii* communities in Glen Canyon National Recreation Area. *The Southwestern Naturalist* 40(3):281-287.

Booth, D. T., C. G. Howard, and C. E. Mowry. 2006. 'Nezpar' Indian ricegrass: description, justification for release, and recommendations for use. *Rangelands Archives* 2:53-54.

Boltz, M. 1994. Factors influencing postfire sagebrush regeneration in south-central Idaho. In: Monsen, S.B. and S.G. Kitchen (compilers). *Proceedings--ecology and management of annual rangelands; 1992 May 18-22; Boise, ID*. Gen. Tech. Rep. INT-GTR-313. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: Pp. 281-290.

Bradley, A., Noste, N. and Fischer, W. 1992. Fire ecology of forests and woodlands in Utah. USDA Forest Service, Intermountain Research Station, General Technical Report INT-287, 92 pp.

Bunting, S. 1994. Effects of Fire on Juniper woodland ecosystems in the great basin. In *Proceedings--Ecology and Management of Annual Rangelands*. USDA: FS Intermountain Research Station.

Caudle, D., J. DiBenedetto, M. Karl, H. Sanchez, and C. Talbot. 2013. Interagency ecological site handbook for rangelands. Available at: <http://jornada.nmsu.edu/sites/jornada.nmsu.edu/files/InteragencyEcolSiteHandbook.pdf>. Accessed 4 October 2013.

Comstock, J and J. Ehleringer. 1992. Plant adaptation in the Great Basin and Colorado plateau. *Western North American Naturalist* 52(3):195-215.

Cook, C. W. 1962. An Evaluation of Some Common Factors Affecting Utilization of Desert Range Species. *Journal of Range Management* 15:333-338.

Cook, C.W. and R.D. Child. 1971. Recovery of desert plants in various states of vigor. *Journal of Range Management* 24(5):339-343.

Daubenmire, R.F. 1970. Steppe vegetation of Washington. Technical Bulletin 62. Pullman, WA: Washington State University, College of Agriculture, Washington Agricultural Experiment Station. 131 p.

- Daubenmire, R.F. 1975. Plant succession on abandoned fields, and fire influences, in a steppe area in southeastern Washington. *Northwest Science* 49(1):36-48.
- Dobrowolski, J.P., Caldwell, M.M. and Richards, J.H. 1990. Basin hydrology and plant root systems. In: *Plant Biology of the Basin and Range*. Springer-Verlag Pub., New York, NY.
- Eckert, R.E., Jr., A.D. Bruner and G.J. Klomp. 1972. Response of understory species following herbicidal control of low sagebrush. *Journal of Range Management* 25:280-285.
- Eckert, R.E., Jr. and J.S. Spencer. 1987. Growth and reproduction of grasses heavily grazed under rest-rotation management. *Journal of Range Management* 40(2):156-159.
- Everett, R. L. and K. Ward. 1984. Early plant succession on pinyon-juniper controlled burns. *Northwest Science* 58:57-68. *Fire Effects Information System* (Online; <http://www.fs.fed.us/database/feis/plants/>).
- Horton, H. 1989. Interagency forage and conservation planting guide for Utah. Extension Circular 433. Logan, UT: Utah State University, Cooperative Extension Service. 67 p.
- 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.
- Jameson, Donald A. 1962. Effects of burning on a galleta-black grama range invaded by juniper. *Ecology*. 43(4): 760-763.
- Jensen, M. E. 1990. Interpretation of Environmental Gradients Which Influence Sagebrush Community Distribution in Northeastern Nevada. *Journal of Range Management* 43:161-167.
- Kitchen, S.G. and E.D. McArthur. 2007. Big and black sagebrush landscapes. In: Hood, S.M. and M. Miller (Eds.). *Fire ecology and management of the major ecosystems of southern Utah*. Gen. Tech. Rep. RMRS-GTR-202. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 73-95.
- McArthur, E.D., A.C. Blauer, A.P. Plummer, and R. Stevens. 1979. Characteristics and hybridization of important Intermountain shrubs. III. Sunflower family. Res. Pap. INT-220. Ogden, UT. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 82 p.
- Meyer, S.E. 2008. *Artemisia L.--sagebrush*. In: Bonner, F.T. and R.P. Karrfalt (Eds.). *The woody plant seed manual*. Agriculture Handbook 727. Washington, DC: U.S. Department of Agriculture, Forest Service: 274-280.
- Miller, R. F. and R. J. Tausch. 2000. The role of fire in pinyon and juniper woodlands: a descriptive analysis. Pages 15-30 in *Proceedings of the invasive species workshop: the role of fire in the control and spread of invasive species*. Fire conference.
- Miller, R. F., J. C. Chambers, D. A. Pyke, F. B. Pierson, and C. J. Williams. 2013. A review of fire effects on vegetation and soils in the Great Basin Region: response and ecological site characteristics.
- Mozingo, H.N. 1987. *Shrubs of the Great Basin: A natural history*. Reno, NV: University of Nevada Press. 342 p.
- 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/>.
- Noy-Meir, I. 1973. Desert Ecosystems: Environment and Producers. *Annual Review of Ecology and Systematics*. Vol. 4:25-51.
- Pearson, L. 1964. Effect of harvest date on recovery of range grasses and shrubs. *Agronomy Journal* 56:80-82.
- Pearson, L.C. 1976. Primary production in grazed and ungrazed desert communities of eastern Idaho. *Ecology* 46(3):278-285.
- Quinones, F.A. 1981. Indian ricegrass evaluation and breeding. Bulletin 681. Las Cruces, NM: New Mexico State University, Agricultural Experiment Station. 19 p.
- Schultz, B. and K. McAdoo. 2002. Common sagebrush in Nevada. Special Publication SP-02-02. Reno, NV. University of Nevada, Cooperative Extension. 9 p.
- Smoliak, S., J. F. Dormaar, and A. Johnston. 1972. Long-Term Grazing Effects on Stipa-Bouteloua Prairie Soils. *Journal of Range Management* 25:246-250.
- Stevens, R., K.R. Jorgensen, and J.N. Davis. 1981. Viability of seed from thirty-two shrub and forb species through fifteen years of

warehouse storage. The Great Basin Naturalist 41(3):274-277.

Stubbendieck, J., J.T. Nichols, and K.K. Roberts. 1985. Nebraska range and pasture grasses (including grass-like plants). E.C. 85-170. Lincoln, NE: University of Nebraska, Department of Agriculture, Cooperative Extension Service. 75 p.

Tausch, R. J. and N. E. West. 1988. Differential establishment of pinyon and juniper following fire. American Midland Naturalist:174-184.

Tausch, R. J. 1999. Historic pinyon and juniper woodland development. Proceedings: ecology and management of pinyon-juniper communities within the Interior West. Ogden, UT, USA: US Department of Agriculture, Forest Service, Rocky Mountain Research Station, RMRS-P-9:12-19.

Tisdale, E.W. and M. Hironaka. 1981. The sagebrush-grass region: a review of the ecological literature. Bull. 33. Moscow, ID: University of Idaho, Forest, Wildlife and Range Experiment Station. 31 p.

Tueller, P. T. and W. H. Blackburn. 1974. Condition and Trend of the Big Sagebrush/Needleandthread Habitat Type in Nevada. Journal of Range Management 27:36-40.

USDA-NRCS Plants Database (Online; <http://www.plants.usda.gov>).

Van Vuren, D. 1984. Summer diets of bison and cattle in southern Utah. Journal of Range Management 37(3): 260-261.

Wambolt, C.L. 1996. Mule deer and elk foraging preference for 4 sagebrush taxa. Journal of Range Management 49(6):499-503.

West, N.E. 1994. Effects of fire on salt-desert shrub rangelands. In: Ecology and Management of Annual Rangelands. Gen. Tech. Rep. INT-313. Boise, ID: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 416 p.

Winward, A.H. 2001. Sagebrush taxonomy and ecology workshop--October 5-6, 1999. In: Vegetation, wildlife and fish ecology and rare species management--Wasatch-Cache National Forest. Logan, UT: U.S. Department of Agriculture, Forest Service, Intermountain Region, Uinta- Wasatch-Cache National Forest.

Wright, H.A., L.F. Neuenschwander, and C.M. Britton. 1979. The role and use of fire in sagebrush-grass and pinyon-juniper plant communities: A state-of-the-art review. Gen. Tech. Rep. INT-58. Ogden, UT. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 48 p.

Wright, H. A., and J. O. Klemmedson. 1965. Effect of Fire on Bunchgrasses of the Sagebrush-Grass Region in Southern Idaho. Ecology 46:680-688.

Wright, H. A. 1985. Effects of fire on grasses and forbs in sagebrush-grass communities. Pages 12-21 in 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: Monsen, S.B. and N. Shaw (Eds). Managing Intermountain rangelands—improvement of range and wildlife habitats: Proceedings of symposia; 1981 September 15-17; Twin Falls, ID; 1982 June 22-24; Elko, NV. Gen. Tech. Rep. INT-157. Ogden, UT. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. Pp. 18-31.

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Approval

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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)	PATTI NOVAK-ECHENIQUE
Contact for lead author	State Rangeland Management Specialist
Date	05/15/2013
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

- 1. Number and extent of rills:** Rills are rare to few. Occurrence is limited to steeper slopes in areas subjected to summer convection storms or rapid spring snowmelt.

- 2. Presence of water flow patterns:** Water flow patterns are rare to few and limited to steeper slopes in areas subjected to summer convection storms or rapid snowmelt.

- 3. Number and height of erosional pedestals or terracettes:** Pedestals are none to rare.

- 4. Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare Ground to 50-60%.

- 5. Number of gullies and erosion associated with gullies:** Gullies are none to rare.

- 6. Extent of wind scoured, blowouts and/or depositional areas:** None

- 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 catastrophic events.

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 2 to 5 on most soil textures found on this site. (This will be field tested.)

9. Soil surface structure and SOM content (include type of structure and A-horizon color and thickness): Surface structure is typically thin to medium platy. Soil surface colors are light grays and soils are typified by an ochric epipedon. Organic matter of the surface 2 to 3 inches is typically <1.0 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., Indian ricegrass]) slow runoff and increase infiltration. Shrub canopy and associated litter 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. Platy or subangular blocky 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: Tall shrubs (antelope bitterbrush and black sagebrush) > deep-rooted, cool season, perennial bunchgrasses

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

Other: evergreen trees

Additional:

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

14. Average percent litter cover (%) and depth (in): Between plant interspaces 5-10% and depth <¼ in.

15. Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production): For normal or average growing season (thru June) ± 150 lbs/ac; Favorable years ±250 lbs/ac and unfavorable years 100 lbs/ac

16. Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future

establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site: Potential invaders include cheatgrass, halogeton, Russian thistle, and annual mustards.

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 in extreme or extended drought periods.
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