Ecological site R024XY031NV
SHALLOW CALCAREOUS LOAM 10-14 P.Z.

Last updated: 3/07/2025
Accessed: 06/22/2026

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): 024X–Humboldt Basin and Range Area

Major land resource area (MLRA) 24, the Humboldt Area, covers an area of approximately 8,115,200 acres (12,680 sq. mi.). It is found in the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. Elevations range from 3,950 to 5,900 feet (1,205 to 1,800 meters) in most of the area, some mountain peaks are more than 8,850 feet (2,700 meters). A series of widely spaced north-south trending mountain ranges are separated by broad valleys filled with alluvium washed in from adjacent mountain ranges. Most valleys are drained by tributaries to the Humboldt River. However, playas occur in lower elevation valleys with closed drainage systems. Isolated ranges are dissected, uplifted fault-block mountains. Geology is comprised of Mesozoic and Paleozoic volcanic rock and marine and continental sediments. Occasional young andesite and basalt flows (6 to 17 million years old) occur at the margins of the mountains. Dominant soil orders include Aridisols, Entisols, Inceptisols and Mollisols. Soils of the area are generally characterized by a mesic soil temperature regime, an aridic soil moisture regime and mixed geology. They are generally well drained, loamy and very deep. Annual precipitation ranges from 6 to 12 inches (15 to 30 cm) for most of the area, but can be as much as 40 inches (101 cm) in the mountain ranges. The majority of annual precipitation occurs as snow in the winter. Rainfall occurs as high-intensity, convective thunderstorms in the spring and fall.

Ecological site concept

This ecological site is on summits and side slopes of hills and mountains on all exposures. Soils are shallow to moderately deep, well drained and formed in residuum derived from chert, argillite and other mixed parent material. The soil profile is characterized by an ochric epipedon and greater than 35 percent rock fragments by volume. Important abiotic factors contributing to the presence of this site include low available water holding capacity and the presence of secondary carbonates in the soil profile.

Associated sites

R024XY021NV	**Loamy Slope 12-14 P.Z.** This site is on lava plateaus and tablelands. Soils are deep, well drained and formed in residuum/colluvium. They are characterized by an ochric epipedon and an argillic horizon. The subsoil is a strongly contrasting very gravelly or cobbly clay loam. An abrupt boundary occurs between the surface layer and subsoil.
R024XY030NV	**SHALLOW CALCAREOUS LOAM 8-10 P.Z.** This ecological site is on fan remnants. The soils are shallow to a duripan, well drained and formed in loess with a component of volcanic ash and alluvium derived from mixed parent material. The soil profile is characterized by an ochric epipedon, effervescence throughout the profile and less than 35 percent rock fragments by volume.

Similar sites

R024XY042NV	**STEEP GRAVELLY LOAM 14+ P.Z.** Idaho fescue (FEID) dominant grass; more productive site.
R024XY030NV	**SHALLOW CALCAREOUS LOAM 8-10 P.Z.** Thurber's needlegrass (ACTH7)- Indian ricegrass (ACHY) codominant grasses; less productive site.
R024XY016NV	**Mountain Ridge** Idaho fescue (FEID) dominant grass; less productive site.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Artemisia nova*
Herbaceous	(1) *Pseudoroegneria spicata* (2) *Achnatherum thurberianum*

Physiographic features

This site is on summits and side slopes of mountains on all aspects. Slopes range from 2 to 75 percent, but slope gradients of 15 to 50 percent are typical. Elevations range from 4900 to 8000 feet (1493 to 2438m).

Table 2. Representative physiographic features

Landforms	(1) Mountain (2) Hillside or mountainside
Runoff class	High to very high
Flooding frequency	None
Elevation	1,490 – 2,440 m
Slope	0 – 80 %
Water table depth	180 cm
Aspect	W, NW, N, NE, E, SE, S, SW

Climatic features

The climate associated with this site is semiarid and characterized by cool, moist winters and warm, dry summers. Average annual precipitation is 10 to 14 inches (25 to 36cm). Mean annual air temperature is 41 to 45 degrees F. The average growing season is about 80 to 100 days.

Table 3 Representative climatic features

Frost-free period (characteristic range)	80 days
Freeze-free period (characteristic range)	100 days
Precipitation total (characteristic range)	200 mm
Frost-free period (actual range)	80 days
Freeze-free period (actual range)	100 days
Precipitation total (actual range)	200 mm
Frost-free period (average)	80 days
Freeze-free period (average)	100 days
Precipitation total (average)	200 mm

- (1) WINNEMUCCA MUNI AP [USW00024128], Winnemucca, NV

Influencing water features

There are no influencing water features associated with this site.

Soil features

The soils associated with this site are shallow to a duripan or bedrock, well drained and formed in residuum and colluvium from mixed parent material. The soil profile is characterized by an ochric epipedon, 30 to over 50 percent gravel and cobbles by volume and the presence of secondary carbonate accumulation. The reaction ranges from moderately or strongly alkaline. The available water capacity is very low to low. The soil series associated with this site include: Anowell, Cleavmor, Coff, Elhina, Fenelon, Pamison, Quopant, Tecomar, Trinidad, and Wiskan.

Table 4. Representative soil features

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

Surface texture	(1) Extremely gravelly silt loam (2) Extremely stony silt loam (3) Extremely cobbly silt loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Slow to moderate
Soil depth	10 – 50 cm
Surface fragment cover <=3"	20 – 60 %
Surface fragment cover >3"	0 – 40 %
Available water capacity (0-101.6cm)	2.29 – 13.97 cm
Calcium carbonate equivalent (0-101.6cm)	0 – 80 %
Electrical conductivity (0-101.6cm)	Not specified
Sodium adsorption ratio (0-101.6cm)	0 – 10
Soil reaction (1:1 water) (0-101.6cm)	6.6 – 10
Subsurface fragment volume <=3" (Depth not specified)	10 – 60 %

Subsurface fragment volume >3" (Depth not specified)	0 – 50 %

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

This 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 156 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 71 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 with 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 (Artemisia tridentata spp.) (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 dominant on this site include bluebunch wheatgrass, Thurber's needlegrass and Indian ricegrass. 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.

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 (Bromus tectorum) has been linked to disturbances (fire, abusive grazing) that have resulted in fluctuations in resources (Chambers et al. 2007). The introduction of annual weedy species, like cheatgrass, may cause an increase in fire frequency and eventually lead to an annual state. Conversely, as fire frequency decreases, sagebrush will increase and with inappropriate grazing management the perennial bunchgrasses and forbs may be reduced.

This 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. Four possible alternative stable states have been identified for this site.

Fire Ecology:

Fire is not a major ecological component of these community types (Winward 2001), and would be infrequent. Fire return intervals have been estimated at 100 to 200 years (Kitchen and McArthur 2007); however, fires were probably patchy 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). Since black sagebrush has a transient soil seed bank, 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 shadscale (Atriplex confertifolia), spiny hopsage (Grayia spinosa) and rabbitbrush (Chrysothamnus viscidiflorus or Ericameria nauseosa) may become the dominant shrub species following fire, often with an understory of Sandberg bluegrass and/or cheatgrass and other weedy species. Sandberg bluegrass has been found to increase following fire likely due to its low stature and productivity (Daubenmire 1975).

Thurber's needlegrass reproduces from seed and tillers; however, following fire the reestablishment of the needlegrass component is largely seed dependent (Hironaka et al. 1983). Reestablishment on burned sites has been found to be relatively slow due to low

germination and seedling vigor. In a controlled environment study, Thurber's needlegrass was found to have a maximum germination rate of 25% under ideal conditions (Martens et al. 1994). Fire-caused mortality of Thurber's needlegrass varies by both plant size and season (Young et al. 1976). Wright and others (1979) concluded that Thurber's needlegrass is probably the least fire-resistant needlegrass, largely due to its densely tufted stems. Aboveground vegetation is often consumed by fire and burning has been found to decrease Thurber's needlegrass vegetative and reproductive vigor (Uresk et al. 1976). The seasonal response to burning is also important in determining the extent of damage by fire with growing season burning causing greater mortality (50 to 70 percent) than dormant season burning (Young et al. 1976). Regeneration of Thurber's needlegrass is often dependent on competition from other species. Cheatgrass has been found to be a highly successful competitor with seedlings of this needlegrass and may preclude reestablishment (Evans and Young 1978). Repeated frequent fire in the black sagebrush – Thurber's needlegrass community will eliminate both species from the site and facilitate the establishment of an annual grass and weed community with varying amounts of Sandberg bluegrass, shadscale, spiny hopsage and rabbitbrush.

Indian ricegrass commonly found on these sites, 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.

Utah juniper (Juniperus osteosperma) and singleleaf pinyon (Pinus monophylla) can invade these sites from nearby seed sources. These trees are 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.

With an extended fire return interval, eventually, singleleaf pinyon and Utah juniper will dominate the site and black sagebrush will be severely reduced along with the herbaceous understory. A few perennial bunchgrasses and mat-forming forbs may remain underneath trees. The potential for soil erosion increases as the woodland matures and the understory plant community cover declines.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

Figure 7. Legend 2018

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**			179-381	
	bluebunch wheatgrass	PSSPS	*Pseudoroegneria spicata ssp. spicata*	112-196	–
	Thurber's needlegrass	ACTH7	*Achnatherum thurberianum*	56-140	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	11-45	–
2	**Secondary Perennial Grasses**			11-84	
	Webber needlegrass	ACWE3	*Achnatherum webberi*	3-17	–
	squirreltail	ELEL5	*Elymus elymoides*	3-17	–
	Idaho fescue	FEID	*Festuca idahoensis*	3-17	–
	needle and thread	HECO26	*Hesperostipa comata*	3-17	–
	basin wildrye	LECI4	*Leymus cinereus*	3-17	–
	bluegrass	POA	*Poa*	3-17	–
Forb					
3	**Perennial Forbs**			28-84	
	aster	ASTER	*Aster*	3-28	–
	milkvetch	ASTRA	*Astragalus*	3-28	–

	tapertip hawksbeard	CRAC2	*Crepis acuminata*	3-28	–
	buckwheat	ERIOG	*Eriogonum*	3-28	–
	lupine	LUPIN	*Lupinus*	3-28	–
	phlox	PHLOX	*Phlox*	3-28	–
Shrub/Vine					
4	**Primary Shrubs**			140-196	
	black sagebrush	ARNO4	*Artemisia nova*	140-196	–
5	**Secondary Shrubs**			11-56	
	Utah serviceberry	AMUT	*Amelanchier utahensis*	6-17	–
	yellow rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	6-17	–
	spiny hopsage	GRSP	*Grayia spinosa*	6-17	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	6-17	–
	snowberry	SYMPH	*Symphoricarpos*	6-17	–

Table 6. Community 1.2 plant community composition

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

Table 7. Community 1.3 plant community composition

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

Table 8. Community 2.1 plant community composition

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

Table 9. Community 2.2 plant community composition

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

Table 10. Community 2.3 plant community composition

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

Table 11. Community 3.1 plant community composition

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

Table 12. Community 3.2 plant community composition

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

Table 13. Community 4.1 plant community composition

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

Table 14. Community 4.2 plant community composition

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

Table 15. Community 5.1 plant community composition

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

Table 16. Community 5.2 plant community composition

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

Animal community

Livestock Interpretations: This site has limited value for livestock grazing, due to steep slopes. Grazing management should be keyed to perennial grass and palatable shrub production. Bluebunch wheatgrass is considered one of the most important forage grass species on western rangelands for livestock. Although bluebunch wheatgrass can be a crucial source of forage, it is not necessarily the most highly preferred species. Thurber's needlegrass species begin growth early in the year and remain green throughout a relatively long growing season. This pattern of development enables animals to use Thurber's needlegrass when many other grasses are unavailable. Cattle prefer Thurber's needlegrass in early spring before fruits have developed as it becomes less palatable when mature. Thurber's needlegrasses are grazed in the fall only if the fruits are softened by rain. 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. In winter, at lower elevations, black sagebrush is heavily utilized by domestic sheep. 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 Intwerpretations: 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. Thurber needlegrass is valuable forage for wildlife. Indian ricegrass is eaten by pronghorn in moderate amounts whenever available. 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. In Nevada, Indian ricegrass may even dominate jackrabbit diets during the spring through early summer months. 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. Black sagebrush is a significant browse species within the Intermountain region. It is especially important on low elevation winter ranges in the southern Great Basin, where extended snow free periods allow animal's access to plants throughout most of the winter. In these areas it is heavily utilized by pronghorn and mule deer. Sagebrush-grassland communities provide critical sage-grouse breeding and nesting habitats. Sagebrush is a crucial component of their diet year-round, and sage-grouse select sagebrush almost exclusively for cover.

Hydrological functions

Runoff is medium to very high. Permeability is slow to moderate. Hydrologic soil groups are B, C, and D. Rills are none to rare. Rock fragments armor the surface. Water flow patterns are few and can be expected in areas subjected to summer convection storms or rapid snowmelt. Pedestals are none to rare. Occurrence is usually limited to areas of water flow patterns. Frost heaving of shallow rooted plants should not be considered a "normal" condition. Perennial herbaceous plants (especially deep-rooted bunchgrasses [i.e., bluebunch wheatgrass & Thurber's needlegrass]) slow runoff and increase infiltration. Shrub canopy and associated litter break raindrop impact.

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

Indian ricegrass was traditionally eaten by some Native Americans. The Paiutes used 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.

Inventory data references

NASIS soil component data.

Other references

Barney, M. A. and N. C. Frischknecht. 1974. Vegetation Changes following Fire in the Pinyon-Juniper Type of West-Central Utah. Journal of Range Management 27:91-96.

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 64:670-697.

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: J. Chambers, N. Devoe, A. Evenden [eds]. Collaborative Management and Research in the Great Basin -- Examining the issues and developing a framework for action Gen. Tech. Rep. RMRS-

GTR-204. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO. p. 45-48
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: Pgs 281-290.
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.
Bradley, A.F., N.V. Noste, and W.C. Fischer. 1992. Fire ecology of forests and woodlands in Utah. Gen. Tech. Rep. INT-287. Ogden, UT. U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 128 p.
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. P. and J. R. Ehleringer. 1992. Plant adaptation in the Great Basin and Colorado plateau. Western North American Naturalist 52:195-215.
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.
Cook, C. W. 1962. An Evaluation of Some Common Factors Affecting Utilization of Desert Range Species. Journal of Range Management 15:333-338.
Chambers, J., B. Bradley, C. Brown, C. D'Antonio, M. Germino, J. Grace, S. Hardegree, R. Miller, and D. Pyke. 2013. Resilience to Stress and Disturbance, and Resistance to Bromus tectorum L. Invasion in Cold Desert Shrublands of Western North America. Ecosystems 17:1-16.
Chambers, J. C., B. A. Roundy, R. R. Blank, S. E. Meyer, and A. Whittaker. 2007. What makes great basin sagebrush ecosystems invasible by Bromus tectorum? Ecological Monographs 77:117-145.
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., M. M. Caldwell, and J. H. Richards. 1990. Basin hydrology and plant root systems. In: C. B. Osmand, L. F. Pitelka, G. M. Hildy [eds]. Plant biology of the Basin and range. Ecological Studies. 80: 243-292
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.
Evans, R.A. and J.A. Young. 1978. Effectiveness of rehabilitation practices following wildfire in a degraded big sagebrush-downy brome community. Journal of Range Management 31(3):185-188.
Furniss, M.M. and W.F. Barr. 1975. Insects affecting important native shrubs of the northwestern United States. US Intermountain Forest and Range Experiment Station. USDA Forest Service General Technical Report INT INT-19.
Ganskopp, D. 1988. Defoliation of Thurber needlegrass: herbage and root responses. Journal of Range Management 41(6):472-476.
Hironaka, M., M.A. Fosberg, and A.H. Winward. 1983. Sagebrush-grass habitat types of southern Idaho. Bulletin Number 35. Moscow, ID: University of Idaho, Forest, Wildlife and Range Experiment Station. 44 p.
Horton, H. 1989. Interagency forage and conservation planting guide for Utah. Extension Circular 433. Logan, UT: Utah State University, Cooperative Extension Service. 67 p.
Jensen, M.E. 1990 Interpretation of environmental gradients which influence sagebrush community distribution in northeastern Nevada. J. of Range Management 43:161-166.
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. Pgs 73-95.
Martens, E., D. Palmquist, and J.A. Young. 1994. Temperature profiles for germination of cheatgrass versus native perennial bunchgrasses. 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: Pgs 238-243.
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: Pgs 274-280.
Miller, R. F. and R. J. Tausch. 2000. The role of fire in pinyon and juniper woodlands: a descriptive analysis. In Proceedings of the invasive species workshop: the role of fire in the control and spread of invasive species. Fire conference. P. 15-30
Miller, R.F., F.A. Branson, I.S. McQueen, and C.T. Snyder. 1982. Water relations in soils as related to plant communities in Ruby Valley, Nevada. Journal of Range Management 35(4): 462-468.
Mozingo, H.N. 1987. Shrubs of the Great Basin: A natural history. Reno, NV: University of Nevada Press. 342 p.
Noy-Meir, I. 1973. Desert ecosystems: environment and producers. Annual Review of Ecology and Systematics 4:25-51.
Pearson, L.C. 1965. Primary production in grazed and ungrazed desert communities of eastern Idaho. Ecology 46(3):278-285.
Richards, J. H. and M. M. Caldwell. 1987. Hydraulic lift: Substantial nocturnal water transport between soil layers by Artemisia tridentata roots. Oecologia 73:486-489.
Sampson, A.W. and B.S. Jespersen. 1963. California range brushlands and browse plants. Berkeley, CA: University of California, Division of Agricultural Sciences; California Agricultural Experiment Station, Extension Service. 162 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.
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. L. 1985. Nebraska Range and Pasture Grasses: (including Grass-like Plants). University of Nebraska, Department of Agriculture, Cooperative Extension Service, Lincoln, NE.
Tausch, R. J. and N. E. West. 1988. Differential Establishment of Pinyon and Juniper Following Fire. American Midland Naturalist 119:174-184.
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.
Uresk, D.W., J.F. Cline, and W.H. Rickard. 1976. Impact of wildfire on three perennial grasses in south-central Washington. Journal of Range Management 29(4):309-310.
Van Vuren, D. 1984. Summer diets of bison and cattle in southern Utah. Journal of Range Management 37(3): 260-261.
West, N. E. 1994. Effects of fire on salt-desert shrub rangelands.in Proceedings--Ecology and Management of Annual Rangelands, General Technical Report INT-313. USDA Forest Service, Intermountain Research Station, Boise, ID.
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. 1985. Effects of fire on grasses and forbs in sagebrush-grass communities. In: K.E. Sanders [ed.] Rangeland Fire Effects; A Symposium: proceedings of a symposium sponsored by Bureau of Land Management and University of Idaho at Boise Idaho. Boise, ID, USDI-BLM. P. 12-21
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.
Wambolt, C.L. 1996. Mule deer and elk foraging preference for 4 sagebrush taxa. Journal of Range Management 49(6):499-503.
Young, J. A., R. A. Evans, and P. T. Tueller. 1976. Great Basin plant communities--pristine and grazed. In: Elston, Robert, ed. Holocene environmental change in the Great Basin. Res. Pap. No. 6. Reno, NV: University of Nevada, Nevada Archeological Society: 187-216.
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. Pgs 18-31.

Contributors

CP/GKB
T Stringham
P NovakEchenique

Approval

Kendra Moseley, 3/07/2025

Rangeland health reference sheet

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

Author(s)/participant(s)	Patti Novak-Echenique
Contact for lead author	State Rangeland Management Specialist
Date	03/18/2010
Approved by	

Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** **Rills are none to rare. A few may occur on steeper slopes after summer convection storms or rapid snowmelt. These would be short (<1m).**

2. **Presence of water flow patterns:** **Water flow patterns are none to rare, but can be expected in areas subjected to summer convection storms or rapid snowmelt. Water flow patterns are short (<2 m), meandering, and not connected.**

3. **Number and height of erosional pedestals or terracettes:** **Pedestals are none to rare. Occurrence is usually limited to areas of water flow patterns.**

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

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

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 large rainfall 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 4 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 typically thin to thick 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 to 2 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., bluebunch wheatgrass & Thurber needlegrass]) slow runoff and increase infiltration. Shrub canopy and associated litter break raindrop impact and allow for snow capture on the 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 or calcic 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 Plant Community: Deep-rooted, cool season, perennial bunchgrasses > low shrubs (black sagebrush)

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

    Other: microbiotic crusts

    Additional: With an extended fire return interval, singleleaf pinyon and Utah juniper may invade this site and eventually dominate. The shrub and herbaceous component will be greatly reduced.

---

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 (<15%) have dead centers.

---

14. **Average percent litter cover (%) and depth (in):** Within plant interspaces (15-25%) and depth of litter is <½ inch

---

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** For normal or average growing season (through mid-June) ± 500 lbs/ac; Spring moisture significantly affects total production. Favorable years ± 700 lbs/ac and unfavorable years ± 300 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, Russian thistle, annual mustards, and knapweeds.

---

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