

Ecological site R028AY091NV LOAMY FAN 10-14 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.

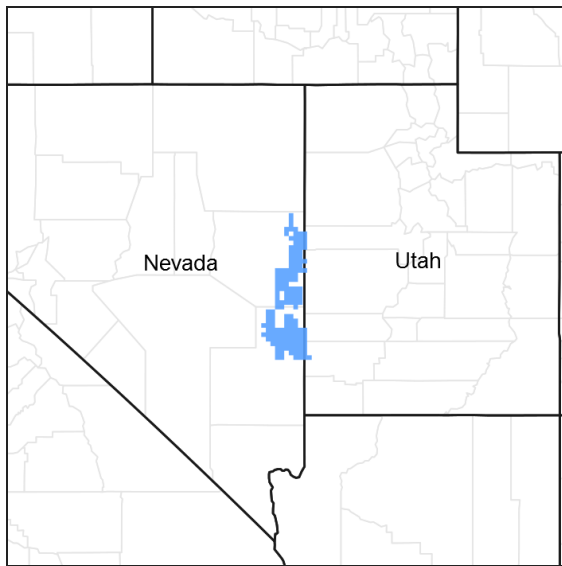


Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

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 inset fans of upper piedmont slopes and on stream terraces on all aspects. Slope gradients of 0 to 8 percent are typical. Elevations are 5400 to 7700 feet.

The climate associated with this site is semiarid, characterized by cold, moist winters and warm, dry summers. Average annual precipitation is 10 to about 14 inches. Mean annual air temperature is 45 to 50 degrees F. The average growing season is 100 to 120 days.

Soils associated with this site are generally very deep, well drained and have formed in mixed alluvium dominantly from volcanic rock sources. Surface textures are medium textured and are usually less than 10 inches thick. Available water capacity is moderate and permeability is very slow to moderately rapid. These soils receive additional moisture as run-in from higher landscapes.

The reference state is dominated by basin big sagebrush and basin wildrye. Thickspike wheatgrass and needleandthread are other common species associated with this site. Production ranges from 700 to 1300 pounds per acre.

Associated sites

R028AY015NV	LOAMY 8-10 P.Z.
R028AY043NV	SHALLOW CALCAREOUS LOAM 10-14 P.Z.
R028AY092NV	LOAMY 12-14 P.Z.
R028AY095NV	LOAMY 10-12 P.Z.

Similar sites

R028AY122NV	DEEP SODIC LOAM 8-10 P.Z. More productive site; SAVE4 important shrub
R028AY121NV	DEEP LOAMY 8-10 P.Z. More productive site
R028BY045NV	LOAMY FAN 8-12 P.Z. PLJA rare to absent
R028AY031NV	LOAMY FAN 8-10 P.Z. ACHY codominant grass; ARTRW dominant shrub
R028AY086NV	COARSE LOAMY FAN 10-12 P.Z. SAVE4 important shrub
R028AY055NV	LOAMY BOTTOM 14+ P.Z. Much more productive site; ARTRV dominant shrub
R028AY010NV	COARSE GRAVELLY LOAM 10-12 P.Z. PSSPS important grass
R028AY090NV	LOAMY BOTTOM 10-14 P.Z. Much more productive site

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) <i>Artemisia tridentata</i> subsp. <i>tridentata</i>
Herbaceous	(1) <i>Leymus cinereus</i> (2) <i>Elymus lanceolatus</i> subsp. <i>lanceolatus</i>

Physiographic features

This site occurs on inset fans of upper piedmont slopes and on stream terraces on all aspects. Slope gradients of 0 to 8 percent are typical. Elevations are 5400 to 7700 feet.

Table 2. Representative physiographic features

Landforms	(1) Inset fan (2) Stream terrace
Flooding duration	Very brief (4 to 48 hours) to brief (2 to 7 days)
Flooding frequency	Very rare to occasional
Ponding frequency	None
Elevation	1,646–2,347 m
Slope	0–8%
Aspect	Aspect is not a significant factor

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).

The climate associated with this site is semiarid, characterized by cold, moist winters and warm, dry summers. Average annual precipitation is 10 to about 14 inches. Mean annual air temperature is 45 to 50 degrees F. The average growing season is 100 to 120 days.

The Mean annual precipitation at the Great Basin Natinal Park Climate Station (263340) is 13.33 inches.

Monthly mean precipitation is:

January 1.05; February 1.18; March 1.37; April 1.21; May 1.24; June .87; July .97; August 1.18; September 1.08; October .96; December .96

Table 3. Representative climatic features

Frost-free period (average)	0 days
Freeze-free period (average)	110 days
Precipitation total (average)	305 mm

Influencing water features

These soils receive additional moisture as run-in from higher landscapes.

Soil features

Soils associated with this site are generally very deep, well drained and have formed in mixed alluvium dominantly from volcanic rock sources. Surface textures are medium textured and are usually less than 10 inches thick. Available water capacity is moderate and permeability is very slow to moderately rapid. These soils receive additional moisture as run-in from higher landscapes. The soil series associated with this site include: Fanu, Pagecreek, Ravendog, and Sevenmile.

The representative soil series is Ravendog, a Coarse-loamy, mixed, superactive, mesic Torrifluventic Haploxerolls. Diagnostic horizons include a mollic epipedon from the soil surface to 16 inches. Durinodes and identifiable secondary carbonates occur from 16 to 60 inches. Clay content in the particle control section averages 8 to 18 percent. Rock fragments range from 5 to 35 percent, mainly gravel. Reaction is slightly alkaline through strongly alkaline. Effervescence is slightly through violently effervescent. Lithology consists of fragments is mixed rocks.

Table 4. Representative soil features

Surface texture	(1) Loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Moderate to rapid
Soil depth	183–213 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	12.45–18.8 cm
Calcium carbonate equivalent (0-101.6cm)	1–5%
Electrical conductivity (0-101.6cm)	0 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	8.2–8.8
Subsurface fragment volume <=3" (Depth not specified)	5–35%
Subsurface fragment volume >3" (Depth not specified)	0%

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 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 moisture resource supporting the greatest amount of plant growth is usually the water stored in the soil profile during the winter. 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).

This ecological site is dominated by deep-rooted cool season, perennial bunchgrasses such as basin wildrye and long-lived shrubs (50+ years) such as basin big sagebrush. These shrubs have high root to shoot ratios. Root length of mature big 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). Differences in root depth distribution between grasses and shrubs result in resource partitioning in this system.

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 m but taper off more rapidly than shrubs. However, basin wildrye is weakly rhizomatous and has been found to root to depths of up to 2 meters and to exhibit greater lateral root spread than many other grass species (Abbott et al. 1991, Reynolds and Fraley 1989).

Basin wildrye is a large, cool-season perennial bunchgrass with an extensive deep coarse fibrous root system (Reynolds and Fraley 1989). Clumps may reach up to six feet in height (Ogle et al 2012a). Basin wildrye does not tolerate long periods of inundation; it prefers cycles of wet winters and dry summers and is most commonly found in deep soils with high water holding capacities or seasonally high water tables (Ogle et al 2012a, Perryman and Skinner 2007).

Seasonally high water tables have been found to be necessary for maintenance of site productivity and reestablishment of basin wildrye stands following disturbances such as fire, drought or excessive herbivory (Eckert et al. 1973). The sensitivity of basin wildrye seedling establishment to reduced soil water availability is increased as soil pH increases (Stuart et al. 1971). Lowering of the water table through extended drought, channel incision or water pumping will decrease basin wildrye production and establishment, while sagebrush, black greasewood, rabbitbrush, and invasive weeds increase. Farming and abandonment may facilitate the creation of surface vesicular crust, increased surface ponding, and decreased infiltration; which leads to dominance by sprouting shrubs and an annual understory.

This ecological site has moderate resilience to disturbance and resistance to invasion. A primary disturbance on this site is drought, fire, flooding, Aroga infestation (*Aroga websteri*), and channel incision or other disturbance leading to a lowered seasonal water table. This facilitates an increase in shrubs and a decrease in basin wildrye. The introduction of annual weedy species, like cheatgrass (*Bromus tectorum*), may cause an increase in fire frequency and eventually lead to an annual state or a state dominated by rabbitbrush. Other troublesome non-native weeds such as broadleaved pepperweed or tall whitetop (*Lepidium latifolium*), hoary cress or whitetop (*Cardaria draba*), scotch cottonthistle (*Onopordum acanthium*) or bull thistle (*Cirsium vulgare*) are potential invaders on this site. Four possible alternative stable states have been identified for this site.

Fire Ecology:

Natural fire return intervals are estimated to vary between less than 35 years up to 100 years in sagebrush ecosystems with basin wildrye (Paysen et al. 2000). Higher production sites would have experienced fire more frequently than lower production sites. Few if any fire history studies have been conducted on basin big sagebrush; however, Sapsis and Kauffman (1991) suggest that fire return intervals in basin big sagebrush are intermediate between mountain big sagebrush (15 to 25 years) and Wyoming big sagebrush (50 to 100 years). In many Great Basin plant communities, changes in fire frequency occurred along with fire suppression, livestock grazing, and OHV use. Fire severity is described as "variable" depending on weather, fuels, and topography and is typically stand replacing (Sapsis and Kauffman 1991). The introduction and expansion of cheatgrass has dramatically altered the fire regime (Balch et al. 2013), therefore altering restoration potential of big sagebrush/basin wildrye plant communities (Evans and Young 1978).

The effect of fire on bunchgrasses relates to culm density, culm-leaf morphology, and the size of the plant. The initial condition of bunchgrasses within the site along with seasonality and intensity of the fire all factor into the individual species response. For most forbs and grasses the growing points are located at or below the soil surface providing relative protection from disturbances which decrease above ground biomass, such as grazing or fire. Thus, fire mortality is more correlated to duration and intensity of heat which is related to culm density, culm-leaf morphology, size of plant and abundance of old growth (Wright 1971, Young 1983). Season and severity of the fire will influence plant response as will. post-fire soil moisture availability.

Basin wildrye is relatively resistant to fire, particularly dormant season fire, as plants sprout from surviving root crowns and rhizomes (Zschaechner 1985). Needle and thread is top-killed by fire but is likely to resprout if fire does not consume above ground stems (Akinsoji 1988, Bradley, Noste and Fischer 1992). In a study by Wright and Klemmedson (1965), season of burn rather than fire intensity seemed to be the crucial factor in mortality for needle and thread grass. Early spring season burning was seen to kill the plants while August burning had no effect. . Needle and thread is a fine-leaved grass and is considered sensitive to fire (Akinsoji 1988, Bradley et al. 1992, Miller et al. 2013). In a study by Wright and Klemmedson (1965), season of burn rather than fire intensity seemed to

be the crucial factor in mortality for needle and thread grass. Early spring season burning was seen to kill the plants while August burning had no effect. Thus, under wildfire scenarios needle and thread is often present in the post-burn community. Fire maintained the grass dominance of these ecosystems, therefore increases in the fire return interval favors increases in the shrub component of the plant community. The reduction of grasses potentially facilitates increases in bare ground and invasive weeds. Lack of fire combined with excessive herbivory converts these sites to sagebrush, black greasewood, and rabbitbrush dominance.

Basin big sagebrush is easily killed by fire and do not sprout after fire. Repeated fires may eliminate the onsite seed source; reinvasion into these areas may be extremely slow (Bunting et al. 1987). Basin big sagebrush reinvades a site primarily by off-site seed or seed from plants that survive in unburned patches. Approximately 90% of big sagebrush seed is dispersed within 30 feet (9 m) of the parent shrub (Goodrich et al. 1985) with maximum seed dispersal at approximately 108 feet (33 m) from the parent shrub (Shumar and Anderson 1986). Therefore regeneration of big sagebrush after stand replacing fires is difficult and dependent upon proximity of residual mature plants and favorable moisture conditions (Johnson and Payne 1968, Humphrey 1984). Reestablishment after fire may require 50 to 120 or more years (Baker 2006).

Depending on fire severity, rabbitbrush may increase after fire. Rubber rabbitbrush is top-killed by fire, but can resprout after fire and can also establish from seed (Young 1983).

State and transition model

MLRA 28A
Loamy Fan 10-14"
028AY091NV

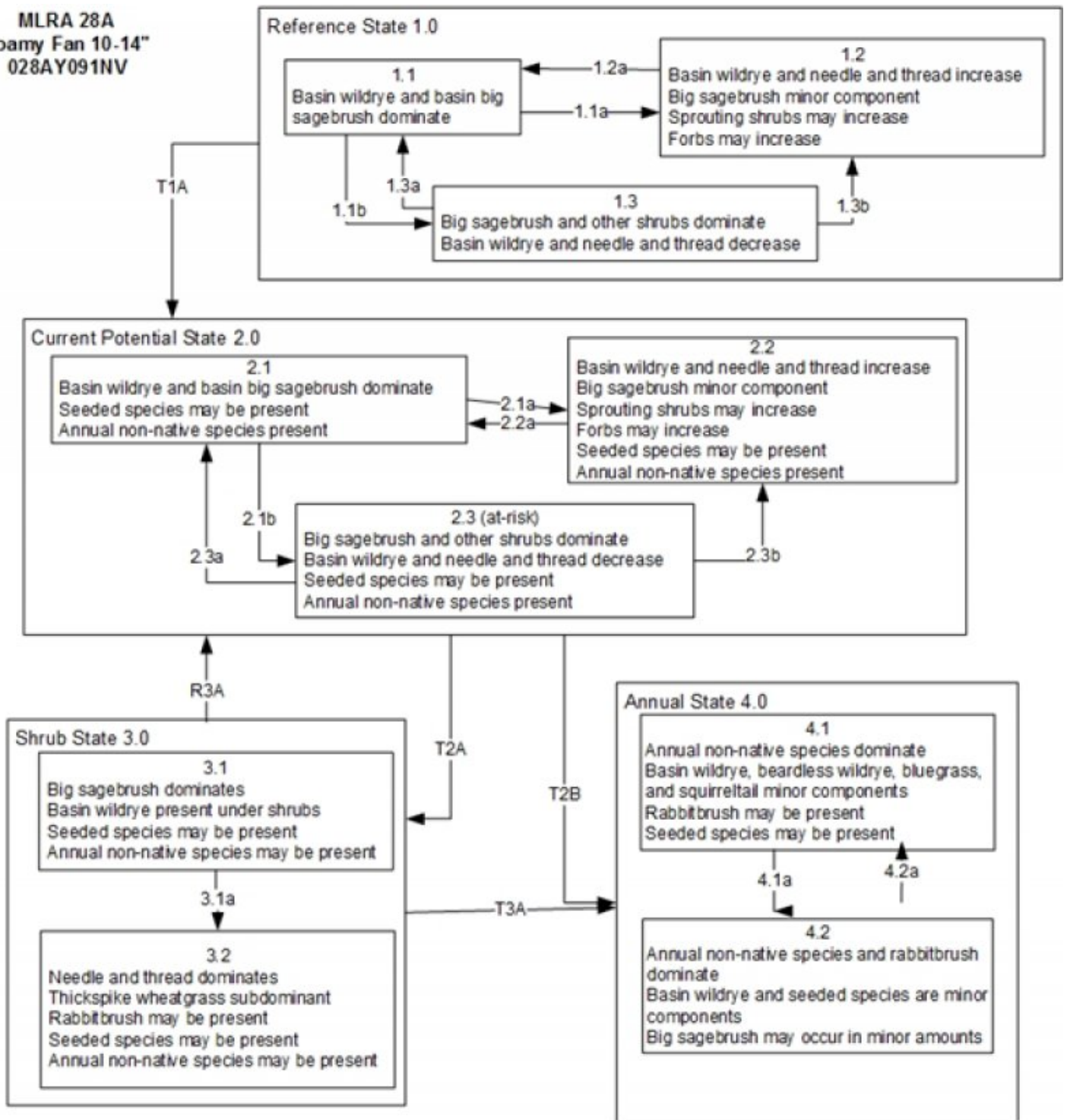


Figure 4. State and Transition Model, Stringham 2/2015

Reference State 1.0 Community Phase Pathways

1.1a: Low severity fire creates grass/sagebrush mosaic; high severity fire significantly reduces sagebrush cover and leads to early/mid-seral community dominated by grasses and forbs.

1.1b: Time and lack of disturbance such as fire or long-term drought. Excessive herbivory may also decrease perennial understory.

1.2a: Time and lack of disturbance allows for shrub regeneration.

1.3a: A low severity fire, Aroga moth, or combinations will reduce some of the sagebrush overstory and allow grass species to increase.

1.3b: High severity fire significantly reduces sagebrush cover and allows grass species to dominate.

Transition T1A: Introduction of annual non-native species.

Current Potential State 2.0 Community Phase Pathways

2.1a: Low severity fire creates grass/sagebrush mosaic; high severity fire significantly reduces sagebrush cover and leads to early/mid-seral community dominated by grasses and forbs. Non-native annual species present.

2.1b: Time and lack of disturbance such as fire or long-term drought. Inappropriate grazing management may also reduce perennial understory.

2.2a: Time and lack of disturbance allows for regeneration of sagebrush.

2.3a: A low severity fire, Aroga moth, or combinations will reduce some of the sagebrush overstory and allow grass species to increase. May also be caused by brush management with minimal soil disturbance or late-fall/winter grazing that causes mechanical damage to sagebrush.

2.3b: High severity fire significantly reduces sagebrush cover and allows grass species to dominate.

Transition T2A: Time and lack of disturbance, may be coupled with grazing management and/or hydrologic changes that favor shrubs over perennial grasses.

Transition T2B: Severe fire.

Shrub State 3.0 Community Phase Pathways

3.1a: Fire or brush treatment with minimal soil disturbance.

Transition T3A: Severe fire.

Restoration Pathway R3A: Mechanical/chemical brush treatment coupled with herbicide. Seeding of perennial bunchgrasses may be necessary.

Annual State 4.0 Community Phase Pathways

4.1a: Time and lack of disturbance

4.2a: Fire

Figure 5. Legend Stringham 2/2015

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 three general community phases: a shrub-grass dominant phase, a perennial grass 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 or disease attack.

Community 1.1 Community Phase

This community is dominated by basin wildrye, and basin big sagebrush. Thickspike wheatgrass and needle and thread are other important species associated with this site. Perennial forbs and other grasses make up smaller components. Potential vegetative composition is about 65% grasses, 10% forbs and 25% shrubs and trees. Approximate ground cover (basal and crown) is 30 to 40 percent.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	510	729	947
Shrub/Vine	165	235	306
Forb	78	112	146
Tree	31	45	58
Total	784	1121	1457

Community 1.2 Community Phase

This community phase is characteristic of a post-disturbance, early-seral community. Basin wildrye and other perennial bunchgrasses dominate. Rubber rabbitbrush may be sprouting. Depending on fire severity or intensity of Aroga moth infestations, patches of intact big sagebrush may remain.

Community 1.3 Community Phase

Basin big sagebrush increases in the absence of disturbance. Decadent big sagebrush and/or rubber rabbitbrush dominates the overstory and the deep-rooted perennial bunchgrasses in the understory are reduced either from competition with shrubs and/or from herbivory.

Pathway a Community 1.1 to 1.2

Fire will decrease or eliminate the overstory of big sagebrush and allow for the perennial bunchgrasses to dominate the site. Fires will typically be low severity, resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring may be more severe and reduce sagebrush cover to trace amounts. A severe infestation of Aroga moth or prolonged flooding could also cause a large decrease in big sagebrush giving a competitive advantage to the perennial grasses and forbs.

Pathway b Community 1.1 to 1.3

Time and lack of disturbance such as fire allows for sagebrush to increase and become decadent. Chronic drought, herbivory, or combinations of these will cause a decline in perennial bunchgrasses and fine fuels, leading to a reduced fire frequency and allowing big sagebrush to dominate the site.

Pathway a Community 1.2 to 1.1

Time and lack of disturbance will allow basin big sagebrush to increase.

Pathway a Community 1.3 to 1.1

A low severity fire, Aroga moth, prolonged flooding or combinations will reduce some of the big sagebrush overstory and allow grass species to increase.

Pathway b Community 1.3 to 1.2

Fire will decrease or eliminate the overstory of big sagebrush and allow for the perennial bunchgrasses to dominate the site. Fires will typically be low severity resulting in a mosaic pattern due to low fine fuel loads. A fire following an unusually wet spring or a change in management favoring an increase in fine fuels may be more severe and reduce

sagebrush cover to trace amounts. A severe infestation of Aroga moth or prolonged flooding could also cause a large decrease in big sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs.

State 2

Current Potential State

This state is similar to the Reference State 1.0 with three similar community phases. Ecological function has not changed, however the resiliency of the state has been reduced by the presence of invasive weeds. Non-natives may increase in abundance but will not become dominant within this State. These non-natives can be highly flammable and can promote fire where historically fire had been infrequent. Negative feedbacks enhance ecosystem resilience and contribute to the stability of the state. These feedbacks include the presence of all structural and functional groups, low fine fuel loads, and retention of organic matter and nutrients. Positive feedbacks decrease ecosystem resilience and stability of the state. These include the non-natives' high seed output, persistent seed bank, rapid growth rate, ability to cross pollinate, and adaptations for seed dispersal. A site may be considered to be in the Current Potential State if the non-native seeded species crested wheatgrass is present.

Community 2.1

Community Phase

This community phase is similar to the Reference State Community Phase 1.1, but non-native species are present in trace amounts. Basin wildrye and basin big sagebrush dominate the site. Seeded species such as crested wheatgrass may be present and/or dominate the understory. Forbs and other shrubs and grasses make up smaller components of this site.

Community 2.2

Community Phase

This community phase is characteristic of a post-disturbance, early seral community where annual non-native species are present. Sagebrush is present in trace amounts; perennial bunchgrasses dominate the site. Depending on fire severity or intensity of Aroga moth infestations, patches of intact sagebrush may remain. Rabbitbrush may be sprouting. Seeded species such as crested wheatgrass may be present and/or dominate the understory. Perennial forbs may be a significant component after fire for several years. Annual non-native species are stable or increasing within the community.

Community 2.3

Community Phase (At Risk)

This community is at risk of crossing a threshold to another state. Basin big sagebrush dominates the overstory and perennial bunchgrasses in the understory are reduced, either from competition with shrubs or from inappropriate grazing, or from both. Rabbitbrush may be a significant component. Annual non-natives species may be stable or increasing due to lack of competition with perennial bunchgrasses. Seeded species such as crested wheatgrass (*Agropyron cristatum*) may be present. This site is susceptible to further degradation from grazing, drought, and fire.

Pathway a

Community 2.1 to 2.2

Fire reduces the shrub overstory and allows for perennial bunchgrasses to dominate the site. Fires are typically low severity resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring or a change in management favoring an increase in fine fuels may be more severe and reduce sagebrush cover to trace amounts. A severe infestation of Aroga moth or prolonged flooding could also cause a large decrease in sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs. Annual non-native species are likely to increase after fire.

Pathway b

Community 2.1 to 2.3

Time and lack of disturbance allows for sagebrush to increase and become decadent. Chronic drought reduces fine fuels and leads to a reduced fire frequency, allowing big sagebrush to dominate the site. Inappropriate grazing management reduces the perennial bunchgrass understory; conversely Sandberg bluegrass may increase in the understory depending on grazing management.

Pathway a **Community 2.2 to 2.1**

Time and lack of disturbance and/or grazing management that favors the establishment and growth of sagebrush allows the shrub component to recover. The establishment of big sagebrush can take many years.

Pathway a **Community 2.3 to 2.1**

Heavy late-fall or winter grazing may cause mechanical damage and subsequent death to big sagebrush, facilitating an increase in the herbaceous understory. An infestation of Aroga moth will reduce some big sagebrush overstory and allow perennial grasses to increase in the community. Brush treatments with minimal soil disturbance will also decrease sagebrush and release the perennial understory. Annual non-native species are present and may increase in the community.

Conservation practices

Brush Management

Pathway b **Community 2.3 to 2.2**

Fire eliminates/reduces the overstory of sagebrush and allows for the understory perennial grasses to increase. Fires will typically be low severity resulting in a mosaic pattern due to low fine fuel loads. A fire that follows an unusually wet spring or change in management favoring an increase in fine fuels may be more severe and reduce the shrub component to trace amounts. A severe infestation of Aroga moth will also cause a large decrease in sagebrush within the community, giving a competitive advantage to the perennial grasses and forbs. Annual non-native species respond well to fire and may increase post-burn.

State 3 **Shrub State**

This state is a product of many years of heavy grazing during time periods harmful to perennial bunchgrasses. Basin wildrye is significantly reduced and other perennial grasses such as squirreltail and Sandberg bluegrass will increase. Big sagebrush dominates the overstory and rabbitbrush may be a significant component. Big sagebrush cover exceeds site concept and may be decadent, reflecting stand maturity and lack of seedling establishment due to competition with mature plants. The shrub overstory and shallower rooted grasses dominate site resources such that soil water, nutrient capture, nutrient cycling and soil organic matter are temporally and spatially redistributed.

Community 3.1 **Community Phase**



Figure 7. Loamy Fan 10-14" (028AY091NV) T.K. Stringham, June 2013.

Decadent big sagebrush dominates the overstory. Rabbitbrush may be significant components. Deep-rooted perennial bunchgrasses may be present in trace amounts or absent from the community. Annual non-native species increase. Crested wheatgrass may be a significant component in this phase if the site has a history of seeding treatments. Bare ground is significant.

Community 3.2 Community Phase



Figure 8. Loamy Fan 10-14" (028AY091NV) P. Novak-Echenique, June 2013.

Needle and thread dominates the site; annual non-native species may be present but are not dominant. Thickspike wheatgrass may be sub-dominant. Trace amounts of sagebrush or rabbitbrush may be present. Basin wildrye is present in trace amounts or is absent.

Pathway a Community 3.1 to 3.2



Community Phase

Community Phase

Fire, heavy fall grazing causing mechanical damage to shrubs, and/or brush treatments with minimal soil disturbance will greatly reduce the overstory shrubs to trace amounts and allow for needle and thread to dominate the site. Prescribed burning in the fall will also cause this phase shift.

State 4

Annual State

This state has two community phases. One community phase is characterized by the dominance of annual non-native species such as cheatgrass and annual mustards in the understory. The other community phase is dominated by rabbitbrush with an understory of cheatgrass and mustards. Big sagebrush and/or rabbitbrush may dominate the overstory.

Community 4.1 Community Phase

Annual non-native plants such as annual mustards and cheatgrass dominate this site. Crested wheatgrass may be a significant component in this phase if the site has a history of seeding treatments.

Community 4.2 Community Phase

Annual non-native plants such as annual mustards and cheatgrass dominate the understory while sprouting shrubs such as rabbitbrush dominate the overstory. Big sagebrush may be present in trace amounts. Crested wheatgrass may be a significant component in this phase if the site has a history of seeding treatments.

Pathway a Community 4.1 to 4.2

Time and lack of disturbance allow sprouting shrubs to recover and mature. Sagebrush may re-establish in a limited extent.

Pathway a Community 4.2 to 4.1

Fire.

Transition A State 1 to 2

Trigger: This transition is caused by the introduction of non-native annual plants, such as cheatgrass and mustards. Slow variables: Over time the annual non-native species will 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.

Transition A State 2 to 3

Trigger: To Community Phase 3.1: Repeated, heavy, growing season grazing will decrease or eliminate basin wildrye and favor shrub growth and establishment. To Community Phase 3.2: Severe fire in the depleted state 2.3 will remove sagebrush overstory. Grazing and/or fire may couple with hydrologic changes and accelerate the transition to state 3.0. Slow variables: Long term decrease in basin wildrye density due to grazing or lowering water table. Threshold: Loss of the large, deep-rooted basin wildrye changes nutrient cycling, nutrient redistribution, and reduces soil organic matter.

Transition B State 2 to 4

Trigger: Severe fire. Slow variables: Increased production and cover of non-native annual species. Threshold: Loss of deep-rooted perennial bunchgrasses and shrubs truncates, spatially and temporally, nutrient capture and cycling within the community. Increased, continuous fine fuels from annual non-native plants modify the fire regime by changing intensity, size and spatial variability of fires.

Restoration pathway A State 3 to 2

Restoration of this state would require mechanical or chemical brush treatment and control of annual invasive weed species. Seeding of grasses may be necessary if basin wildrye is severely reduced or no longer present in the community. Prescribed burning is not recommended if there is a significant component of cheatgrass or other non-native weeds in the understory.

Conservation practices

Brush Management
Range Planting

Transition A State 3 to 4

Trigger: Severe fire. Slow variables: Increased production and cover of non-native annual species. Threshold: Increased, continuous fine fuels modify the fire regime by changing intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture spatially and temporally thus impacting nutrient cycling and distribution.

Additional community tables

Table 6. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	Primary Perennial Grasses			448–841	
	basin wildrye	LECI4	<i>Leymus cinereus</i>	280–448	–
	thickspike wheatgrass	ELLAL	<i>Elymus lanceolatus ssp. lanceolatus</i>	112–224	–
	needle and thread	HECO26	<i>Hesperostipa comata</i>	56–168	–
2	Secondary Perennial Grasses			56–112	
	Indian ricegrass	ACHY	<i>Achnatherum hymenoides</i>	6–34	–
	blue grama	BOGR2	<i>Bouteloua gracilis</i>	6–34	–
	squirreltail	ELEL5	<i>Elymus elymoides</i>	6–34	–
	Sandberg bluegrass	POSE	<i>Poa secunda</i>	6–34	–
Forb					
3	Perennial			2–112	
	lupine	LUPIN	<i>Lupinus</i>	6–22	–
Shrub/Vine					
4	Primary Shrubs			112–280	
	basin big sagebrush	ARTRT	<i>Artemisia tridentata ssp. tridentata</i>	112–280	–
5	Secondary Shrubs			6–168	
	Utah serviceberry	AMUT	<i>Amelanchier utahensis</i>	11–34	–
	curl-leaf mountain mahogany	CELE3	<i>Cercocarpus ledifolius</i>	11–34	–
	yellow rabbitbrush	CHVI8	<i>Chrysothamnus viscidiflorus</i>	11–34	–
	rubber rabbitbrush	ERNA10	<i>Ericameria nauseosa</i>	11–34	–
	winterfat	KRLA2	<i>Krascheninnikovia lanata</i>	11–34	–
	antelope bitterbrush	PUTR2	<i>Purshia tridentata</i>	11–34	–
	greasewood	SAVE4	<i>Sarcobatus vermiculatus</i>	11–34	–
	snowberry	SYMPH	<i>Symphoricarpos</i>	11–34	–
Tree					
6	Evergreen			11–45	
	Utah juniper	JUOS	<i>Juniperus osteosperma</i>	6–22	–
	singleleaf pinyon	PIMO	<i>Pinus monophylla</i>	6–22	–

Animal community

Livestock Interpretations:

This site is suitable for livestock grazing. Grazing management considerations include timing, intensity, frequency, and duration of grazing. Grazing management should be keyed to basin wildrye and other perennial grass production.

During settlement, many of the cattle in the Great Basin were wintered on extensive basin wildrye stands, however due to sensitivity to spring use many stands were decimated by early in the 20th century (Young et al. 1976). Less palatable species such as basin big sagebrush, black greasewood, and rabbitbrush increased in dominance along with invasive non-native species such as Russian thistle (*Salsola tragus*), mustards, and cheatgrass (Roundy 1985). Spring defoliation of basin wildrye and/or consistent, heavy grazing during the growing season has been found to significantly reduce basin wildrye production and density (Krall et al. 1971). Thus, inadequate rest and recovery from defoliation can cause a decrease in basin wildrye and an increase in rabbitbrush, black greasewood, basin big

sagebrush and non-native weeds (Young et al. 1976, Roundy 1985). Additionally, native basin wildrye seed viability has been found to be low and seedlings lack vigor (Young and Evans 1981). Roundy (1985) found that although basin wildrye is adapted to seasonally dry saline soils, high and frequent spring precipitation is necessary to establish it from seed. This suggests that establishment of native basin wildrye seedlings occurs only during years of unusually high precipitation. Therefore, reestablishment of a stand that has been decimated by grazing may be episodic.

Basin wildrye is valuable forage for livestock (Ganskopp et al. 2007) and wildlife, but is intolerant of heavy, repeated, or spring grazing (Krall et al. 1971). The early growth and abundant production of basin wildrye make it a valuable source of forage for livestock. It is important forage for cattle and is readily grazed by cattle and horses in early spring and fall. Though coarse-textured during the winter, basin wildrye may be utilized more frequently by livestock and wildlife when snow has covered low shrubs and other grasses. Basin wildrye is used often as a winter feed for livestock and wildlife; not only providing roughage above the snow but also cover in the early spring months (Majerus 1992). Inadequate rest and recovery from defoliation causes a decrease in basin wildrye and an increase in basin big sagebrush and rubber rabbitbrush. Further deterioration of the sites promotes shrub dominance, increased bare ground and the invasion of annual weeds, primarily cheatgrass and Russian thistle.

Basin big sagebrush may serve as emergency food during severe winter weather, but it is not usually sought out by livestock.

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:

Basin big sagebrush/basin wildrye communities provide cover and food for large ungulates, upland game birds, and smaller wildlife. Because of its tall, heavy growth, basin wildrye provides forage for elk (*Cervus canadensis*) and other big game in the winter when snow cover is more than two feet (Plummer et al 1968).

Basin big sagebrush is the least palatable of all the subspecies of big sagebrush. Basin big sagebrush is browsed by mule deer from fall to early spring, but is not preferred. Sagebrush-grassland communities provide critical sage-grouse breeding and nesting habitats. Meadows surrounded by sagebrush may be used as feeding and strutting grounds. Sagebrush is a crucial component of their diet year-round, and sage-grouse select sagebrush almost exclusively for cover. Sage-grouse prefer mountain big sagebrush and Wyoming big sagebrush communities to basin big sagebrush communities. Basin wildrye provides winter forage for mule deer, though use is often low compared to other native grasses. Basin wildrye provides summer forage for black-tailed jackrabbits. Because basin wildrye remains green throughout early summer, it remains available for small mammal forage for longer time than other grasses. Creeping wildrye is used for forage for many wildlife species and is often used for cover.

Wild ungulates use basin big sagebrush for cover and feed. Mule deer, pronghorn (*Antilocapra americana*) and elk will browse basin big sagebrush from autumn through early spring (Wambolt et al. 1994). Early and midseral basin big sagebrush provide forage and protection from predators for mule deer (Wildlife Action Plan Team 2012). Mule deer preference for the shrub varies seasonally. Basin big sagebrush was used more by mule deer populations in Oregon and Utah in winter than by the same populations in fall. (Sheehy and Winward 1981, Welch et al. 1981) This could be because basin big sagebrush is consumed as a last resort plant and browsed when plants considered more palatable were no longer available (Welch et al. 1981). Elk and pronghorn antelope will browse basin big sagebrush in areas where mountain and Wyoming sagebrush are unavailable (Beale and Smith 1970, Wambolt 1996). A study by Brown (1977) determined that desert bighorn sheep preferred big sagebrush over other shrub types; however, the variety was not noted.

These plants communities provide cover and food for smaller desert wildlife such as lagomorphs and rodents. Pygmy rabbits (*Brachylagus idahoensis*) rely on tall basin big sagebrush for shelter and food throughout the year (Green and Flinders 1980, White et al. 1982, Wildlife Action Plan Team 2012). A study by Larrison and Johnson (1973) captured deer mice (*Peromyscus maniculatus*) in big sagebrush communities more than any other plant community, suggesting the mice prefer these plant communities for cover over other plant communities.

Basin big sagebrush serves as valuable habitat for native birds. Studies have suggested that sage grouse use basin big sagebrush for cover and food where mountain and Wyoming big sagebrush are absent (Welch et al. 1991). Birds such as Brewer's sparrows (*Spizella breweri*) are considered dependent on sagebrush communities for cover and will nest in basin big sagebrush. Thus when basin big sagebrush communities are converted to agriculture fields, Brewer's sparrow populations can decline due to loss of habitat (Knick et al. 2003). In fact, mature basin big sagebrush act as nesting structures, protection from predators and thermal cover for Greater sage grouse (*Centrocercus urophasianus*), the loggerhead shrike (*Lanius ludovicianus*), the sage sparrow (*Artemisiospiza nevadensis*), Brewer's sparrow and sage thrasher (*Oreoscoptes montanus*) (Wildlife Action Plan Team 2012). The plant also acts as important cover for game-birds such as the gray partridge (*Perdix perdix*), mountain quail

(*Oreotyx pictus*), and mourning doves (*Zenaida macroura*), as well as passerines such as, towhees (*Pipilo* spp.) and finches (*Haemorhous* spp.), that occur on arid range lands in the West (Dobbs et al. 2012, Booth 1985). Changes in plant community composition caused by, human activity, invasive weeds, fire frequency associated with this ecological site could affect the distribution and presence of wildlife species.

Hydrological functions

Runoff is very low to low. Permeability is very slow to moderately rapid. Hydrologic soil groups are A, B, and C. Livestock Interpretations:

This site is suitable for livestock grazing. Grazing management considerations include duration, intensity and timing. During settlement, many of the cattle in the Great Basin were wintered on extensive basin wildrye stands, however due to sensitivity to spring use many stands were decimated by early in the 20th century (Young et al. 1976). Less palatable species such as sagebrush, rabbitbrush and black greasewood increased in dominance along with invasive non-native species such as Russian thistle (*Salsola tragus*), mustards, and cheatgrass (Roundy 1985). Spring defoliation of basin wildrye and/or consistent, heavy grazing during the growing season has been found to significantly reduce basin wildrye production and density (Krall et al. 1971). Thus, inadequate rest and recovery from defoliation can cause a decrease in basin wildrye and an increase in rabbitbrush and sagebrush and non-native weeds (Young et al. 1976, Roundy 1985). Additionally, native basin wildrye seed viability has been found to be low and seedlings lack vigor (Young and Evans 1981). Roundy (1985) found that although basin wildrye is adapted to seasonally dry saline soils, high and frequent spring precipitation is necessary to establish it from seed. This suggests that establishment of native basin wildrye seedlings occurs only during years of unusually high precipitation. Therefore, reestablishment of a stand that has been decimated by grazing may be episodic. Though coarse-textured during the winter, basin wildrye may be utilized more frequently by livestock and wildlife when snow has covered low shrubs and other grasses. Basin wildrye is used often as a winter feed for livestock and wildlife; not only providing roughage above the snow but also cover in the early spring months (Majerus 1992).

Thickspike wheatgrass is palatable to all classes of livestock and wildlife. It is a preferred feed for cattle, sheep, horses, and elk in spring and is considered a desirable feed for deer and antelope in spring. It is considered a desirable feed for cattle, sheep, and horses in summer, fall, and winter. Thickspike wheatgrass's extensive rhizome system allows established stands to withstand heavy grazing and trampling. Needleandthread provides highly palatable forage, especially in the spring before fruits have developed. Needlegrasses are grazed in the fall only if the fruits are softened by rain. Basin big sagebrush may serve as emergency food during severe winter weather, but it is not usually sought out by livestock.

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.

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and will nest in basin big sagebrush. Thus when basin big sagebrush communities are converted to agriculture fields, Brewer's sparrow populations can decline due to loss of habitat (Knick et al. 2003). In fact, mature basin big sagebrush act as nesting structures, protection from predators and thermal cover for Greater sage grouse (*Centrocercus urophasianus*), the loggerhead shrike (*Lanius ludovicianus*), the sage sparrow (*Artemisospiza nevadensis*), Brewer's sparrow and sage thrasher (*Oreoscoptes montanus*) (Wildlife Action Plan Team 2012). The plant also acts as important cover for game-birds such as the gray partridge (*Perdix perdix*), mountain quail (*Oreotyx pictus*), and mourning doves (*Zenaida macroura*), as well as passerines such as, towhees (*Pipilo* spp.) and finches (*Haemorhous* spp.), that occur on arid range lands in the West (Dobbs et al. 2012, Booth 1985).

Thickspike wheatgrass provides some cover for small mammals and birds. Needle and thread is moderately important spring forage for mule deer, but use declines considerably as more preferred forages become available.

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

Some Native American peoples used the bark of big sagebrush to make rope and baskets. Basin wildrye was used as bedding for various Native American ceremonies, providing a cool place for dancers to stand.

Other information

Basin big sagebrush shows high potential for range restoration and soil stabilization. Basin big sagebrush grows rapidly and spreads readily from seed. Basin wildrye is useful in mine reclamation, fire rehabilitation and stabilizing disturbed areas. Its usefulness in range seeding, however, may be limited by initially weak stand establishment. Thickspike is a good revegetation species because it forms tight sod under dry rangeland conditions, has good seedling strength, and performs well in low fertility or eroded sites. It does not compete well with aggressive introduced grasses during the establishment period, but are very compatible with slower developing natives. It's drought tolerance combined with rhizomes, fibrous root systems, and good seedling vigor make these species ideal for reclamation in areas receiving 8 to 20 inches annual precipitation. Thickspike wheatgrass can be used for hay production and will make nutritious feed, but is more suited to pasture use. Needleandthread is useful for stabilizing eroded or degraded sites.

Type locality

Location 1: White Pine County, NV	
Township/Range/Section	T22N R69E S24
Latitude	39° 46' 7"
Longitude	114° 7' 32"
General legal description	S½ Inset fans north of Pleasant Valley, Kern Mountains area, White Pine County, 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.

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

Indicators

1. **Number and extent of rills:** Rills are not expected on this site due to gentle slopes.

2. **Presence of water flow patterns:** Water flow patterns are none to rare. A few can be expected after summer convection storms or rapid snowmelt. These are typically short (<1m), meandering and not connected.

3. **Number and height of erosional pedestals or terracettes:** Pedestals and terracettes 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 ± 10-20% 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 3 to 6 on most soil textures found on this site. Areas of this site occurring on soils that have a physical crust will probably have stability values less than 3. (To be field tested.)

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Surface structure is weak thin platy or medium subangular blocky. Soil surface colors are grayish browns and soils are typified by a mollic 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., basin wildrye & needleandthread] 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. Subangular blocky, platy, or massive sub-surface 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: Deep-rooted, cool season, perennial bunchgrasses (basin wildrye)

Sub-dominant: tall shrubs (basin big sagebrush and mountain big sagebrush) = cool season, rhizomatous grasses >>
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: With an extended fire return interval, the shrub/tree component will increase and eventually dominate the site. The herbaceous component will greatly decrease.

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):** Within plant interspaces 25-35% and depth of litter is <1/4 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 June) \pm 1000 lbs/ac. Favorable years \pm 1300 lbs/ac and unfavorable years \pm 700 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, bassia, and annual mustards. Singleleaf pinyon and Utah juniper may increase and dominate this site.

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