USDA Natural Resources
Conservation Service

Ecological site R047XA332UT
Upland Stony Loam (black sagebrush)

Last updated: 2/05/2025
Accessed: 05/11/2025

General information

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

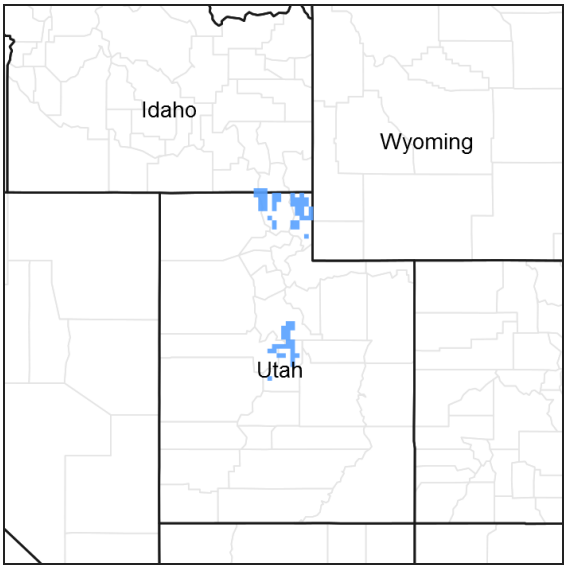


Figure 1. Mapped extent

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): 047X–Wasatch and Uinta Mountains

MLRA 47 occurs in Utah (86 percent), Wyoming (8 percent), Colorado (4 percent), and Idaho (2 percent). It encompasses approximately 23,825 square miles (61,740 square kilometers). The northern half of this area is in the Middle Rocky Mountains Province of the Rocky Mountain System. Parts of the western edge of this MLRA are in the Great Basin Section of the Basin and Range Province of the Intermontane Plateaus. The MLRA includes the Wasatch Mountains, which trend north and south. The steeply sloping, precipitous Wasatch Mountains have narrow crests and deep valleys. Active faulting and erosion are a dominant force in controlling the geomorphology of the area.
The mountains in this area are primarily fault blocks that have been tilted up. Alluvial fans at the base of the mountains are recharge zones for the basin fill aquifers. An ancient shoreline of historic Bonneville Lake is evident on the footslopes along the western edge of the area. Rocks exposed in the mountains are mostly Mesozoic and Paleozoic sediments.
The average precipitation is from 12 to 16 inches in the valleys and can range up to 73 inches in the mountains. Peak precipitation occurs in the winter months. The average annual temperature is 30 to 50 degrees Fahrenheit (-1 to 15 C). The freeze-free period averages 140 days and ranges from 60 to 220 days, generally decreasing in length with elevation.
The dominant soil orders in this MLRA are Entisols, Inceptisols, and Mollisols. The lower elevations are dominated by a frigid temperature regime, while the higher elevations experience cryic temperature regimes. The soil moisture

regime is typically xeric. The minerology is generally mixed and the soils are very shallow to very deep, generally well drained, and loamy or loamy-skeletal.

LRU notes

This LRU includes the Wasatch Mountains which tend to run north and south. These steeply sloping, precipitous mountains have narrow crests and deep valleys. They are primarily fault blocks that have been tilted up. The alluvial fans located at the base of these mountains are important recharge zones for valley aquifers.

Classification relationships

Modal Soil: Lonjon SiL, 2-10%, 10-30% — loamy-skeletal, carbonatic, frigid Typic Calcixerolls

Ecological site concept

This ecological site typically occurs on foothills, alluvial fans ridges and mountainsides at elevations between 5,400 to 8,000 feet. This site typically has a restrictive bedrock layer 20 to 40 inches below the soil surface. The dominant aspect of this ecological site in reference condition is black sagebrush with an diverse perennial forb community and perennial bunchgrasses.

Associated sites

R047XA316UT	**Upland Shallow Loam (black sagebrush)** This site is found in association with the Upland Stony Loam site in soils that are less than 20 inches deep.

Similar sites

R047XA301UT	**Upland Clay Loam (early sagebrush)** This site is dominated by Early sagebrush (Artemisia arbuscula ssp. longiloba) and the surface texture is clay loam.

Table 1. Dominant plant species

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

Physiographic features

This site occurs on foothills, alluvial fans, ridges, mountainsides and hills at elevations between 5,400 and 8,000 feet. Slopes are mostly 10 to 50 percent, but may vary from 2 to 70 percent. Runoff is medium to high. Flooding and ponding do not occur on this site.

Table 2. Representative physiographic features

Landforms	(1) Foothills > Hillslope (2) Mountainside (3) Alluvial fan (4) Hill (5) Lake terrace (6) Mountain slope
Runoff class	Medium to high
Flooding frequency	None
Ponding frequency	None
Elevation	5,400–8,000 ft

Slope	2–50%
Aspect	Aspect is not a significant factor

Table 3. Representative physiographic features (actual ranges)

Runoff class	Not specified
Flooding frequency	Not specified
Ponding frequency	Not specified
Elevation	4,500–8,000 ft
Slope	2–70%

Climatic features

The climate of this site is characterized by cold, snowy winters and cool dry summers. The frost-free and freeze-free periods may be extremely short in Rich County where this site is prevelant. Annual precipitation ranges from 13 to 17 inches with most of the moisture coming in the spring, winter and fall. Winter snowpack adds moisture to the soil as it melts in the spring. However, much of the spring moisture is unavailable to plants by mid-June, and reduced precipitation causes many herbaceous species to go dormant by July 1. June, July and August are the driest months of the year for this site.

Table 4. Representative climatic features

Frost-free period (average)	109 days
Freeze-free period (average)	141 days
Precipitation total (average)	15 in

Influencing water features

Due to its landscape position, this site is not influenced by streams or wetlands.

Wetland description

N/A

Soil features

The soils of this site formed in alluvium or colluvium derived from a wide variety of igneous and sedimentary rocks. They are stony, cobbly or gravelly loams, and are well to somewhat excessively well-drained. They are moderately deep to deep and may have bedrock at depths greater than 20 inches. Rock fragments are commonly seen on the soil surface and occupy greater than 35 percent volume of the soil profile.
The surface layer is dark in color and 10 to 15 inches thick. The soils may have a layer of clay accumulation and/or a layer of calcium carbonate accumulation in the subsoil. They may be calcareous or non-calcareous. Permeability is moderate to moderately rapid. Available water capacity is 1.7 to 4.5 inches in the upper 40 inches of soil. The soil moisture regime is xeric bordering on aridic. The soil temperature regime is frigid.

Soil Surveys correlated to this site:
Cache Valley Area: Lakwin (La); Sterling (RFG2, RGG2)
Rich County: Fontreen (FEE); Lonjon (LCD, LCE); McCarey (CBD); Ramshorn Variant (RBD, RBE); Searla (SFD); Sumine (SNF)
Fairfield-Nephi Area: Lissant (LcF)
Sanpete Calley Area: Bezzant (BFD, BGE), Mountainville (MmC, MoC)
Sevier County: Forsey (PFD), McCarey (MZF)
Loa-Marysvale Area: (Forsey (FRD)

Table 5. Representative soil features

Parent material	(1) Slope alluvium–limestone and sandstone (2) Colluvium–quartzite (3) Residuum–sedimentary rock
Surface texture	(1) Stony loam (2) Very stony sandy loam (3) Gravelly silt loam (4) Silt loam (5) Cobbly loam (6) Gravelly loam
Family particle size	(1) Loamy-skeletal
Drainage class	Well drained to somewhat excessively drained
Permeability class	Moderately slow to moderately rapid
Depth to restrictive layer	20–60 in
Soil depth	20–60 in
Surface fragment cover <=3"	9–24%
Surface fragment cover >3"	0–23%
Available water capacity (0-40in)	1.7–4.5 in
Calcium carbonate equivalent (0-40in)	0–40%
Electrical conductivity (0-40in)	0–2 mmhos/cm
Sodium adsorption ratio (0-40in)	0–1
Soil reaction (1:1 water) (0-40in)	6.6–8.4
Subsurface fragment volume <=3" (0-40in)	15–45%
Subsurface fragment volume >3" (0-40in)	2–30%

Table 6. Representative soil features (actual values)

Drainage class	Not specified
Permeability class	Not specified
Depth to restrictive layer	Not specified
Soil depth	Not specified
Surface fragment cover <=3"	9–38%
Surface fragment cover >3"	0–29%
Available water capacity (0-40in)	Not specified
Calcium carbonate equivalent (0-40in)	0–65%
Electrical conductivity (0-40in)	Not specified
Sodium adsorption ratio (0-40in)	0–5

Soil reaction (1:1 water) (0-40in)	6.6–9
Subsurface fragment volume <=3" (0-40in)	6–68%
Subsurface fragment volume >3" (0-40in)	0–35%

Ecological dynamics

It is impossible to determine in any quantitative detail the historic climax plant community (HCPC) for this ecological site because of the lack of direct historical documentation preceding all human influence. In some areas, the earliest reports of dominant plants include the cadastral survey conducted by the General Land Office, which began in the late 19th century for this area (Galatowitsch 1990). However, up to the 1870s the Shoshone Indians, prevalent in northern Utah and neighboring states, grazed horses and set fires to alter the vegetation for their needs (Parson 1996). In the 1860s, Europeans brought cattle and horses to the area grazing large numbers of them on unfenced parcels year-long (Parson 1996). Itinerant and local sheep flocks followed as the proportion of browse increased.

Below is a State and Transition Model diagram to illustrate the “phases” (common plant communities), and “states” (aggregations of those plant communities) that can occur on the site. Differences between phases and states depend primarily upon observations of a range of disturbance histories in areas where this ESD is represented. These situations include grazing gradients to water sources, fence-line contrasts, patches with differing dates of fire, herbicide treatment, tillage, etc. Reference State 1 illustrates the common plant communities that probably existed just prior to European settlement.

The major successional pathways within states, (“community pathways”) are indicated by arrows between phases. “Transitions” are indicated by arrows between states. The drivers of these changes are indicated in codes decipherable by referring to the legend at the bottom of the page and by reading the detailed narratives that follow the diagram. The transition between Reference State 1 and State 2 is considered irreversible because of the naturalization of exotic species of both flora and fauna, possible extinction of native species, and climate change. There may have also been accelerated soil erosion.

When available, monitoring data (of various types) were employed to validate more subjective inferences made in this diagram. See the complete files in the office of the State Range Conservationist for more details.

The plant communities shown in this State and Transition Model may not represent every possibility, but are probably the most prevalent and recurring plant communities. As more monitoring data are collected, some phases or states may be revised, removed, and/or new ones may be added. None of these plant communities should necessarily be thought of as “Desired Plant Communities.” According to the USDA NRCS National Range & Pasture Handbook (USDA-NRCS 2003), Desired Plant Communities (DPC’s) will be determined by the decision-makers and will meet minimum quality criteria established by the NRCS. The main purpose for including descriptions of a plant community is to capture the current knowledge at the time of this revision.

State and transition model

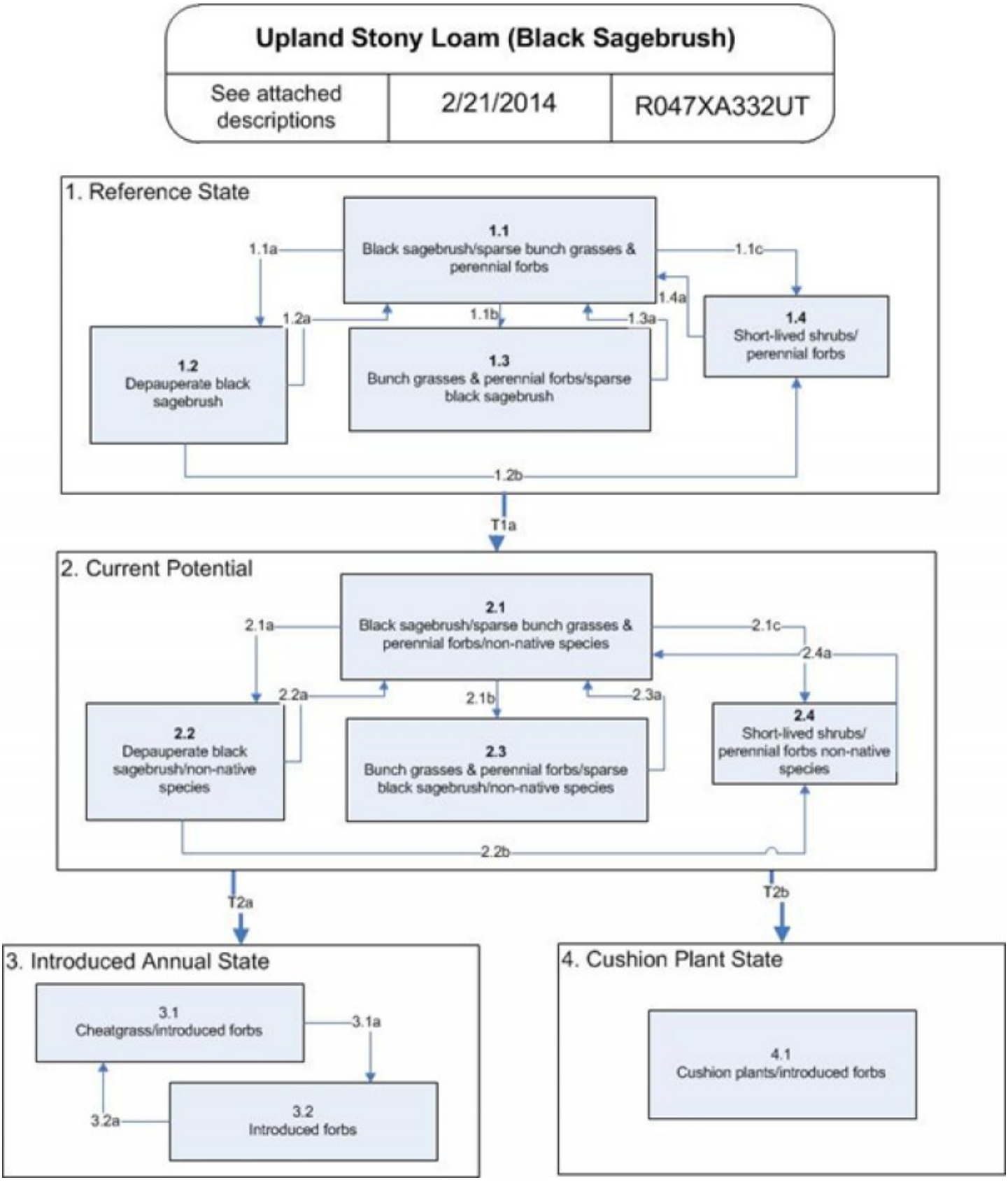


Figure 4. R047XA332UT State and Transition Model

State 1
Reference State

The Reference State is a description of this ecological site just prior to Euro-American settlement but long after the arrival of Native Americans. The description of the Reference State was determined by NRCS Soil Survey Type Site Location information, and familiarity with rangeland relict areas where they exist. The least modified plant community (1.1) within the Reference State would have been a black sagebrush-dominated (*Artemisia nova*) stand with scattered prickly pear (*Opuntia polyacantha*) and associated bunch grasses such as bluebunch wheatgrass

(*Pseudoroegneria spicata*), Indian ricegrass (*Achnatherum hymenoides*), Sandberg bluegrass (*Poa secunda*), muttongrass (*Poa fendleriana*), and bottlebrush squirreltail (*Elymus elymoides*). Forbs such as phlox (Phlox spp.), buckwheat (Eriogonum spp.), locoweed (Astragalus spp.), and common yarrow (*Achillea millefolium*) would have been common. The generally shallow and stony soils would have accentuated the effects of drought and reduced the chances of fire altering this state. The reference plant community (1.1) would have been relatively stable with occasional use by wildlife. However, heavy utilization by bison, elk, and Native American horses on these sites (1.1a) would have depleted the grasses creating a near monoculture of black sagebrush (1.2). Heavy browsing by deer during the dormant season of black sagebrush (1.1b) would have created an herbaceous variant (1.3). Occasional very wet years during El Nino-Southern Oscillation periods could have caused temporary soil anoxia (West 2000) (1.1c) killing the sagebrush and allowing the forbs and grasses to dominate for a short time (1.3). Infestation of some insects and pathogens on sagebrush (1.1c) could have led to a similar result where the herbaceous species become temporarily dominant (1.3). The interaction of an unusually dry period and heavy utilization by all grazers (e.g. deer, bison, elk, and horses used by native American) (1.1d) would have removed the palatable species from the plant community while allowing unpalatable, shorter-lived species such as yellow rabbitbrush (*Chrysothamnus viscidiflorus* ssp. viscidiflorus), locoweed, and phlox to predominate (1.4). The depauperate black sagebrush (*Artemisia nova*) community (1.2) could have also shifted to the unpalatable short-lived shrub community phase (1.4) in areas that have sustained heavy browsing by deer (1.2b). Relatively rocky sites such as these typically would not have declined in overall cover or productivity. However, the portion that is palatable may have changed appreciably. Similarly, these soils would have been more resistant to erosion than other stone-free soils. Each of the phases within State 1 could have returned to Community Phase 1.1 if climate conditions were within the normal range of variability and there was a release from heavy grazing and browsing pressure (1.2a, 1.3a, 1.4a). A small amount of Wyoming big sagebrush and an informally recognized variety of big sagebrush (*A. tridentata*), called “bonnevillensis” (Shultz, 2009) would have also been present. A more complete list of species by lifeform for the Reference State is available in the accompanying tables in the “Plant Community Composition by Weight and Percentage” section of this document.

Community 1.1
Black sagebrush/sparse bunch grasses & perennial forbs

The least modified plant community within the Reference State would have been a black sagebrush-dominated stand with scattered prickly pear and associated bunch grasses, such as bluebunch wheatgrass, Indian ricegrass, Sandberg bluegrass, muttongrass, and bottlebrush squirreltail. Phlox, buckwheat, locoweed, and common yarrow would have been the commonly associated forbs.

Table 7. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	375	475	575
Shrub/Vine	300	380	460
Forb	75	95	115
Total	**750**	**950**	**1150**

Table 8. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	29-31%
Grass/grasslike foliar cover	14-16%
Forb foliar cover	4-6%
Non-vascular plants	0%
Biological crusts	0%
Litter	0%
Surface fragments >0.25" and <=3"	0%
Surface fragments >3"	0%

Bedrock	0%
Water	0%
Bare ground	0%

Table 9. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	–	–	–
>0.5 <= 1	–	29-31%	14-16%	4-6%
>1 <= 2	–	–	–	–
>2 <= 4.5	–	–	–	–
>4.5 <= 13	–	–	–	–
>13 <= 40	–	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Community 1.2
Depauperate black sagebrush

This plant community would have developed under heavy continuous season-long grazing by bison, elk, and Native American horses. Heavy utilization of grasses would have created a near monoculture of black sagebrush.

Community 1.3
Bunch grasses & Perennial Forbs/Sparse black sagebrush

There are several environmental conditions that would have produced this plant community. Heavy browsing by deer would have resulted in an herbaceous-dominated variant because of the utilization of black sagebrush during the dormant season. Under the occasional very wet period associated with an El Nino-Southern Oscillation event, temporary soil anoxia could have developed (West 2000), killing the sagebrush and allowing the forbs and grasses to dominate for a short time. A similar plant community would have also developed following an outbreak of insects and pathogens where sagebrush was the dominant host.

Community 1.4
Short-lived Shrubs/Perennial Forbs

This plant community would have developed under the combined effect of unusual drought conditions and heavy grazing by all grazers including deer, bison, elk, and Native American horses. Focused utilization would have reduced the palatable species while allowing the noxious, unpalatable, and shorter-lived species such as yellow rabbitbrush, locoweed, and phlox to predominate.

Pathway 1.1a
Community 1.1 to 1.2

Heavy continuous season-long grazing by bison, elk, and Native American horses would have converted the Reference State to a depauperate black sagebrush community.

Pathway 1.1b
Community 1.1 to 1.3

Heavy browsing by deer would have converted the Reference State to a plant community dominated by bunchgrasses and perennial forbs. An extremely wet period such as an El Nino-Southern Oscillation event and

subsequent anoxious soil conditions would have converted the Reference State to a plant community dominated by bunchgrasses and perennial forbs. The same result would occur following a sudden insect (or other pathogen) outbreak on sagebrush.

Pathway 1.1c
Community 1.1 to 1.4

The interaction of exceptionally dry climatic influences compounded by heavy continuous season-long grazing by all grazers including deer, bison, elk, and Native American horses, would have converted the Reference State to an unpalatable short-lived shrub & perennial forb plant community.

Pathway 1.2a
Community 1.2 to 1.1

The absence of grazing would have allowed the native bunchgrasses and perennial forbs to return to the system converting it back to the Community Phase 1.1.

Pathway 1.2b
Community 1.2 to 1.4

Heavy browsing by deer would have converted the depauperate black sagebrush community to an unpalatable short-lived shrub community phase.

Pathway 1.3a
Community 1.3 to 1.1

A return to normal climate conditions and the absence of heavy browsing would have allowed black sagebrush to re-establish and convert back to the Community Phase 1.1.

Pathway 1.4a
Community 1.4 to 1.1

A return to normal climate conditions followed by a prolonged reduction in grazing pressure would have allowed black sagebrush and native bunchgrasses to re-establish returning to the reference plant community (1.1).

State 2
Black Sagebrush/ Introduced Non-natives State

State 2 is identical to State 1 in form and function, with the exception of the presence of non-native plants and animals, possible extinctions of native species, and a different climate. State 2 is a description of the ecological site shortly following Euro-American settlement, which can be regarded as the current potential. The least modified plant community (2.1) within State 2 is a black sagebrush-dominated stand with scattered prickly pear and associated bunch grasses such as bluebunch wheatgrass, Indian ricegrass, Sandberg bluegrass, muttongrass, and bottlebrush squirreltail. Forbs such as phlox, buckwheat, locoweed, and common yarrow are common. The generally shallow and stony soils accentuate the effect of drought and reduce the chances of fires altering this state. This plant community is relatively stable under mixed use by wildlife and livestock. However, heavy utilization by bison, elk, horses, and domestic cattle on these sites during the growing season (2.1a) would deplete the grasses creating a near monoculture of black sagebrush (2.2). Heavy browsing by deer and sheep (2.1b) would create an herbaceous variant (2.3) because of year-round utilization of black sagebrush. Occasionally very wet years during El Nino-Southern Oscillation periods can cause temporary soil anoxia (West 2000) (2.1c) killing the sagebrush and allowing the forbs and grasses to dominate for a short time (2.3). Some insects and pathogens on sagebrush (2.1c) can lead to a similar result where the herbaceous species become temporarily dominant (2.3). The interaction of an unusually dry period and heavy utilization of grasses by bison, elk, horses, and domestic cattle (2.1d) would remove the palatable species from the plant community while allowing unpalatable, shorter-lived species such as yellow rabbitbrush, locoweed, and phlox to predominate. Species composition does not change, jus their abundance (2.4). The depauperate black sagebrush community (2.2) may also shift to the unpalatable short-lived shrub community phase (2.4) with heavy utilization of browse by deer and sheep (2.2b). Relatively rocky sites such as these typically

do not decline in overall cover or productivity, however, the portion that is palatable may change appreciably. Similarly, these soils are more resistant to erosion than associated stone-free soils. Each of the phases within State 2 can return to Community Phase 2.1 when climate conditions are within the normal range of variability and grazing pressure is moderated (2.2a, 2.3a, 2.4a). A small amount of Wyoming big sagebrush and/or an informally recognized variety of big sagebrush, called “bonnevillensis” (Shultz, 2009) may also be present.

Community 2.1
Black sagebrush/Sparse bunchgrasses & Perennial forbs

R047XA332UT Upland Stony Loam (Black sagebrush) community 2.1 Black sagebrush / sparse bunch grasses & perennial forbs. Cover is 15% grasses, 15% forbs, 30% shrubs, 5% bare ground, 30% rock and 5% litter. The overstory is dominated by Black sagebrush and the understory is dominated by

Figure 6. State 2.1

R047XA325UT- Upland Stony Loam (black sagebrush) community phase 2.1- Black sagebrush/sparse bunchgrasses/perennial forbs-Shrubs cover

Figure 7. Community Phase 2.1

The least modified plant community within the Black Sagebrush/ Introduced Non-natives State is a black sagebrush-dominated stand with scattered prickly pear and associated bunch grasses such as bluebunch wheatgrass, Indian ricegrass, Sandberg bluegrass, muttongrass, and bottlebrush squirreltail. Phlox, buckwheat, locoweed, and common yarrow are commonly associated forbs.

Community 2.2
Depauperate Black sagebrush

R047XA325UT- Upland Stony Loam (black sagebrush) community phase 2.2- Depauperate black sagebush-Black sagebrush community phase

Figure 8. Community phase 2.2

This plant community is developed under heavy continuous season-long grazing by bison, elk, cattle, and horses. Heavy utilization of grasses creates a near monoculture of black sagebrush.

Community 2.3
Bunch grasses & perennial forbs/ Sparse black sagebrush

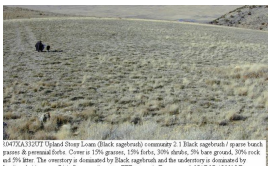
Figure 9. Community Phase 2.3

There are several environmental conditions that would produce this plant community. Heavy year-round browsing by deer and sheep would result in an herbaceous-dominated variant because of the utilization of black sagebrush. Following the occasional very wet period associated with an El Nino-Southern Oscillation event, temporary soil anoxia could develop, (West 2000) killing the sagebrush and allowing the forbs and grasses to dominate for a short time. A similar plant community would also develop following an outbreak of insects and pathogens where sagebrush is the dominant host.

Community 2.4
Short-lived shrubs/perennial forbs

This plant community is developed under extreme drought conditions combined with heavy continuous season-long grazing. Such disturbances will reduce the palatable species and allow the unpalatable, shorter-lived species such as yellow rabbitbrush, locoweed, and phlox to predominate. Because of the prevalence of historic unrestricted ungulate grazing, this is the most likely of the phases within State 2 to transition to States 3 or 4.

Pathway 2.1a
Community 2.1 to 2.2

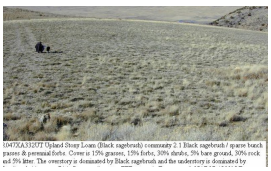


Black sagebrush/Sparse bunchgrasses & Perennial forbs

Depauperate Black sagebrush

Heavy continuous season-long grazing by bison, elk, horses, and cattle would convert the Black sagebrush/ Sparse bunchgrasses & Perennial forbs phase to a depauperate black sagebrush community.

Pathway 2.1b
Community 2.1 to 2.3



Black sagebrush/Sparse bunchgrasses & Perennial forbs

Bunch grasses & perennial forbs/ Sparse black sagebrush

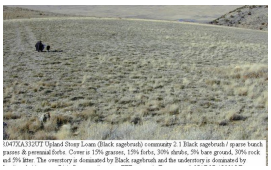
Heavy browsing by deer and sheep would convert the Black sagebrush/ Sparse bunchgrasses & Perennial forbs phase to a plant community dominated by bunchgrasses and perennial forbs. An extremely wet period such as an El Nino-Southern Oscillation event and subsequent anoxious soil conditions would convert the Black sagebrush/ Sparse bunchgrasses & Perennial forbs phase to a plant community dominated by bunchgrasses and perennial forbs. The same result would be seen following a sudden insect (or other pathogen) outbreak on sagebrush.

Pathway 2.1c
Community 2.1 to 2.4

The interaction of exceptionally dry climatic influences and heavy continuous season-long grazing by all grazers would convert the Black sagebrush/ Sparse bunchgrasses & Perennial forbs phase to an unpalatable short-lived shrub and perennial forb plant community.

Pathway 2.2a
Community 2.2 to 2.1

Depauperate Black sagebrush



Black sagebrush/Sparse bunchgrasses & Perennial forbs

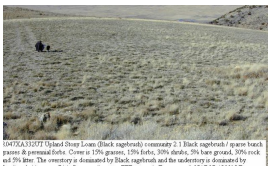
This plant community can move back towards the Black sagebrush/ Sparse bunchgrasses & Perennial forbs phase when grazing management, particularly of sheep, and use by deer, take place only during the non-growing season of the herbaceous component, along with broadcast re-seeding with native perennial forbs and grasses.

Pathway 2.2b
Community 2.2 to 2.4

Heavy browsing by deer and sheep would convert the depauperate black sagebrush phase to the unpalatable short-lived shrub and perennial forb community

Pathway 2.3a
Community 2.3 to 2.1

Bunch grasses & perennial forbs/ Sparse black sagebrush



Black sagebrush/Sparse bunchgrasses & Perennial forbs

This plant community can move back to the Black sagebrush/ Sparse bunchgrasses & Perennial forbs phase with a return to normal climate conditions and when grazing by both livestock and wildlife is concentrated during the spring to put pressure on the herbaceous component, allowing the native woody component to re-establish.

Pathway 2.4a
Community 2.4 to 2.1

A return to the Black sagebrush/ Sparse bunchgrasses & Perennial forbs phase is possible with a return to normal (or wetter) climate conditions and high intensity short duration grazing management to allow the native woody component to re-establish and decrease the competition by herbaceous species.

State 3
Introduced Annuals/Biennials State

Invasive annuals and biennial forbs such as cheatgrass (*Bromus tectorum*), Russian thistle (*Salsola tragus*), knapweeds (Centaurea spp.), and horehound (*Marrubium vulgare*) are favored by an increase in nutrient build-up in old, eutrophicated sheep bedgrounds. Where fire return intervals are frequent (3.2a) annuals such as cheatgrass and Russian thistle will predominate (3.1). Longer intervals between fire events (3.1a) will result in a plant community dominated by biennial forbs (3.2). The soil profiles of the plant communities within this state are mainly intact. Although there have been previous attempts to apply tillage and chemicals to improve the composition and productivity in areas where the ESD has developed into this state (see files in the State Range Conservationist Office for details), the biological responses may be too low to justify the economic investment. Therefore, currently available rangeland manipulations are not recommended.

Community 3.1
Annual grass/annual forb

This plant community will develop where fire return intervals are frequent and annual species such as cheatgrass and Russian thistle predominate.

Community 3.2
Annual forb/beinnal forb

This plant community will develop when intervals between fires are longer, allowing biennial species such as knapweeds, tumblemustard (*Sisymbrium altissimum*), and Dyer's woad (*Isatis tinctoria*) to become established.

Pathway 3.1a
Community 3.1 to 3.2

When intervals between fire events are prolonged, biennial forbs will dominate the plant community.

Pathway 3.2a
Community 3.2 to 3.1

When fire return intervals are frequent, annual forbs and grasses will dominate the plant community.

State 4
Cushion Plant State

Curlycup gumweed (*Grindelia squarrosa*) and other cushion plants such as spiny phlox (*Phlox hoodii*), pricklyphlox

(Leptodactylon spp.), etc. are found on highly eroded sites, where accelerated soil erosion and soil compaction caused by mechanical damage has removed the fine soil particles and compacted the soils leaving a rocky self-armored surface (4.1). As with State 3, although there have been previous attempts to apply tillage and chemicals to improve the composition and productivity in areas where the ESD has developed into this state (see files in the State Range Conservationist Office for details), the biological responses may be too low to justify the economic investment. Therefore, currently available rangeland manipulations are not recommended.

Community 4.1
Cushion Plant/annual forb

Figure 10. Desert pavement

This plant community will develop following prolonged mechanical damage caused by trail and road development, excessive trail/foot traffic, and jeep/ATV impacts resulting in permanent reduction of plant cover. The only plants remaining are those tolerant of drought, infertile soil, and mechanical disturbances.

Transition T1a
State 1 to 2

The simultaneous introduction of exotic species, both plants and animals, and possible extinctions of native flora and fauna, along with climate change, will cause State 1 to transition to State 2. A return pathway back to State 1 would be impracticable because of these issues.

Transition T2a
State 2 to 3

The Black Sagebrush/ Introduced Non-natives State will transition to the Introduced Annuals/Biennials State following a sustained period of eutrophication caused by excessive year-long livestock grazing, trampling and bedding, especially by large flocks of domestic sheep. Sheep bedding, salting, watering, and handling locations involve intensive trampling, urination, defecation, and consequent eutrophication, which can be influential in this type of transition. It is also common to see accelerated soil erosion in such locations.

Transition T2b
State 2 to 4

The Black Sagebrush/ Introduced Non-natives State will transition to the Cushion Plant State under conditions marked by accelerated soil erosion and soil compaction caused by mechanical damage from trail and road development, excessive trail/foot traffic, and/or jeep/ATV impacts resulting in permanent reduction of plant cover.

Additional community tables

Table 10. Community 1.1 plant community composition

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

Shrub/Vine					
0	**Dominant Shrubs**			310–400	
	black sagebrush	ARNO4	*Artemisia nova*	250–300	–
	yellow rabbitbrush	CHVIV4	*Chrysothamnus viscidiflorus ssp. viscidiflorus var. viscidiflorus*	30–50	–
	antelope bitterbrush	PUTR2	*Purshia tridentata*	20–30	–
	Saskatoon serviceberry	AMAL2	*Amelanchier alnifolia*	10–20	–
3	**Sub-Dominant Shrubs**			70–130	
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	30–50	–
	Wyoming big sagebrush	ARTRW8	*Artemisia tridentata ssp. wyomingensis*	10–20	–
	slender buckwheat	ERMI4	*Eriogonum microthecum*	10–20	–
	winterfat	KRLA2	*Krascheninnikovia lanata*	0–20	–
	creeping barberry	MARE11	*Mahonia repens*	10–20	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	10–20	–
	spineless horsebrush	TECA2	*Tetradymia canescens*	0–20	–
Grass/Grasslike					
0	**Dominant Grasses**			260–470	
	bluebunch wheatgrass	PSSP6	*Pseudoroegneria spicata*	150–250	–
	Sandberg bluegrass	POSE	*Poa secunda*	20–50	–
	western wheatgrass	PASM	*Pascopyrum smithii*	30–50	–
	squirreltail	ELEL5	*Elymus elymoides*	10–20	–
1	**Sub-Dominant Grasses**			110–200	
	Grass, annual	2GA	*Grass, annual*	30–50	–
	Grass, perennial	2GP	*Grass, perennial*	30–50	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	10–20	–
	Letterman's needlegrass	ACLE9	*Achnatherum lettermanii*	10–20	–
	needle and thread	HECO26	*Hesperostipa comata*	10–20	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	10–20	–
	muttongrass	POFE	*Poa fendleriana*	10–20	–
Forb					
0	**Dominant Forbs**			30–50	
	arrowleaf balsamroot	BASA3	*Balsamorhiza sagittata*	20–30	–
	spiny phlox	PHHO	*Phlox hoodii*	10–20	–
2	**Sub-Dominant Forbs**			60–180	
	Forb, annual	2FA	*Forb, annual*	30–50	–
	Forb, perennial	2FP	*Forb, perennial*	30–50	–
	tuber starwort	PSJA2	*Pseudostellaria jamesiana*	0–25	–
	stemless mock goldenweed	STAC	*Stenotus acaulis*	0–25	–
	salsify	TRPO	*Tragopogon porrifolius*	0–10	–
	blue flax	LIPE2	*Linum perenne*	0–10	–
	Gray's biscuitroot	LOGR	*Lomatium grayi*	0–10	–

	beardtongue	PENST	*Penstemon*	0–10	–
	common yarrow	ACMI2	*Achillea millefolium*	0–10	–
	agoseris	AGOSE	*Agoseris*	0–10	–
	onion	ALLIU	*Allium*	0–10	–
	pussytoes	ANTEN	*Antennaria*	0–10	–
	silverleaf milkvetch	ASAR4	*Astragalus argophyllus*	0–10	–
	milkvetch	ASTRA	*Astragalus*	0–10	–
	Indian paintbrush	CASTI2	*Castilleja*	0–10	–
	Douglas' dustymaiden	CHDO	*Chaenactis douglasii*	0–10	–
	wavyleaf thistle	CIUN	*Cirsium undulatum*	0–10	–
	bastard toadflax	COUM	*Comandra umbellata*	0–10	–
	larkspur	DELPH	*Delphinium*	0–10	–
	shortstem buckwheat	ERBR5	*Eriogonum brevicaule*	0–10	–
	mountain pepperweed	LEMO2	*Lepidium montanum*	0–10	–
	bitter root	LERE7	*Lewisia rediviva*	0–5	–

Animal community

This site is used by cattle and sheep during spring, summer, and fall.
This site has high values for rangeland and openland but low values for woodland and wetland.
Wildlife species that may be found on this site are sage grouse, pronghorn antelope, mule deer, and elk.

Hydrological functions

Recreational uses

This site has fair to good aesthetic appeal and is valued for open space. In good condition it has a relatively large number of forbs and a few shrubs which bloom in the spring and early summer. It has very little value for screening because of the low growing nature of the plants and is not valued for camping and picnicking. Hiking, horseback riding, and wildlife viewing are potential recreational activities. Snowmobiling is a possible winter recreation activity, but this may conflict with large populations of wintering mule deer and pronghorn antelope.

Wood products

None

Inventory data references

Information presented here has been derived from NRCS clipping data and other inventory data. Field observations from range trained personnel were also used.

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Contributors

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Approval

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Rangeland health reference sheet

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

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Date	02/24/2014
Approved by	Kendra Moseley
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** No rills present at low slopes. Very minor rill development may occur as slope increases. If rills are present, they should be widely spaced and not connected. The presence of surface and subsurface rock fragment should reduce rill formation.

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2. **Presence of water flow patterns:** Water flow patterns will be very short if present and narrow. They should be

interrupted by plants and surface rocks. Flow patterns may be around surface rock and perennial plant bases and show minor evidence of erosion. Evidence of flow will increase somewhat with slope.

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3. **Number and height of erosional pedestals or terracettes:** Plants may show minor pedestaling on their down slope side. Terracettes should be few and stable.

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** 20 – 30%. (Soil surface is typically covered with 50% rock).

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5. **Number of gullies and erosion associated with gullies:** No gullies present.

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6. **Extent of wind scoured, blowouts and/or depositional areas:** Very little evidence of active wind generated soil movement. Wind caused blowouts and depositions are not present, but may be present after a fire.

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7. **Amount of litter movement (describe size and distance expected to travel):** Some down slope redistribution caused by water. Some litter removal may occur in flow channels with deposition occurring at points of obstruction. Litter movement will increase with slope.

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** 70 to 80% of this site should have an erosion rating of 4 or 5. 20 to 30% may have a rating of 3 to 4. The average should be a 4. Litter accumulation and cryptogamic crusts reduce erosion. The presence of surface rock also reduces site erosion.

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil surface varies from 3 to 10 inches. Structure is fine granular or fine platy. Color typically varies from light grayish brown (10YR6/2) to brown (10YR4/3). Soils typically have a mollic epipedon that extends from 8 to 17 inches deep.

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** When perennial grasses decrease, reducing ground cover and increasing bare ground, runoff will increase and infiltration will be reduced. There will also be more runoff after a fire on this site.

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11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** None. Some soils have bedrock at approximately 10 to 30 inches.

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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: Non-sprouting shrubs (black sagebrush) >= perennial bunchgrasses (bluebunch wheatgrass)

Sub-dominant: sprouting shrubs (rabbitbrush) = forbs (arrowleaf balsamroot, spiny phlox)

Other:

Additional:

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Slight decadence in the principle shrubs could occur near the end of the long fire cycle. Very little mortality should be apparent in other plants.

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14. **Average percent litter cover (%) and depth (in):**

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** 900 - 1000 #/acre on an average year

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

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17. **Perennial plant reproductive capability:** All perennial plants should have the ability to reproduce in all years, except in extreme drought years.
