USDA Natural Resources
Conservation Service

Ecological site R047XA530UT
High Mountain Gravelly Loam (subalpine big sagebrush)

Last updated: 2/06/2025
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General information

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

MLRA notes

Major Land Resource Area (MLRA): 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. The southern half is in the High Plateaus of the Utah Section of the Colorado Plateaus Province of the Intermontane Plateaus. 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, and the Unita Mountains, which trend east and west. 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 Uinta Mountains have a broad, gently arching, elongated shape. Structurally, they consist of a broadly folded anticline that has an erosion-resistant quartzite core. The Wasatch and Uinta Mountains have an elevation of 4,900 to about 13,500 feet (1,495 to 4,115 meters). 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, but Precambrian rocks are exposed in the Uinta Mountains. The Uinta Mountains are one of the few ranges in the United States that are oriented west to east. The southern Wasatch Mountains consist of Tertiary volcanic rocks occurring as extrusive lava and intrusive crystalline rocks.
The average precipitation is from 8 to 16 inches (203 to 406 mm) in the valleys and can range up to 73 inches (1854 mm) in the mountains. In the northern and western portions of the MLRA, peak precipitation occurs in the winter months. The southern and eastern

portions have a greater incidence of high-intensity summer thunderstorms; hence, a significant amount of precipitation occurs during the summer months. The average annual temperature is 30 to 50 degrees F (-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 Aridisols, Entisols, Inceptisols, and Mollisols. The lower elevations are dominated by a frigid temperature regime, while the higher elevations experience cryic temperature regimes. Mesic temperature regimes come in on the lower elevations and south facing slopes in the southern portion of this MLRA. The soil moisture regime is typically xeric in the northern part of the MLRA, but grades to ustic in the extreme eastern and southern parts. The minerology is generally mixed and the soils are very shallow to very deep, generally well drained, and loamy or loamy –skeletal.

LRU notes

Major Land Resource Unit 47A is located in the northern half of the Middle Rocky Mountains Province of the Rocky Mountain System. This MLRA 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.

Ecological site concept

The soils of this site formed mostly in colluvium, slope alluvium and/or alluvium over residuum weathered from shale. Surface soils are very channery loam to loam in texture. Rock fragments may be present on the soil surface and throughout the profile, and make up greater than 35 percent of the soil volume. These soils are moderately deep, well-drained, and have moderately slow to moderate permeability. Available water-holding capacity ranges from 0.7 to 3.5 inches of water in the upper 40 inches of soil. The soil moisture regime is mostly udic and the soil temperature regime is cryic. Precipitation ranges from 24-34 inches annually.

Associated sites

F047XA531UT	**High Mountain Stony Loam (quaking aspen)** These sites often occur adjacent to each other.

Similar sites

R047XA516UT	**High Mountain Loam (mountain big sagebrush)** Similar floral characteristics, however this site has less rock fragment in the soil profile.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Artemisia tridentata ssp. spiciformis*
Herbaceous	Not specified

Physiographic features

This ecological site typically occurs on mountain slopes with slopes normally range from 5 to 60 percent but may occasionally be steeper. Slope steepness, aspect and elevation will influence the vegetative floristics of this site. Sites are typically located between 7,400 to 10,300 feet in elevation. Runoff is high to very high.

Table 2. Representative physiographic features

Landforms	(1) Mountain slope
Runoff class	High to very high
Flooding frequency	None
Ponding frequency	None
Elevation	2,256–3,139 m
Slope	5–60%
Ponding depth	Not specified
Water table depth	Not specified

Climatic features

The climate of this site characterized by cold, snowy winters and cool summers. The average annual precipitation ranges from 24 to 34 inches. October thru April, are typically the wettest months with June thru August being the driest. The most reliable sources of moisture for plant growth are the snow that accumulates over the winter and spring rains. Summer thunderstorms are intermittent and sporadic in nature, and thus, are less reliable sources of moisture to support vegetative growth on this site.

Table 3. Representative climatic features

Frost-free period (characteristic range)	
Freeze-free period (characteristic range)	
Precipitation total (characteristic range)	610-864 mm

Influencing water features

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

Soil features

The soils of this site formed mostly in colluvium, slope alluvium or alluvium over residuum weathered from shale. Surface soils are very channery loam to loam in texture. Rock fragments may be present on the soil surface and throughout the profile, and make up greater than 35 percent of the soil volume. These soils are moderately deep, well-drained, and have moderately slow to moderate permeability. Available water-holding capacity ranges from 0.7 to 3.5 inches of water in the upper 40 inches of soil. The soil moisture regime is mostly udic and the soil temperature regime is cryic. Precipitation ranges from 24 to 34 inches annually.

Table 4. Representative soil features

Parent material	(1) Colluvium–shale (2) Alluvium–shale (3) Slope alluvium–shale
Surface texture	(1) Very channery loam (2) Loam
Family particle size	(1) Loamy-skeletal
Drainage class	Well drained
Permeability class	Moderately slow to moderate
Depth to restrictive layer	51–102 cm
Soil depth	51–102 cm
Surface fragment cover <=3"	10–40%
Surface fragment cover >3"	0–15%
Available water capacity (Depth not specified)	1.78–8.89 cm
Calcium carbonate equivalent (Depth not specified)	0%
Electrical conductivity (Depth not specified)	0–1 mmhos/cm
Sodium adsorption ratio (Depth not specified)	0
Soil reaction (1:1 water) (Depth not specified)	6.1–7.9

Subsurface fragment volume <=3" (Depth not specified)	0%
Subsurface fragment volume >3" (Depth not specified)	30–40%

Ecological dynamics

It is impossible to determine in any quantitative detail the reference state 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. 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. In the 1860's, Europeans brought cattle and horses to the area, grazing large numbers of them on unfenced parcels year-long. Itinerant and local sheep flocks followed, largely replacing cattle as the browse component 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 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.

Plant Community Narratives:
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 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 dominant shrub would have been subalpine sagebrush (Artemisia spiciformis) (Shultz 2006). A lush perennial understory would have been composed of grasses including slender wheatgrass (*Elymus trachycaulus*), spike fescue (*Leucopoa kingii*), Columbia needlegrass (*Achnatherum nelsonii*), and nodding brome (*Bromus anomalus*). Forbs would have included sticky purple geranium (*Geranium viscosissimum*), Fendler's meadow-rue (*Thalictrum fendleri*), Nevada pea (*Lathyrus lanszwertii*), and sulphur-flower buckwheat (*Eriogonum umbellatum* var. umbellatum) among many others. A more complete list of species by lifeform for the Reference State is available in accompanying tables in the "Plant Community Composition by Weight and Percentage" section of this document. The time elapsed since last wildfire would have been the driving factor behind the relative abundance of shrubs relative to the associated understory. Following a recent wildfire (1.2a), an herbaceous dominant phase would have been found (1.1). As the time since last fire increased (1.1a), the shrub component would have increased (1.2).

Community Phase 1.1: scattered subalpine sagebrush with diverse & abundant herbs
This plant community would have been a sagebrush-steppe where the herbaceous component would have been slightly greater than the shrub component. The dominant herbaceous species would have included slender wheatgrass, spike fescue, Columbia needlegrass, nodding brome, sticky purple geranium, Fendler's meadowrue, Nevada pea, and sulphur-flower buckwheat, along with a scattering of subalpine sagebrush.

Community Pathway 1.1a:
As the length of time elapsed since the last fire lengthened the shrubs would have increased relative to the herbs.

Community Phase 1.2: subalpine sagebrush-steppe with diverse with increasing shrub dominance
This phase would have been characterized by a greater proportion of subalpine sagebrush relative to the herbs.

Community Pathway 1.2a:
Wildfire would temporarily reduce the shrub dominance allowing the native perennial grasses and forbs to dominate.

Transition T1a: from State 1 to State 2 (Reference State to subalpine Sagebrush/ Introduced Non-natives State)
The simultaneous introduction of exotic species, both plants and animals, possible

extinctions of native flora and fauna, and climate change has caused State 1 to transition to State 2. Reversal of such historic changes (i.e. a return pathway) back to State 1 is not practical, but because this plant community is particularly resilient, it may be possible to achieve a plant community that is almost identical to the Reference State.

State 2: subalpine Sagebrush/ Introduced Non-natives State:
State 2 is very similar to State 1 in form and function, with the exception of the presence of non-native plants and animals, possible extinctions of some native species, and a different climate. State 2 is a description of the ecological site shortly following Euro-American settlement. This state can be regarded as the current potential. The primary shrub is subalpine sagebrush. The native perennial herbs are slightly reduced due to impacts from heavy seasonal grazing, but the species would likely still include those present in the Reference State (State 1). A small component of non-native introduced annuals are now also present including Douglas' knotweed (*Polygonum douglasii*), mountain tarweed (*Madia glomerata*), and Kentucky bluegrass (*Poa pratensis*). The resiliency of this State is maintained by a healthy, productive, and diverse plant community that can provide native seed sources and promotes soil stability, water infiltration, and soil moisture retention. The maintenance this State will be encouraged by a reduction in livestock grazing pressure. Conversely, continued heavy livestock grazing during the growing season will negatively impact the resiliency of this State.

Community Phase 2.1: subalpine sagebrush/diminished native perennial herbs/introduced annuals
The primary plant community in State 2 is a subalpine sagebrush-dominated site with a slightly diminished native perennial herbaceous understory. Species include slender wheatgrass, spike fescue, Columbia needlegrass, nodding brome, sticky purple geranium, Fendler's meadow-rue, Nevada pea, and sulphur-flower buckwheat; however several introduced annual species occur as well.

Transition T2a: from State 2 to State 3 (subalpine Sagebrush/ Introduced Non-natives State to subalpine Sagebrush Super-dominance State)
Prolonged lack of fire and heavy continuous season long grazing (which occurred at many sites particularly between the 1860s and the 1950s), creates a shrub-dominated site where introduced annuals begin to replace the native herbaceous species. The approach to this transition is indicated by an increase in size, age class, and density of sagebrush and by a reduction in the understory. The trigger causing this transition is heavy growing season livestock grazing. If seed sources for desirable native species are still present, it may be possible to avoid or reverse this transition with a reduction in growing season livestock grazing.

State 3: subalpine Sagebrush Super-dominance State:
subalpine sagebrush has grown denser and taller in areas that have received nearly a century-long period of heavy livestock grazing during growing season of herbs and where fire has been suppressed (T2a). Introduced annuals such as common dandelion (*Taraxacum officinale*), mountain tarweed, and Douglas' knotweed have become

abundant in the understory. The stability of this less desirable State is maintained by the lack of a healthy, productive and diverse herb component capable of providing native seed source and soil moisture retention. Heavy growth-season livestock grazing will negatively impact the resiliency of this State.

Community Phase 3.1: tall & dense subalpine sagebrush/ diminished native perennial herbs/ Increasing introduced annuals
This plant community is characterized subalpine sagebrush dominance. The native perennial herbs have nearly been grazed out while several grazing-tolerant annual species have been introduced.

Transition T3a: from State 3 to State 4 (subalpine Sagebrush Super-dominance State to Managed Herbaceous State
Depending on the desired outcome and provided adequate native perennial species are still present, a the establishment of a native herbaceous community is possible through brush removal using either chemical means (i.e. 2,4-D) or prescribed fire, followed by a period of grazing deferment for at least one year, and moderate grazing thereafter.

Transition T3b: from State 3 to State 5 (subalpine Sagebrush Super-dominance State to Introduced Grassland State
On sites with lowered productivity and reduced native species, some have opted to till and re-seed with an introduced species such as orchardgrass (*Dactylis glomerata*), or Kentucky bluegrass (*Poa pratensis*) to increase forage production potential. Smooth brome (*Bromus inermis*) may have also been seeded to control soil erosion.

State 4: Managed Herbaceous State:
This state is dominated by native perennial herbs, either pure grasses or mixed forbs and grasses (4.1). If shrubs are removed by chemical means, the forb component will also be removed leaving only the native perennial grasses. If prescribed fire is used to remove shrubs, this will provide an equal opportunity for both grasses and forbs to respond. If keeping the shrubs back is desirable, then re-treatment using fire or chemicals may be necessary (4.1a). The resiliency of this State will be maintained by reductions in livestock grazing. Accelerated soil erosion will reduce the resiliency of this State.

Community Phase 4.1: native perennial grasses or herb dominance
This plant community is dominated by purely grasses or a mixture of native perennial forbs and grasses following brush removal by either chemical or prescribed fire, respectively.

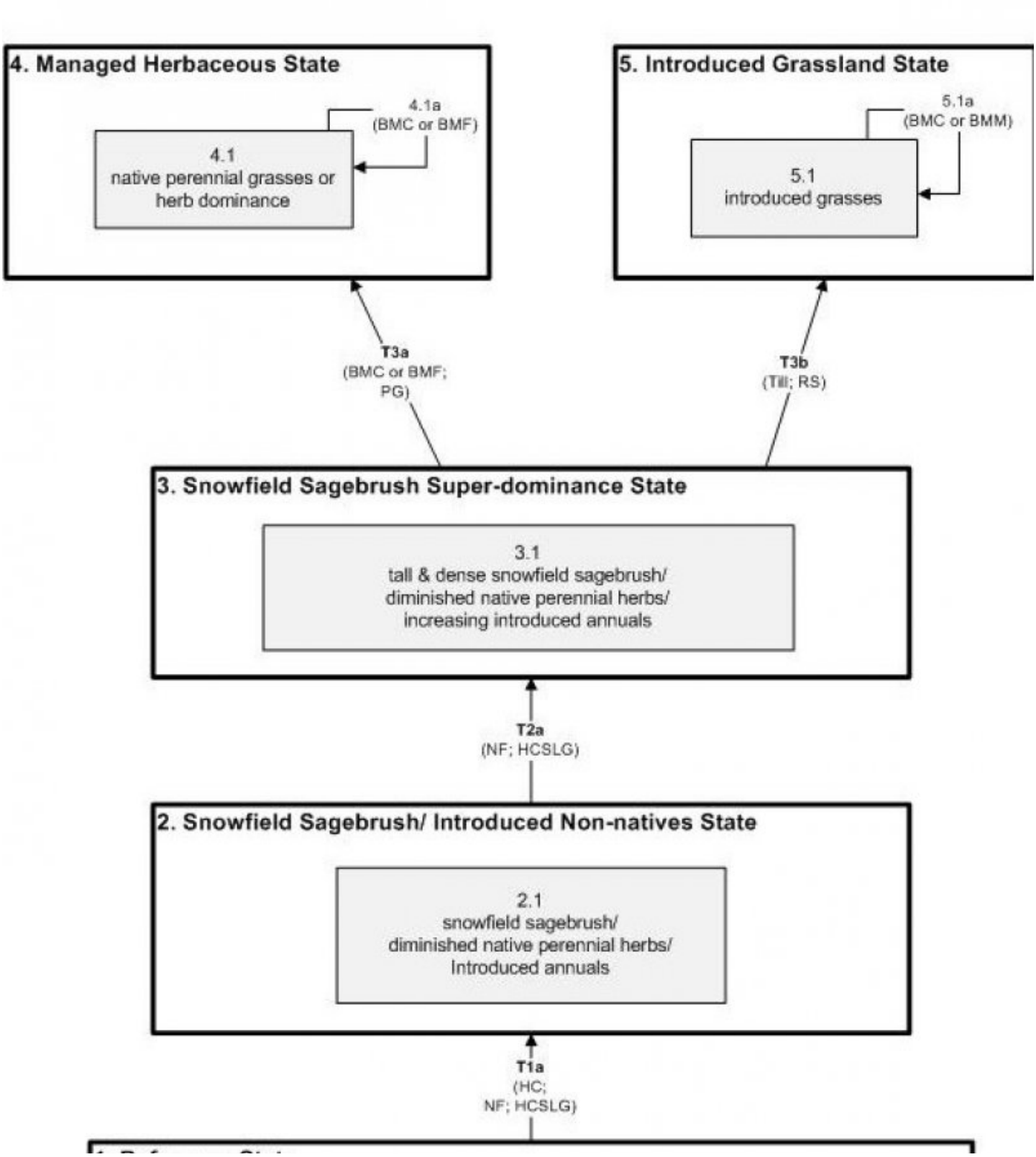
Community Pathway 4.1a:
Re-treatment of brush by either chemical means or prescribed fire may be necessary to maintain this herbaceous State.

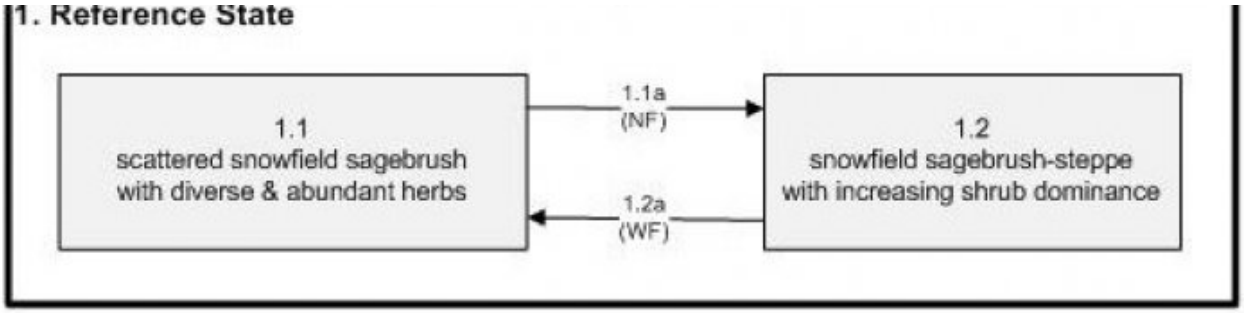
State 5: Introduced Grassland State:
This State is dominated by introduced grasses such as ‘Sherman’ big bluegrass (a variety of Poa ampla), smooth brome, or orchardgrass.

Community Phase 5.1: introduced grasses
Introduced grasses are dominant in this plant community.

Community Pathway 5.1a:
Re-treatment of brush by either chemical or mechanical means will be required to maintain a grass-dominated State.

State and transition model





BMC	Brush Management Chemical	PG	Prescribe Grazing
BMF	Brush Management Fire	RS	Re-seed
BMM	Brush Management Mechanical	Till	Tillage
HC	Historic Change	WF	Wildfire
HCSLG	Heavy Continuous Season Long Grazing		
NF	No Fire		

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.

Other references

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Contributors

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Approval

Kendra Moseley, 2/06/2025

Rangeland health reference sheet

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

Author(s)/participant(s)	
Contact for lead author	
Date	05/20/2025
Approved by	Kendra Moseley
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

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2. **Presence of water flow patterns:**

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3. **Number and height of erosional pedestals or terracettes:**

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

5. **Number of gullies and erosion associated with gullies:**

6. **Extent of wind scoured, blowouts and/or depositional areas:**

7. **Amount of litter movement (describe size and distance expected to travel):**

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

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:

    Sub-dominant:

    Other:

    Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**

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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):**

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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:**

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17. **Perennial plant reproductive capability:**
