

Ecological site R060BE567MT Coarse Clay 10-14

Last updated: 9/07/2023
Accessed: 05/03/2024

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.

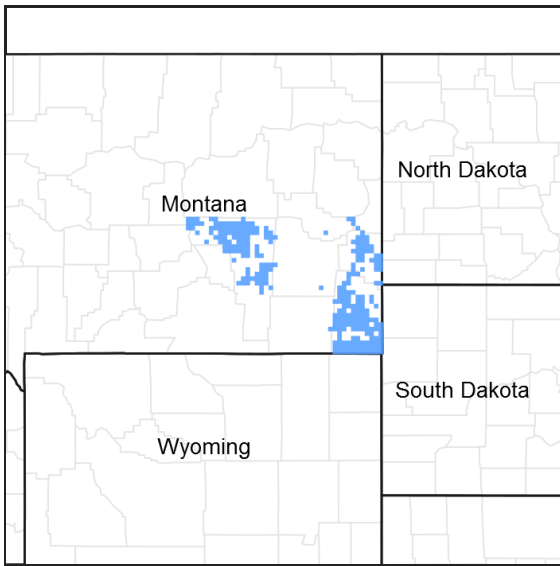


Figure 1. Mapped extent

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): 060B–Pierre Shale Plains, Northern Part

MLRA 060B, Pierre Shale Plains (Northern Part), is almost entirely in Montana (94 percent) and Wyoming (6 percent). The area makes up about 2,160,000 acres and occurs in the uplands between most of the major rivers in southeastern Montana and northeastern Wyoming. The area is within the Missouri Plateau, Unglaciated, Section of the Great Plains Province of the Interior Plains. It is an area of old plateaus and terraces that have been deeply eroded.

The shale plains have long, smooth, gentle to strong slopes. Slopes along drainageways and streams are moderately steep or steep. Elevation ranges from 1,900 to 3,500 feet on uplands. Marine and continental sediments of the Cretaceous Montana Group underlie most of this MLRA.

The average annual precipitation in the area is 14 inches and ranges from 11 to 17 inches. Most of the annual precipitation occurs as high-intensity, convective thunderstorms during the growing season. Precipitation in winter occurs mainly as snow, which usually is accompanied by high winds that cause much drifting.

The average annual temperature is 43 to 46 degrees Fahrenheit. The freeze-free period averages 142 days and ranges from 130 to 160 days. The frost-free period averages 120 days and ranges from 110 to 135 days.

The dominant soil orders in this MLRA are Alfisols, Entisols, and Vertisols. The soils in the area dominantly have a frigid soil temperature regime, an ustic soil moisture regime, and smectitic mineralogy. The soils are shallow to very deep, generally well drained, and clayey.

The area supports native prairie vegetation characterized by a diversity of cool-season and warm-season grasses, sedges, forbs, and shrubs. A majority of this area is in farms or ranches and comprised of rangeland used for livestock grazing. Some small areas of nearly level to moderately sloping soils are used for winter wheat or for livestock feed crops.

Classification relationships

NRCS Soil Geography Hierarchy

- Land Resource Region: Western Great Plains
- Major Land Resource Area (MLRA): 060B Pierre Shale Plains, Northern Part

National Hierarchical Framework of Ecological Units (Cleland et al., 1997; McNab et al., 2007)

- Domain: Dry
- Division: Temperate Steppe
- Province: Great Plains-Palouse Dry Steppe Province (331)
- Section: North Central Highlands (331K) and Missouri Plateau Section (331M)

National Vegetation Classification Standard (Federal Geographic Data Committee, 2008)

- Class: Xeromorphic Woodland, Scrub and Herb Vegetation Class (3)
- Subclass: Cool Semi-Desert Scrub and Grassland Subclass (3.B)
- Formation: Cool Semi-Desert Scrub and Grassland Formation (3.B.1)
- Division: Cool Semi-Desert Scrub and Grassland Division (3.B.1.Ne)
- Macrogroup: Artemisia tridentata - Artemisia tripartita ssp. tripartita - Purshia tridentata Steppe and Shrubland Macrogroup (3.B.1.Ne.3)
- Group: Artemisia tridentata ssp. wyomingensis - Artemisia tridentata ssp. tridentata Steppe & Shrubland Group (3.B.1.Ne.3.a)

EPA Ecoregions

- Level 1: Great Plains (9)
- Level 2: West-Central Semi-Arid Prairies (9.3)
- Level 3: Northwestern Great Plains (9.3.3)
- Level 4: Sagebrush Steppe (43e)

Ecological site concept

This ecological site occurs on hills and plains in shale uplands at elevations ranging from 1,900 to 3,500 feet. Slopes range from 0 to 25 percent. This site occurs on all aspects, although aspect is not a significant factor. This ecological site is associated with hard, acidic shales that are shallow to moderately deep and are well drained. Fragments from the shale parent material cause these soils to respond similar to sand. The soil surface textures are typically clay, silty clay, or silty clay loam.

Associated sites

| | |
|-------------|--|
| R060BE577MT | <p>Shallow Clay 10-14</p> <p>The Shallow Clay ecological site occurs on slopes ranging from 0 to 70 percent, has a soil depth of 10 to 20 inches to shale, and has lower total annual production. The Shallow Clay ecological site has more developed soils with minimal to no shale fragments near the soil surface. The Shallow Clay ecological site is located on similar landform positions as the Coarse Clay ecological site.</p> |
| R060BE566MT | <p>Clayey 10-14</p> <p>The Clayey ecological site occurs on slopes ranging from 0 to 15 percent, has a soil depth of 20 to 72 inches to shale, and has higher total annual production. The Clayey ecological site has more developed soils with minimal to no shale fragments near the soil surface. The Clayey ecological site is generally located below the the Coarse Clay ecological site.</p> |

| | |
|-------------|--|
| R060BE583MT | <p>Clayey Steep 10-14</p> <p>The Clayey Steep ecological site occurs on slopes ranging from 15 to 45 percent, has a soil depth of 20 to 72 inches to shale, and has higher total annual production. The Clayey Steep ecological site has more developed soils with minimal to no shale fragments near the soil surface. The Clayey Steep ecological site is located on similar landform positions as the Coarse Clay ecological site.</p> |
|-------------|--|

Similar sites

| | |
|-------------|--|
| R060BE577MT | <p>Shallow Clay 10-14</p> <p>The Shallow Clay ecological site occurs on slopes ranging from 0 to 70 percent, has a soil depth of 10 to 20 inches to shale, and has lower total annual production. The Shallow Clay ecological site has more developed soils with minimal to no shale fragments near the soil surface. The Shallow Clay ecological site is located on similar landform positions as the Coarse Clay ecological site.</p> |
|-------------|--|

Table 1. Dominant plant species

| | |
|------------|---|
| Tree | (1) <i>Pinus ponderosa</i> (2) <i>Juniperus scopulorum</i> |
| Shrub | (1) <i>Yucca</i> |
| Herbaceous | (1) <i>Calamovilfa longifolia</i> (2) <i>Schizachyrium scoparium</i> |

Physiographic features

This ecological site occurs on hills and plains in shale uplands at elevations ranging from 1,900 to 3,500 feet. Slopes range from 0 to 25 percent. This site occurs on all aspects, although aspect is not a significant factor.

Table 2. Representative physiographic features

| | |
|--------------------|------------------------------------|
| Landforms | (1) Hill (2) Plain |
| Runoff class | Medium to high |
| Flooding frequency | None |
| Ponding frequency | None |
| Elevation | 579–1,067 m |
| Slope | 0–25% |
| Water table depth | 152–183 cm |
| Aspect | Aspect is not a significant factor |

Climatic features

MLRA 060B is a semi-arid region and is considered to have a continental climate characterized by cold winters, hot summers, low humidity, light rainfall, and much sunshine. The climate is the result of the MLRA's location in the geographic center of North America. Temperatures can be extreme.

The average annual temperature is 43 to 46 degrees Fahrenheit. Summer daytime temperatures are typically quite warm, generally averaging in the lower to mid-80's for July and August. Summertime temperatures will typically reach 100 degrees or more at some point during the summer and can reach 90 degrees during any month between May and September. Conversely, winter temperatures can be cold, averaging in the mid-teens to mid-20's for December and January. There will typically be several days of below zero temperatures each winter. It is not uncommon for temperatures to reach 30 to 40 degrees below zero, or even colder, most any winter.

The average annual precipitation in this area is 14 inches, and ranges from 11 to 17 inches. During an average year, 70 to 75 percent of the annual precipitation falls between April and September, which are the primary growing season months. A majority of the annual precipitation occurs as frontal storms early in the growing season during

the months of May and June and high-intensity, convective thunderstorms during July and August. Some rainfall occurs during the fall.

Seasonal precipitation is often limiting for plant growth. Annual fluctuations in species composition and total production are typical depending on the amount and timing of rainfall. Precipitation during the winter occurs primarily as snow, although snowfall is generally not heavy. Snow cover is typically 1 to 3 inches. Heavy snowfall occurs infrequently, usually late in the winter or early spring. Snowfall is generally accompanied by high winds that causes drifting.

The prevailing wind direction is from the northwest. Precipitation fluctuates widely from year to year and severe drought occurs 2 out of 10 years on average. There are few natural barriers on the northern Great Plains and the winds move freely across the plains and account for rapid changes in temperature. Spring can be windy throughout the MLRA, with winds averaging over 10 mph about 15 percent of the time. Speeds of 50 mph or stronger can occasionally occur.

For local climate station information, refer to <https://wrcc.dri.edu/summary/Climsmemt.html>.

Table 3. Representative climatic features

| | |
|--|--------------|
| Frost-free period (characteristic range) | 110-135 days |
| Freeze-free period (characteristic range) | 130-160 days |
| Precipitation total (characteristic range) | 254-356 mm |
| Frost-free period (actual range) | |
| Freeze-free period (actual range) | |
| Precipitation total (actual range) | 254-432 mm |
| Frost-free period (average) | 120 days |
| Freeze-free period (average) | 142 days |
| Precipitation total (average) | 356 mm |

Climate stations used

- (1) INGOMAR 14 NE [USC00244386], Ingomar, MT
- (2) RIDGEWAY 1 S [USC00247034], Hammond, MT
- (3) ALBION 1 N [USC00240088], Alzada, MT
- (4) BAKER MUNI AP [USW00094055], Baker, MT

Influencing water features

This upland ecological site is not influenced by a water table or run in from adjacent sites. Due to the semi-arid climate in which it occurs, the water budget is normally contained within the soil pedon. Soil moisture is recharged by spring rains, but it rarely exceeds field capacity in the upper 40 inches before being depleted by evapotranspiration. During intense precipitation events, precipitation rates frequently exceed infiltration rates and the site delivers moisture to downslope sites through surface runoff. Moisture loss through evapotranspiration exceeds precipitation for a majority of the growing season. Soil moisture is the primary limiting factor for vegetative production on this ecological site.

Wetland description

Not Applicable

Soil features

Soils for this ecological site are coarse granular clays, typically derived from acid shale. They are typically shallow or moderately deep (10 to 40 inches) to paralithic bedrock, slightly to extremely acid, and well drained. Soil textures

are typically clay, silty clay, or silty clay loam in the surface horizon and clay, silty clay, or silty clay loam in the underlying horizons. Content of coarse fragments ranges from 0 to 80 percent, with up to 35 percent of these being soft shale fragments. The soil temperature regime is primarily frigid and the soil moisture regime is aridic ustic.

Table 4. Representative soil features

| | |
|--|---|
| Parent material | (1) Residuum–shale |
| Surface texture | (1) Clay (2) Silty clay (3) Silty clay loam |
| Drainage class | Well drained |
| Permeability class | Very slow to slow |
| Depth to restrictive layer | 66–127 cm |
| Soil depth | 0–102 cm |
| Surface fragment cover <=3" | 0–5% |
| Surface fragment cover >3" | 0–3% |
| Available water capacity (0-101.6cm) | 3.3–5.84 cm |
| Electrical conductivity (0-50.8cm) | 0–4 mmhos/cm |
| Sodium adsorption ratio (0-50.8cm) | 0–13 |
| Soil reaction (1:1 water) (0-101.6cm) | 3.6–5.5 |
| Subsurface fragment volume <=3" (0-101.6cm) | 0–80% |
| Subsurface fragment volume >3" (0-101.6cm) | 0–5% |

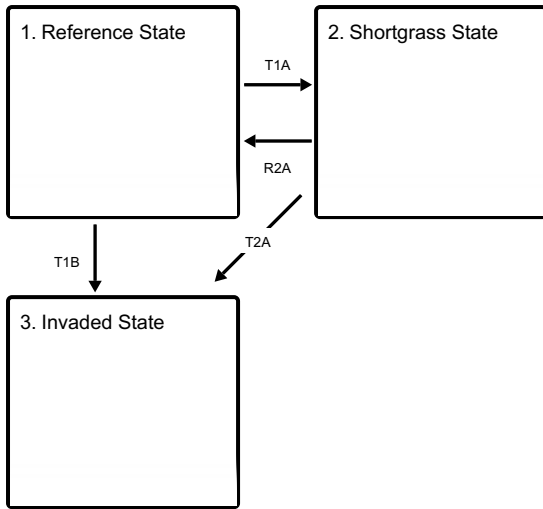
Ecological dynamics

The Reference State is the plant community in which interpretations are primarily based and is used as a reference in order to understand the original potential of the site. The Reference State evolved under the combined influences of climatic conditions, periodic fire activity, grazing by large herbivores, and impacts from small mammals and insects. Changes may occur to the Reference State due to management actions such as improper grazing management, climatic conditions such as drought, and natural events such as multiple fires in close succession. The Reference Plant Community for this ecological site is dominated by a diversity of tall and medium height, cool-season and warm-season grasses which are tightly intermixed and well distributed over the site. Various forbs, half-shrubs, and shrubs are common on this site. The Reference Plant Community is not necessarily the management goal, as other vegetative states may be considered desired plant communities as long as critical resource concerns are met.

In addition to the Reference State, other plant communities can occur on this site and are usually the result of historic management practices. Long term overgrazing on this ecological site results in a decrease of tallgrasses, mid-grasses, and more palatable forbs and in an increase of shortgrasses, sedges, and less palatable forbs. Half-shrubs and shrubs increase in the absence of prescribed fire and wildfire. More frequent fire intervals decreases the shrub component resulting in a site dominated by herbaceous species. There are various transitional stages which may occur on this ecological site.

State and transition model

Ecosystem states



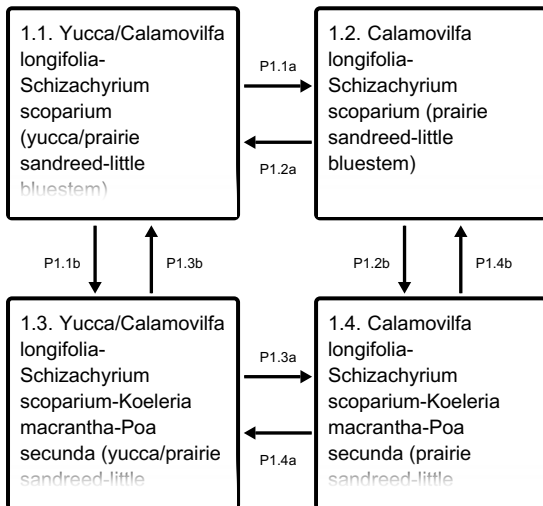
T1A - Prolonged drought, improper grazing, or a combination of these factors

T1B - Introduction of non-native invasive species (annual bromes, crested wheatgrass, noxious weeds)

R2A - Proper grazing management in combination with rangeland seeding, grazing land mechanical treatment, and timely moisture (management intensive and costly)

T2A - Introduction of non-native invasive species (annual bromes, crested wheatgrass, noxious weeds)

State 1 submodel, plant communities



P1.1a - Prescribed fire and wildfire, mechanical and chemical treatments, biological processes

P1.1b - Drought, improper grazing management

P1.2a - Approximately 30 years post-fire regrowth

P1.2b - Drought, improper grazing management, multiple fires in close succession

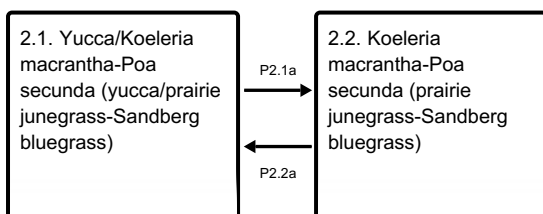
P1.3b - Normal or above average precipitation, proper grazing management

P1.3a - Prescribed fire and wildfire, mechanical and chemical treatments, biological processes

P1.4b - Normal or above average precipitation, proper grazing management

P1.4a - Approximately 30 years post-fire regrowth

State 2 submodel, plant communities



P2.1a - Prescribed fire and wildfire, mechanical and chemical treatments, biological processes

P2.2a - Approximately 30 years post-fire regrowth

State 3 submodel, plant communities

3.1. Bromus tectorum-
Bromus arvensis
(cheatgrass-field
brome)

State 1 Reference State

The Reference State (1) evolved under the combined influences of climatic conditions, periodic fire activity, grazing by large herbivores, and impacts from small mammals and insects. The Reference State is the plant community in which interpretations are primarily based and is used as a reference in order to understand the original potential of the site. The Reference State (1) for this ecological site consists of 4 community phases.

Community 1.1

Yucca/Calamovilfa longifolia-Schizachyrium scoparium (yucca/prairie sandreed-little bluestem)

This plant community is characterized by a warm-season grass and shrub community. The predominant species are warm-season species such as prairie sandreed and little bluestem. Cool-season species such as western wheatgrass and sun sedge also occur at lesser amounts. Shortgrass species such as blue grama, prairie junegrass, Sandberg bluegrass, and buffalograss are present at low cover. Forbs such as prairie thermopsis, dotted blazing star, American vetch, common yarrow, and green sagewort occur at approximately 10 percent canopy cover and shrubs and half shrubs such as yucca, longleaf sagebrush, prairie rose, skunkbush sumac, and creeping juniper occur at approximately 5 to 15 percent canopy cover or less.

Community 1.2

Calamovilfa longifolia-Schizachyrium scoparium (prairie sandreed-little bluestem)

This plant community is characterized by a warm-season grass community. The predominant species are warm-season species such as prairie sandreed and little bluestem. Cool-season species such as western wheatgrass and sun sedge also occur at lesser amounts. Shortgrass species such as blue grama, prairie junegrass, Sandberg bluegrass, and buffalograss are present at low cover. Forbs such as prairie thermopsis, dotted blazing star, American vetch, common yarrow, and green sagewort occur at approximately 10 percent canopy cover. Shrub and half shrub species are absent or rare. This community phase occurs when the plant community is burned by either wildfire or prescribed fire and may persist as long as 30 years following the burn (Watts, M.J., and C.L. Wambolt. 1996).

Community 1.3

Yucca/Calamovilfa longifolia-Schizachyrium scoparium-Koeleria macrantha-Poa secunda (yucca/prairie sandreed-little bluestem-prairie junegrass-Sandberg bluegrass)

This plant community is characterized by a dominance of unpalatable forbs and mid-statured grasses and an increase in shortgrass species such as blue grama, prairie junegrass, Sandberg bluegrass, and buffalograss. Shrubs and half shrubs such as yucca, longleaf sagebrush, prairie rose, skunkbush sumac, and creeping juniper occur at moderate cover.

Community 1.4

Calamovilfa longifolia-Schizachyrium scoparium-Koeleria macrantha-Poa secunda (prairie sandreed-little bluestem-prairie junegrass-Sandberg bluegrass)

This plant community is characterized by a dominance of unpalatable forbs and mid-statured grasses and an

increase in shortgrass species such as blue grama, prairie junegrass, Sandberg bluegrass, and buffalograss. Shrubs and half shrubs such as yucca, longleaf sagebrush, prairie rose, skunkbush sumac, and creeping juniper occur at low cover.

Pathway P1.1a **Community 1.1 to 1.2**

Community Phase 1.1 will transition to Community Phase 1.2 through prescribed fire and wildfire, mechanical and chemical treatments, and biological processes. Wyoming big sagebrush is greatly reduced and perennial grasses will dominate the site.

Pathway P1.1b **Community 1.1 to 1.3**

Drought, improper grazing practices such as continuous season-long or year-long grazing, or a combination of these factors can shift Community Phase 1.1 to Community Phase 1.3. These factors favor an increase in shortgrasses such as blue grama and a decrease in cool-season mid-statured grasses. Wyoming big sagebrush cover will be similar to Community Phase 1.1.

Pathway P1.2a **Community 1.2 to 1.1**

Approximately 30 years or more of natural vegetative regrowth will transition Community Phase 1.2 to Community Phase 1.1. Approximately 30 years or more without fire permits Wyoming big sagebrush to recolonize the site.

Pathway P1.2b **Community 1.2 to 1.4**

Drought, improper grazing management such as continuous season-long or year-long grazing, multiple fires in close succession, or a combination of these factors can shift Community Phase 1.2 to Community Phase 1.3. These factors favor an increase in shortgrass species such as blue grama and a decrease in cool-season mid-statured grasses. Wyoming big sagebrush cover will be similar to Community Phase 1.2.

Pathway P1.3b **Community 1.3 to 1.1**

Approximately 30 years or more post-fire, normal or above average precipitation, and proper grazing management transitions Community Phase 1.3 to Community Phase 1.1. This transition may also occur through natural succession.

Pathway P1.3a **Community 1.3 to 1.4**

Prescribed fire and wildfire, mechanical and chemical treatments, and biological processes will transition Community Phase 1.3 to Community Phase 1.4. Wyoming big sagebrush is greatly reduced and perennial grasses will dominate the site.

Pathway P1.4b **Community 1.4 to 1.2**

Less than approximately 30 years post-fire vegetative regrowth; normal or above-average precipitation, and proper grazing management transitions Community Phase 1.4 to Community Phase 1.2.

Pathway P1.4a **Community 1.4 to 1.3**

Approximately 30 years or more of natural shrub regrowth will transition Community Phase 1.4 to Community

Phase 1.3. Approximately 30 years or more without fire permits Wyoming big sagebrush to recolonize the site.

State 2

Shortgrass State

The dynamics of the Shortgrass State (2) are driven by long-term drought, improper grazing practices such as continuous season-long or year-long grazing, or a combination of these factors. The Shortgrass State (2) for this ecological site consists of 2 community phases.

Community 2.1

Yucca/Koeleria macrantha-Poa secunda (yucca/prairie junegrass-Sandberg bluegrass)

This plant community is characterized by a dominance of unpalatable shrubs and forbs. Mid-statured grasses such as prairie sandreed, little bluestem, and western wheatgrass are absent or rare. Shortgrass species such as blue grama, prairie junegrass, Sandberg bluegrass, and buffalograss are common. Shrubs and half shrubs such as yucca, longleaf sagebrush, prairie rose, skunkbush sumac, and creeping juniper are common.

Community 2.2

Koeleria macrantha-Poa secunda (prairie junegrass-Sandberg bluegrass)

The Forb/Shortgrass Community Phase (2.2) is characterized by a dominance of unpalatable forbs. Mid-statured grasses such as prairie sandreed, little bluestem, and western wheatgrass are absent or rare. Shortgrass species such as blue grama, prairie junegrass, Sandberg bluegrass, and buffalograss are common. Shrubs and half shrubs such as yucca, longleaf sagebrush, prairie rose, skunkbush sumac, and creeping juniper occur at low cover.

Pathway P2.1a

Community 2.1 to 2.2

Prescribed fire and wildfire, mechanical and chemical treatments, and biological processes will transition the Community Phase 2.1 to Community Phase 2.2. Wyoming big sagebrush is greatly reduced and perennial grasses will dominate the site.

Pathway P2.2a

Community 2.2 to 2.1

It is estimated that approximately 30 years or more of natural vegetative regrowth could transition Community Phase 2.2 to Community Phase 2.1. It is possible that this transition could occur over time, however, the processes are not fully understood at this time. Therefore, this pathway is considered hypothetical until further investigation can be completed.

State 3

Invaded State

The Invaded State (3) occurs when invasive plant species invade native grassland communities and displace the native species. The Invaded State (3) consists of 1 community phase.

Community 3.1

Bromus tectorum-Bromus arvensis (cheatgrass-field brome)

Observations suggest that native species diversity declines significantly when invasive or noxious species exceed approximately 30 percent of the plant community. Non-native, perennial, drought tolerant grasses such as crested wheatgrass, non-native, annual, invasive species such as cheatgrass and field brome, and noxious weed species can eventually dominate the seedbank of this site and displace native species. Reduced plant species diversity, simplified structural complexity, and altered ecological processes result in a state that is substantially departed from the Reference State (1). The dominance of annual, invasive grasses such as cheatgrass and field brome increases the fire cycle frequency.

Transition T1A

State 1 to 2

Prolonged drought, improper grazing practices such as continuous season-long or year-long grazing, or a combination of these factors weaken the resilience of the Reference State (1) and drive its transition to the Shortgrass State (2). The Reference State (1) transitions to the Shortgrass State (2) when mid-statured graminoids are greatly reduced and shortgrasses such as blue grama, prairie junegrass, Sandberg bluegrass, and buffalograss dominate the plant community.

Transition T1B

State 1 to 3

The Reference State (1) transitions to the Invaded State (3) when non-native grasses or noxious weeds invade the plant community. Exotic plant species dominate the site in terms of cover and production and site resilience has been substantially reduced. In addition, other rangeland health attributes, such as reproductive capacity of native grasses and soil quality, have been substantially altered from the Reference State (1).

Restoration pathway R2A

State 2 to 1

Shortgrass species can resist displacement by other species. A reduction in livestock grazing pressure alone may not be sufficient to reduce the cover of shortgrass species in the Shortgrass State (3) and mechanical treatments may be necessary. Therefore, returning the Shortgrass State (2) to the Reference State (1) can require considerable cost, energy, and time.

Conservation practices

| |
|--------------------|
| Prescribed Grazing |
|--------------------|

Transition T2A

State 2 to 3

The Shortgrass State (2) transitions to the Invaded State (3) when non-native grasses, noxious weeds, and other invasive plants invade the Shortgrass State (2). Exotic plant species dominate the site in terms of cover and production. Site resilience has been substantially reduced.

Additional community tables

Inventory data references

Specific field data was not obtained for this provisional ecological site description. Existing field data was used in conjunction with a review of scientific literature and professional experience to approximate the plant communities, states, and transitions. All community phases are considered provisional based on the sources identified in this ecological site description.

Other references

Cleland, D.T., et al. 1997. National Hierarchical Framework of Ecological Units. In: M.S. Boyce and A. Haney (eds.) *Ecosystem Management Applications for Sustainable Forest and Wildlife Resources*, Yale University Press, New Haven, CT.

Dormaar, J.F., and S. Smoliak. 1985. Recovery of vegetative cover and soil organic matter during revegetation of abandoned farmland in a semiarid climate. *Journal of Range Management* 38:487-491.

Federal Geographic Data Committee. 2008. *The National Vegetation Classification Standard, Version 2*. FGDC Vegetation Subcommittee. FGDC-STD-005-2008 (Version 2). pp. 126.

Fire Effects Information System. USDA Forest Service.

<http://www.fs.fed.us/database/feis/plants/shrub/amealn/all.html>.

Interagency Ecological Site Handbook for Rangelands. USDA Natural Resources Conservation Service, USDA Forest Service, USDI Bureau of Land Management. January 2013.

Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin. USDA Handbook 296. USDA Natural Resources Conservation Service. 2006.

McNab, W.H., et al. 2007. Description of Ecological Sub-Regions: Sections of the Conterminous United States. USDA Forest Service. General Technical Report WO-76B.

National Cooperative Soil Survey. USDA Natural Resources Conservation Service.
<https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/survey/partnership/ncss/>.

National Ecological Site Handbook. USDA Natural Resources Conservation Service. March 2017.

National Range and Pasture Handbook. USDA Natural Resources Conservation Service. December 2003.

National Soil Information System. USDA Natural Resources Conservation Service.
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053552.

National Soil Survey Handbook. USDA Natural Resources Conservation Service. November 2019.

National Water and Climate Center. USDA Natural Resources Conservation Service.
<https://www.wcc.nrcs.usda.gov/>.

NRCS Plants Database. USDA Natural Resources Conservation Service.
<https://plants.usda.gov/java/>.

Samuel, M.J., and R.H. Hart. 1994. Sixty-one years of secondary succession on rangelands of the Wyoming High Plains. *Journal of Range Management* 47:184-191.

Soil Survey Manual. USDA Natural Resources Conservation Service. March 2017.

Watts, M.J., and C.L. Wambolt. 1996. Long-term recovery of Wyoming big sagebrush after four treatments. *Journal of Environmental Management* 46:95-102.

Web Soil Survey. USDA Natural Resources Conservation Service.
<https://websoilsurvey.nrcs.usda.gov/app/HomePage.htm>.

Contributors

Jeff Fenton
Scott Brady
Maryjo Kimble
Kami Kilwine

Approval

Kirt Walstad, 9/07/2023

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 | 05/03/2024 |
| Approved by | Kirt Walstad |
| Approval date | |
| Composition (Indicators 10 and 12) based on | Annual Production |

Indicators

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

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

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

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):**
-

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

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):**
-

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:**
-

17. **Perennial plant reproductive capability:**
-