# Ecological site R058CY103ND
# Badlands

Last updated: 10/31/2018
Accessed: 04/25/2024

## 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.

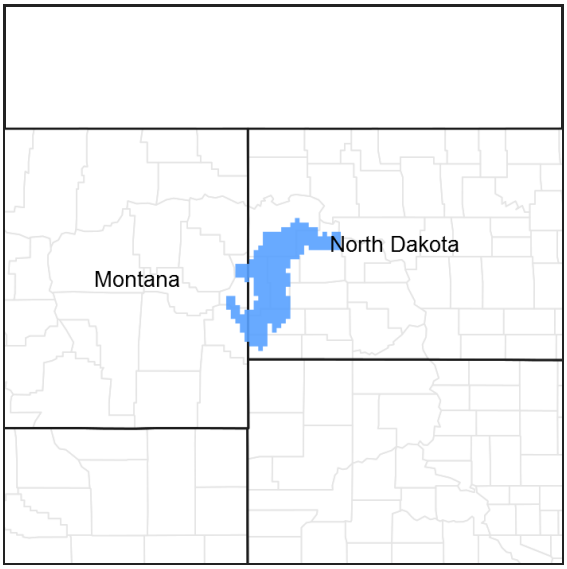



**Figure 1. Mapped extent**

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): 058C–Northern Rolling High Plains, Northeastern Part

MLRA 58C covers 2,780 square miles and encompasses approximately 1.8 million acres. MLRA 58C spans two states with 96% of the area in North Dakota and 4% in Montana. The acreage inside MLRA 58C is 54% privately owned and 44% federal land. The federal land consists of the Fort Berthold Indian Reservation, Little Missouri National Grasslands, and Theodore Roosevelt National Park. MLRA 58C landscape is characterized by steeply sloping, dissected badlands along the Little Missouri River and its tributaries. Tertiary marine shale, siltstone, and sandstone sediments are the most common soil parent materials in this MLRA. Primary land uses are rangeland for grazing and wildlife habitat. Micro-climates inherent in badlands landscapes influence both variety and abundance of vegetation in MLRA 58C. South- and west-facing exposures are dry, hot, and sparsely vegetated. More humid and cooler north- and east-facing exposures are favorable for abundant forage and woody vegetation.

## Classification relationships

Major land resource area (MLRA): 058C-Northern Rolling High Plains, Northeastern Part

## Ecological site concept

The Badlands ecological site is characterized by exposed soft, sedimentary siltstone and shale bedrock that is

actively eroding. These sites have greater than 80 percent bare ground. Slopes are typically steeper than 50 percent, but range from strongly sloping to very steep. The Badlands ecological site is constantly undergoing geological erosion, and surface runoff is very rapid. This site is located on steep-sided buttes, escarpments, knobs, and ridges, and is characterized by sparse vegetation, deeply entrenched drainageways, and depositional fans below the landforms.

## Associated sites

| | |
|---|---|
| R058CY070ND | **Badlands Fan**<br>The Badlands Fan ecological site is below the Badlands ecological site on alluvial fans at the base of very steep badland escarpments. These are medium-textured, well drained soils that developed in stratified layers of slope alluvium eroding from the adjacent, sparsely-vegetated, very steep, soft sedimentary bedrock that characterizes the Badlands site that is above it on the landscape. Carbonates are present at or near the soil surface. Soils on Badlands Fan sites will form a ribbon less than 2 inches before breaking. As a result of constant deposition of sediments from the adjacent steep, sparsely-vegetated badland escarpment above it on the landscape, the Badlands Fan site has more bare ground and less production than the Limy Residual site that is below it on the landscape. Principle species: Blue grama, western wheatgrass, and sedges. |
| R058CY079ND | **Limy Residual**<br>In association with the Badlands ecological site, the Limy Residual site is on nearby, relatively stable alluvial fans below the Badlands and Badlands Fan ecological sites. Soils on the Limy Residual site are very deep, medium-textured soils that are calcareous either at the surface or within 8 inches of the soil surface. Slopes range from 0 to 25%. The Limy Residual site is down slope from the Badlands Fan site, which is adjacent to and directly below the Badlands ecological site. The result of constant, progressive erosion of the steep badland escarpments is that they gradually recede away from the slope alluvium that has been deposited at the base of the escarpments. As the alluvial fans get farther away from the actively eroding badlands escarpments, they become more stable. Deposition on them is less frequent, and soil development progresses. Soils on these relatively stable alluvial fans have a thin surface A horizon, but these soils generally do not have a mollic epipedon. The soils on Limy Residual sites will form a ribbon less than 2 inches before breaking. Limy Residual ecological sites are up slope from Loamy and Flat Bottomed Wooded Draw ecological sites and down slope from Badlands and Badlands Fan ecological sites. The Limy Residual site has less bare ground and better production than the Badlands and Badlands Fan ecological sites since it is on a relatively stable landscape position and subject to less frequent deposition of sediments from the steep, actively eroding badland escarpments. Indicator species: western wheatgrass, little bluestem, plains muhly, porcupinegrass and sideoats grama, with Missouri goldenrod, dotted gayfeather, pasqueflower, purple coneflower and purple prairie clover, and shrubs like winterfat and prairie rose. |
| R058CY083ND | **Very Shallow**<br>Across the Badlands landscape of MLRA 58C, Very Shallow ecological sites are on two distinctly different landform positions in association with the Badlands ecological site. Very Shallow sites are either on steep, convex shoulders and upper back slopes adjacent to and in conjunction with Shallow Loamy sites or on porcelanite (scoria) covered summits of very steep badland escarpments. On steep, convex shoulders and upper back slopes, Very Shallow sites are typically adjacent to and associated with Shallow Loamy sites immediately below the summit on north- and east-facing aspects opposite the badland escarpment which typically faces south or west. The Very Shallow ecological site is also on the summits of very steep, sparsely vegetated badland escarpments, ridges, and hills that are capped with an erosion resistant layer of porcelanite (scoria). Soils on Very Shallow sites are medium-textured, well drained soils with either soft, sedimentary bedrock that restricts root penetration within 10 inches of the soil surface or greater than 90% porcelanite (scoria) fragments within 20 inches of the soil surface. The Very Shallow site is sparsely vegetated, but has more production than the Badlands site. This site is drier and has more bare ground than the Shallow Loamy site, and plant species on this site have high drought tolerance. Indicator species include blue grama, plains muhly, little bluestem, bluebunch wheatgrass, upland sedges, fringed sagewort, and creeping juniper. |

| | |
|---|---|
| R058CY086ND | **Shallow Loamy**<br>When associated with the Badlands ecological site, the Shallow Loamy ecological site is typically on the summit above the very steep, sparsely vegetated badland escarpment. In the Little Missouri Badlands of MLRA 58C, Shallow Loamy sites may also occur on upper back slopes immediately below the summit on north- and east-facing aspects opposite the badland escarpment which generally faces south or west. Slopes range from 3 to 70%. Shallow Loamy ecological sites are well-vegetated, complex slopes with Shallow Loamy sites adjacent to and in conjunction with Very Shallow sites that are on steep, convex shoulder slopes. Soils on the Shallow Loamy sites are medium-textured, well drained soils with soft, unweathered mudstone or siltstone bedrock between 10 inches and 20 inches below the soil surface. The unweathered mudstone and siltstone beds are a root restrictive layer in these soils. The soils on Shallow Loamy sites will form a ribbon longer than 1 inch, but less than 2 inches before breaking. Although the soils are shallow to soft sedimentary beds, the Shallow Loamy site is vegetated and has more production than the Badlands site or the Very Shallow ecological site. Indicator species: little bluestem, plains muhly, western wheatgrass, sideoats grama, and needleandthread with dotted gayfeather, pasqueflower, purple coneflower, purple prairie clover, and shrubs like broom snakeweed. |

**Table 1. Dominant plant species**

| | |
|---|---|
| Tree | Not specified |
| Shrub | Not specified |
| Herbaceous | Not specified |

## Physiographic features

MLRA 58C is known as the Little Missouri Badlands, which formed when the Little Missouri River was diverted along a shorter, steeper course by Pleistocene glaciers. Due to the resulting increased gradient after its eastward diversion by the glaciers, the Little Missouri River began rapidly downcutting into the soft, calcareous sedimentary shale, siltstone, and sandstone of the Fort Union and Hell Creek geological formations. This rapid downcutting eroded and carved the Badlands of MLRA 58C. This cycle of erosion and deposition continues today.

Most of the soils in MLRA 58C developed from residuum weathered in place. As a result of constant erosion and deposition, the majority of soils in MLRA 58C are Entisols and Inceptisols. Mollisols have formed on the high, stable drainage divides and plateaus above the steeper, dissected hillslopes and fans that define the Badlands. Elevation ranges from 1,838 feet (560 meters) to 3,430 feet (1,045 meters). The Little Missouri River flows through the entire length of MLRA 58C and empties into Lake Sakakawea that was formed by the Garrison Dam on the Missouri River.

The Badland ecological site consists of bare, eroding exposures of soft siltstone and shale bedrock on steep-sided buttes, escarpments, knobs, ridges, and in deeply entrenched, steep-sided-drainageways. The exposed bedrock makes up about 80 percent of any given area and supports little or no vegetation. Runoff is rapid and geologic erosion is active.

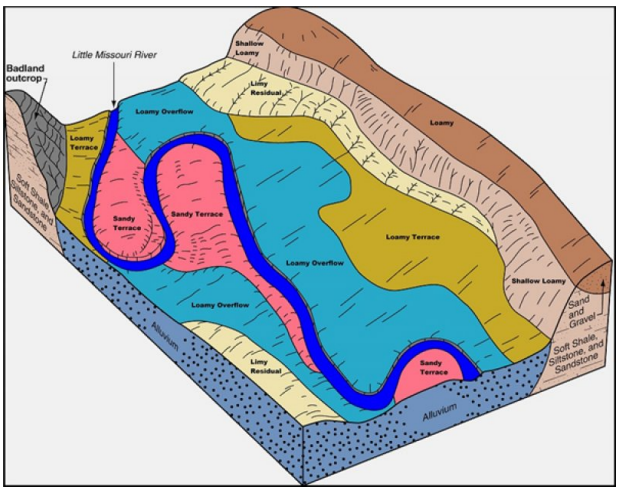



**Figure 2. MLRA 58C ecological site block diagram.**

**Table 2. Representative physiographic features**

| | |
|---|---|
| Landforms | (1) Escarpment<br>(2) Butte<br>(3) Ridge |
| Flooding frequency | None |
| Ponding frequency | None |
| Elevation | 1,838–3,430 ft |
| Slope | 9–100% |
| Ponding depth | 0 in |
| Water table depth | 72–0 in |
| Aspect | S, W |

## Climatic features

MLRA 58C is considered to have a continental climate with cold winters and hot summers, low humidity, light rainfall, and much sunshine. Extremes in temperature are common and characteristic of MLRA 58C. The continental climate is the result of this MLRA's location in the geographic center of North America. There are few natural barriers on the northern Great Plains, so air masses move unobstructed across the plains and account for rapid changes in temperature.

Annual precipitation ranges from 14 to 17 inches per year. The normal average annual temperature is about 41° F. January is the coldest month with an average temperature of about 17° F. July is the warmest month with an average temperature of about 70° F. The range of normal average monthly temperatures between the coldest and warmest months is 53° F. This large temperature range attests to the continental nature of MLRA 58C's climate. Daytime wind speeds are generally stronger than nighttime wind speeds, and occasional strong storms may bring brief periods of high winds with gusts to more than 50 miles per hour.

Growth of native cool-season plants begins in late March and continues to early to mid-July. Native warm-season plants begin growth in mid-May and continue to the end of August. Green-up of cool- season plants can occur in September and October when adequate soil moisture is present.

**Table 3. Representative climatic features**

| | |
|---|---|
| Frost-free period (average) | 107 days |
| Freeze-free period (average) | 131 days |
| Precipitation total (average) | 16 in |

## Climate stations used

- (1) GRASSY BUTTE 2ENE [USC00323705], Grassy Butte, ND
- (2) MEDORA [USC00325813], Medora, ND
- (3) FAIRFIELD [USC00322809], Fairfield, ND
- (4) WATFORD CITY 14S [USC00329246], Grassy Butte, ND
- (5) TROTTERS 3 SSE [USC00328812], Beach, ND

## Influencing water features

No significant water features influence this site.

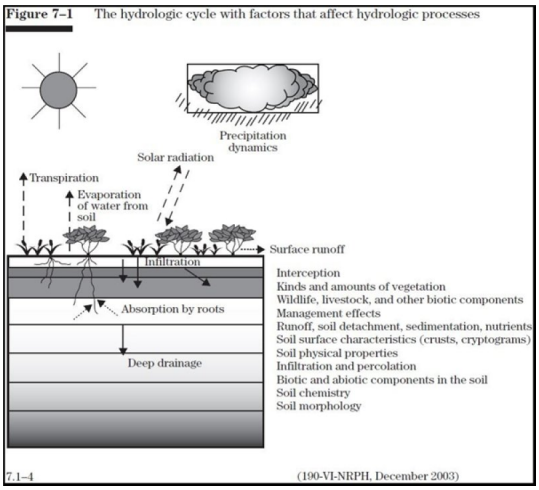



**Figure 7. Fig.7-1 from National Range and Pasture Handbook.**

## Soil features

The Northern Rolling High Plains, Northeastern Part (MLRA 58C) is also known as the Little Missouri Badlands, and many map units in MLRA 58C have the miscellaneous land type ‘Badland’ either as a named component or as an inclusion. Since 'Badland' is considered a miscellaneous land type, there is not a named soil series correlated to the Badlands ecological site. However, there are numerous map units that have the Badlands ecological site in them. Many of these Badlands complex map units are of large extent in MLRA 58C. This site is on the hot, dry south and west exposures of very steep badlands landforms, and slopes range from 9 to 150 percent slopes.

Actual soil material on the surface of the Badlands component varies between half an inch to 3 inches of calcareous silty or loamy material over soft, calcareous sedimentary siltstone or shale bedrock that was laid down during the Tertiary and late Cretaceous periods. Constant, active geological erosion and deposition make it difficult for soil to develop and vegetation to establish on the Badlands ecological site. Very steep slopes, carbonates at the surface, and sparse or no vegetation make these sites highly susceptible to water and wind erosion. Erosion increases where vegetative cover is sparse or non-existent, so soil development is extremely limited on Badlands ecological sites. Badlands ecological sites may be sparsely vegetated with Big sagebrush and rubber rabbitbrush, but if the thin soil surface layer is lost due to erosion, the result is reduced plant numbers or complete loss of vegetation on the site.

The following soil properties listed in the table below represent the soil profile from the surface of the soil to a depth of 3 inches (8 cm).

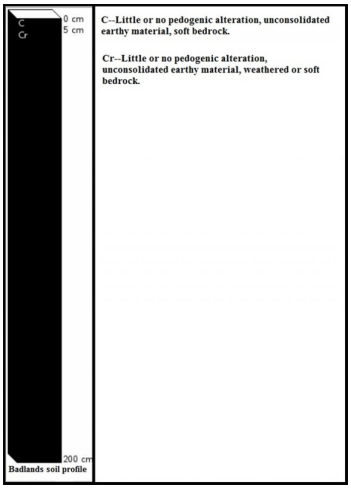



**Figure 8. Badlands typical soil profile.**

**Table 4. Representative soil features**

| | |
|---|---|
| Drainage class | Well drained |

| | |
|---|---|
| Permeability class | Slow |
| Soil depth | 1–3 in |
| Surface fragment cover <=3" | 0–12% |
| Surface fragment cover >3" | 0–1% |
| Available water capacity (0-40in) | 0–0.5 in |
| Calcium carbonate equivalent (0-40in) | 10–35% |
| Electrical conductivity (0-40in) | 2–4 mmhos/cm |
| Sodium adsorption ratio (0-40in) | 0–5 |
| Soil reaction (1:1 water) (0-40in) | 7.4–8.4 |
| Subsurface fragment volume <=3" (Depth not specified) | 0% |
| Subsurface fragment volume >3" (Depth not specified) | 0% |

## Ecological dynamics

The site developed under Northern Great Plains climatic conditions, geological erosion processes and included natural influence of large herbivores and occasional fire.

This site is nearly void of all vegetation. It is comprised of exposed, eroding, soft, silty, and clayey bedrock.

The plant community, that does exist, upon which interpretations are primarily based is the Reference Plant Community. The Reference Plant Community has been determined by study of rangeland relic areas, areas protected from excessive disturbance, and areas under long-term rotational grazing regimes.

Following the state and transition diagram are narratives for each of the described states and community phases. These may not represent every possibility, but they are the most prevalent and repeatable states/community phases. The plant composition tables shown below have been developed from the best available knowledge at the time of this revision. As more data are collected, some of these community phases and/or states may be revised or removed, and new ones may be added. The main purpose for including the descriptions here is to capture the current knowledge and experience at the time of this revision.

## State and transition model

**Ecosystem states**

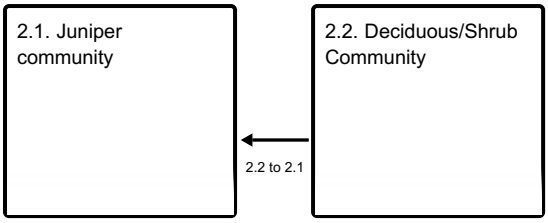
1. Escarpment State

2. Woody State

**State 1 submodel, plant communities**

1.1. Escarpment community

**State 2 submodel, plant communities**




## State 1
## Escarpment State

The Escarpment State is supported by empirical data, historical data, local expertise, and photographs. This state consists of exposed, eroding, soft, silty, and clayey bedrock. This state is defined by one native plant community that is a result of geological erosion, periodic fire, drought, and grazing. These events are part of the natural disturbance regime and climatic process. The Reference Plant Community consists of 80 percent bare ground with a small amount of native vegetation.

## Community 1.1
## Escarpment community


**Figure 9. Theodore Roosevelt National Park, North unit.**

This is the interpretive plant community and is considered to be the Reference Plant Community. This community evolved with geological erosion, grazing by large herbivores on the less steep slopes, occasional prairie fires and periodic flooding events. Less than 15 percent of this community is vegetated. If vegetation exist it consists of scattered grasses, forbs, and shrubs. This plant community is susceptible to water and wind erosion.

## State 2
## Woody State

The Woody State is dominated by a tree and shrub plant community. This state is defined by two plant communities. The increase and spread of shrubs and trees results from an absence of fire. Special planning will be necessary to assure that sufficient amounts of fine fuel are available to carry fires with enough intensity to control woody species. In some locations the use of chemicals as a brush management tool may be desirable to initiate and accelerate this transition. Birds, small mammals and livestock are instrumental in the distribution of seed and accelerating the spread of most shrubs common to this site. The speed of encroachment varies considerably.

## Community 2.1
## Juniper community

The primary forest cover type dominated by Badlands topography consists of a Rocky Mountain juniper complex. In the absence of fire and with enough time, north-facing slopes become forested with solid stands of Rocky Mountain juniper. The addition of fire initiates complex plant species succession. Depending upon intensity, fire can completely remove the existing juniper cover. Drier sites such as south and west exposures, ridge tops, and nose

slope positions may also include clumps of common juniper and prostrate juniper. In the absence of fire for long periods of time, prostrate juniper may completely cover arid west slopes. When juniper stands are removed by fire, a wide assortment of deciduous trees and shrubs begin colonizing the site. Species such as juneberry, ash, elm, rose, buffaloberry, hawthorne, aspen, dogwood, skunkbush sumac, and snowberry are quick to capture most sites. During these initial stages, the deciduous trees and shrubs provide valuable wildlife food and cover. In some areas, browsing deer keep shrubs pruned for quite a few years. After years of deciduous tree and shrub cover, Rocky Mountain junipers are observed making encroachments in the understory. After a longer period of time, the deciduous material dies or is overtopped by the juniper and a new juniper forest exists. The rate at which this succession proceeds is dependent upon site productivity and frequency of fires. Site productivity has a major impact on the variety of deciduous species that may colonize a site as well as the continuity of the pioneer woodland cover. Representative stands of this intermediate phase included 20 feet tall elm and ash; 25 feet tall aspen; 8 feet tall chokecherry, buffaloberry, and juneberry; 2-3 feet tall snowberry; 4-6 feet tall dogwood and plum. Widely scattered Rocky Mountain juniper were evident in the stand as 6-8 feet tall specimens.

### Community 2.2
### Deciduous/Shrub Community

When juniper stands are removed by fire, a wide assortment of deciduous trees and shrubs begin colonizing the site. Species such as juneberry, ash, elm, rose, buffaloberry, hawthorne, aspen, dogwood, skunkbush sumac, and snowberry are quick to capture most sites. During these initial stages, the deciduous trees and shrubs provide valuable wildlife food and cover. In some areas, browsing deer keep shrubs pruned for quite a few years. After years of deciduous tree and shrub cover, Rocky Mountain junipers are observed making encroachments in the understory. After a longer period of time, the deciduous material dies or is overtopped by the juniper and a new juniper forest exists. The rate at which this succession proceeds is dependent upon site productivity and frequency of fires. Site productivity has a major impact on the variety of deciduous species that may colonize a site as well as the continuity of the pioneer woodland cover. Representative stands of this intermediate phase included 20 feet tall elm and ash; 25 feet tall aspen; 8 feet tall chokecherry, buffaloberry, and juneberry; 2-3 feet tall snowberry; 4-6 feet tall dogwood and plum. Widely scattered Rocky Mountain juniper were evident in the stand as 6-8 feet tall specimens.

### Pathway 2.2 to 2.1
### Community 2.2 to 2.1

Long term rest from fire events.

**Conservation practices**

| |
|---|
| Prescribed Burning |

## Additional community tables

## Animal community

This site is not conducive to managed grazing by domestic livestock. The slopes are generally greater than 50 percent.

Animal Community – Grazing Interpretations:

Calculating Safe Stocking Rates: Proper stocking rates should be incorporated into a grazing management strategy that protects the resource, maintains or improves rangeland health, and is consistent with management objectives. In addition to usable forage, safe stocking rates should consider ecological condition, trend of the site, past grazing use history, season of use, stock density, kind and class of livestock, forage digestibility, forage nutritional value, variation of harvest efficiency based on desirability preference of plant species and/or grazing system and site graze ability factors (such as steep slopes, site inaccessibility, or distance to drinking water).

Often the current plant community does not entirely match any particular Community Phase as described in this Ecological Site Description. Because of this, a resource inventory is necessary to document plant composition and production. Proper interpretation of inventory data will permit the establishment of a safe initial stocking rate.

No two years have exactly the same weather conditions. For this reason, year-to-year and season-to season fluctuations in forage production are to be expected on grazing lands. Livestock producers must make timely adjustments in the numbers of animals or in the length of grazing periods to avoid overuse of forage plants when production is unfavorable and to make advantageous adjustments when forage supplies are above average.

Initial stocking rates should be improved through the use of vegetation monitoring and actual use records that include number and type of livestock, the timing and duration of grazing, and utilization levels. Actual use records over time will assist in making stocking rate adjustments based on the variability factors.

Average annual production must be measured or estimated to properly assess useable forage production and stocking rates.

## Recreational uses

None

## Wood products

No appreciable wood products are present on the site.

## Other products

None

## Other information

Site Development and Testing Plan.

Chris Tecklenburg (Natural Resource Specialist, Ecological Sites, Kansas NRCS) assumed responsibilities for development of provisional ESDs in MLRA 58C on 8-17-2017. Most information for the provisional Badland ecological site comes from archived soil surveys in Golden Valley, McKenzie, Billings, Slope, and Dunn counties, North Dakota.

This site is going through the Provisional ESD process. This site is scheduled to go through the approval process fiscal year 2021.

Future work (for approved ESD) includes field visits to verify ecological site concepts with field staff. Field staff include but not limited to project office leader, area soil scientist, state soil scientist, ecological site specialist, state rangeland conservationist, area rangeland management specialist, and local field personnel. This site should include collaboration between North Dakota and Montana. Field visits are to be determined by spatial extent of the site as well as personal knowledge of the site. Activity during field visits will include but not limited to: identifying the soil, landform, plant community, and verifying existing site concepts. Data collection will be determined by the MLRA 58C technical team.

## Inventory data references

Chris Tecklenburg (Natural Resource Specialist, Ecological Sites, Kansas NRCS) was assigned responsibilities for the development of provisional ESDs in MLRA 58C on 8-17-2017.

Information presented here has been derived from NRCS soil surveys. Also, field knowledge of range-trained personnel was used. All descriptions were peer reviewed and/or field tested by various private, state and federal agency specialist.

## Other references

High Plains Regional Climate Center, Weather data, web site http://hprcc.unl.edu. Available online. Accessed 9/25/2017.

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## Contributors

Chris Tecklenburg

## Approval

David Kraft, 10/31/2018

## Acknowledgments

The ecological site development process is a collaborative effort, conceptual in nature, dynamic, and is never considered complete.

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USDA is an equal opportunity provider, employer, and lender.

## 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 | |
| Approved by | |
| 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):**

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

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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):**

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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:

    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:**

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