USDA Natural Resources Conservation Service

Ecological site R103XY006MN
Bedrock Controlled Upland Prairies

Last updated: 10/04/2023
Accessed: 05/19/2024

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.

MLRA notes

Major Land Resource Area (MLRA): 103X–Central Iowa and Minnesota Till Prairies

MLRA 103 is in Minnesota (56 percent) and Iowa (44 percent) and consists of approximately 18 million acres. It is in the Western Lake Section of the Central Lowland Province of the Interior Plains in an area known as the "Des Moines Lobe" of the Wisconsin-age ice sheet. The MLRA is mostly on a young, nearly level to gently rolling, glaciated till plain that has moraines and glacial lake plains in some areas. The plain is covered with glacial till, outwash, and glacial lake deposits. Recent alluvium consisting of clay, silt, sand, and gravel fill the bottoms of most of the major river valleys. Paleozoic bedrock sediments, primarily shale and limestone, underlie the glacial deposits in most of the area.

The annual precipitation increases from northwest to southeast. Most of the rainfall occurs as high-intensity, convective thunderstorms during the summer. Two-thirds or more of the precipitation falls during the freeze-free period. Snowfall is common in winter. Ground water supplies are adequate for the domestic, livestock, municipal, and industrial needs. Nearly all of this area is farmland, and about four-fifths is cropland.

Classification relationships

Major Land Resource Area (MLRA): Central Iowa and Minnesota Till Prairies (103) (USDA Handbook 296, 2006)

USFS Subregions: North Central Glaciated Plains Section (251B); Upper Minnesota River-Des Moines Lobe (251BA) and Southern Des Moines Lobe (251Be) Subsections (Cleland et al. 2007)

The reference state shares similarities to Minnesota Department of Natural Resources UPs13 Southern Dry Prairie

International Vegetation Classification Hierarchy
Class: 2. Shrub & Herb Vegetation
Subclass: 2.B. Temperate & Boreal Grassland & Shrubland
Formation: 2.B.2. Temperate Grassland & Shrubland
Division: 2.B.2.Nb. Central North American Grassland & Shrubland
Macrogroup: M054. Central Lowlands Tallgrass Prairie
Central Tallgrass Prairie NatureServe Element Code: CES205.683

Ecological site concept

The Bedrock Controlled Upland Prairies ecological site is characterized by very shallow (<10"), shallow (10-20"), or moderately deep (20-40") soils that are influenced by bedrock and have a low available water capacity (1-7"). This site typically occurs within larger river valleys that have been scoured to the bedrock by glacial meltwaters, such as the Minnesota and Des Moines Rivers. Soils are mostly Mollisols that developed under prairie vegetation. These soils have a dark (black) mollic epipedon that is above the subsurface horizons and/or bedrock.

Associated sites

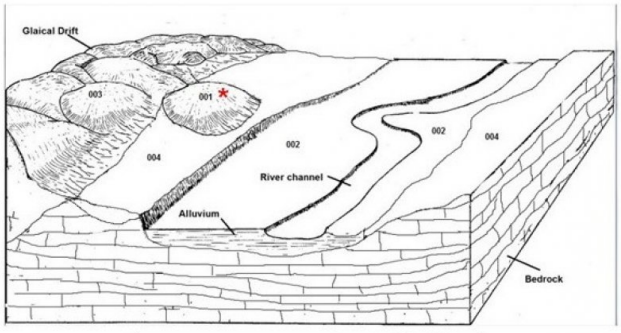
F103XY032MN	**Loamy Floodplains** The Loamy Floodplains ecological site is located on medium textured alluvium throughout MRLA 103. Soils textures include loam, silt loam, sandy loam and fine sandy loam. Some areas within this ecological site will exhibit long-term flooding (7-30 days).
F103XY031MN	**Sandy Floodplains** The Sandy Floodplains ecological site is located on sandy-textured Mollisol soils in floodplains and drainageways throughout MLRA 103. Soils drainage class ranges from moderately well drained to excessively drained. Brief flooding may occur on areas within this ecological site.
R103XY010MN	**Bedrock Controlled Wet Prairies** The Bedrock Controlled Wet Prairies ecological is characterized by poorly drained soils whose parent materials are loamy slope alluvium or alluvial/glaciofluvial deposits overlying carbonaceous bedrock. This site is associated with river valleys. Soils range in depth from 10

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Amorpha canescens*
Herbaceous	(1) *Schizachyrium scoparium* (2) *Bouteloua curtipendula*

Physiographic features

The Bedrock Controlled Upland Prairies ecological site typically situated near larger rivers, especially in the Minnesota and Des Moines river valleys in Minnesota and Iowa, respectively. Glacial meltwaters scoured these broad valleys, leaving areas of bedrock occurring as strath terraces above the floodplain. The terms “linear” or “sloping” best describes the physiographic character of this site. Bedrock substratum and slope are the most defining parameters.



Code	Ecological Site Name	Representative Soil Series
001	Bedrock Controlled Upland Prairie	Copaston, Bechyn
002	Loamy Floodplains	Spillville, Minneiska
003	Loamy Upland Prairie	Clarion, Nicollet
004	Sandy Floodplains	Zumbro, Buckney

Figure 1. Block diagrams of the representative Bedrock Controlled Upland Prairies and associated ecological sites.

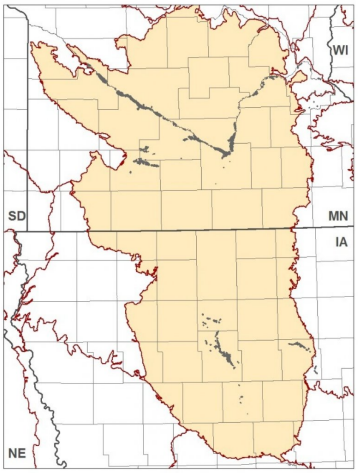


Figure 2. Distribution of the Bedrock Controlled Upland Prairies ecological site within MLRA 103. In many cases, the data set is not spatially consistent across political boundaries due to the method by which soils were mapped; e.g. due to county subsets.

Table 2. Representative physiographic features

Hillslope profile	(1) Backslope (2) Summit (3) Shoulder
Landforms	(1) Strath terrace
Runoff class	Low to very high
Elevation	210–560 m
Slope	0–75%
Water table depth	30–102 cm
Aspect	W, NW, N, NE, E, SE, S, SW

Climatic features

The soil temperature regime of MLRA 103 is classified as “mesic” (i.e., mean annual soil temperature between 46 and 59°F). The average freeze-free period of this ecological site is 154 days, while the frost-free period is 132 days. The average mean annual precipitation average is 30 inches, which includes rainfall plus the water equivalent from snowfall.

Table 3. Representative climatic features

Frost-free period (characteristic range)	129-136 days
Freeze-free period (characteristic range)	150-160 days
Precipitation total (characteristic range)	686-864 mm
Frost-free period (actual range)	128-137 days
Freeze-free period (actual range)	148-161 days
Precipitation total (actual range)	660-864 mm
Frost-free period (average)	132 days
Freeze-free period (average)	154 days
Precipitation total (average)	762 mm

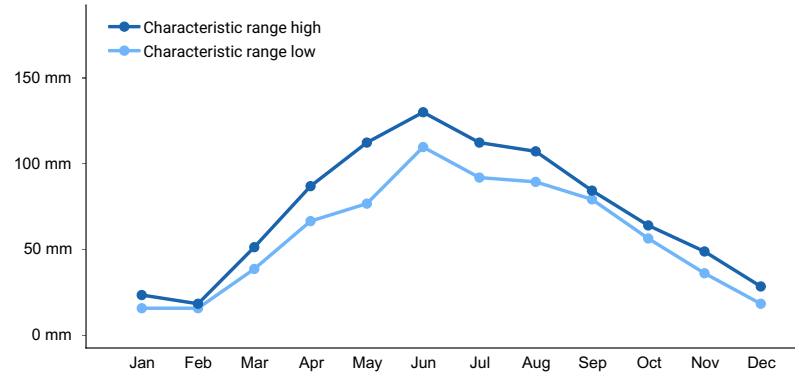


Figure 3. Monthly precipitation range

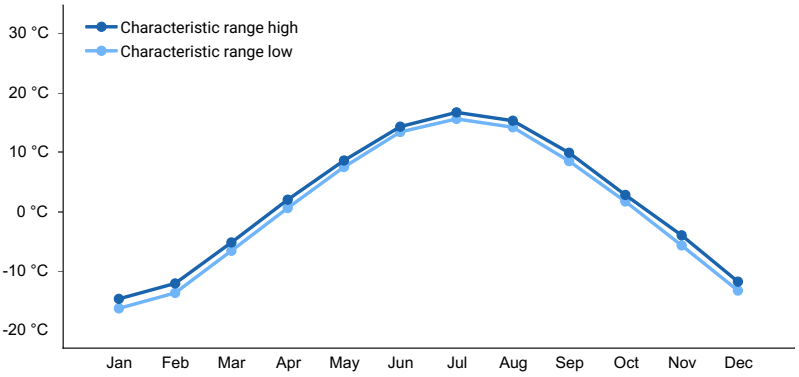


Figure 4. Monthly minimum temperature range

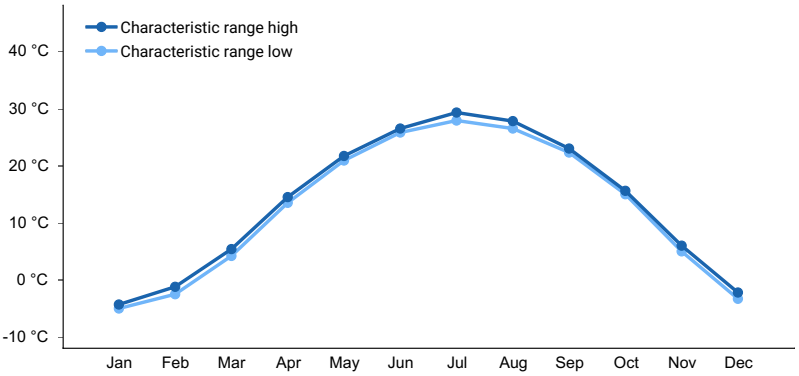


Figure 5. Monthly maximum temperature range

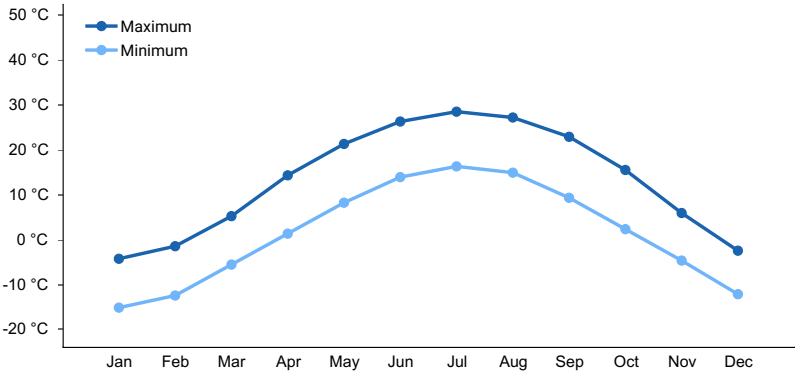


Figure 6. Monthly average minimum and maximum temperature

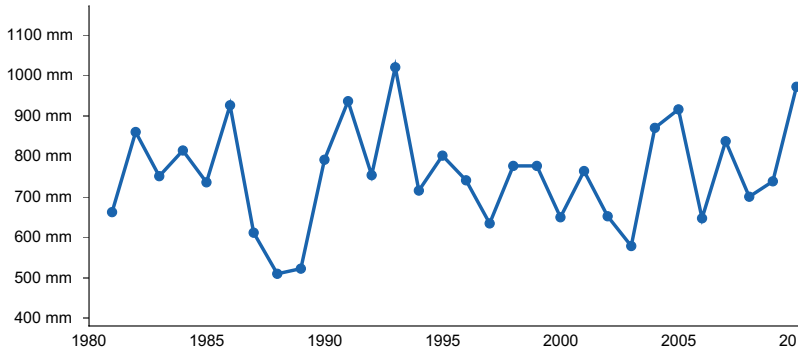


Figure 7. Annual precipitation pattern

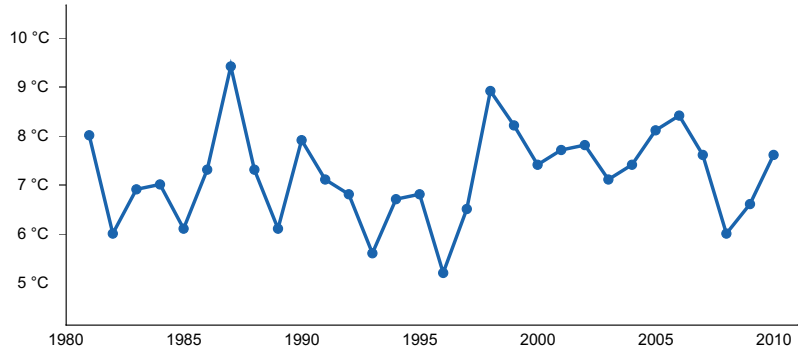


Figure 8. Annual average temperature pattern

Climate stations used

- (1) GRANITE FALLS [USC00213311], Granite Falls, MN
- (2) MANKATO [USC00215073], Mankato, MN
- (3) OLIVIA 3E [USC00216152], Bird Island, MN
- (4) LAKEFIELD 2NE [USC00214453], Lakefield, MN
- (5) ALBERT LEA 3 SE [USC00210075], Albert Lea, MN
- (6) PERRY [USC00136566], Perry, IA

Influencing water features

With natural hydrology intact, this ecological site may receive water from direct precipitation, runoff from higher sites, and recharge through base flow from adjacent sites. In the spring months, this site can produce surface runoff. The soils are typically classified as endosaturated. Drainage class ranging from somewhat poorly drained to somewhat excessively drained. The water table can be near the soil surface during the spring months, especially in the somewhat poorly drained soils, but will drop as low as the depth to the underlying bedrock during dry periods.

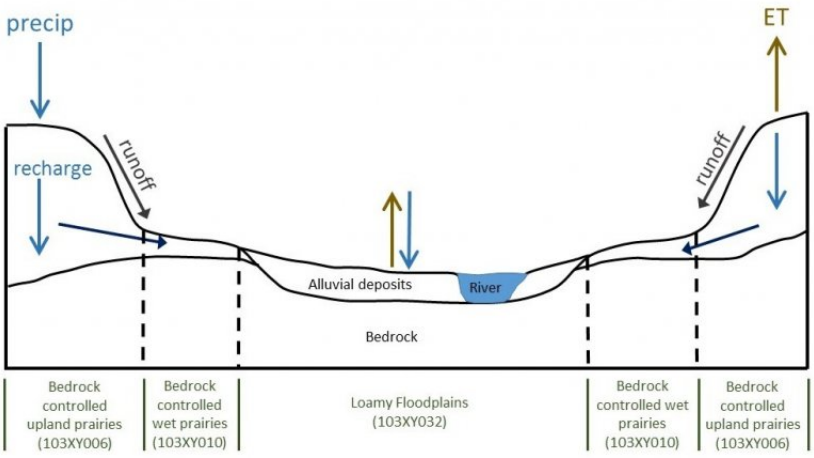


Figure 9. Representation of hydrological factors in a typical area of the Bedrock Controlled Upland Prairie and associated ecological sites on the Des Moines Lobe (MLRA 103).

Soil features

This ecological site is typically on mineral soils that developed under prairie vegetation. These prairie soils have a thick, nearly black, organic rich mollic epipedon. The parent materials include loamy slope alluvium and alluvial glaciofluvial deposits overlying carbonaceous bedrock (i.e., limestone or dolomite), usually in close association with river valleys. Soil drainage class varies from somewhat poorly to somewhat excessively drained. Common surface textures are loam, clay loam, silt loam, silty clay loam, and fine sandy loam. The subsurface textural group is typically classified as coarse loamy, fine loamy, or fine. Most soils are Mollisols with the majority of the components classified as Typic Hapludolls or Lithisc Hapludolls. A minority are classified as Aquic Hapludolls or Oxyaquic Dystrudepts. The central concept soils are Copaston, Rockton, and Ridgeport.

Soil series include Bechyn, Germantown, Copaston, Gosport, Emeline, Ridgeport, Jacwin, Kensett, and Rockton.

Table 4. Representative soil features

Parent material	(1) Till (2) Glaciofluvial deposits (3) Slope alluvium
Surface texture	(1) Loam (2) Clay loam (3) Silt loam (4) Silty clay loam (5) Fine sandy loam
Family particle size	(1) Fine-loamy (2) Coarse-loamy (3) Fine
Drainage class	Somewhat poorly drained to somewhat excessively drained
Permeability class	Rapid to very rapid
Soil depth	10–102 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-152.4cm)	2.54–17.78 cm
Calcium carbonate equivalent (0-101.6cm)	0–30%
Soil reaction (1:1 water) (0-101.6cm)	3.5–8.4
Subsurface fragment volume <=3" (0-101.6cm)	0–15%
Subsurface fragment volume >3" (0-101.6cm)	0–5%

Ecological dynamics

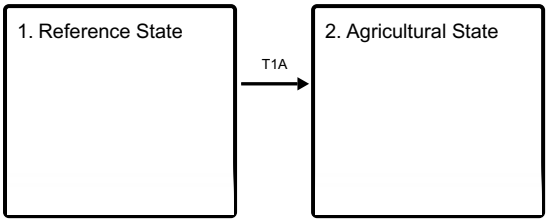
The Bedrock Controlled Upland Prairies ecological site is characterized by two states: the Reference State and the Agricultural State. Some areas within this ecological site are utilized for cropland; however, many areas preclude tillage due to shallow soils and/or slope. Two plant communities exist in the Reference State are characterized by different fire return intervals. The mechanism of change between communities is fire frequency. Grazing can also be a trigger for change.

Two communities make up the Agricultural State: the Row Crop Community (mostly moderately deep soils on lower

sloping sites) and the Seeded Grassland Community. Shallow soils (Bechyn, Emeline, and Copaston) are generally utilized for pasture or have reverted to a ruderal woodland. Moderately deep soils (Germantown, Gosport, Ridgeport, Jacwin, Kensett, and Rockton) on lower sloping sites are often utilized for row crops or pasture.

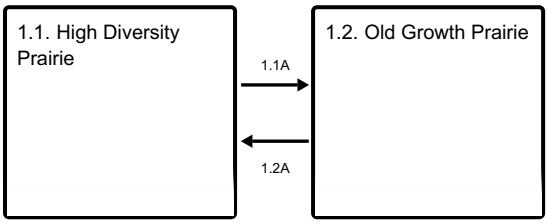
State and transition model

Ecosystem states



T1A - Transition to agriculture; tillage; seeding; continued management

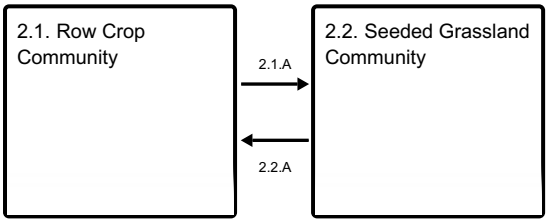
State 1 submodel, plant communities



1.1A - Fire return interval 3-5 years.

1.2A - Fire return interval less than 3 years

State 2 submodel, plant communities



2.1.A - Grass seeding; grassland management

2.2.A - Tillage; crop production

State 1
Reference State

The Bedrock Controlled Upland Prairies ecological site reference plant community is native prairie with grasses and forbs tolerant of dry conditions. Community phases in the model are dependent upon the impacts of fire. Frequent fire maintains the grassland community. A secondary trigger for maintenance or change is grazing. Intensive grazing can reduce the extent of highly palatable species thereby allowing the growth of less desirable plants to increase. Grazing management guidelines vary by site depending on specific site characteristics and management objectives. High-quality, undisturbed, native prairie remnants are extremely uncommon. Many areas currently managed as prairie were previously disturbed. It is therefore likely that many native prairie species were extirpated even from these sites.

Resilience management. Prescribed fire and managed grazing are key resilience management practices. Prescribed grazing incorporates periods of grazing rest during the growing season which benefits tallgrass maintenance. Excessive grazing can quickly impact the vegetative composition and negatively impact soil stability. Prescribed fire is the controlled application of fire to modify vegetation structure and influence ecological processes.

Dominant plant species

- leadplant (*Amorpha canescens*), shrub
- little bluestem (*Schizachyrium scoparium*), grass
- porcupinegrass (*Hesperostipa spartea*), grass

Community 1.1
High Diversity Prairie

This plant community consists of native grasses and forbs tolerant of dry conditions. The vegetative composition is influenced primarily by fire return intervals of less than 3 years and/or grazing. Frequent fire will reduce thatch and woody species plus stimulate seed regeneration. A suite of diagnostic forbs is yet to be developed, but goldenrod and aster species are common.

Resilience management. Prescribed fire and managed grazing are key resilience management practices.

Dominant plant species

- leadplant (*Amorpha canescens*), shrub
- little bluestem (*Schizachyrium scoparium*), grass
- sideoats grama (*Bouteloua curtipendula*), grass
- big bluestem (*Andropogon gerardii*), grass
- goldenrod (*Solidago*), other herbaceous
- aster (*Symphyotrichum*), other herbaceous

Community 1.2
Old Growth Prairie

This plant community is characterized by a fire return interval of 3 to 5 years, which is longer than that of Community 1.1. Native grasses are dominant, but species composition may be altered and woody species density has increased. Thatch and dead plant residue are denser than in Community 1.1.

Resilience management. Prescribed fire and grazing are resilience management practices. Although this community has a longer fire return interval than Community 1.1, it also relies on fire and grazing to maintain vegetation community structure.

Dominant plant species

- leadplant (*Amorpha canescens*), shrub
- little bluestem (*Schizachyrium scoparium*), grass
- big bluestem (*Andropogon gerardii*), grass

Pathway 1.1A
Community 1.1 to 1.2

Fire and grazing are the primary triggers on these sites. In this state and transition model, the frequency of fire is the primary factor affecting the transition from Community 1.1 and Community 1.2. Pathway 1.1A consists of a fire free period of 3 to 5 years. Native warm-season grass species remain dominant, but an increase of woody species is noticeable within the plant community. Encroachment by woody species continues in the absence of fire. Although fire frequency is the main driver of community change, secondary triggers also influence changes in species density and overall community composition. Examples of secondary triggers are grazing and drought.

Pathway 1.2A
Community 1.2 to 1.1

This pathway consists of a fire return interval of less than 3 years. Fire intolerant species are set back, woody species are reduced, and the amount of dead plant material is reduced.

State 2
Agricultural State

The Agricultural State is characterized by grazing, hay production, or row crops. Only lower slope sites, usually those with moderately deep soils, are feasible for row crops. Many areas in this ecological site are not appropriate for row crop production due to slope and/or shallow soils. On those sites that are tilled, the dynamic soil properties such as bulk density, structure, organic carbon content, and saturated hydraulic conductivity are altered. Certain practices can mitigate the impacts of traditional tillage agricultural practices on soil health. Conservation tillage minimizes soil disturbance and can improve soil structure and overall soil health. Corn or soybean plantings and a cover crop rotation can build soil structure, improve infiltration rates, reduce runoff and erosion, and protect water quality. Some areas have been seeded to cool-season or warm-season grasses. Native warm-season grass planting is often conducted under conservation programs such as the NRCS Conservation Reserve Program (CRP). Although highly beneficial to wildlife, these sites generally lack the species diversity in a high-quality reference state. Cool-season grasses are also feasible for some areas. Species selection will depend on the landowner's objectives and site specifics.

Resilience management. Disturbance management and harvest management are resilience management practices. The maintenance of this state requires that the intensity, frequency, duration, and timing of agricultural practices (disturbances) be managed to control or modify vegetation structure.

Dominant plant species

- corn (*Zea mays*), grass
- soybean (*Glycine max*), other herbaceous

Community 2.1
Row Crop Community

Limited areas within this ecological site may be utilized for row crops. Sites utilized for cropland are generally lower slope and have moderately deep soils. Tillage and intentional plant establishment (crop seeding) are the primary triggers for this community. The most common crops are corn and soybeans on an annual rotation. Dryness, slope, and shallow soils will be limiting factors for soils of this ecological site.

Resilience management. Disturbance management and harvest management are resilience management practices. The maintenance of the desired vegetation community requires management of the intensity, frequency, duration, and timing of disturbances caused by agricultural practices.

Dominant plant species

- corn (*Zea mays*), grass
- soybean (*Glycine max*), other herbaceous

Community 2.2
Seeded Grassland Community

The primary trigger is the intentional establishment of a grassland community. Warm-season grasses are commonly planted through conservation programs, such as the NRCS Conservation Reserve Program (CRP). Cool-season grasses are also feasible. Many of these areas are eventually transitioned to annual crop production.

Resilience management. Resilience management practices include woody species control, invasive plant management, and/or a program of planned grazing that manages the intensity, frequency, and duration of grazing and the number of grazing animals. Prescribed fire is a resilience management practice on warm-season grasslands. The controlled application of fire modifies vegetation structure and influence ecological processes.

Dominant plant species

- big bluestem (*Andropogon gerardii*), grass
- little bluestem (*Schizachyrium scoparium*), grass
- Indiangrass (*Sorghastrum nutans*), grass

Pathway 2.1.A
Community 2.1 to 2.2

This pathway converts Community 2.1 (row crops) to Community 2.2 (seeded grassland). The primary mechanism of change is the seeding of desired grass species.

Conservation practices

Forage and Biomass Planting

Pathway 2.2.A
Community 2.2 to 2.1

This pathway converts seeded grassland to cropland. This is a common pathway throughout MLRA 103 as areas are placed in crop production. The mechanisms of change are tillage and intentional plant establishment (crop seeding). Resilience management practices include weed control (herbicide application), field cultivation, fertilizer application, and harvest management.

Transition T1A
State 1 to 2

Transition T1A is the conversion of native prairie to agricultural production.

Constraints to recovery. Tillage precludes a return to State 1. Previously tilled areas may seeded with warm-season grasses, but will not exhibit the natural species diversity or ecological resilience of State 1.

Additional community tables

Inventory data references

No field plots were available for this site. A review of the scientific literature and professional experience were used to approximate the plant communities for this provisional ecological site. Information for the state-and-transition model was obtained from the same sources. All community phases are considered provisional based on these plots and the sources identified in ecological site description.

Other references

Cleland, D.T., J.A. Freeouf, J.E. Keys, G.J. Nowacki, C. Carpenter, and W.H. McNab. 2007. Ecological Subregions: Sections and Subsections of the Conterminous United States. USDA Forest Service, General Technical Report WO-76. Washington, DC.

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Approval

Suzanne Mayne-Kinney, 10/04/2023

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	05/19/2024
Approved by	Suzanne Mayne-Kinney
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:

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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:**
