USDA Natural Resources Conservation Service

Ecological site R103XY002MN
Calcareous Upland Prairies

Last updated: 10/04/2023
Accessed: 05/17/2024

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)

Relationship to Other Established Classifications:
The reference state shares similarities with Minnesota Department of Natural Resources UPs23 Southern Mesic Prairie and 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

Ecological site concept

The Calcareous Upland Prairies ecological site is located on upland calcareous soils on backslopes, summits, and shoulders. The soil drainage class is somewhat poorly drained to well drained, and the site does not flood or pond. Soils were developed under prairie vegetation.

Associated sites

R103XY001MN	**Loamy Wet Prairies** The Loamy Wet Prairie ecological site is located on inter-depressional linear slopes and slight depressions on till plains, moraines and short-lived lakeplains. Soil parent materials are loamy till and lacustrine materials. The drainage class is poorly drained but the site does not flood or pond.
R103XY011MN	**Footslope/Drainageway Prairies** The Footslope/Drainageway Prairies ecological site is located mainly on footslopes, toeslopes, and upland drainageways. The most common drainage class is moderately well-drained. The site incurs frequent to occasional extremely brief and very brief flooding.

Similar sites

R103XY003MN	**Sandy Upland Prairies** The Sandy Upland Prairie ecological site is located on uplands including outwash plains and valley trains along modern river valleys. Soils are formed from sandy and course loamy outwash and loamy-mantled outwash. Sites do not flood or pond.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Amorpha canescens*
Herbaceous	(1) *Schizachyrium scoparium* (2) *Symphyotrichum sericeum*

Physiographic features

The Calcareous Upland Prairies ecological site occurs throughout MLRA 103 on ground moraines and till plains. The site is primarily on backslope positions, but may occur on summits and shoulders. The slope positions are linear to convex both vertically and horizontally. Slope percentage varies considerably on this site (0-65%). This site does not flood or pond.

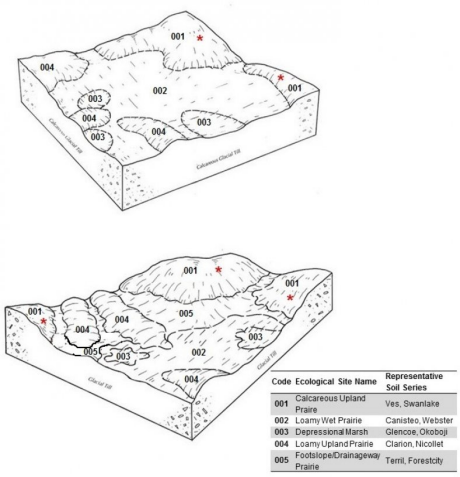


Figure 1. Block diagrams of the representative Calcareous Upland Prairies and associated ecological sites.

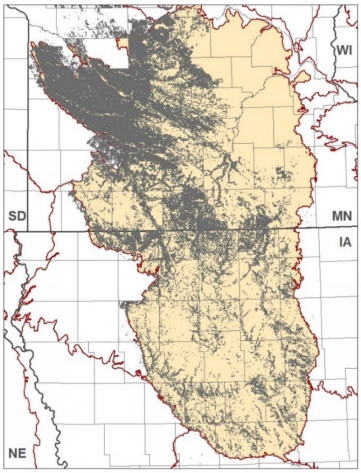


Figure 2. Distribution of the Calcareous Upland Prairies ecological site within MLRA 103. In many cases, the data set is not spatially consistent across political boundaries due to the method by which soils were mapped; e.g. due to county subsets.

Table 2. Representative physiographic features

Hillslope profile	(1) Backslope (2) Summit (3) Shoulder
Landforms	(1) Upland > Ground moraine (2) Upland > Till plain
Runoff class	Low to very high
Elevation	210–569 m
Slope	0–65%
Water table depth	30–203 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 site is 158 days, while the frost-free period is 133 days. The average mean annual precipitation is 32 inches, which includes rainfall plus the water equivalent from snowfall. Sloping soils are generally warmer than lower, more concave soils, which makes this site warmer than adjacent, downslope areas. As a result, snow and frost melt sooner in the spring, thus resulting in longer growing seasons than the adjacent depressions.

Table 3. Representative climatic features

Frost-free period (characteristic range)	131-135 days
Freeze-free period (characteristic range)	153-162 days
Precipitation total (characteristic range)	762-889 mm
Frost-free period (actual range)	129-137 days
Freeze-free period (actual range)	152-166 days
Precipitation total (actual range)	737-914 mm
Frost-free period (average)	133 days
Freeze-free period (average)	158 days
Precipitation total (average)	813 mm

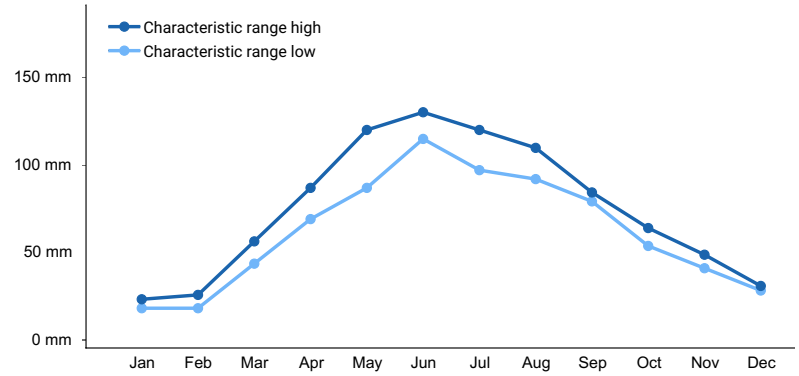


Figure 3. Monthly precipitation range

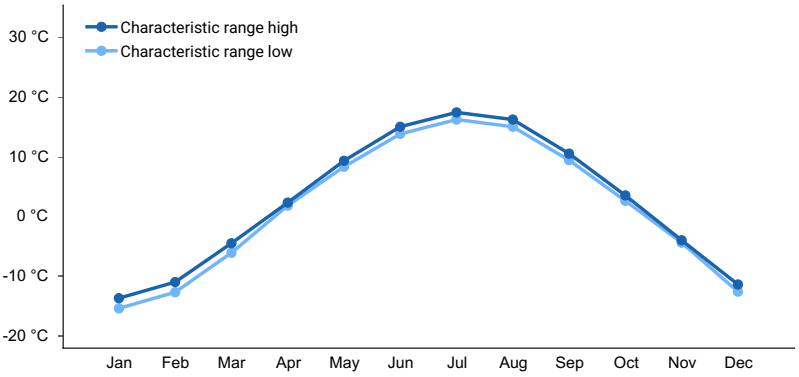


Figure 4. Monthly minimum temperature range

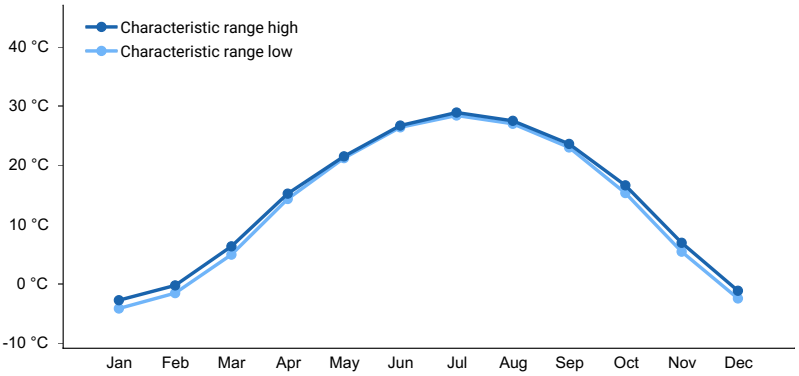


Figure 5. Monthly maximum temperature range

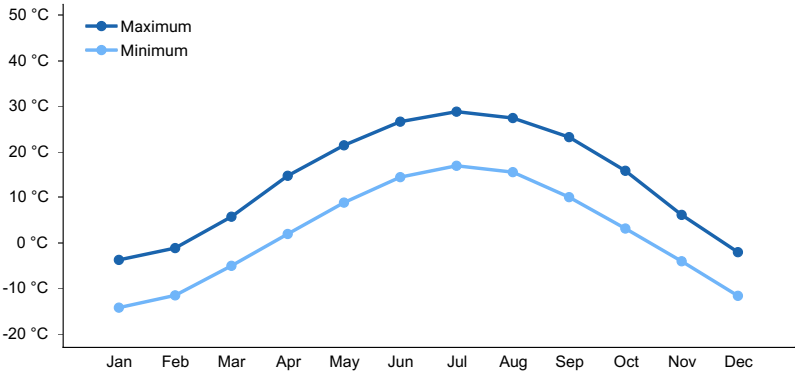


Figure 6. Monthly average minimum and maximum temperature

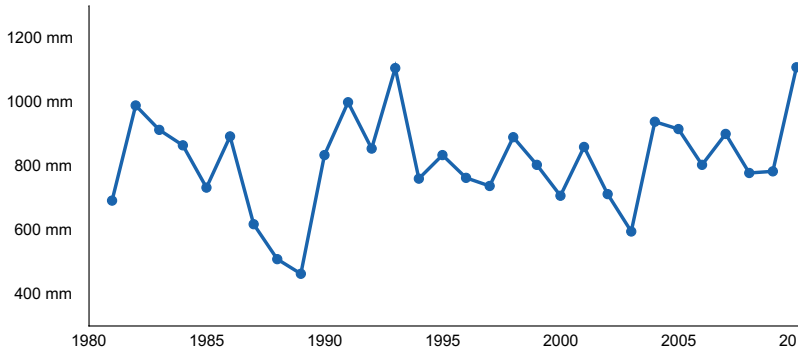


Figure 7. Annual precipitation pattern

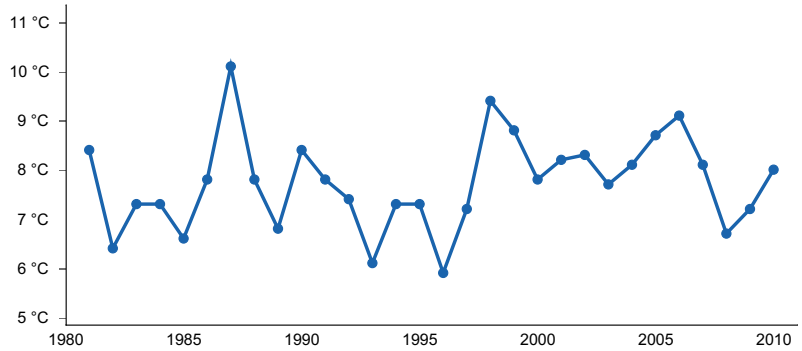


Figure 8. Annual average temperature pattern

Climate stations used

- (1) WINNEBAGO [USC00219046], Winnebago, MN
- (2) DASSEL [USC00212023], Dassel, MN
- (3) MARSHALL [USC00215204], Marshall, MN
- (4) LAKE PARK [USC00134561], Lake Park, IA
- (5) MASON CITY MUNI AP [USW00014940], Clear Lake, IA
- (6) COLO [USC00131710], Colo, IA

Influencing water features

The Calcareous Upland Prairies ecological site receives water from precipitation, subsurface flow, and runoff. Precipitation is the primary water source for most areas. This ecological site provides recharge and runoff to downslope sites. Spring is the wettest time of the year for this MLRA. The soils on this site are classified as endosaturated as the water table is typically between 12 to 80 inches during the spring and drops below the series control section in the growing season during dry periods.

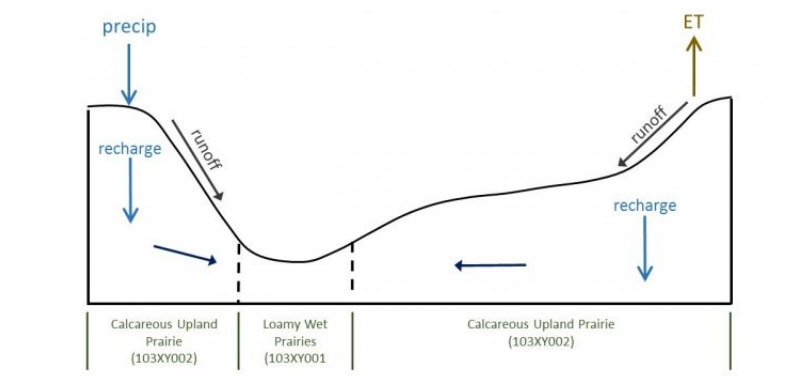


Figure 9. Representation of hydrological factors in a typical area of the Calcareous Upland Prairies and associated ecological sites.

Soil features

The soils associated with this ecological site formed mostly in glacial till and are of a drainage class and moisture status that makes them drier than hydric. Included soils are classified as Hapludolls, Calciudolls, or Eutrudepts in Typic, Calcic or Aquic subgroups. The drainage class ranges from somewhat poorly drained to well drained, with well drained being the most common. The prevalent soil surface texture is loam, clay loam, silt loam, fine sandy loam, very fine sandy loam, or sandy loam. The subsurface layer, below the mollic epipedon, is either coarse loamy or fine loamy and sometimes stratified. These soils are derived mostly from original unsorted Des Moines lobe materials. Soil series include Amiret, Annton, Belview, Doland, Louris, Malachy, Moines, New London, Seaforth, Storden, Sunberg, Swanlake, Torning, Ves, and Zell.

Table 4. Representative soil features

Parent material	(1) Till (2) Slope alluvium
Surface texture	(1) Loam (2) Clay loam (3) Silt loam (4) Sandy loam
Family particle size	(1) Fine-loamy (2) Coarse-loamy
Drainage class	Somewhat poorly drained to well drained
Permeability class	Slow to very rapid
Soil depth	203 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-152.4cm)	17.78–33.02 cm
Calcium carbonate equivalent (0-101.6cm)	0–35%
Soil reaction (1:1 water) (0-101.6cm)	5.6–8.4
Subsurface fragment volume <=3" (0-101.6cm)	0–15%
Subsurface fragment volume >3" (0-101.6cm)	0–5%

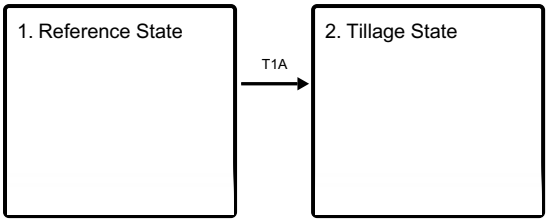
Ecological dynamics

The communities within the Reference State are dependent upon the influences of grazing and frequency of fire events. Fire is an important trigger that promotes continued herbaceous vegetation dominance and removes dense thatch thereby allowing for seedling regeneration. Fire also removes plant litter, helps cycle nutrients, and allows light to reach the seedbed. Frequent fire maintains this plant community in a grassland state, by keeping fire-sensitive woody species from proliferating and gaining dominance. A secondary trigger is grazing. Intensive grazing reduces the extent of highly palatable species thereby allowing the growth of less desirable plants to increase.

High-quality, unplowed areas of the Reference State are extremely uncommon today. Most remaining natural areas that are managed for native prairie were once utilized for agricultural production and reseeded. It is therefore likely that many native prairie species are extirpated even from these restored sites.

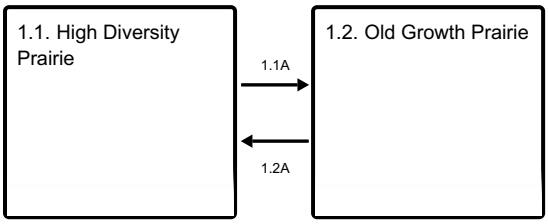
State and transition model

Ecosystem states



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

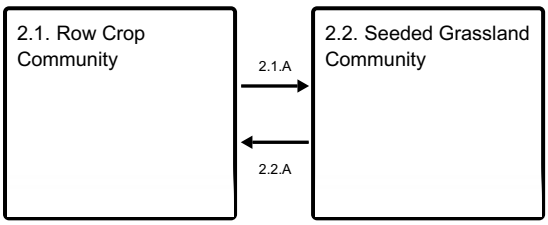
State 1 submodel, plant communities



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 reference plant community is native prairie with a diversity of grasses and forbs. Plant community composition is influenced by grazing, drought, and frequency of fire events. Fire is a trigger that promotes continued herbaceous vegetation dominance and removes dense thatch thereby allowing for seedling regeneration. Fire also removes plant litter, helps cycle nutrients, and allows light to reach the seedbed. Areas of this ecological site historically burned every 5 years or less. Frequent fire maintains this plant community in a grassland state, by keeping fire-sensitive woody species from proliferating and gaining dominance. The secondary trigger for conversion is grazing. Intensive grazing reduces the extent of highly palatable species thereby allowing the growth of less desirable plants to increase. Grazing management guidelines vary by site depending on site specifics and management objectives. Numerous grasses and forbs may grow on this state and the community composition will be determined by fire, drought, and grazing. High-quality, unplowed areas of the reference state are extremely uncommon today. Most remaining natural areas that are managed for prairie were once utilized for agricultural production. It is therefore likely that many native prairie species are extirpated even from these sites.

Resilience management. Prescribed fire and managed grazing are key resilience management practices. This is a stable plant community when grazing and fire are adequately managed. 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
- big bluestem (*Andropogon gerardii*), grass
- western silver aster (*Symphyotrichum sericeum*), other herbaceous

Community 1.1
High Diversity Prairie

This plant community consists of native warm-season grasses and a variety of native forbs. The vegetative composition is influenced primarily by fire return intervals of less than 3 years. Dominant species include little bluestem, leadplant, and an array of native forbs. Frequent fire reduces the extent of woody species and maintains the natural dominance and diversity of native grasses and forbs. A suite of diagnostic herbaceous species is yet to be developed; however, aster (Symphyotrichum spp.), prairie clover (Dalea spp.), blazing star (Liatris spp.), sunflower (Helianthus spp.), and goldenrod (Solidago spp.) are common. Grazing is a primary trigger on many sites and the intensity and timing of the grazing management practices will control the health, composition, and structure of the vegetative community.

Resilience management. Prescribed fire and managed grazing are key resilience management practices. This is a stable plant community when grazing and fire are adequately managed. Prescribed grazing incorporates periods of grazing rest during the growing season which benefits grass maintenance. Excessive grazing can quickly impact the vegetative composition and negatively impact soil stability and water quality.

Dominant plant species

- leadplant (*Amorpha canescens*), shrub
- little bluestem (*Schizachyrium scoparium*), grass
- aster (*Symphyotrichum*), other herbaceous

Community 1.2
Old Growth Prairie

This community is characterized by a longer fire return interval than that of Community 1.1. Native grasses are still dominant, but more woody species are present. Thatch and dead plant residue are denser than in Community 1.1. Thatch will increase annually. Woody species will increase within the community. Grazing can also greatly influence the composition of this site. Unmanaged grazing has the potential to negatively impact plant composition resulting in a decrease in desired grasses and an increase in undesirable woody species and unpalatable plants.

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. Prescribed grazing promotes grass regeneration and vigor. By incorporating periods of pasture rest and recovery during the growing season, landowners can insure that the palatable grasses and forbs are maintained within the community.

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 is the primary trigger that affects the plant community composition. This pathway consists of a fire free period of 3 to 5 years. Secondary triggers include 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 woody species are set back, and

the amount of dead plant material is reduced.

State 2
Tillage State

Tillage is the primary mechanism affecting the transition to this state. In this state, dynamic soil properties such as bulk density, structure, organic carbon content, and saturated hydraulic conductivity are altered by agricultural practices. Most areas in this state will remain in use for crop production in the foreseeable future – primarily in an intensive corn and soybean rotation. Certain practices can mitigate the impacts of traditional 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 in this ecological site are not appropriate for intensive crop production due to slope. Where the gradient exceeds 20 percent row crop production is not feasible due to limitations on farm machinery. A small percentage of areas have been seeded back to grass. Some previously tilled areas have been converted to warm-season grasslands as part of the NRCS Conservation Reserve Program (CRP). Although highly beneficial to wildlife, these sites generally lack the diversity of species in a high-quality reference state. Depending on the management objectives of the landowner, cool-season grasses may be planted. Although cool-season grasslands are not as species rich or biologically diverse as warm-season grasslands, they still offer various soil health benefits and some ecological benefits for grassland bird species.

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

This plant community typically consists of intensively produced, traditional row crops. 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. Conservation practices may be implemented to reduce erosion. These practices can help protect the soil surface from erosion and improve water infiltration. Examples include no-till or ridge-till, which leave residue on the surface of the field. Additional soil health benefits can be gained by adding alternative crops to fields that are already in conservation tillage. By diversifying the crop rotation, landowners take additional management steps to improve soil health and protect water quality.

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

This plant community grows in areas that were previously tilled and used for agricultural production but have been transitioned to either warm-season or cool-season grasses. 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). Species often include big bluestem, little bluestem, and native forbs that benefit wildlife and pollinators. Seed mix selection depends on landowner objectives and site-specific characteristics. A small percentage of acres are in cool-season grass species such as Kentucky bluegrass and reed canarygrass. Management inputs include site preparation, seeding, and weed control. Many of these areas are

eventually transitioned to annual crop production.

Resilience management. The maintenance of the desired vegetation structure requires management of the intensity, frequency, duration, and timing of disturbances (seeding, weed control, brush control). 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

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).

Transition T1A
State 1 to 2

Transition T1A is the conversion of the reference state to agriculture. The triggers are tillage and intentional plant establishment (crop seeding). Resilience management practices include continual agricultural practices such as seeding, fertilizing, and managing invasive plants with herbicides or field cultivation. Hydrological modifications, such as ditching and tiling, may also be installed.

Constraints to recovery. Tillage and long-term intensive agricultural production generally preclude a return to State 1. Areas in row crop production may be placed in conservation programs and seeded with warm-season grasses, but will not exhibit the natural species diversity or ecological resiliency 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

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Contributors

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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	05/17/2024
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):**

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:

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17. **Perennial plant reproductive capability:**
