USDA Natural Resources Conservation Service

Ecological site R103XY010MN
Bedrock Controlled Wet 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 (251B) and Minnesota and Northeast Iowa Morainal-Oak Savannah (222M) Sections; Upper Minnesota River-Des Moines Lobe (251Ba), Southern Des Moines Lobe (251Be), and Big Woods Moraines (222Mb) Subsections (Cleland et al. 2007)

Relationship to Other Established Classifications:
Biophysical Setting (Landfire, 2009)-Central Tallgrass Prairie (4214210)

The reference state shares similarities to Minnesota Department of Natural Resources WPs54b Southern Wet Prairie

Ecological site concept

The Bedrock Controlled Wet Prairies ecological site generally occurs near larger rivers where glacial meltwaters scoured the valley leaving areas of bedrock occurring as strath terraces above the floodplain. Soils are poorly drained and the water table is usually at or near the soil surface in wet spring months. Occasional flooding may occur on some areas.

Associated sites

R103XY006MN	**Bedrock Controlled Upland Prairies** The Bedrock Controlled Upland Prairies ecological site is characterized by shallow to moderately deep soils that are influenced by bedrock and have a low available water capacity.
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.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Amorpha canescens*
Herbaceous	(1) *Andropogon gerardii* (2) *Spartina pectinata*

Physiographic features

The Bedrock Controlled Wet Prairies ecological site is relatively uncommon in the MLRA since areas of bedrock exposure are uncommon. This site is generally found near larger rivers, especially in the Minnesota and Dec Moines River valleys. Glacial meltwaters scoured these broad valley leaving areas of bedrock occurring as strath terraces above the floodplain. This concept is surrounded by river deposited alluvium or outwash soils. Landscape positions are typically low gradient linear segments or depressions which tend to occur on strath terraces. Low relief, 0-2% linear to concave slopes with loamy soils textures and a bedrock substratum interact to make this ecological site wetter than the adjacent upslope areas but drier than adjacent downslope areas. The low slope gradient, bedrock substratum, and linear to slightly concave slope shapes are defining characteristics of this ecological site. This site does not typically pond, but the water table is usually at or near the soils surface in wet spring months.

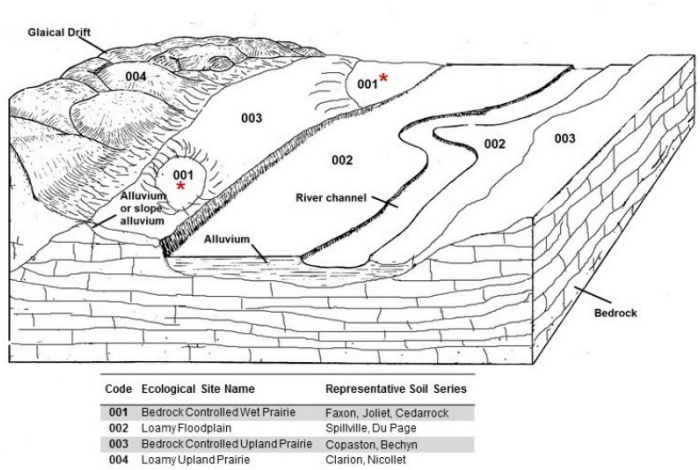


Figure 1. Block diagrams of the representative Bedrock Controlled Wet Prairies and associated ecological sites.

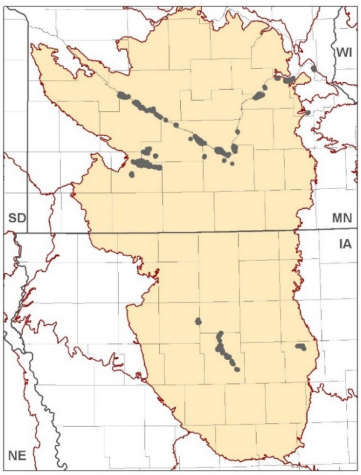


Figure 2. Distribution of the Bedrock Controlled Wet Prairies ecological site within MLRA 103. In many cases, the data set is not spatially consistent across political boundaries due to the method by which soils were mapped; e.g. due to county subsets.

Table 2. Representative physiographic features

Landforms	(1) Strath terrace
Runoff class	Negligible to medium
Flooding duration	Very brief (4 to 48 hours) to brief (2 to 7 days)
Flooding frequency	None to occasional
Elevation	244–335 m
Slope	0–2%
Water table depth	0–102 cm
Aspect	Aspect is not a significant factor

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 156 days, while the frost-free period is 133 days. The average mean annual precipitation is 33 inches, which includes rainfall plus the water equivalent from snowfall. Cold air drainage from above and the fact that wet soils are generally colder than dry soils make this site colder than adjacent, upslope areas. As a result, snow and frost remain longer in the spring, thus resulting in shorter growing seasons than the adjacent uplands.

Table 3. Representative climatic features

Frost-free period (characteristic range)	132-136 days
Freeze-free period (characteristic range)	149-162 days
Precipitation total (characteristic range)	762-889 mm
Frost-free period (actual range)	129-137 days
Freeze-free period (actual range)	148-163 days
Precipitation total (actual range)	762-940 mm
Frost-free period (average)	133 days
Freeze-free period (average)	156 days
Precipitation total (average)	838 mm

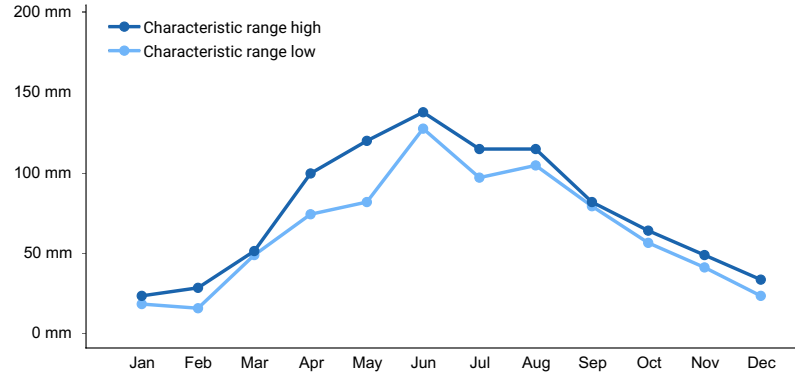


Figure 3. Monthly precipitation range

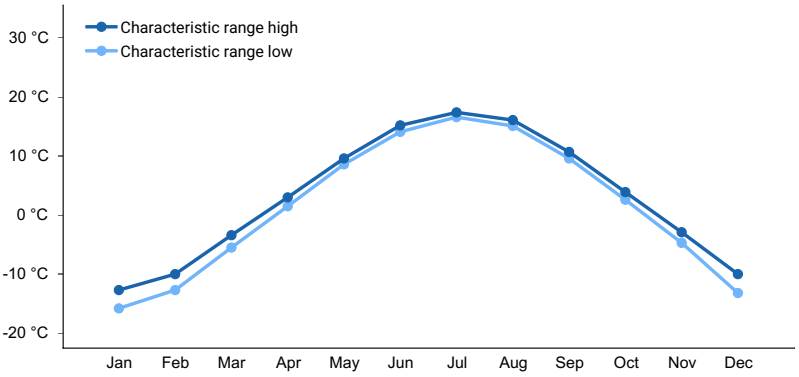


Figure 4. Monthly minimum temperature range

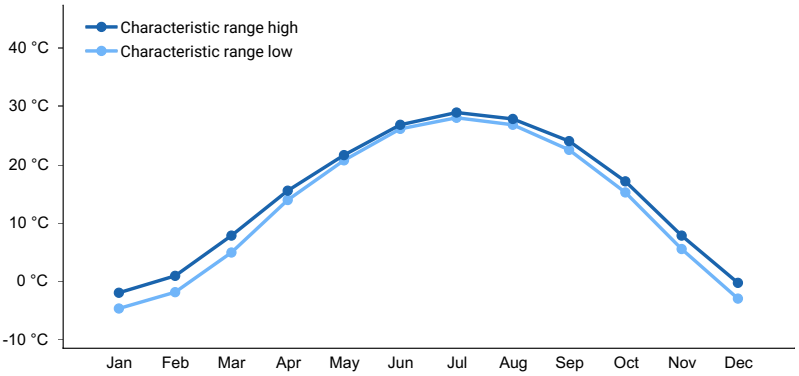


Figure 5. Monthly maximum temperature range

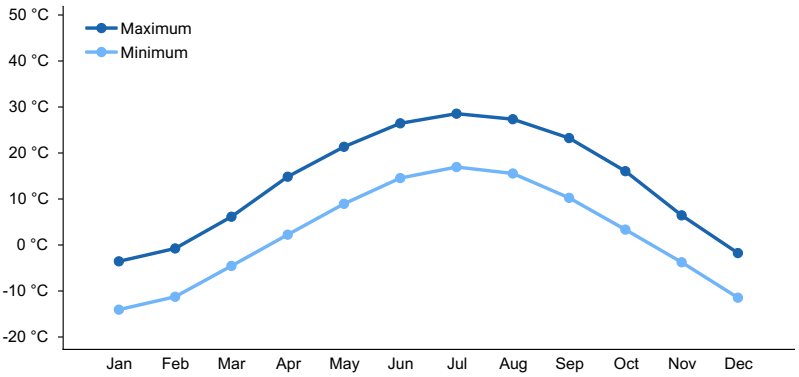


Figure 6. Monthly average minimum and maximum temperature

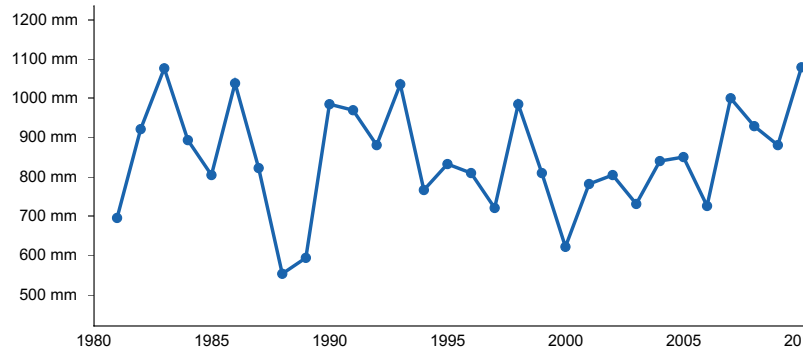


Figure 7. Annual precipitation pattern

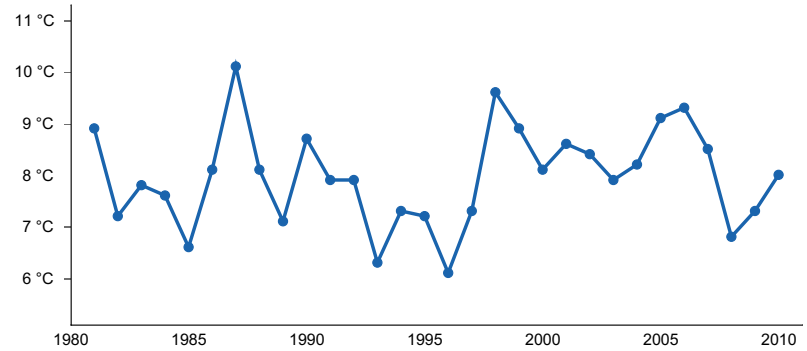


Figure 8. Annual average temperature pattern

Climate stations used

- (1) BOONE [USC00130807], Boone, IA
- (2) STEWART [USC00218025], Brownton, MN
- (3) WILLMAR WWTP [USC00219004], Willmar, MN
- (4) BRITT [USC00130923], Britt, IA
- (5) STORM LAKE 2 E [USC00137979], Storm Lake, IA
- (6) PERRY [USC00136566], Perry, IA

Influencing water features

With the natural hydrology intact, this site receives water mainly from three sources: direct precipitation, runoff, and recharge through base flow from adjacent upland areas. During the wet months, this site can produce surface runoff. Soils are typically classified as endosaturated as the water table is at or near the soil surface during the spring months. During dry periods, the water table may drop to the depth to the underlying bedrock. Some areas are occasionally flooded.

In the hydrogeomorphic (HGM) classification system, areas not affected by flooding are considered a Recharge Mineral Soil Flat, producing recharge to groundwater (USDA-NRCS, 2008; Gilbert et al., 2006). This site has a Saturated Cowardin Hydrologic Regime of Palustrine; Persistent Emergent Wetlands. It also has a United States Army Corps of Engineers Wetland Plant Community of D; Fresh (wet) Meadows, Sedge Meadows and Wet Prairies (Mineral Soils).

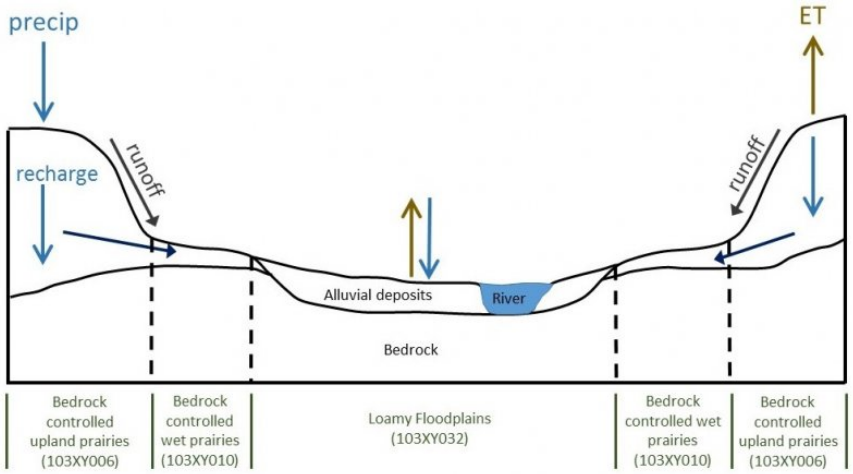


Figure 9. Representation of hydrological factors in a typical area of the Bedrock Controlled Wet Prairies and associated ecological sites on the Des Moines Lobe (MLRA 103).

Soil features

The soil series representing this site are Cedarrock, Faxon, Joliet, Little Cottonwood, Mound Creek, and Tilfer. These mineral soils are rich in organic matter and developed under prairie vegetation. Prairie soils typically have thick, nearly black, mollic epipedons. Parent materials include loamy slope alluvium and alluvial/glaciofluvial deposits overlying carbonaceous bedrock (i.e., limestone or dolomite), usually with close association with rivers valleys. Soil drainage class is poorly drained. The most common surface textures are silt loam, silty clay loam, and clay loam. The subsurface textural group is typically classified as fine loamy or coarse loamy. The soil order is Mollisol, with most components classified as Typic Endoaquolls. Some are Lithic Endaquolls.

Soils of the Bedrock Controlled Wet Prairie ecological site were formed under saturated conditions that produced anaerobic conditions during at least part of the year. Thick, dark mollic epipedons tend to mask the typical redoximorphic features used to determine seasonal high water table depths. Beneath the mollic epipedons, these soils have a depleted matrix with low chroma (2 or less) and high value (4 or more). The primary hydric soil indicators include: Depleted below Dark Surface (A11), Thick Dark Surface (A12), and Redox Dark Surface (F6, option a; USDA-NRCS, 2010).

Table 4. Representative soil features

Parent material	(1) Slope alluvium (2) Glaciofluvial deposits
Surface texture	(1) Silt loam (2) Silty clay loam (3) Clay loam
Drainage class	Poorly drained
Permeability class	Rapid to very rapid
Soil depth	25–102 cm
Surface fragment cover <=3"	0–25%
Surface fragment cover >3"	0–25%
Available water capacity (0-152.4cm)	7.62–20.32 cm
Calcium carbonate equivalent (0-101.6cm)	0–30%
Soil reaction (1:1 water) (0-101.6cm)	5.1–8.6
Subsurface fragment volume <=3" (0-101.6cm)	0–17%

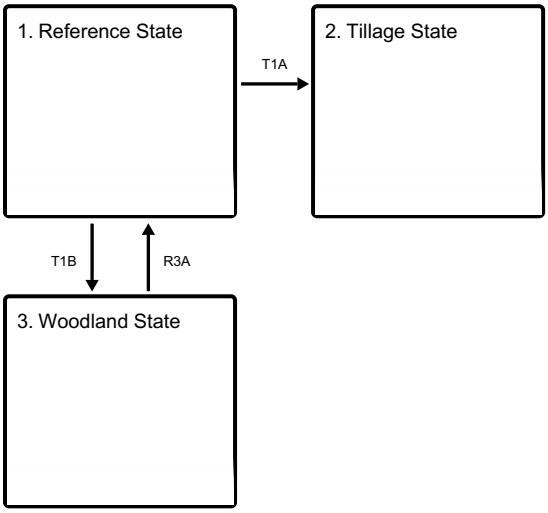
Subsurface fragment volume >3" (0-101.6cm)	0–10%

Ecological dynamics

The Bedrock Controlled Wet Prairies ecological site is characterized by three states: the Reference State, the Tillage State, and the Woodland State. Although the Tillage State is described in this model, this does not imply that all areas of this site are suitable for tillage. Some soils in this group are shallow (less than 20" in depth) and not well suited for intensive crop production. Two grassland communities exist in the Reference State and are characterized by different fire return intervals. Grazing can also be a trigger for change on this ecological site. The Tillage State describes sites that have been tilled and generally have modified hydrology (ditching, tiling). Some areas of this ecological site are in a Woodland State. Without fire or grazing to control woody vegetation, this site will eventually revert to a woodland. These sites often are impacted by unmanaged grazing and non-native vegetation.

State and transition model

Ecosystem states

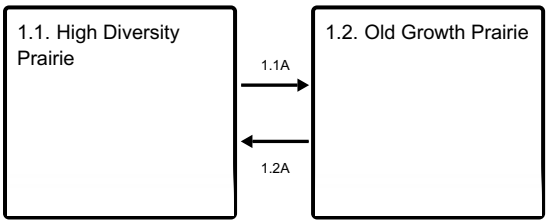


T1A - Transition to agriculture; tillage; seeding; continued management

T1B - Plant community succession in absence of fire or grazing management

R3A - Restoration inputs including woody species removal and invasive control

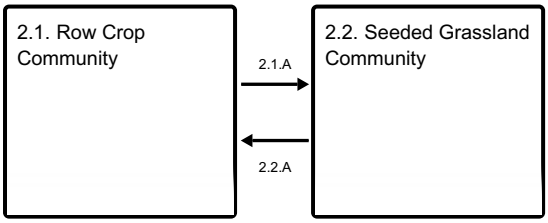
State 1 submodel, plant communities



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 3 submodel, plant communities

3.1. Woodland Community

State 1
Reference State

The Bedrock Controlled Wet Prairies reference state is a wet-tolerant native tallgrass prairie. Even though these sites are on poorly drained soils, plants adapted to these sites must also be tolerant of dry conditions for a portion of the growing season. Community phases within the Reference State are dependent upon the frequency of fire or influence of grazing. The secondary trigger for conversion is grazing. Today, high-quality, unplowed areas are extremely uncommon. Most remaining natural areas that are managed for tallgrass prairie were once tilled and utilized for agricultural production. It is therefore likely that many of the historic native prairie species are 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.

Dominant plant species

- big bluestem (*Andropogon gerardii*), grass
- prairie cordgrass (*Spartina pectinata*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- goldenrod (*Solidago*), other herbaceous
- white heath aster (*Symphyotrichum ericoides*), other herbaceous

Community 1.1
High Diversity Prairie

This plant community consists of native grasses and forbs. The vegetative composition is influenced primarily by a fire return intervals of less than 3 years. Fire reduces woody species, stimulates seed regeneration, and reduces the amount of thatch. Common grass species include big bluestem, prairie cordgrass, indiangrass, and multiple species of sedges. The composition of forb species is often highly diverse. A suite of diagnostic forbs is yet to be developed; however, common species include goldenrod and asters.

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

- big bluestem (*Andropogon gerardii*), grass
- prairie cordgrass (*Spartina pectinata*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- goldenrod (*Solidago*), other herbaceous
- white heath aster (*Symphyotrichum ericoides*), 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. Grass species are dominant, but more woody species are present. Thatch and dead plant residue are dense and begins to reduce seedling regeneration by shading and obstruction.

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
- willow (*Salix*), shrub
- dogwood (*Cornus*), shrub
- big bluestem (*Andropogon gerardii*), grass
- prairie cordgrass (*Spartina pectinata*), grass
- goldenrod (*Solidago*), other herbaceous

Pathway 1.1A
Community 1.1 to 1.2

Fire is the primary trigger that affects grassland community composition. This pathway consists of a fire free period of 3 to 5 years. Other triggers can be 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. Hydrological modifications (tiling and ditching) may be installed to improve drainage. Not all areas within this ecological site are suitable for intensive row crop production due to shallow soils (10-20" to bedrock). Undrained areas also have a seasonal high water table with can limit agricultural uses. Tillage alters dynamic soil properties such as bulk density, structure, organic carbon content, and saturated hydraulic conductivity. Most areas in this state will remain in use for crop production in the foreseeable future. Conservation 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. A small percentage of this ecological sites have been seeded back to grass. Some previously tilled areas have been converted to warm-season grasslands as part of a NRCS conservation program. Species seeded will depend upon the hydrology of the site and landowners' objectives. Cool-season grasses are also feasible. Species often include reed canarygrass and Kentucky bluegrass. Although cool-season grasslands are not as diverse as warm-season grasslands, they still offer benefits to soil health and wildlife. Some previously tilled and farmed sites may revert to a woodland through abandonment; however, this is a small percentage of acres within MLRA 103 so is not currently a community in this model.

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. A secondary trigger is substantial hydrological modifications (ditching and tiling), which are commonly installed to improve soil drainage. The most common crops are corn and soybeans on an annual rotation.

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 community is 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.

Resilience management. Disturbance management and harvest management are resilience management practices. The maintenance of the desired vegetation structure requires management of the intensity, frequency, duration, and timing of disturbances caused by agricultural practices. Practices include seeding, controlling weeds and brush, and applying fertilizer. Practices include seeding, controlling weeds and brush, and fertilizing. 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

- prairie cordgrass (*Spartina pectinata*), grass
- big bluestem (*Andropogon gerardii*), grass
- reed canarygrass (*Phalaris arundinacea*), grass
- Kentucky bluegrass (*Poa pratensis*), 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. Warm-season grasses are often established through a conservation program such as the NRCS Conservation Reserve Program.

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.

State 3
Woodland State

In the absence of a natural fire regime, grazing, or management inputs, this site will transition to a wooded state. Often, other disturbances such as unmanaged grazing, altered hydrology, and invasive species impact these areas. Community composition and characteristics will vary depending on the type, severity, and length of disturbances. Trees on site often include boxelder, green ash, willow, and cottonwood. Reed canarygrass, Kentucky bluegrass, smooth brome, and other non-native cool-season grasses often invade open areas.

Dominant plant species

- eastern cottonwood (*Populus deltoides*), tree
- willow (*Salix*), tree
- green ash (*Fraxinus pennsylvanica*), tree
- boxelder (*Acer negundo*), tree
- dogwood (*Cornus*), shrub
- willow (*Salix*), shrub
- reed canarygrass (*Phalaris arundinacea*), grass
- Kentucky bluegrass (*Poa pratensis*), grass

Community 3.1
Woodland Community

This site is a scrubby woodland plant community usually consisting of various species of trees, shrubs, and often, non-native species. Common trees include eastern cottonwood, willows, green ash, and boxelder. Open areas may be dominated by reed canarygrass and Kentucky bluegrass. Weed species, such as great ragweed (*Ambrosia trifida* L.) and stinging nettle (*Urtica dioica* L.), are often present. Plant community composition will be determined by disturbances, management inputs, and seed sources.

Dominant plant species

- eastern cottonwood (*Populus deltoides*), tree
- willow (*Salix*), tree
- green ash (*Fraxinus pennsylvanica*), tree
- boxelder (*Acer negundo*), tree
- dogwood (*Cornus*), shrub
- willow (*Salix*), shrub
- reed canarygrass (*Phalaris arundinacea*), grass
- Kentucky bluegrass (*Poa pratensis*), grass

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). Hydrological modifications, such as ditching and tiling, are often also installed. Not all areas in the Bedrock Controlled Wet Prairies ecological site are suitable for tillage and intensive agriculture. Limiting factors are shallow soils (10-20" to bedrock) and a seasonal high water table.

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. Some tilled areas may be abandoned and return to woodland, but this is a small percentage of acres and not currently given a community in this model. Most acres converted to agriculture will stay as such for the foreseeable future.

Transition T1B
State 1 to 3

Plant community succession via the lack of natural fire and/or grazing. Brush and trees will increase and plant community structure will begin to move from a prairie to a woodland. Disturbances such as overgrazing and non-

native vegetation may influence the plant community composition and structure.

Restoration pathway R3A
State 3 to 1

Sites that have not been tilled and still have natural hydrologic functions may be feasible to restore back to a reference community. Soil structure is intact and remnant plant communities may still exist on site. Previously tilled sites (State 2) may revert to a woodland through abandonment; however, the soil function has been altered through tillage, drainage, and intensive crop production. This site will not be the same ecologically as a true reference site.

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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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):**

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:**