USDA Natural Resources Conservation Service

Ecological site R103XY020MN
Loamy Upland Savannas

Last updated: 10/04/2023
Accessed: 04/26/2024

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 to the Minnesota Department of Natural Resources UPs24 Southern Mesic Savanna

Ecological site concept

The Loamy Upland Savannas ecological site is characterized by loamy soils that developed under a savanna landscape of native grasses and scattered fire-tolerant trees. Historically the plant community structure and composition was influenced by intermittent fire events. This ecological site is largely confined to areas directly south and west of the Big Woods ecoregion and along central and southern rivers in MLRA 103.

Associated sites

R103XY022MN	**Loamy Wet Savannas** The Loamy Wet Savannas ecological site is located on soils that are derived from fine loamy till. Soils are classified as poorly drained. This site occurs on morainal ridges or in slight concavities and linear segments with a slope of less than 2 percent.

R103XY012MN	**Wet Footslope/Drainageway Prairies** The Wet Footslope/Drainageway Prairies ecological site are located on mainly on footslopes, toeslopes, and upland drainageways. The site concept incurs frequent to occasional extremely brief and very brief flooding. Soils drainage class is poorly drained. Reference vegetation is a wet prairie.

Similar sites

R103XY021MN	**Clayey Upland Savannas** The Clayey Upland Savannas ecological site is characterized by a savanna community on soils derived from clayey till and lacustrine materials. Drainage class ranges from moderately well to somewhat poorly drained.

Table 1. Dominant plant species

Tree	(1) *Quercus macrocarpa* (2) *Populus tremuloides*
Shrub	(1) *Amorpha canescens* (2) *Corylus americana*
Herbaceous	(1) *Andropogon gerardii*

Physiographic features

The Loamy Upland Savannas ecological site occurs extensively (>100,000 acres) within MLRA 103. Although widespread, the central concept for this site resides in areas south and west of the Big Woods ecoregion and along central and southern rivers in MLRA 103. The site occurs on ground moraines, lake plains, and outwash plains. The most common landform positions are backslopes, summits, and shoulders. The positions are linear to convex both vertically and horizontally.

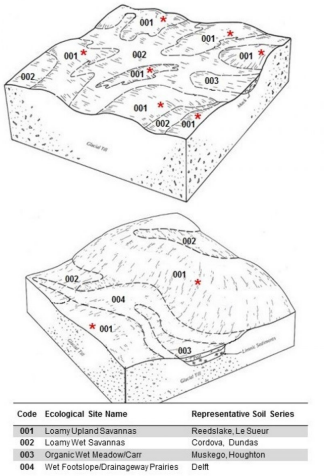


Figure 1. Block diagrams of the representative Loamy Upland Savannas and associated ecological sites.

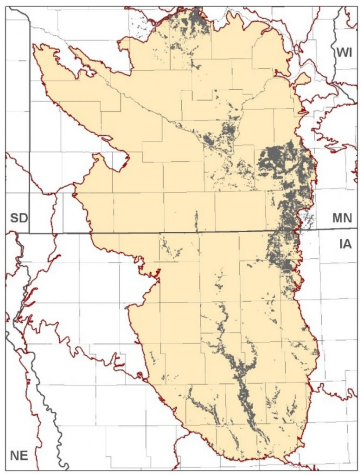


Figure 2. Distribution of the Loamy Upland Savannas ecological site within MLRA 103. In many cases, the data set is not spatially consistent across political boundaries due to the method by which soils were mapped; e.g. due to county subsets.

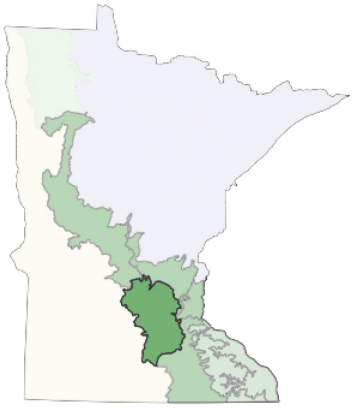


Figure 3. The Big Woods ecoregion shaded in dark green (Minnesota Department of Natural Resources)

Table 2. Representative physiographic features

Hillslope profile	(1) Backslope (2) Summit (3) Shoulder
Landforms	(1) Ground moraine (2) Lateral moraine (3) End moraine (4) Lake plain (5) Outwash plain
Runoff class	Very low to very high
Elevation	699–1,410 ft
Slope	0–40%
Water table depth	12–80 in
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 154 days, while the frost-free period is 130 days. The average mean annual precipitation is 32 inches, which includes rainfall plus the water equivalent from snowfall. A lower water table and the fact that dry soils are generally warmer than wet soils make this site slightly warmer than adjacent, downslope landforms.

Table 3. Representative climatic features

Frost-free period (characteristic range)	124-136 days
Freeze-free period (characteristic range)	147-158 days
Precipitation total (characteristic range)	30-36 in
Frost-free period (actual range)	113-146 days
Freeze-free period (actual range)	139-173 days
Precipitation total (actual range)	29-36 in
Frost-free period (average)	130 days
Freeze-free period (average)	154 days

Precipitation total (average)	32 in

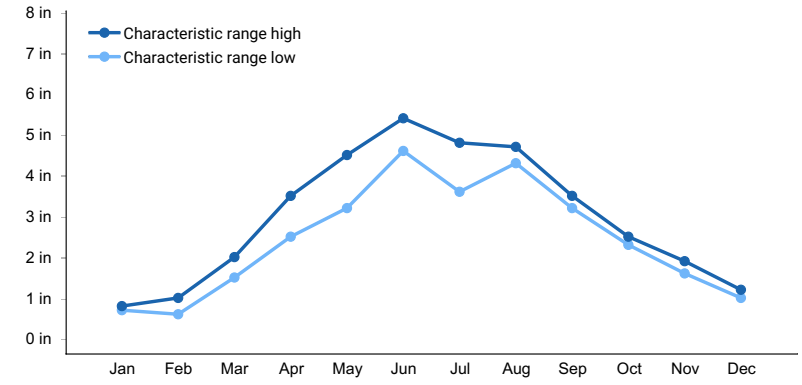


Figure 4. Monthly precipitation range

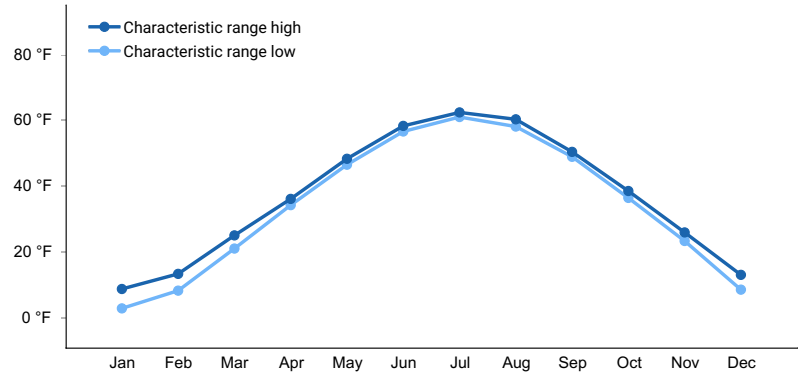


Figure 5. Monthly minimum temperature range

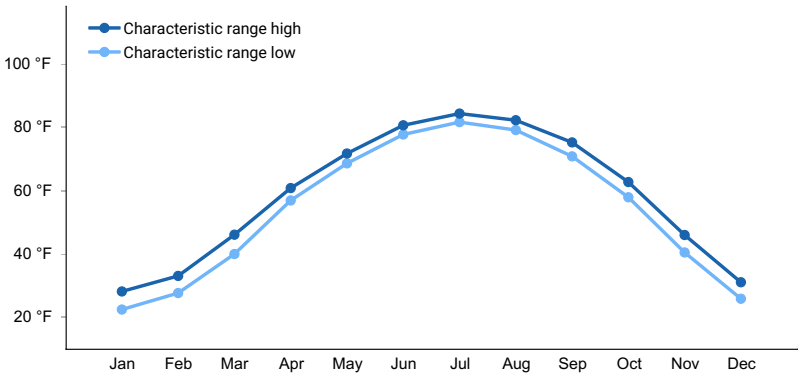


Figure 6. Monthly maximum temperature range

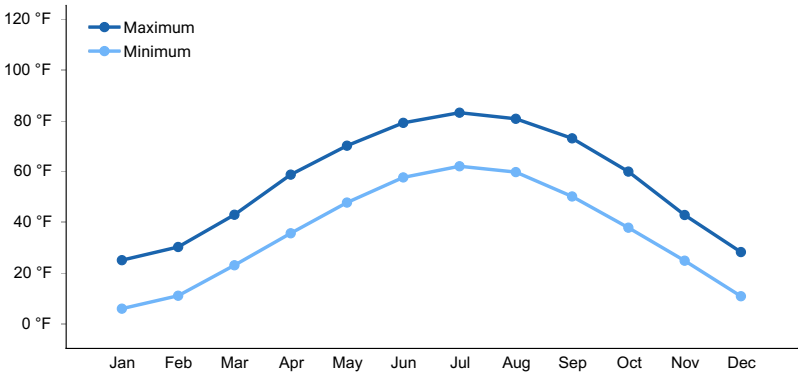


Figure 7. Monthly average minimum and maximum temperature

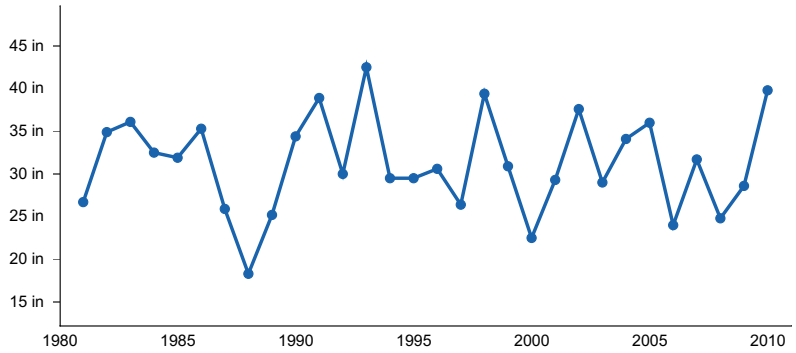


Figure 8. Annual precipitation pattern

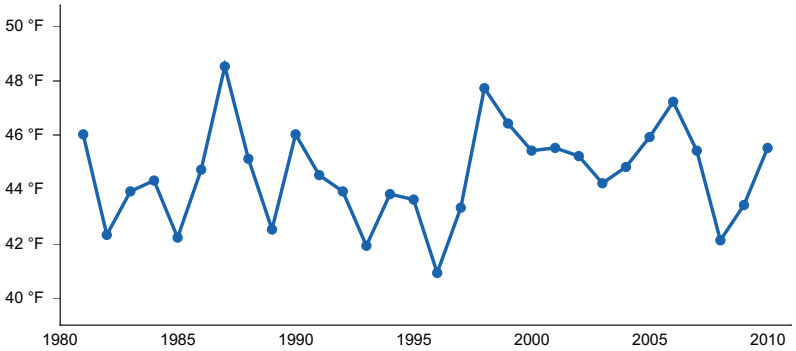


Figure 9. Annual average temperature pattern

Climate stations used

- (1) BUFFALO 2NE [USC00211107], Buffalo, MN
- (2) HUTCHINSON 1 N [USC00213962], Hutchinson, MN
- (3) JORDAN 1SSW [USC00214176], Jordan, MN
- (4) WEBSTER CITY [USC00138806], Webster City, IA
- (5) DES MOINES WSFO-JOHNSTON [USC00132209], Johnston, IA

Influencing water features

The Loamy Upland Savannas ecological site receives water mainly from precipitation, runoff, and subsurface flow. Since some components reside in relatively high landscape settings, direct precipitation may be the only water source that some of these components receive. Spring is the wettest time of the year. Soils on this site are endosaturated. Generally, a 10% slope gradient is a break for differences in the depth to saturation. Soils below 10% slope tend to have saturation above 100 cm during the spring months and those above this slope threshold tend to have saturation below 100cm. For other soil components the seasonal high depth to saturation is around 30 cm from the surface. The water table may drop to as low as six feet (200cm) later in the growing season during dry periods for most of the soil components in this group.

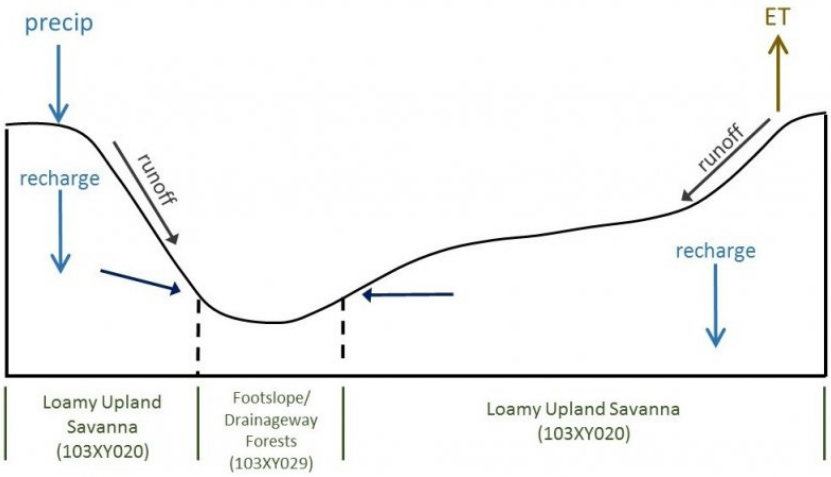


Figure 10. Representation of hydrological factors in a typical area of the Loamy Upland Savannas and associated ecological sites on the Des Moines Lobe (MLRA 103).

Soil features

The Loamy Upland Savannas ecological site is located on loamy textured soils that developed under scattered trees and native grasses. Clay particles were illuviated from horizons higher in the soil profile and accumulated deeper. Argillic horizons from readily in Des Moines Lobe materials after leaching of all carbonates from the upper portion of the soil takes place (Grimm, 1984)

The soil series associated with this ecological site are Angus, Le Sueur, Cokato, and Reedslake. These soils are classified as Mollic Hapludalfs, Typic Argiudolls, Oxyaquic Argiudolls or Aquic Argiudolls. The parent material for these soils is loamy glacial till. These soils are very deep (>60 inches to bedrock) and the drainage class is somewhat poorly drained to well drained. These soils also have a seasonal high depth to saturation generally below 12 inches (30cm). The epipedon (a soil horizon that forms at or near the surface) texture includes loam, silt loam, clay loam, and sandy loam. The soil family particle size class is fine loamy. Coarse fragments are between 0 and 9 percent by volume. Soil pH classes are strongly acid to moderately alkaline throughout.

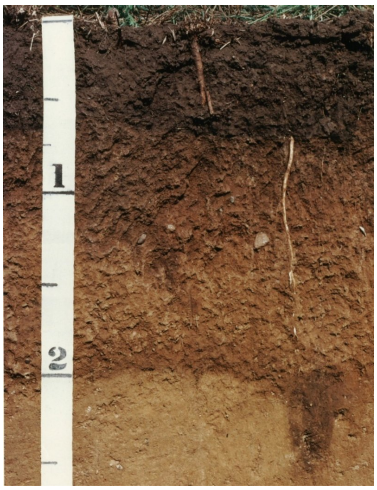


Figure 11. A Mollic Hapludalf (Lester) from Collinwood Township, Meeker County, Minnesota.

Table 4. Representative soil features

Parent material	(1) Till
Surface texture	(1) Loam (2) Silt loam (3) Fine sandy loam (4) Clay loam (5) Sandy loam

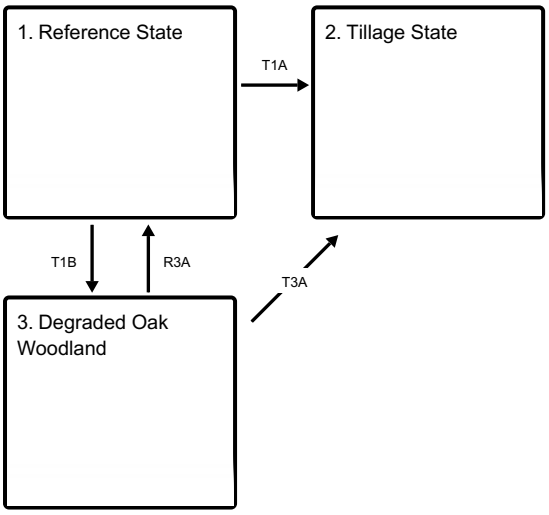
Drainage class	Somewhat poorly drained to well drained
Permeability class	Moderately slow to moderate
Soil depth	80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-40in)	10–12 in
Calcium carbonate equivalent (0-40in)	0–25%
Soil reaction (1:1 water) (0-40in)	5.1–8.4
Subsurface fragment volume <=3" (0-40in)	0–9%
Subsurface fragment volume >3" (0-40in)	0–3%

Ecological dynamics

The Loamy Upland Savannas ecological site is a mesic savanna ecosystem. Due to topography, natural fire disturbance was suppressed, but not eliminated on this site resulting in a savanna landscape. The state and transition model consists of three states: Reference State, Tillage State, and the Degraded Oak Woodland State. The Reference State describes a mesic savanna with native grasses and scattered hardwoods. State 2 is the Tillage State which describes land transitioned to agricultural production. This is the most common state in MLRA 103 for this site. A few areas within this State have been reseeded to native warm season or cool-season grasses. State 3 is a Degraded Oak Woodland State in which disturbances have modified the native plant community composition and structure. Lack of natural fire, unmanaged grazing, and invasive species are common triggers transitioning a site to State 3.

State and transition model

Ecosystem states



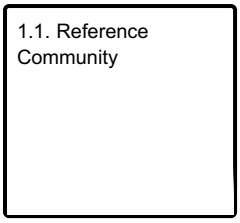
T1A - Tillage, planting

T1B - Absence of natural fire regime, increase in woody vegetation, and invasion of non-native species

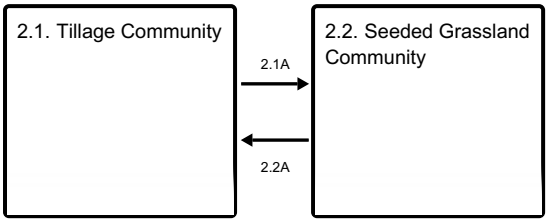
R3A - Restoration activities

T3A - Tillage, planting

State 1 submodel, plant communities



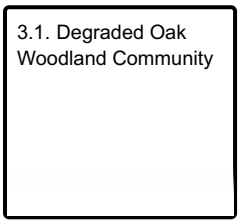
State 2 submodel, plant communities



2.1A - Establishment of grasses

2.2A - Transition to row crop agriculture

State 3 submodel, plant communities



State 1
Reference State

The Loamy Upland Savannas ecological site reference state is a mesic savanna that exhibits a diversity of native grasses and forbs along with a variety of shrubs and scattered oak and aspen. Plant community structure and composition within the Reference State are variable and dependent upon the impacts of drought, grazing, and fire events. Fire was historically present on this site but to a lesser degree than the prairie ecological sites of MRLA 103. This reduced occurrence of fire resulted in a grassland community that included woody shrubs and scattered trees. Fire frequency will control plant community structure and composition. Areas frequently burned are a shrubby prairie. Longer fire intervals result in more trees and a true savanna ecosystem. Areas protected from fire will eventually transition to a woodland. A secondary trigger for maintenance or conversion of this ecological site 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. Characteristic vegetation in the reference savanna state includes bur oak, aspen, American hazelnut, leadplant, and big bluestem. Other mesic prairie grasses species and native forbs will be present in a reference plant community. High-quality, untilled areas of the Loamy Upland Savannas ecological site are uncommon in MLRA 103 as most sites have been transitioned to agricultural production.

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- quaking aspen (*Populus tremuloides*), tree
- leadplant (*Amorpha canescens*), shrub
- American hazelnut (*Corylus americana*), shrub
- big bluestem (*Andropogon gerardii*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- prairie dropseed (*Sporobolus heterolepis*), grass

Community 1.1

Reference Community

The Loamy Upland Savannas ecological site is characterized by a diversity of native grasses, forbs, shrubs, and scattered fire-tolerant oak trees. Common reference species include bur oak, aspen, American hazelnut, leadplant, big bluestem, Indiangrass, prairie dropseed, and a diversity of forbs. The vegetative composition is influenced primarily by drought, grazing, and fire. Variations within the plant community structure and composition will occur on these sites depending on the disturbance regime. A mosaic of bur oak savanna, shrub prairie, and degraded oak woodlands can occur across the landscape depending on topography and disturbances. A suite of diagnostic forbs is yet to be developed.

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- quaking aspen (*Populus tremuloides*), tree
- leadplant (*Amorpha canescens*), shrub
- American hazelnut (*Corylus americana*), shrub
- big bluestem (*Andropogon gerardii*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- prairie dropseed (*Sporobolus heterolepis*), grass

State 2
Tillage State

Soil tillage is the primary mechanism to transition a site to the Tillage State. In this state, dynamic soil properties such as bulk density, structure, organic carbon content, and saturated hydraulic conductivity are altered by agricultural practices. 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. Areas included in this ecological site have slopes between 0-40%. Where the gradient exceeds 20%, farm machinery is limited. A few areas within this ecological site have been seeded back to grass. Under conservation programs such as the NRCS Conservation Reserve Program (CRP), previously tilled areas have been converted to warm-season grasslands. Native forbs are commonly included in seed mixes to benefit wildlife and pollinators. Although highly beneficial to wildlife, these sites generally lack the diversity of native plant species that occurs in the Reference State. Cool-season grasses are also feasible. Species selection will depend on the landowner’s objectives and site specifics. 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. Most tilled areas will remain in crop production in the foreseeable future.

Dominant plant species

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

Community 2.1
Tillage Community

The Tillage 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. Multiple crops, however, are feasible for these areas with appropriate management. Agriculture practices will be limited by slope on many areas within this ecological site as slopes on this ecological site range from 0% to over 40%.

Dominant plant species

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

Community 2.2

Seeded Grassland Community

The primary mechanism of change to this community is the seeding of desired grass species. This pathway is commonly triggered in conjunction with a conservation program such as the NRCS Conservation Reserve Program (CRP) with the establishment of native, warm-season grasses. Cool-season grasses are also feasible. Numerous species may be planted including Kentucky bluegrass, reed canarygrass, smooth brome, tall fescue, and timothy depending on the landowner's objectives and management. Legumes, such as white clover and red clover, are commonly incorporated to improve forage nutrition.

Resilience management. Resilience management practices are needed after establishment of warm-season grasses. Examples include prescribed fire, brush management, and herbaceous weed treatment. Prescribed burning is utilized to reduce the extent of woody vegetation, reduce the buildup of dead plant material, and promote the regeneration of grasses and forbs. Resilience management practices for cool-season grass sites include planned grazing, invasive plant management, and appropriate harvest management.

Dominant plant species

- big bluestem (*Andropogon gerardii*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- switchgrass (*Panicum virgatum*), grass

Pathway 2.1A
Community 2.1 to 2.2

The mechanism of change is the seeding of grass species. Warm season or cool season grasses may be planted depending on the landowner's objectives. Warm season grasses may be established as part of a conservation program.

Conservation practices

Forage and Biomass Planting

Pathway 2.2A
Community 2.2 to 2.1

The site is transitioned back to cropland through tillage and seeding of crops.

State 3
Degraded Oak Woodland

This State is characterized by a disturbed and degraded woodland condition. Characteristics of this site include the dominance of trees (no longer a true savanna community), the presence of invasive plant species, and a reduction in the diversity of native understory. Trees include bur oak and mixed hardwoods. Invasives, such as Kentucky bluegrass and common buckthorn, are often dominant the understory. As the tree and shrub density increases, the ground layer plant diversity decreases and transitions to more shade-tolerant species.

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- American hazelnut (*Corylus americana*), shrub
- Kentucky bluegrass (*Poa pratensis*), grass
- common buckthorn (*Rhamnus cathartica*), grass

Community 3.1
Degraded Oak Woodland Community

This plant community exhibits and increase in woody species and invasive plants. Native plant diversity is decreasing. Due to the increasing shade levels, ground flora are transitioning to more shade-tolerant species. The community is no longer a savanna but transitioning to a woodland.

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- American hazelnut (*Corylus americana*), shrub
- Kentucky bluegrass (*Poa pratensis*), grass
- common buckthorn (*Rhamnus cathartica*), grass

Transition T1A
State 1 to 2

The site is transitioned to agricultural production through tillage and seeding of desired crops.

Transition T1B
State 1 to 3

Transition mechanisms include absence of a natural fire regime, invasion of non-native plant species, and a continual increase in woody species. Native plant diversity will decrease as the community transitions from a open savanna to a woodland.

Restoration pathway R3A
State 3 to 1

Restoration of the site to include non-native vegetation control, woody species removal, introduction of prescribed fire, establishment of desired native species.

Transition T3A
State 3 to 2

Site is transitioned to agricultural production via tillage and seeding of desired crops.

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	04/26/2024
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):**

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

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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:**