USDA Natural Resources Conservation Service

Ecological site R103XY019MN
Sandy Upland Savannas

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

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:
This ecological site shares similarities with Minnesota Department of Natural Resources UPs14 Southern Dry Savanna.

Ecological site concept

The Sandy Upland Savannas ecological site is characterized by scattered trees and native grasses on sandy, well drained to excessively drained soils. Theses soils developed under a mix of grassland and scattered trees. This site does not flood or pond. This ecological site differs from other upland savannas in that is represents a drier, less productive condition. It is also confined to a more southerly extent within the MLRA, and therefore lacks aspen (Populus tremuloides) which is more dominant in the northern savannas of MLRA 103. Historically, fire and grazing were important triggers that influenced plant community structure and composition.

Associated sites

R103XY007MN	**Sandy Wet Prairies** The Sandy Wet Prairies ecological site is located on sandy, endosaturated soils located on outwash plains, valley trains, and glacial terraces associated with major river valleys. Soils contain sandy and gravelly outwash parent materials and often have a loamy mantle 20-40 inches deep. Drainage class is poorly drained.

Table 1. Dominant plant species

Tree	(1) *Quercus macrocarpa* (2) *Quercus ellipsoidalis*
Shrub	(1) *Amorpha canescens* (2) *Corylus americana*
Herbaceous	(1) *Schizachyrium scoparium* (2) *Hesperostipa spartea*

Physiographic features

The Sandy Upland Savannas ecological site occurs on outwash plains, outwash valleys, and ground, lateral and end moraines. The landform positions include subtle low gradient linear segments, depressions, backslopes, footslopes, summits and shoulders. The most common landform positions are backslopes, summits, and shoulders that are linear to slightly convex both vertically and horizontally. Linear segments and depressions occur, but to a lesser extent.

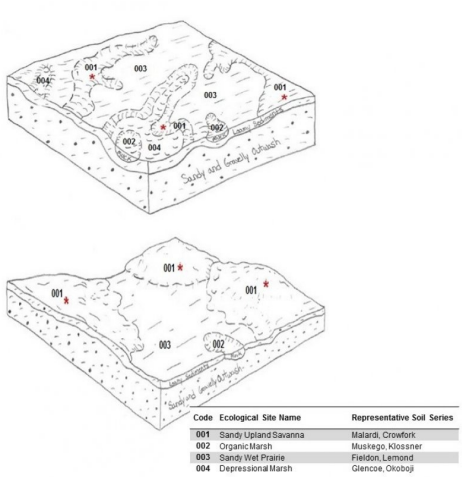


Figure 1. Block diagrams of the representative Sandy Upland Savannas and associated ecological sites.

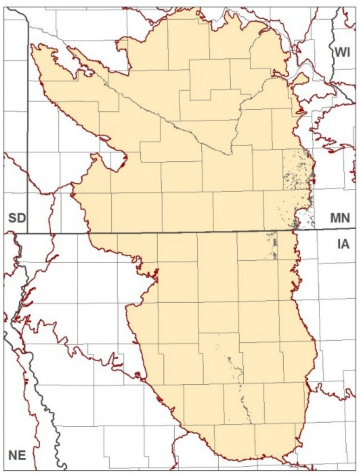


Figure 2. Distribution of the Sandy Upland Savannas ecological site within MLRA 103. In many cases, the data set is not spatially consistent across political boundaries due to the method by which soils were mapped; e.g. due to county subsets.

Table 2. Representative physiographic features

Hillslope profile	(1) Backslope (2) Summit (3) Shoulder
Landforms	(1) Ground moraine (2) Lateral moraine (3) End moraine (4) Outwash plain
Runoff class	Negligible to high
Elevation	341–1,948 ft
Slope	0–40%
Water table depth	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 site is 139 days, while the frost-free period is 122 days. The average mean annual precipitation is 31 inches, which includes rainfall plus the water equivalent from snowfall. Cold air drainage and the fact that dry soils are generally warmer than wet soils make this site warmer than adjacent, downslope areas.

Table 3. Representative climatic features

Frost-free period (characteristic range)	126-137 days
Freeze-free period (characteristic range)	148-162 days
Precipitation total (characteristic range)	34-36 in
Frost-free period (actual range)	123-140 days
Freeze-free period (actual range)	147-163 days
Precipitation total (actual range)	32-36 in
Frost-free period (average)	132 days
Freeze-free period (average)	156 days
Precipitation total (average)	34 in

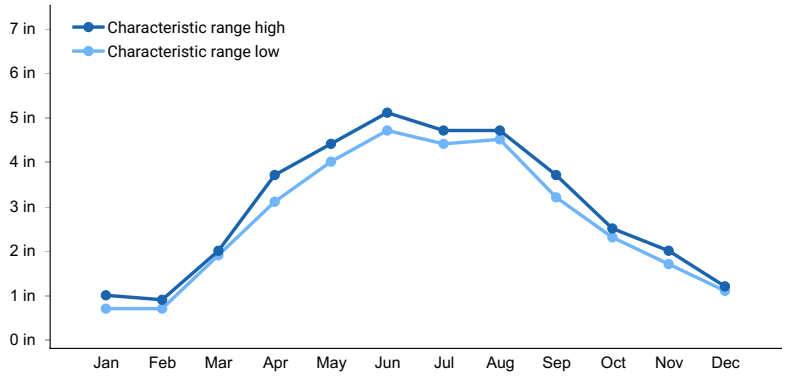


Figure 3. Monthly precipitation range

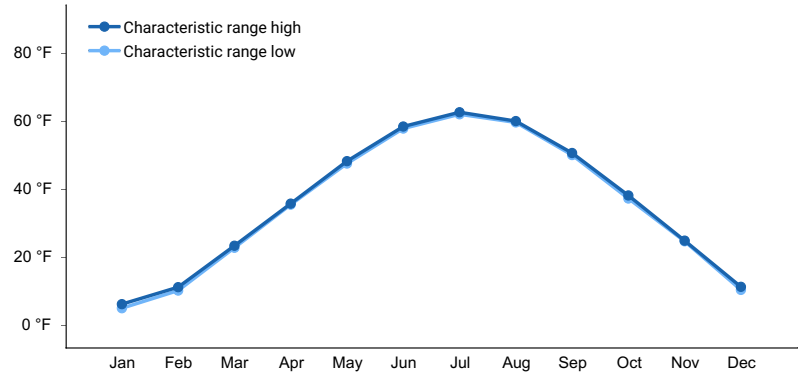


Figure 4. Monthly minimum temperature range

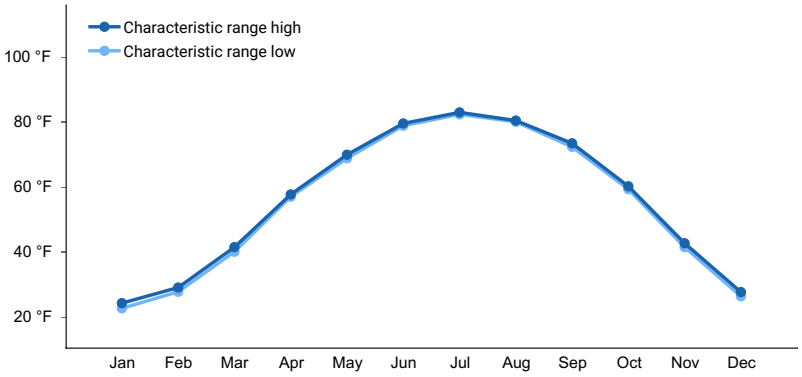


Figure 5. Monthly maximum temperature range

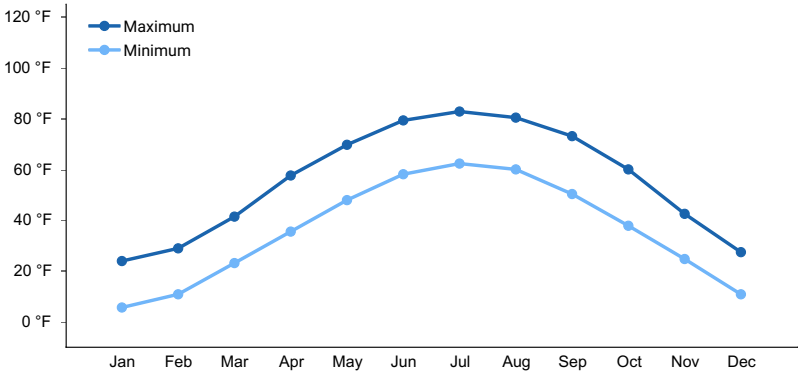


Figure 6. Monthly average minimum and maximum temperature

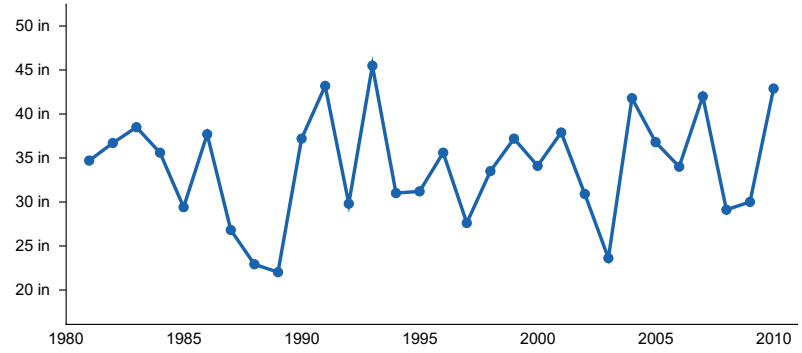


Figure 7. Annual precipitation pattern

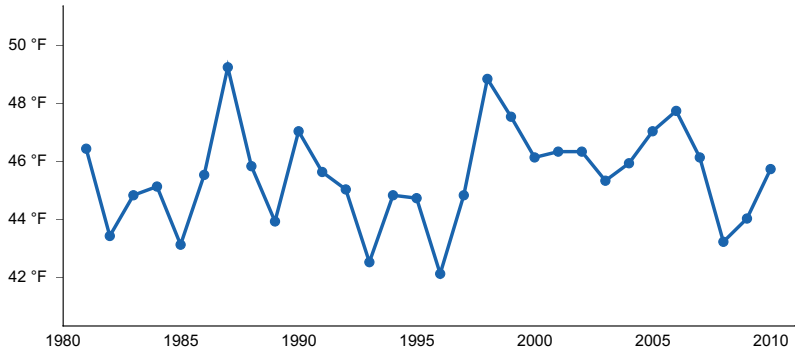


Figure 8. Annual average temperature pattern

Climate stations used

- (1) ALBERT LEA 3 SE [USC00210075], Albert Lea, MN
- (2) WELLS [USC00218808], Wells, MN
- (3) OWATONNA [USC00216287], Owatonna, MN
- (4) WASECA EXP STN [USC00218692], Waseca, MN
- (5) FT DODGE 5NNW [USC00132999], Fort Dodge, IA
- (6) FOREST CITY 2 NNE [USC00132977], Forest City, IA

Influencing water features

The Sandy Upland Savannas ecological site receives water primarily from precipitation, lateral subsurface flow, and runoff from adjacent sites. Since some of these areas have little for contributing area, direct precipitation may be the only water source they recieve. Spring is the wettest time of the year.

This site is endosaturated. In some areas of this ecological site, the water table can be as high as 30 cm in the spring; however, the central concept of this site is typically well drained to excessively drained soils that have a depth to saturation below 200 cm for most of the year.

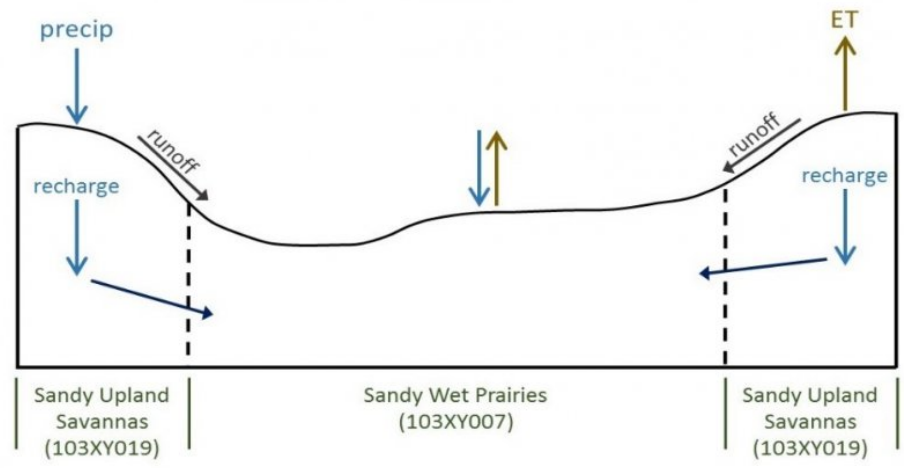


Figure 9. Representation of hydrological factors in a typical area of the Sandy Upland Savannas and associated ecological sites on the Des Moines Lobe (MLRA 103).

Soil features

The main soil series associated with this ecological site are Rasset, Malardi, Crowfork, and Lasa. These soils are classified as Typic Argiudolls or Entic Hapludolls. The included Mollisols developed under scattered trees and dry conditions. Clay particles were illuviated from horizons higher in the profile and accumulated deeper. Argillic horizons form readily in Des Moines Lob materials after leaching of all carbonates from the upper portion of the soil takes place (Grimm, 1984). Soil parent materials are either outwash or a loamy mantle over outwash. These soils are very deep (>60 inches to bedrock). The drainage class is well to excessively drained, and the central concept of

this ecological site is that the seasonal high depth to saturation stays below 200 centimeters.

The textures of the soil layer at or near the surface (epipedon) include sandy loam, loam, silt loam, loamy sand, and fine sandy loam. The soil family particle size class is coarse loamy to sandy. Coarse fragments are between 0 and 59 percent by volume. Soil reaction classes are strongly acid to moderately alkaline throughout the soil series control section.

Table 4. Representative soil features

Parent material	(1) Glaciofluvial deposits (2) Outwash
Surface texture	(1) Sandy loam (2) Loam (3) Fine sandy loam (4) Silt loam
Drainage class	Well drained to excessively drained
Permeability class	Moderately rapid to very rapid
Soil depth	80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-60in)	4–8 in
Calcium carbonate equivalent (0-40in)	0–30%
Soil reaction (1:1 water) (0-40in)	5.1–8.4
Subsurface fragment volume <=3" (0-40in)	0–60%
Subsurface fragment volume >3" (0-40in)	0–15%

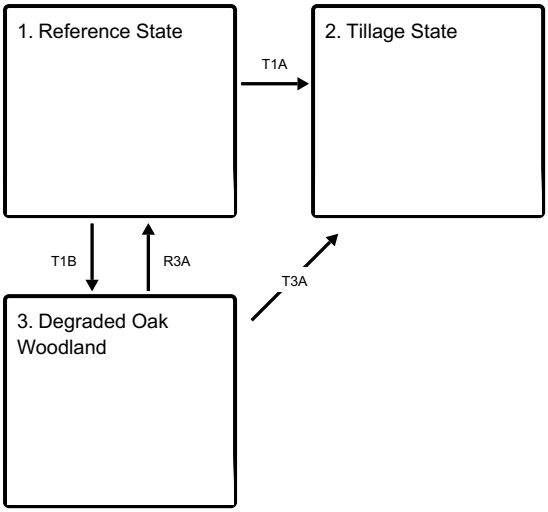
Ecological dynamics

The Sandy Upland Savannas ecological site is primarily located in areas adjacent to the Big Woods region of Minnesota and along the central and southern rivers in MLRA 103. Natural fire disturbance was suppressed but not eliminated in these areas resulting in a savanna landscape. This site differs from the other upland savanna concepts in that it is typically a drier, less productive site. It is also confines to a more southerly extent, so therefore lacks aspen that is more dominant in the northern reaches of the savanna in MRLA 103.

The state and transition model (STM) consists of three states: Reference State, Tillage State, and the Degraded Oak Woodland State. The Reference State describes a dry to dry-mesic savanna with native grasses and scattered oaks. 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 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



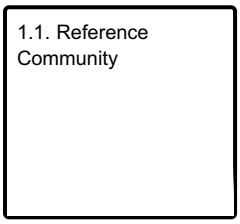
T1A - Tillage, planting

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

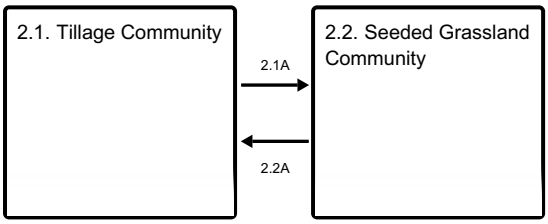
R3A - Restoration activities

T3A - Tillage, planting

State 1 submodel, plant communities



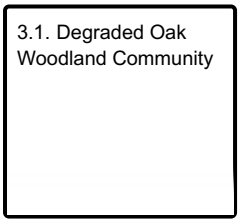
State 2 submodel, plant communities



2.1A - Establishment of grasses

2.2A - Transition to row crop agriculture

State 3 submodel, plant communities



State 1
Reference State

The Sandy Upland Savannas ecological site reference state is a dry to dry-mesic savanna that exhibits a diversity of native grasses and forbs along with scattered oaks. Plant community structure and composition within the Reference State are variable and dependent upon the impacts of drought, grazing, and fire events. Depending upon disturbance regimes, woody species will vary in density and structure. Areas with frequent fire will trend toward a

shrubby prairie. Longer fire return intervals will result in a mixed oak savanna. A long-term absence of fire will transition the site toward a dry woodland. Characteristic vegetation in the reference savanna state includes bur oak, northern pin oak, American hazelnut, leadplant, little bluestem, and porcupinegrass. High-quality, untilled areas of the Sandy 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
- northern red oak (*Quercus rubra*), tree
- American hazelnut (*Corylus americana*), shrub
- leadplant (*Amorpha canescens*), shrub
- little bluestem (*Schizachyrium scoparium*), grass
- porcupinegrass (*Hesperostipa spartea*), grass

Community 1.1
Reference Community

The Sandy Upland Savannas ecological site is characterized by a diversity of native grasses, forbs, and scattered oak trees. Common reference species include bur oak, northern red oak, American hazelnut, leadplant, little bluestem, porcupinegrass, and an array of forbs. The vegetative composition is influenced primarily by drought, grazing and fire.

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- northern red oak (*Quercus rubra*), tree
- American hazelnut (*Corylus americana*), shrub
- leadplant (*Amorpha canescens*), shrub
- little bluestem (*Schizachyrium scoparium*), grass
- porcupinegrass (*Hesperostipa spartea*), 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. Where the gradient exceeds 20 percent row crop production is not feasible due to limitations on farm machinery. A few areas within this ecological site have been tilled but 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. Cool-season grasses are also feasible. Species selection will depend on the landowner's objectives and site specifics. Although these areas are not as diverse as the reference state, they still provide soil health and wildlife benefits.

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 on lower slope sites. 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. Agriculture practices will be limited by slope. Many areas within this ecological site are not feasible for machinery as slopes range from 0% to over 40%. Dryness may also be a limiting factor.

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. Commercial vegetative seed mixes commonly include a variety of native grasses plus forbs to enhance wildlife habitat and to benefit native pollinators. This pathway is commonly triggered in conjunction with a conservation program such as the NRCS Conservation Reserve Program (CRP). The site is taken out of crop production and seeded with warm-season grasses to benefit wildlife, soil health, and water quality. A few areas within this ecological site may be seeded to cool-season grasses. Numerous species may be planted depending on the landowner's objectives. Legumes, such as white clover and red clover, are commonly incorporated to improve forage nutrition.

Resilience management. Multiple resilience management practices may be 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 native grasses and forbs. Resilience management practices for cool-season grass sites include planned grazing, invasive plant management, and appropriate disturbance/harvest management. Managed grazing is also a practice on some sites that promotes plant community resilience.

Dominant plant species

- big bluestem (*Andropogon gerardii*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- smooth brome (*Bromus inermis*), grass
- Kentucky bluegrass (*Poa pratensis*), 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 NRCS 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..

State 3
Degraded Oak Woodland

This State is characterized by a disturbed and degraded woodland condition. Characteristics 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 and shrub species. Oaks still generally dominant but are joined by a mix of hardwood species. Non-native plants, 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
- northern pin oak (*Quercus ellipsoidalis*), tree
- black oak (*Quercus velutina*), 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. Tree species include oaks and mixed hardwoods. 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
- northern pin oak (*Quercus ellipsoidalis*), tree
- black oak (*Quercus velutina*), 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 grassland plant diversity will decrease as the community transitions from a open savanna to a closed, shaded woodland.

Restoration pathway R3A
State 3 to 1

Restoration of the site to include non-native vegetation control, 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

Other references

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Contributors

Clayton Johnson (Clayton.Johnson@usda.gov), Soil Survey Office Leader, USDA-NRCS, Albert Lea, MN
Myles Elsen (Myles.Elsen@usda.gov), Soil Scientist, USDA-NRCS, Albert Lea, MN
Anita Arends (Anita.Arends@usda.gov), USDA-NRCS, Springfield, IL

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	05/05/2024
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:**