USDA Natural Resources Conservation Service

Ecological site F103XY028MN
Clayey Wet Forests

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

Land Resource Regions and Major Land Resource Areas (USDA NRCS, 2006)
Major Land Resource Area (MLRA): Central Iowa and Minnesota Till Prairies (MLRS 103)

U.S. Forest Service (USFS)
National Hierarchical Framework of Ecological Units (Cleland et al., 2007)
Section: North central Glaciated Plains (251B)
Subsections: Upper Minnesota River-Des Moines Lobe (251BA) and Southern Des Moines Lobe (251Be)

Relationship to Other Established Classifications:
The reference state shares similarities to Minnesota Department of Natural Resources MHs49 Southern Wet-Mesic Hardwood Forest

Ecological site concept

The Clayey Wet Forests ecological site occurs in concave or linear and low slope gradient areas on lake plains and moraines in northeastern MLRA 103. The site is characterized by clayey, poorly drained soils with a seasonal depth to soil saturation of 0-30 cm. These soils developed predominantly under forest vegetation.

Associated sites

F103XY026MN	**Clayey Upland Forests** The Clayey Upland Forests ecological site is located on uplands. The soils are derived from clayey till and lacustrine (lake) materials, and drainage class ranges from somewhat poorly drained to well drained. The soils have a thin or moderately thick mollic (dark) surface.
R103XY017MN	**Organic Wet Meadow/Carr** The Organic Wet Meadow/Carr ecological site occurs in low wetland areas. These sites are often ponded, have a high water table (i.e. endosaturated) and are classified as very poorly drained. Water-tolerant vegetation such as cattails, bulrushes, and sedges are common.
R103XY015MN	**Depressional Marsh** The Depressional Marsh ecological site is located on landscape positions that include linear to slightly concave (depressional) segments. Soils are very poorly drained and are frequently ponded. The soils also have a relatively high organic matter content in the surface and near surface horizons.

Table 1. Dominant plant species

Tree	(1) *Acer saccharum* (2) *Fraxinus nigra*
Shrub	(1) *Prunus virginiana*
Herbaceous	(1) *Erythronium albidum*

Physiographic features

The Clayey Wet Forests ecological site occurs primarily on end and lateral moraines in the northeastern part of MLRA 103 including the Big Woods ecoregion. They also occur in Glacial Lake Minnesota. Landform positions include depressions, drainageways, footslopes, toeslopes, and low gradient linear segments. These positions are linear to slightly concave vertically and horizontally.

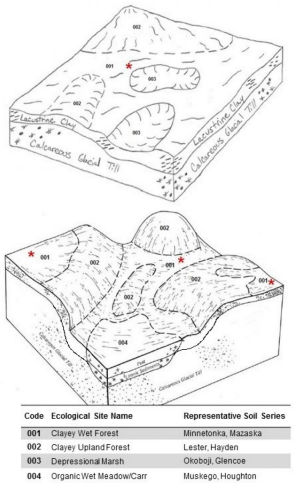


Figure 1. Block diagrams of representative Clayey Wet Forests and associated ecological sites.

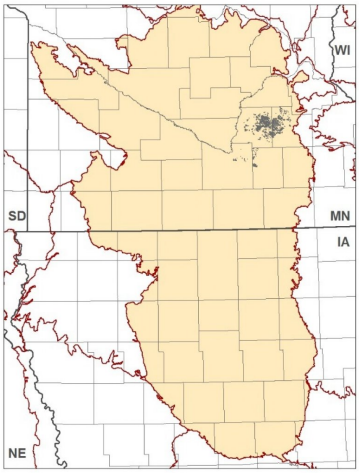


Figure 2. Distribution of Clayey Wet Forests within MLRA 103. In many cases, the data set is not spatially consistent across political boundaries due to the method by which soils were mapped; e. g. county subsets.

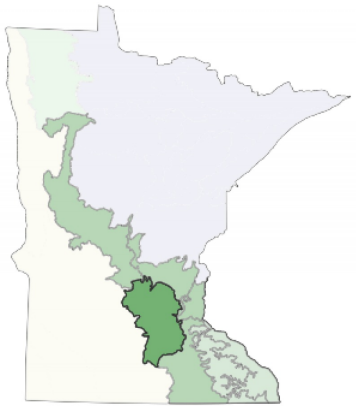


Figure 3. The state of Minnesota with the Big Woods ecoregion shaded in deep green. (MN DNR)

Table 2. Representative physiographic features

Hillslope profile	(1) Footslope (2) Toeslope
Landforms	(1) End moraine (2) Lateral moraine (3) Lake plain (4) Depression (5) Drainageway
Runoff class	Negligible to low
Elevation	669–1,601 ft
Slope	0–3%
Water table depth	0–47 in
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 mean annual precipitation for this site is 31 inches. The average freeze-free period is 157 days, and the average frost-free period is 129 days. Cold air drainage and the fact that wet soils are colder than dry soils make this ecological site slightly colder than adjacent sloping landforms.

Table 3. Representative climatic features

Frost-free period (characteristic range)	128-130 days
Freeze-free period (characteristic range)	155-159 days
Precipitation total (characteristic range)	31 in
Frost-free period (actual range)	128-130 days
Freeze-free period (actual range)	153-161 days
Precipitation total (actual range)	31 in
Frost-free period (average)	129 days
Freeze-free period (average)	157 days
Precipitation total (average)	31 in

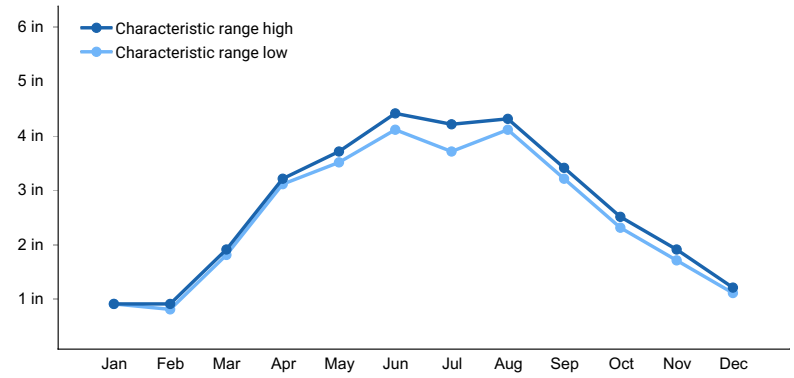


Figure 4. Monthly precipitation range

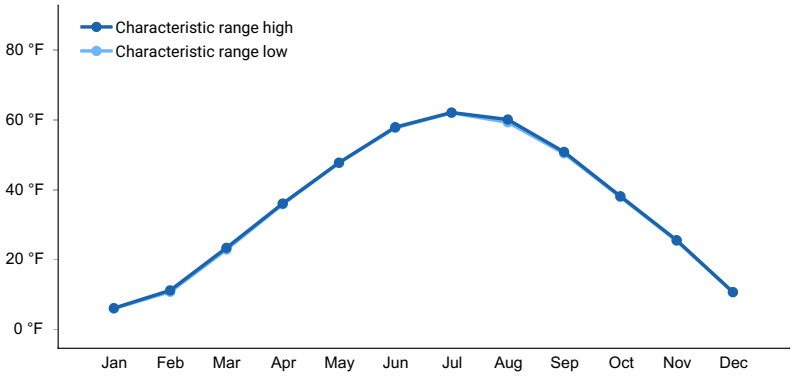


Figure 5. Monthly minimum temperature range

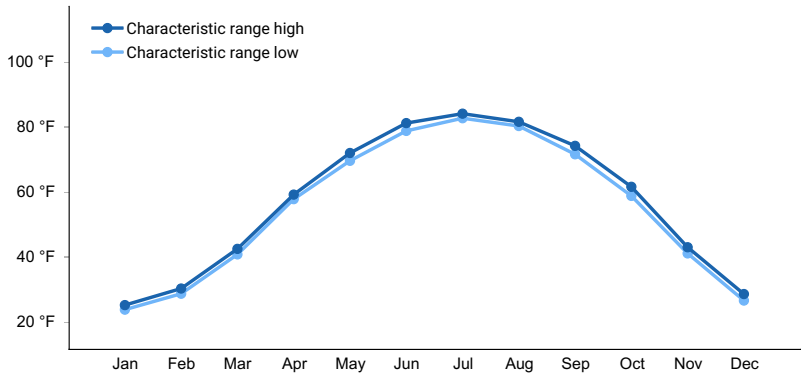


Figure 6. Monthly maximum temperature range

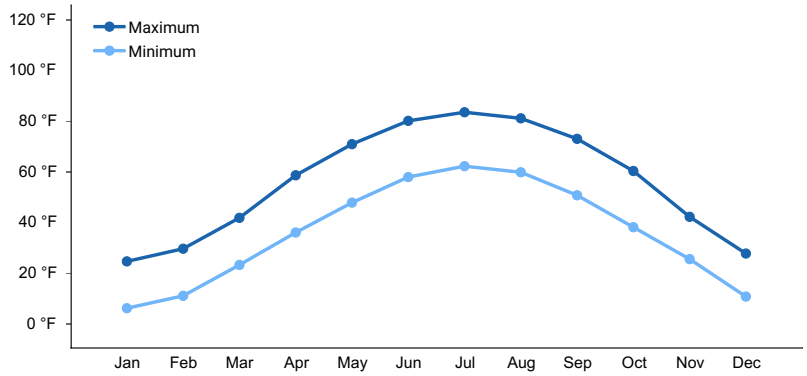


Figure 7. Monthly average minimum and maximum temperature

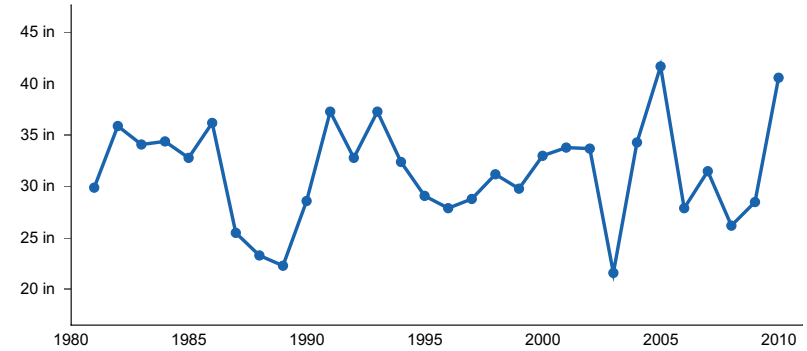


Figure 8. Annual precipitation pattern

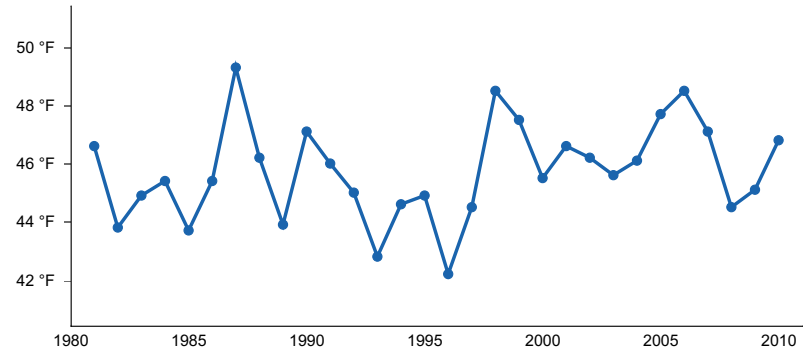


Figure 9. Annual average temperature pattern

Climate stations used

- (1) AMBOY [USC00210157], Amboy, MN
- (2) CHANHASSEN WSFO [USC00211448], Chanhassen, MN

Influencing water features

The Clayey Wet Forests ecological site receives water through precipitation, runoff, and lateral subsurface flow. This site is primarily a groundwater recharge area. Since some of these components have little for contributing area, direct precipitation may be the only water source they receive. Spring is the wettest time of the year for this site. Soils are classified as endosaturated, as the saturation is at or very near the soil surface during the spring months. However, soil saturation levels may drop to as low as six feet during dry periods. In the hydrogeomorphic (HGM) classification system, this site is considered a Mineral Flat wetlands within upland areas which produce ground water recharge. (USDA-NRCS, 2008; Gilbert et al., 2006). This site has a Saturated Cowardin Hydrologic Regime of Palustrine; Forested, Broad-Leaved Deciduous. It also has a United States Army Corps of Engineers Wetland Plant Community of C; Hardwood Swamps, Shrub-Carrs and Alder Thickets (Mineral Soils).

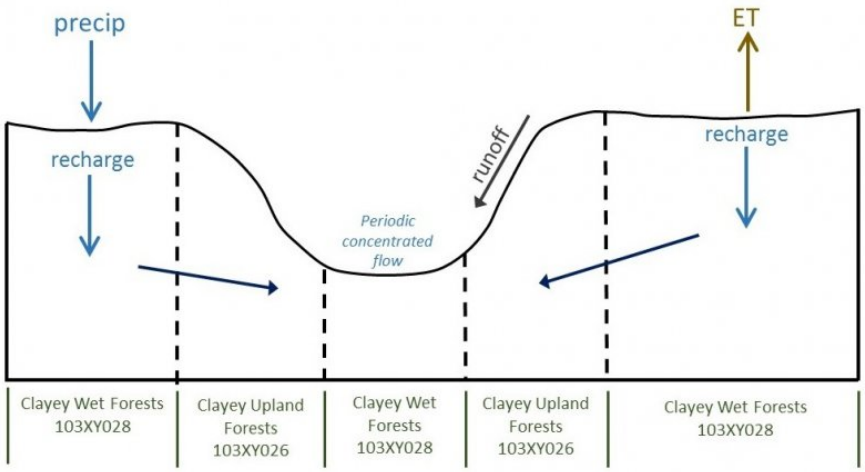


Figure 10. Representation of hydrological factors in a typical area of Clayey Wet Forests and associated ecological sites on the Des Moines Lobe (MLRA 103).

Soil features

The soils associated with the Clayey Wet Forests ecological site are classified as Vertic Argiaquolls. Soil series are Minnetonka and Mazaska. These soils developed under deciduous forest vegetation. Clay particles in these soils were illuviated from the higher albic horizons and accumulated in lower horizons of the soil profile. Argillic horizons form readily in Des Moines Lobe materials after leaching of all carbonates from the upper portion of the soil takes place (Grimm 1984). This site often occurs in slight depressions and accumulates slope alluvium. As a result of this accumulation, dark epipedons (some thicker than prairie soils) formed in these forested areas.

These soils formed under saturated conditions that produced anaerobic conditions during part of the year. Organic matter tends to mask the redoximorphic features that are used to determine seasonal high depth to saturation. The primary hydric soil indicator is a thick, dark surface (A12; USDA-NRCS, 2010). Parent materials are deep fine lacustrine or fine till over loamy till. The soil family particle size class is fine. The epipedon textures include silty clay loam, clay loam, or silty clay. Soil depth is very deep (>60 inches to bedrock). The drainage class is poorly drained, and the seasonal high-water table is at or very near the surface. Coarse fragments are between 0 and 15 percent by volume. Soil pH classes are very strongly acid to moderately alkaline throughout the soil profile.

Table 4. Representative soil features

Parent material	(1) Lacustrine deposits (2) Till
Surface texture	(1) Clay loam (2) Silty clay (3) Silty clay loam
Drainage class	Poorly drained
Permeability class	Very slow to moderate
Soil depth	80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-60in)	8.7–10.9 in
Calcium carbonate equivalent (0-40in)	0–25%
Soil reaction (1:1 water) (0-40in)	4.5–8.4
Subsurface fragment volume <=3" (0-40in)	0–15%

Subsurface fragment volume >3" (0-40in)	0–3%

Ecological dynamics

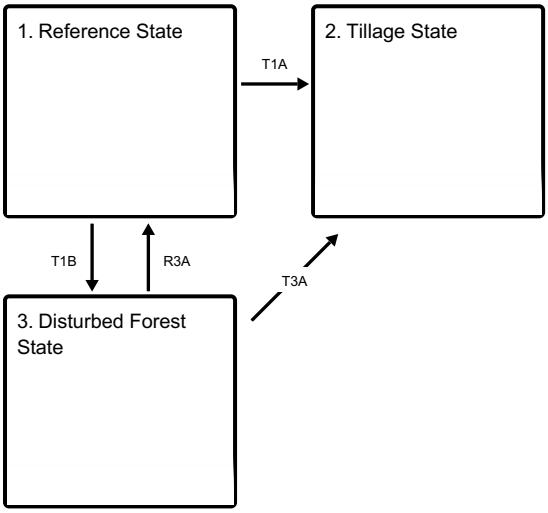
The state and transition model (STM) consists of three states: Reference State, Tillage State, and the Degraded Woodland State. The model Reference State describes a mature, wet-mesic, mixed hardwood forest. State 2 is the Tillage State which describes land transitioned to agricultural production. This 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 Woodland State in which human disturbances have modified the plant community composition and structure. Invasive species, an absence of a natural fire regime, hydrological alterations, and unmanaged grazing are common triggers transitioning a site to State 3.

This site is largely confined to the eastern and northeastern portion of MLRA 103 where fire has been historically suppressed by topography and density of water bodies. This site is common within the Big Woods ecoregion of Minnesota.

The current dominant land use is corn and soybean production. Areas not in row crop agriculture tend to exist as forested preserves or are in other miscellaneous land uses.

State and transition model

Ecosystem states



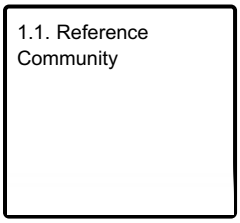
T1A - Site is cleared, tilled, seeded, and managed for crop production

T1B - Site incurs large-scale disturbance and altered plant community

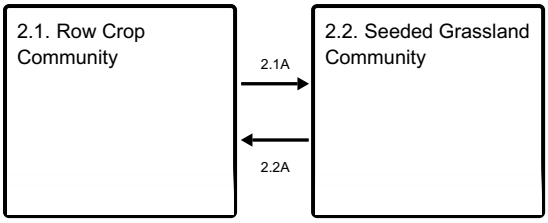
R3A - Restoration of natural hydrology; establishment of desired species; exclusion of anthropogenic disturbances; eradication of invasive species; long-term timber stand management

T3A - Site cleared, soil tillage, crop establishment, and continued agriculture management

State 1 submodel, plant communities



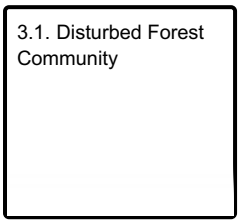
State 2 submodel, plant communities



2.1A - Seeding and management of warm or cool season grasses.

2.2A - Establishment and maintenance of row crop agriculture

State 3 submodel, plant communities



State 1
Reference State

The Wet Clayey Forests Reference State in this model is a mature, wet-mesic, deciduous forest. Common species include sugar maple, black ash, and slippery (red) elm. The shrub components consists of chokecherry plus a variety of tree seedlings and saplings. The understory on high-quality sites is diverse and boast a variety of native herbaceous species. In absence of large-scale natural or anthropogenic disturbances, this ecological site is relatively stable. Small gap regeneration occurs commonly. Early-successional dominants include basswood and sugar maple. Mid-successional species include sugar maple, ash, basswood, and elm.

Resilience management. Resilience management practices include monitoring for invasive vegetation, applying herbicides as needed, and excluding anthropogenic disturbances such as grazing and logging.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- black ash (*Fraxinus nigra*), tree
- slippery elm (*Ulmus rubra*), tree
- chokecherry (*Prunus virginiana*), shrub
- white fawnlily (*Erythronium albidum*), other herbaceous

Community 1.1
Reference Community

The Clayey Wet Forests ecological site is characterized by multiple canopy species, a variable shrub layer, and a diverse ground cover of native herbaceous species. Historically, elms were dominant in many areas, but due to the Dutch elm disease, are greatly reduced today. The shrub layer includes chokecherry and hardwood saplings. Natural small-gap disturbances zones transition through successional plant communities. The early-successional community is dominated by basswood and sugar maple. The mid-successional community is often dominated by sugar maple and black ash.

Resilience management. Resilience management practices include monitoring for invasive vegetation, applying weed control methods as needed, and excluding disturbances such as grazing and large-scale timber harvesting.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- black ash (*Fraxinus nigra*), tree
- slippery elm (*Ulmus rubra*), tree

- chokecherry (*Prunus virginiana*), shrub
- white fawnlily (*Erythronium albidum*), other herbaceous

State 2
Tillage State

The Tillage State contains the Row Crop Community and the Seeded Grassland Community. This state describes areas currently in crop production or areas that were tilled but now are seeded to grass. Pathway mechanisms include preparing the site, planting desired species, applying herbicide, applying fertilizer, and harvesting. Hydrological modifications (tiling and ditching) are commonly installed to improve drainage. Soil tillage is the primary trigger to State 2. Tillage alters dynamic soil properties, including bulk density, structure, organic carbon content, and saturated hydraulic conductivity. Intensive tillage negatively impacts soil ecological functions. Conservation practices help mediate soil health impacts. Conservation tillage minimizes soil disturbance and improves soil structure and soil health. A cover crop rotation builds soil structure, improves infiltration rates, reduces erosion, and protects water quality. Some areas within this ecological site have been converted to a native warm-season grasses under a NRCS conservation program. Species selection will depend on individual site characteristics including hydrology. Cool-season grasses have been established on some areas. Common species include reed canarygrass, and Kentucky bluegrass. Although seeded grasslands are not biologically diverse, they still offer benefits to wildlife, water quality, and soil health.

Resilience management. Prescribed fire is a resilience management practice on warm-season grasslands. Seeding, fertilizing, and controlling weeds and brush are resilience management practices for cool-season grasslands.

Dominant plant species

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

Community 2.1
Row Crop Community

Community 2.1 consists of intensive row crop agriculture. Soil tillage, ditching/tiling, and intentional plant establishment are the primary triggers. The most common crops are corn and soybeans on an annual rotation. Conservation tillage practices may be implemented to reduce soil erosion while still maintaining a crop rotation. 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. Resilience management practices include preparing the sites, planting, fertilizing, controlling weeds, and harvesting. The maintenance of the desired vegetation community is controlled by the intensity, frequency, duration, and timing of agricultural practices.

Dominant plant species

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

Community 2.2
Seeded Grassland Community

This community has been established with warm-season or cool-season grasses. The primary trigger is the intentional establishment of a grass species. Warm-season grasses are commonly planted in conjunction with a USDA-NRCS conservation program. Numerous native grasses and forbs may be selected depending on site characteristics such as hydrology. Cool-season grass species, such as Kentucky bluegrass and reed canarygrass, are a minor land use. Many of these areas are eventually transitioned to annual crop production.

Resilience management. The resilience management practices may include planting desired species, managing grazing, mowing, fertilizing, and controlling unpalatable plant species. Prescribed fire is a resilience management

practice for warm-season grasslands. The controlled application of fire modifies vegetation structure and influence ecological processes.

Dominant plant species

- big bluestem (*Andropogon gerardii*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- reed canarygrass (*Phalaris arundinacea*), grass
- Kentucky bluegrass (*Poa pratensis*), grass

Pathway 2.1A
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 2.2A
Community 2.2 to 2.1

This pathway describes the site transitioning from a seeded grassland to row crop agriculture. This is a common pathway throughout MLRA 103 sites are placed in crop production. The mechanisms of change are tillage, drainage, and intentional plant establishment (crop seeding). Resilience management practices include weed control (herbicide application), disturbance management (field cultivating), and harvest management.

State 3
Disturbed Forest State

This state describes a wooded site that has been disturbed and exhibits altered forest species composition. Numerous ruderal woodland and forest plant communities may occur on this ecological site depending on the type and severity of disturbance, the length of disturbance, available seed sources, ongoing disturbances (selective harvest, grazing), and management activities. Common species include sugar maple, black ash, basswood, elm, and hackberry. Various non-native shrubs, grasses, and herbaceous plants are often present.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- common buckthorn (*Rhamnus cathartica*), tree
- black ash (*Fraxinus nigra*), tree
- Kentucky bluegrass (*Poa pratensis*), grass

Community 3.1
Disturbed Forest Community

Community 3.1 is an altered forest community caused by previous or ongoing human disturbances. Invasive species are common in this community. Canopy composition varies depending on the severity and type of disturbances, community age, and the availability of seed sources. Non-native species, such as Kentucky bluegrass and common buckthorn, are often common and will continue to increase without management intervention.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- common buckthorn (*Rhamnus cathartica*), tree
- black ash (*Fraxinus nigra*), tree
- 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 site clearing, soil tillage. and intentional plant establishment (crop seeding). Resilience management practices include common agricultural practices such as seeding, fertilizing, and managing invasive plants with herbicides or field cultivation. Hydrological modifications, such as ditching and tiling, may be present.

Constraints to recovery. Site clearing and soil tillage preclude recovery of the former state.

Transition T1B
State 1 to 3

Transition T1B is a transition from a mature deciduous forest to a disturbed (ruderal) forest. Triggers include timber harvest, surface site disturbance, grazing, and introduction of non-native species. The native plant community is altered, and these areas do not exhibit the ecological function or vegetative composition of State 1.

Restoration pathway R3A
State 3 to 1

Restoration to the Reference State may be feasible for some sites with long-term management inputs including restoration of natural hydrology, establishment of desired species, forest stand management (selective thinning), and control of invasive species. Triggers include intentional plant establishment (planting desired species), absence of disturbance (site protected from grazing and other site altering disturbances), timber stand improvement inputs, and eradication of invasive plant species.

Conservation practices

Brush Management
Tree/Shrub Site Preparation
Tree/Shrub Establishment
Forest Stand Improvement

Transition T3A
State 3 to 2

Transition T3A is the transition of a disturbed forest state to agriculture production. This is a common pathway in MLRA 103. The mechanisms of change include timber harvest, site preparation, tillage, and intentional plant establishment (crop seeding). Continued resilience management practices are necessary and include weed control (herbicide application), disturbance management (field cultivating), and harvest management.

Constraints to recovery. Soils tillage and the transition to agriculture preclude recovery of the former state.

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	05/05/2024
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:**

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):**

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5. **Number of gullies and erosion associated with gullies:**

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6. **Extent of wind scoured, blowouts and/or depositional areas:**

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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:

---

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):**

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:**