USDA Natural Resources
Conservation Service

Ecological site F103XY026MN
Clayey Upland Forests

Last updated: 10/04/2023
Accessed: 05/21/2025

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

U.S. Department of Agriculture (USDA)
Land Resource Regions and Major Land Resource Areas (USDA NRCS, 2006)
Major Land Resource Area (MLRA): Central Iowa and Minnesota Till Prairies (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)

International Vegetation Classification Hierarchy (NatureServe)
Class: 1 Forest & Woodland
Subclass: 1.B Temperate & Boreal Forest & Woodland
Formation: 1.B.2 Cool Temperate Forest & Woodland
Division: 1.B.2.Na Eastern North American Forest & Woodland

The reference state is similar to Minnesota Department of Natural Resources MHs39 Southern Mesic Maple-Basswood Forest

Ecological site concept

The Clayey Upland Forests ecological site is located on uplands with soils with thin epipedons, fine textures, and argillic subsurface horizons. Surface textures include clay loam, silty clay loam, and silt loam. These soils were formed predominantly under forest vegetation and are classified as Alfisols. This ecological site does not pond or flood.

Associated sites

F103XY028MN	**Clayey Wet Forests** The Clayey Wet Forests ecological site occurred on poorly drained soils derived from clayey till and lacustrine materials. These soils developed under forest vegetation. The site is located on ridges, slight concavities, and linear areas.
R103XY015MN	**Depressional Marsh** The Depressional Marsh ecological site is in concave depressions downslope from the Sandy Upland Forests site. The soils are very poorly drained and often ponded during the early growing season. Water-tolerant vegetation such as cattails, bulrushes, and sedges are dominant.

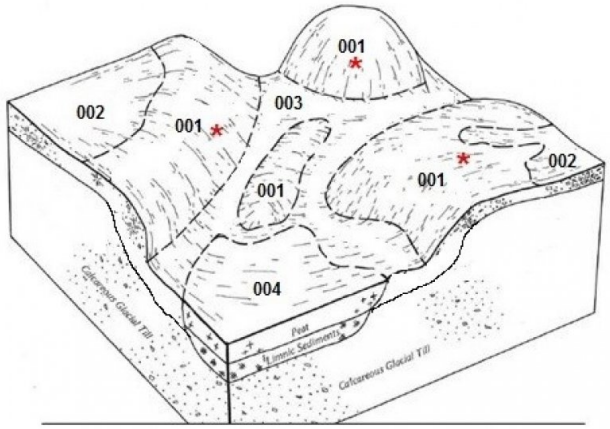
Table 1. Dominant plant species

Tree	(1) *Acer saccharum* (2) *Tilia americana*
Shrub	(1) *Ostrya virginiana* (2) *Prunus virginiana*
Herbaceous	(1) *Viola pubescens*

Physiographic features

The Clayey Upland Forests ecological site occurs primarily on ground, end, and lateral moraines and lake plains. The most common landform position include backslopes,

summits, and shoulders that are linear to slightly convex both vertically and horizontally. This site is generally found in an area known as the Big Woods ecoregion in Minnesota.



Code	Ecological Site Name	Representative Soil Series
001	Clayey Upland Forests	Kilkenny, Lerdal
002	Clayey Wet Forests	Mazaska, Minnetonka
003	Depressional Marsh	Glencoe, Okoboji
004	Organic Wet Meadow/Carr	Houghton, Muskego

Figure 1. Block diagram of the representative Clayey Upland Forests and associated ecological sites.

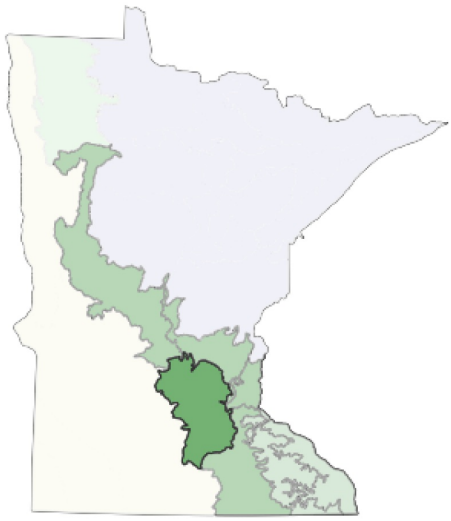


Figure 2. A map of Minnesota with the Big Woods ecoregion shaded in dark green. (Minnesota Department of Natural Resources)

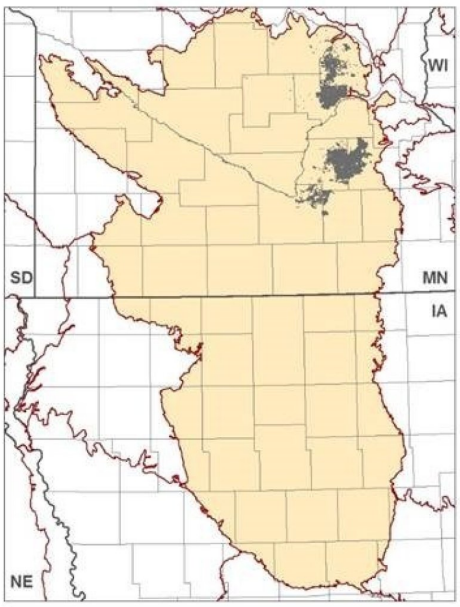


Figure 3. Distribution of the Clayey Upland Forests ecological site within MLRA 103. In many cases, the data set is not spatially consistent across political boundaries due to the method by which soils were mapped; e.g. due to county subsets.

Table 2. Representative physiographic features

Hillslope profile	(1) Backslope (2) Summit (3) Shoulder
Landforms	(1) Ground moraine (2) End moraine (3) Lateral moraine (4) Lake plain
Runoff class	Medium to very high
Elevation	210–560 m
Slope	0–35%
Water table depth	30–203 cm
Aspect	W, NW, N, NE, E, SE, S, SW

Climatic features

The soil temperature regime of MLRA 103 is classified as “mesic” (i.e., mean annual soil temperature between 46 and 59°F). The average freeze-free period of this site is 152 days, while the average frost-free period is 127 days. The average mean annual precipitation is 31 inches, which includes rainfall plus the water equivalent from snowfall. Cold air drainage, a lower water table, 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)	123-131 days
Freeze-free period (characteristic range)	149-156 days
Precipitation total (characteristic range)	787-813 mm
Frost-free period (actual range)	118-133 days
Freeze-free period (actual range)	144-160 days
Precipitation total (actual range)	762-813 mm
Frost-free period (average)	127 days
Freeze-free period (average)	152 days
Precipitation total (average)	787 mm

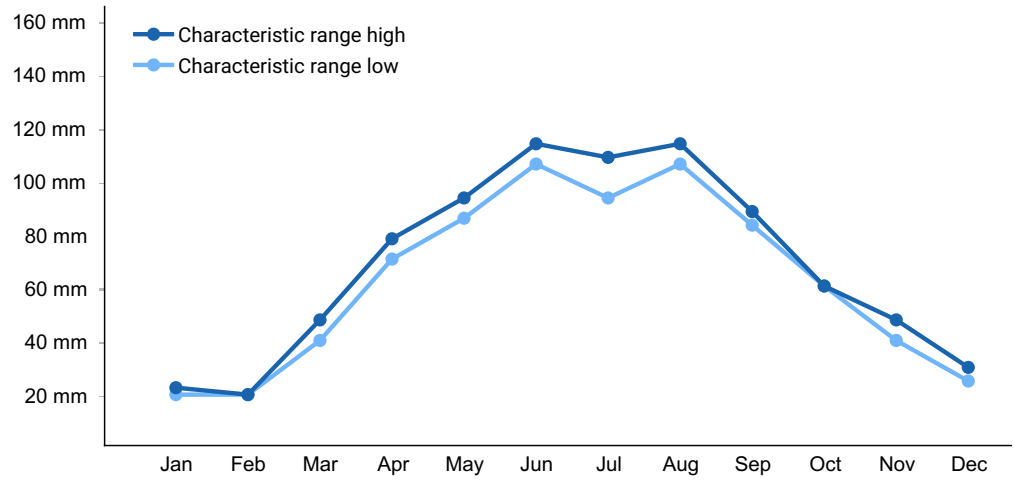


Figure 4. Monthly precipitation range

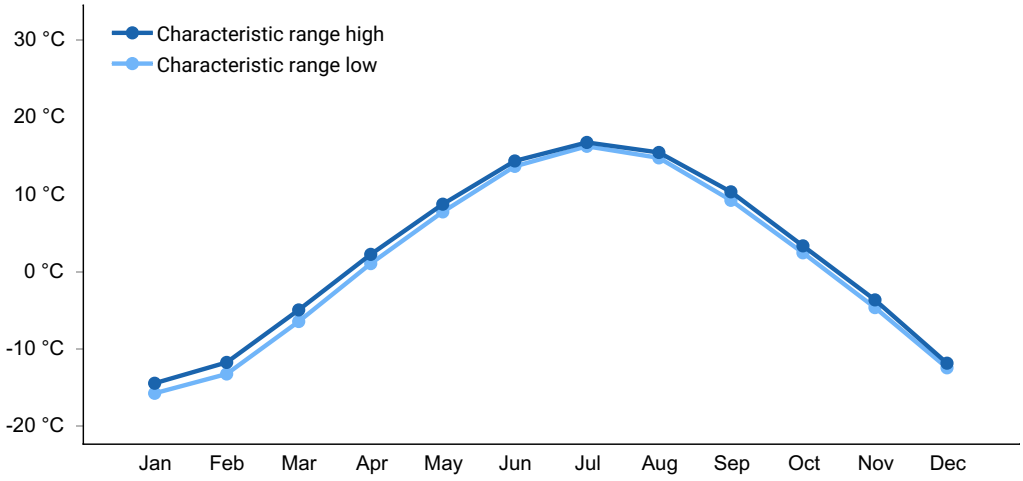


Figure 5. Monthly minimum temperature range

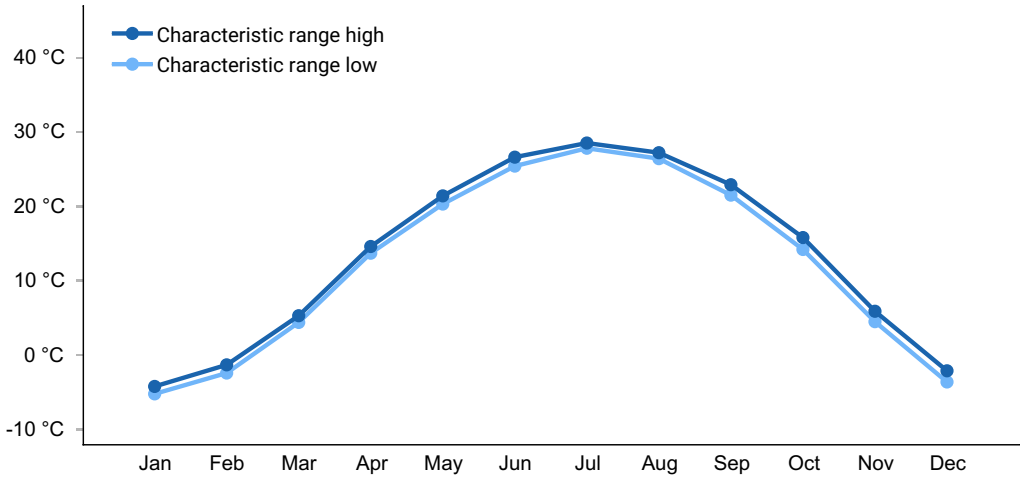


Figure 6. Monthly maximum temperature range

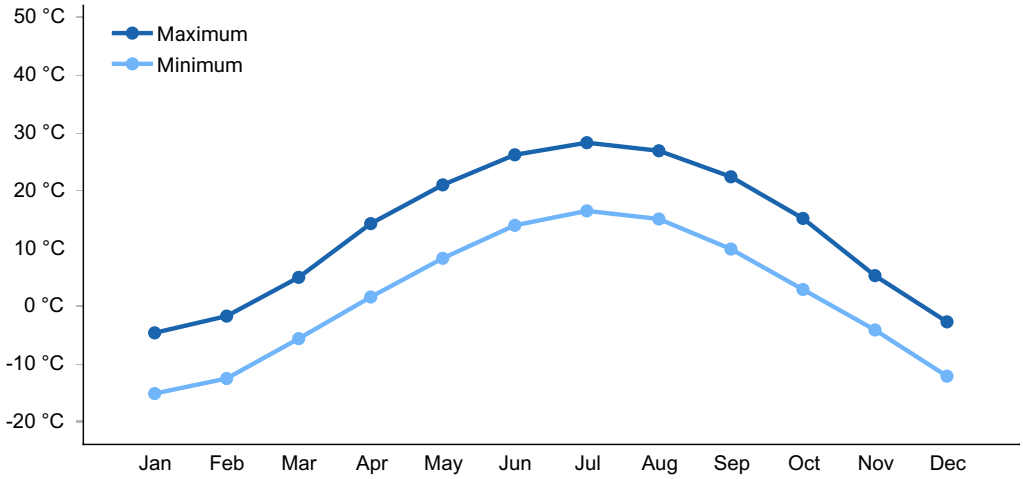


Figure 7. Monthly average minimum and maximum temperature

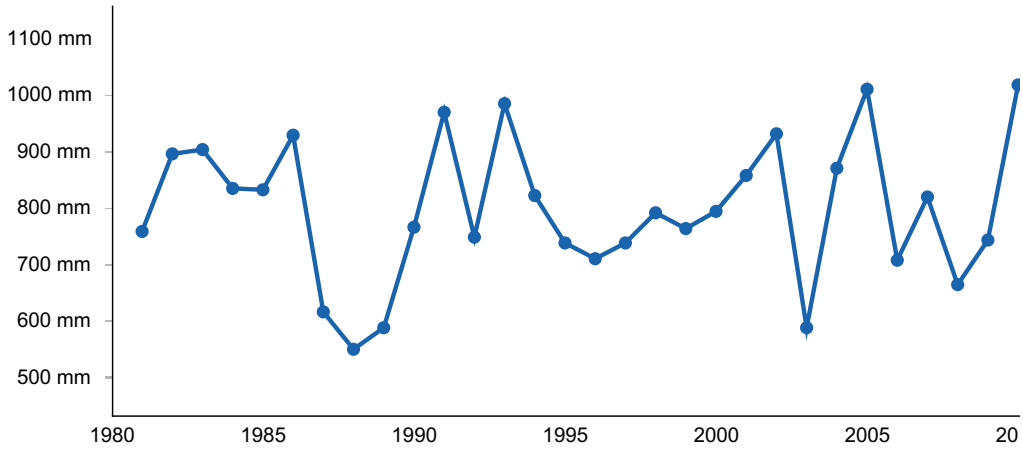


Figure 8. Annual precipitation pattern

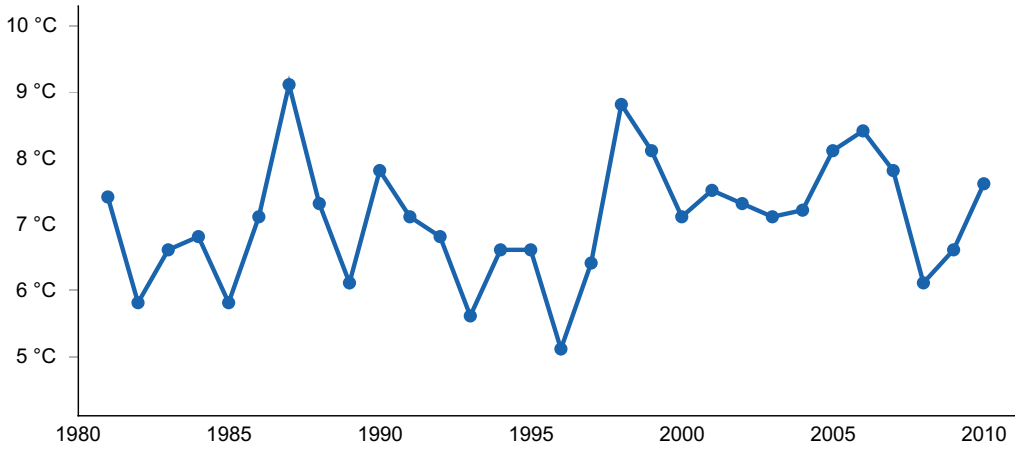


Figure 9. Annual average temperature pattern

Climate stations used

- (1) CHANHASSEN WSFO [USC00211448], Chanhassen, MN
- (2) AMBOY [USC00210157], Amboy, MN
- (3) BUFFALO 2NE [USC00211107], Buffalo, MN
- (4) FARIBAULT [USC00212721], Faribault, MN

Influencing water features

The Clayey Upland Forests ecological site receives water from precipitation, lateral subsurface flow, and to a lesser extent from runoff. On some areas, direct precipitation may be the only water source. Spring is the wettest time of the year. Soils are classified as endosaturated. The depth to saturation for the central concept soil components is between 30 and 50cm during the spring months and may drop to as low as six or more feet (200cm) later in the growing season during dry periods.

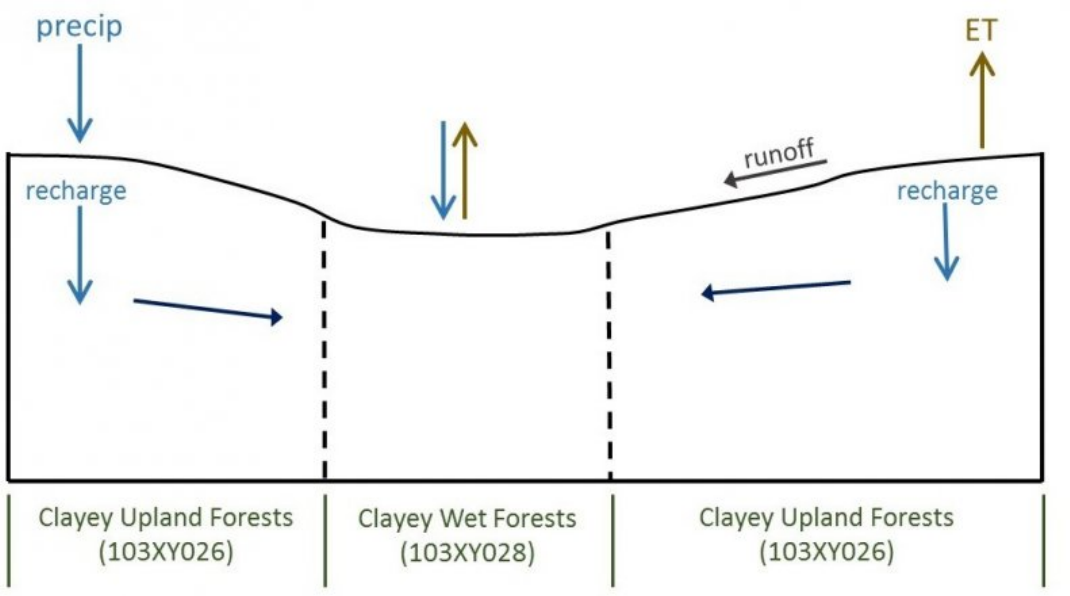


Figure 10. Hydrologic representation of a typical Des Moines Lobe (MLRA 103) Clayey Upland Forest and associated Provisional Ecological Sites.

Soil features

The soils associated with this site are classified as Vertic Hapludalfs or Epiaqualfs. These soils developed predominantly under deciduous forest vegetation. Clay particles were illuviated from horizons higher in the profile and accumulated deeper. 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).

The soil series associated with this site are Kilkenny, Lerdal, and Shiels soils. The soil parent material is fine glacial till, lacustrine deposits, or fine lacustrine deposits over loamy glacial till. Soils are deep (>60 inches to bedrock) and the drainage classes range from somewhat poorly drained to moderately well drained. The seasonal high depth to saturation stays below 30 cm from the surface. Typical soil surface textures include clay loam, silty clay loam, loam, and silt loam. The soil family particle size class is fine. Coarse fragments content is 0 to 15 percent by volume, and soil pH class is very strongly acid to moderately alkaline throughout the series control section.

Table 4. Representative soil features

Parent material	(1) Till (2) Lacustrine deposits
Surface texture	(1) Clay loam (2) Silty clay loam (3) Loam (4) Silt loam
Drainage class	Somewhat excessively drained to moderately well drained
Permeability class	Very slow to rapid
Soil depth	203 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-152.4cm)	21.59–26.67 cm
Calcium carbonate equivalent (0-101.6cm)	0–30%
Soil reaction (1:1 water) (0-101.6cm)	4.5–8.4
Subsurface fragment volume <=3" (0-101.6cm)	0–15%
Subsurface fragment volume >3" (0-101.6cm)	0–3%

Ecological dynamics

The Clayey Upland Forests ecological site is generally confined to the eastern and northern parts of MLRA 103 which includes the Big Woods ecoregion. Wildfires were historically suppressed in this region due to the topography and density of waterbodies. This ecological site currently has three states in the model: the Reference State, the Tillage State, and the Disturbed Forest State.

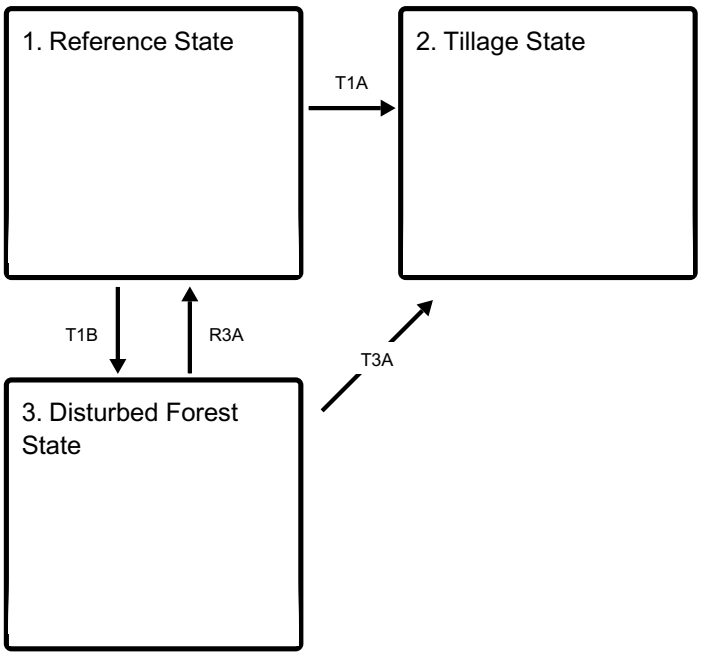
The Reference State is a mature, deciduous forest with multiple co-dominant canopy species including sugar maple and basswood. This is a relatively stable community in the absence of large-scale natural or anthropological disturbance. Small-gap disturbances occur and result in a series of successional communities. Early successional communities include quaking aspen, sugar maple, and American elm. Mid successional communities are often dominated by sugar maple and American elm. This ecological site can be affected by multiple natural triggers (disturbance processes) including wildfire, drought, insects, and windstorms.

The Tillage State is characterized by tillage and agricultural crop production. The two communities under this state are the Row Crop Community and the Seeded Grassland Community. Management inputs include preparing the site, seeding, fertilizing, controlling weeds and brush, and harvesting. This state is appropriate for lower slopes only.

The Disturbed Forest State is a wooded site that has undergone plant community changes due to human disturbances. Triggers include tree removal, invasive plants, and unmanaged grazing. These sites are dominated by various hardwoods along with invasive species, and do not have the ecological stability or native plant diversity of a reference state. The most common triggers are timber harvest or clearing the site for agricultural production (lower slopes only). Once a reference state has been transitioned to a tillage field, the reversibility class is irreversible.

State and transition model

Ecosystem states



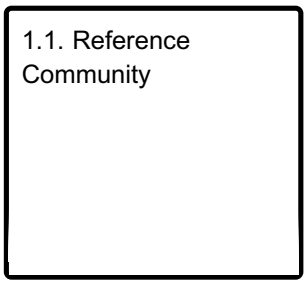
T1A - Site is cleared, tilled, drained, seeded, and managed for crop production

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

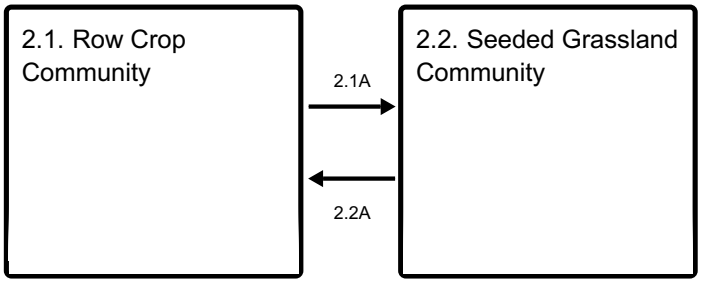
R3A - Restoration inputs may include desired species establishment, disturbance exclusion, invasive species eradication, and forest stand management

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 - Site preparation, soil tillage, crop establishment, weed control

State 3 submodel, plant communities

3.1. Disturbed Forest Community

State 1
Reference State

The Clayey Upland Forests Reference State is a mature deciduous forest. Dominant canopy species include sugar maple and basswood. Common shrubs include hophornbeam and chokecherry.

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

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- American basswood (*Tilia americana*), tree
- hophornbeam (*Ostrya virginiana*), shrub
- chokecherry (*Prunus virginiana*), shrub
- downy yellow violet (*Viola pubescens*), other herbaceous

Community 1.1
Reference Community

The Reference Community is characterized by multiple co-dominant canopy species, a variable shrub layer, and a diverse ground cover of native herbaceous species. Community composition will exhibit variations depending on slope, aspect, and available water capacity. Typical canopy species include sugar maple and basswood. The shrub layer density is variable, with chokecherry and hophornbeam common.

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

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- American basswood (*Tilia americana*), tree
- hophornbeam (*Ostrya virginiana*), shrub
- chokecherry (*Prunus virginiana*), shrub
- downy yellow violet (*Viola pubescens*), 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 often 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 can help mediate these 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 runoff and erosion, and protects water quality. Higher sloping areas within this ecological site are not appropriate for row crop production. When the slope gradient exceeds 20 percent, row crop production is unfeasible due to the farm machinery limitations. Some areas within this ecological site have been converted to a warm-season grasses. This can occur under conservation programs such as the NRCS Conservation Reserve Program (CRP). Common species include big bluestem, switchgrass, and Indiangrass. Plantings include perennial native forbs to benefit wildlife and pollinators. Non-native, cool-season grasses are also feasible. Seed mix selection will depend on landowner goals and objectives. Seeded grasslands are not as species rich or biologically diverse as native grasslands; however, they still offer ecological benefits for wildlife, especially grassland birds, water quality protection, 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 and intentional plant establishment are the primary triggers. The most common crops are corn and soybeans on an annual rotation. Many crops, however, are feasible for these areas. A secondary trigger is drainage modifications (ditching and tiling), which may be installed to improve soil drainage.

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

The Seeded Grassland Community grows in areas that were previously tilled and used for agricultural production, but have been transitioned to either warm-season or cool-season grasses. The primary trigger is the intentional establishment and management of a grass species.

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
- switchgrass (*Panicum virgatum*), grass
- Indiangrass (*Sorghastrum nutans*), 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 and management for the desired grass species.

Conservation practices

Forage and Biomass Planting
Establish pollinator and/or beneficial insect habitat

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 as sites are placed in crop production. The mechanisms of change are tillage and intentional plant establishment

(crop seeding).

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, available seed sources, and any management activities. Common tree species include sugar maple, basswood, ash, and elm. Bur oak may occur with other hardwoods on more mature sites. Non-native plants are often on these sites.

Dominant plant species

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

Community 3.1
Disturbed Forest Community

Community 3.1 is an altered forest community caused by human disturbances. Invasive species are common in this community. Canopy composition includes various hardwoods depending on the severity and type of disturbances, community age, and the availability of seed sources. Invasive, non-native species are common on these sites and will continue to increase without management intervention.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- common buckthorn (*Rhamnus cathartica*), 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. This transition is applicable to sites with lower slopes only.

Constraints to recovery. Site clearing, soil tillage, and hydrological modification 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 disturbances, 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 with long-term management inputs including establishment of desired species, forest stand management (selective thinning), and control of invasive species. Natural hydrological function must be present.

Context dependence. Ditching and tiling may be present on site altering the natural hydrology.

Conservation practices

Brush Management
Tree/Shrub Site Preparation
Tree/Shrub Establishment
Upland Wildlife Habitat Management
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	05/21/2025
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):

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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:**
