USDA Natural Resources Conservation Service

Ecological site R105XY014WI
Mollic Clayey Upland

Last updated: 2/23/2024
Accessed: 05/04/2024

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): 105X–Upper Mississippi River Bedrock Controlled Uplands and Valleys

The Northern Mississippi Valley Loess Hills area corresponds closely to the Western Coulees and Ridges and Southwest Savanna Ecological Landscapes. Some of the following brief overview is borrowed from the Wisconsin Department of Natural Resources Ecological Landscape publication (2015).

Fifty-two percent of the Upper Mississippi River Bedrock Controlled Uplands and Valleys MLRA is in Wisconsin; Iowa, Minnesota, and Illinois contain the rest. This region is the only area in Wisconsin that has not been covered by glaciers within the past 2.4 million years. The Wisconsin portion of this MLRA is approximately 7.4 million acres (11,600 square miles). The landscape is characterized by dissected topography with deeply-incised, steep-walled valleys between bedrock controlled ridges.

Though it's called the "Driftless Region", some glacial drift is found in the major river valleys of this region in the form of outwash, deposited by proglacial streams of glacial meltwater. Wisconsin's most recent glaciations also impacted the sediment of the area through the deposition of loess. After the glacier receded and before vegetation established, the bare surfaces of the glaciated areas were highly susceptible to wind erosion. As a result, a veneer of loess (wind-blown silt) was deposited over the entire region. The thickest deposits—nearly five meters—are on ridges near the Mississippi River and gradually thin moving eastward. The loess caps in Dane and Green counties are generally 0.5-1.5 meters deep. Much of the loess has eroded downslope and collected in floodplains.

Bedrock is shallow throughout this MLRA and is a major influence on topography and hydrology. Most of the MLRA has bedrock within two meters, except in the deep river valleys that are filled with outwash and alluvium materials. Sandstone is the dominant bedrock type in MLRA 105, but the southernmost portion is dominated by dolomite. Military Ridge is an escarpment that straddles the boundary between sandstone and dolomite bedrock. The sandstone north of the ridge is weaker than the erosion-resistant dolomite south of the ridge. The sandstone is deeply cut and dissected into steep slopes and valleys. The dolomite-controlled ridges tend to be less dissected and broader with more gentle, south sloping topography. Geomorphic and fluvial processes formed these landscapes by way of sheet wash, soil creep, and flowage. These processes eroded the hillslopes, cut into bedrock, and transported the debris to streams, forming floodplains and terraces.

Underfit streams are common in MLRA 105, especially in the southern portion. These streams currently occupy large river valleys—especially those of the Black, Chippewa, Mississippi, and Wisconsin Rivers—that were carved by proglacial meltwater streams carrying much larger quantities of water than what's present today. As the climate dried, waterflow decreased and the valleys filled with alluvial sediment. Narrow meanders were formed by the shrinking streams and are often dissimilar to the meanders of the larger valleys they occupy. Fluvial landforms – including terraces, oxbow lakes, sandbars, eroding bluffs, and large floodplain complexes – are found within these large valleys and are subject to varying flooding frequencies, intensities, and durations.
Karst topography formed in this region from dissolution of carbonate bedrock by surface and groundwater. Dolomite and limestone are more easily affected by dissolution, but karst topography also formed in sandstone. Erosion by water (stream meanders, rain/runoff, and groundwater), wind, and frost weaken joints and bedding planes that can

cause collapse. In addition, sandstone materials collapse into cavities in underlying dolomite or limestone.

Historically, MLRA 105 was dominated by oak forests and oak openings making up more than 50% of the area. Prairies were significant and covered 32% of the area south of Military Ridge. Maple-basswood forests covered 19% of the are north of Military Ridge. Dominant tree species were white oak (Quercus alba), bur oak (Quercus macrocarpa), black oak (Quercus velutina), and sugar maple (*Acer saccharum*).

Classification relationships

Relationship to Established Framework and Classification Systems:

Habitat Types of S. Wisconsin (Kotar, 1996): Forested sites are likely to key out to habitat types of *Acer saccharum*-Tilia/Desmodium [ATiDe] and *Acer saccharum*-Tilia/Desmodium(Prunus serotina) [ATiDe(Pr)].

Biophysical Settings (Landfire, 2014): This ES is largely mapped as Eastern Cool Temperate Pasture and Hayland, Eastern Cool Temperate Close Grown Crop, Eastern Cool Temperate Row Crop, and Developed-Low Intensity

WDNR Natural Communities (WDNR, 2015): This ES is most similar to Mesic Prairie as described by the Wisconsin DNR.

Hierarchical Framework Relationships:

Major Land Resource Area (MLRA): Upper Mississippi River Bedrock Controlled Uplands and Valleys (105)

USFS Subregions: Mineral Point Prairie-Savannah (222Le)

Wisconsin DNR Ecological Landscapes: Southwest Savannah

Ecological site concept

The Mollic Clayey Upland ecological site occupies approximately 28,000 acres across MLRA 105, or about 0.4% of total land area. It is one of the least extensive sites in MLRA 105. It is found in the southeastern corner of MLRA 105 on clayey ridges and hills formed in calcareous shale.

This site is defined by well drained, clayey soils where bedrock contact occurs within 1 meter of the soil surface. These sites have deep, dark surfaces (mollic epipedons) resulting from long-term additions of organic materials, especially from fine, fibrous roots of grassy vegetation.

Historically, these sites were prairies, though modern fire suppression has resulted in the encroachment by woody species. Today, many sites are forested. The bedrock acts as a root restricting layer and can limit root growth and perch water. These sites may be vulnerable to tree trips.

Associated sites

F105XY008WI	**Moist Loamy-Clayey Lowland** These sites form in loamy and clayey materials. They are somewhat poorly drained. They may be found adjacent to Mollic Clayey Upland in lower landscape positions.
F105XY013WI	**Loamy-Silty Upland** These sites form in loamy to silty materials, often silty loess and residuum. They are moderately well to well drained. They are sometimes found adjacent to Mollic Clayey Upland.
R105XY010WI	**Shallow Mollic Loamy-Silty Upland** These sites form in loamy to silty materials, often silty loess and residuum. They have deep, dark surfaces and bedrock contact within 3 feet (one meter) of the soil surface. They are well drained to somewhat excessively drained. They are often found adjacent toMollic Clayey Upland.

R105XY011WI	**Mollic Loamy-Silty Upland** These sites form in loamy to silty materials, often silty loess and residuum. They have deep, dark surfaces. They are moderately well to somewhat excessively drained. They are often found adjacent to Mollic Clayey Upland.

Similar sites

F105XY016WI	**Clayey Upland** These sites form in deep clayey materials, often clayey pedisediment and residuum. They are moderately well to well drained. They are very similar to Mollic Clayey Upland but have shallower surface horizons (ochric rather than mollic epipedons).
F105XY015WI	**Shallow Clayey Upland** These sites form in clayey materials, often clayey pedisediment and residuum. They have bedrock contact within one meter of the soil surface. They are moderately well to well drained. They are similar to Mollic Clayey Upland but have shallower surface horizons (ochric rather than mollic epipedons).
R105XY011WI	**Mollic Loamy-Silty Upland** These sites form in loamy to silty materials, often silty loess and residuum. They have deep, dark surfaces. They are moderately well to somewhat excessively drained. They are similar to Mollic Clayey Upland but have slightly coarser soil textures.
R105XY018WI	**Dry Mollic or Umbric Upland** These sites form in sandy materials deposited by wind, water, or weathered from sandstone bedrock. They have deep, dark surfaces. They are moderately well to excessively drained. They are found in similar landscape positions as Mollic Clayey Upland but have much coarser soil textures and a lower nutrient status.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Andropogon gerardii* (2) *Sorghastrum nutans*

Physiographic features

These sites for on ridges and hills in summit, shoulder, and backslope positions. Slope shape is convex or linear. Slopes range from 2 to 30 percent. Elevation of the landform ranges from 705 to 853 feet (215 to 260 meters) above sea level.

These sites are not subject to inundation by water. They generally lack evidence of a seasonally high water table within 80 inches (200 cm) below the soil surface. Runoff potential is medium to high.

Table 2. Representative physiographic features

Hillslope profile	(1) Summit (2) Shoulder (3) Backslope
Slope shape across	(1) Convex
Slope shape up-down	(1) Linear
Landforms	(1) Ridge (2) Hill
Runoff class	Medium to high
Flooding frequency	None
Ponding frequency	None
Elevation	705–853 ft
Slope	2–30%

Water table depth	80 in
Aspect	Aspect is not a significant factor

Climatic features

The climate of the Upper Mississippi River Bedrock Controlled Uplands and Valleys MLRA is typical of southern Wisconsin, with warmer winters, warmer summers, and higher precipitation rates than MLRA in northern Wisconsin. The MRA stretches over about 2.9 degrees of latitude, or nearly 200 miles, from its northern tip in Barron county to its southern Wisconsin extent on the border of Illinois. This results in considerable variation in climate throughout the MLRA. The growing season ranges from 117 to 181 growing degree days, with longer growing seasons in the southern portion.

The average annual precipitation for this ecological site is 36 inches. The average annual snowfall is 44 inches. The annual average maximum and minimum temperatures are 58°F and 36°F, respectively.

Table 3. Representative climatic features

Frost-free period (characteristic range)	116-135 days
Freeze-free period (characteristic range)	134-153 days
Precipitation total (characteristic range)	33-36 in
Frost-free period (actual range)	109-136 days
Freeze-free period (actual range)	126-157 days
Precipitation total (actual range)	32-38 in
Frost-free period (average)	124 days
Freeze-free period (average)	144 days
Precipitation total (average)	35 in

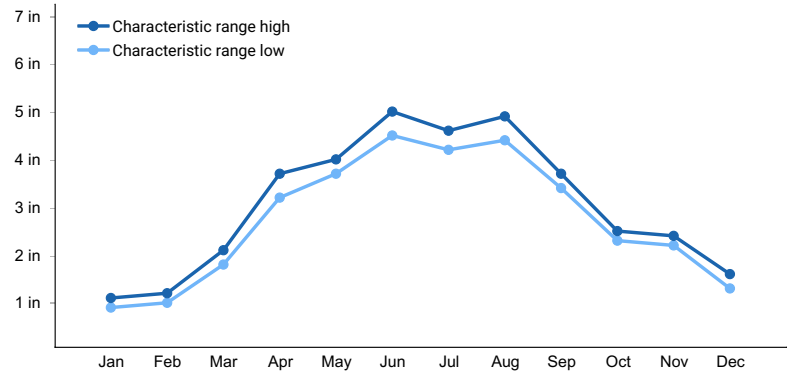


Figure 1. Monthly precipitation range

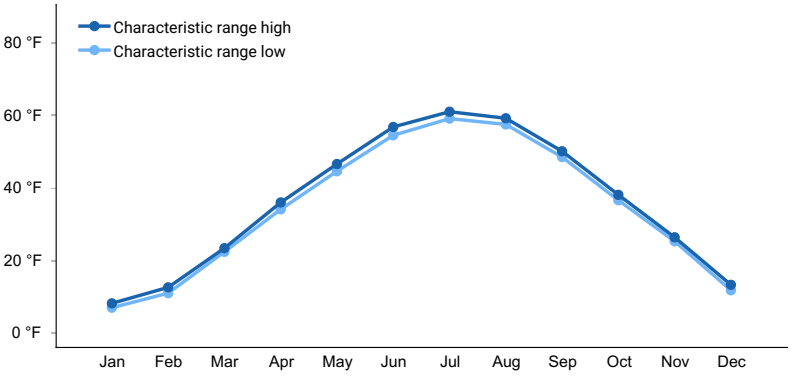


Figure 2. Monthly minimum temperature range

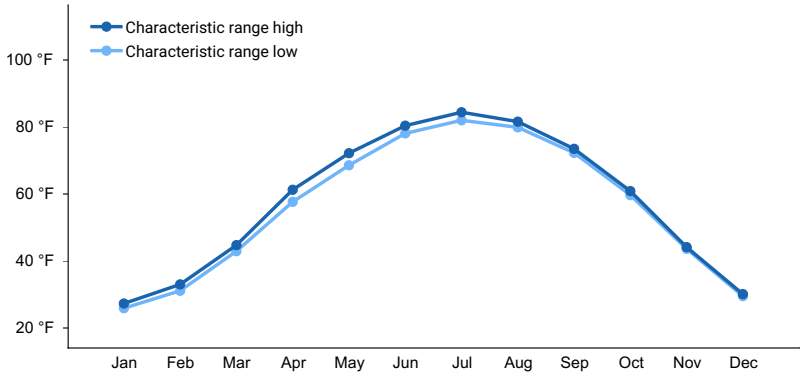


Figure 3. Monthly maximum temperature range

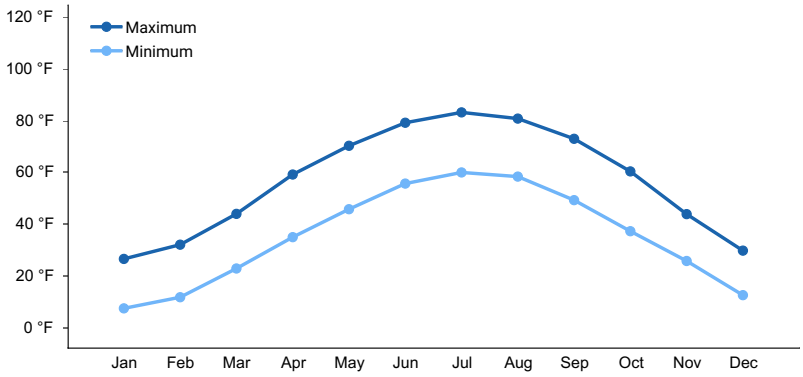


Figure 4. Monthly average minimum and maximum temperature

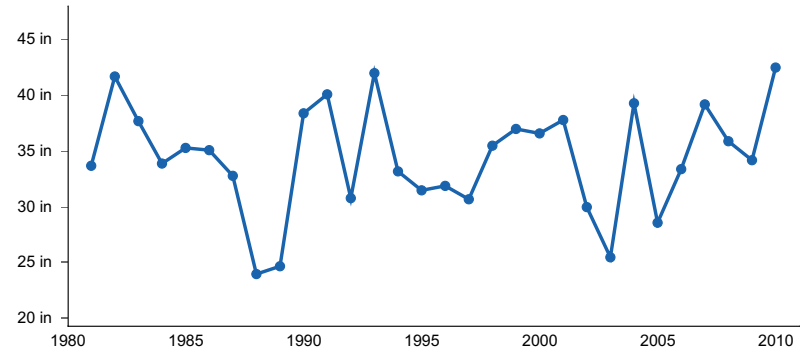


Figure 5. Annual precipitation pattern

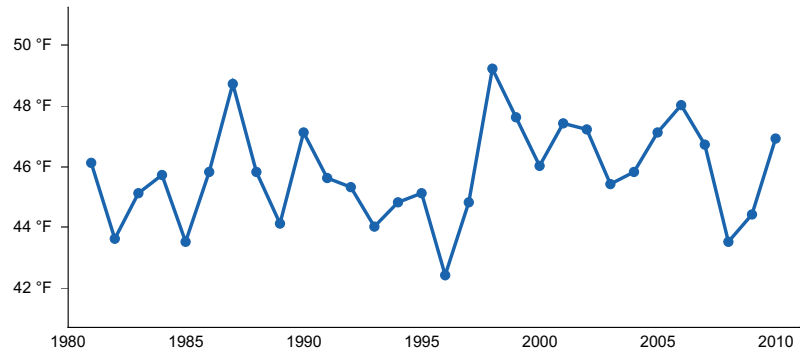


Figure 6. Annual average temperature pattern

Climate stations used

- (1) DODGE [USC00472165], Arcadia, WI
- (2) PRAIRIE DU SAC 2 N [USC00476838], Prairie du Sac, WI
- (3) DODGEVILLE [USC00472173], Dodgeville, WI

- (4) WAUKON [USC00138755], Waukon, IA
- (5) MONDOVI [USC00475563], Mondovi, WI

Influencing water features

Water is received through precipitation and runoff from adjacent uplands. Water is lost from the site primarily through runoff, evapotranspiration, and groundwater recharge.

Permeability of the soils is generally impermeable. The hydrologic soil group is D.

Wetland description

Not Applicable.

Soil features

This site is represented by the Dodgeville, Edmund, and Schapville soil series. The overwhelming majority of soils are classified as Lithic Argiudolls. A very small amount of sites in Lafayette county are classified as Oxyaquic Argiudolls.

These soils form in clayey residuum weathered from calcareous shale, often dolomite. They often have a layer of clayey pedisediment and mantle of silty loess. They have a thick, dark surface horizon rich in base-forming cations (mollic epipedon). These sites will also usually have subsurface horizons of accumulated clay (argillic horizons) and contact with bedrock within 40 inches (100 cm), though neither are defining characteristics for this site. Soils are well drained and do not meet hydric soil requirements.

Subsurface fragments smaller than 3 inches in diameter (gravel) can occupy up to 9% volume of the soil. These fragments will generally be piece of weathered bedrock, mostly dolomite fragments. Soils are neutral to slight alkaline. Formed from carbonate rock, accumulations of secondary carbonates are common in these soils and can often be found starting at the soil surface.

Figure 7. Edmund soil series sampled on 07/29/2020 in Iowa County, WI.

Table 4. Representative soil features

Parent material	(1) Loess (2) Pedisediment (3) Residuum
Surface texture	(1) Silt loam
Drainage class	Well drained
Soil depth	16–40 in

Available water capacity (0-59.1in)	1.1–1.33 in
Calcium carbonate equivalent (0-39.4in)	0–8%
Soil reaction (1:1 water) (0-39.4in)	6.7
Subsurface fragment volume <=3" (0-39.4in)	6–9%
Subsurface fragment volume >3" (0-39.4in)	2%

Ecological dynamics

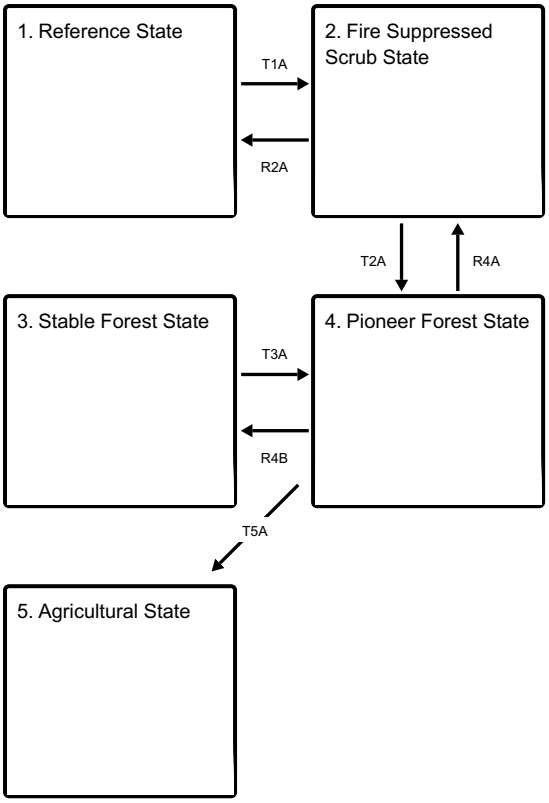
In pre-European settlement time wildfire was the main controlling factor of range and forest community dynamics. Some areas had been persistent in grasslands, but had the capacity to support both grassland and forest depending on the frequency and intensity of fire and the presence of large grazers. Shorter fire return intervals led to grasslands, intermediate fire return intervals to scrub, and long fire return intervals to forest. Any scrub or forest community was dependent on the presence of adjacent seed source. Many of the previous grasslands have been converted to agriculture or have reverted to forest following fire suppression.

Forest communities can be described thusly, following a severe, stand-replacing fire, any of the species present on the landscape could become established, depending on seed source availability and specific conditions of post-fire seedbed. The newly established young stands of any species were easily eliminated by recurring fires, but differences in fire-resisting properties among the species began to play a role in any species' survival success. Many pine and oak species were dominant in the region because of their fire-resistant properties and successful regeneration post-fire. With clear cutting and continued fire suppression, many of these species adapted to fire and intolerant of shade are replaced by other species. Species such as white pine and red oak are still common on the landscape based on their tolerance to some shade; these species to establish under a canopy, and in time, may become a component of the canopy. Mesic hardwoods are sensitive to fire, but in its absence, the have the ability to dominate sites based on their shade tolerance and prolific seed production.

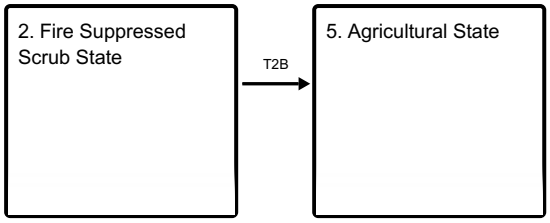
Today, these forests most commonly include stands of red oak, white oak, and other mesic hardwoods may be present as well. Some sites have a the likely reference community of sugar maple and basswood with a mixture of ashes. These sites have the conditions to support shade tolerant mesic hardwoods, but historically had significant wind throw and fire disturbance that allowed for a strong presence of oak species. As long as fire is continually suppressed, maples and other mesic hardwoods will continue to dominate the canopy.

State and transition model

Ecosystem states



States 2 and 5 (additional transitions)



T1A - Suppression of fire

R2A - Return of fire and/or large grazers to the landscape.

T2A - Continued fire suppression for over 20 years

T2B - Removal of forest/shrub cover and tilling for agricultural crop production.

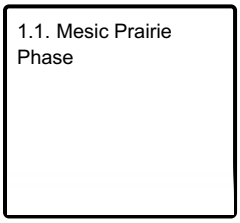
T3A - Cutting, fire, or blowdown removing existing tree canopy.

R4A - Low intensity moderate return interval fire removing fire intolerant species and regeneration

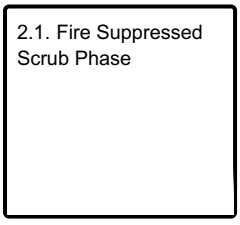
R4B - Deciduous forest community is slowly invaded by conifers.

T5A - Removal of forest/shrub cover and tilling for agricultural crop production.

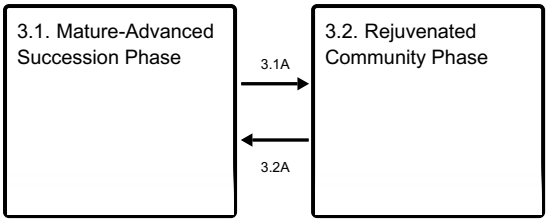
State 1 submodel, plant communities



State 2 submodel, plant communities



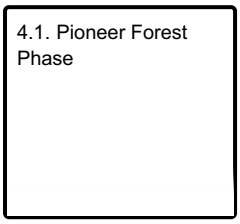
State 3 submodel, plant communities



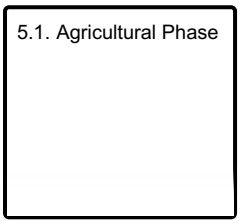
3.1A - Light to moderate intensity fires, blow-downs, ice storms.

3.2A - Disturbance-free period for 30+ years.

State 4 submodel, plant communities



State 5 submodel, plant communities



State 1
Reference State

The Reference State is a grassland state dominated by big bluestem, but also includes Indian grass, and little bluestem. Sunflowers are common. The reference state for this ES is very rare today and was maintained by frequent fire removing the encroachment of tree and shrub species.

Community 1.1
Mesic Prairie Phase

The Mesic Prairie Phase is a grassland state dominated by tall grasses including big bluestem, Indian grass, and sunflowers. This phase is very rare today.

Dominant plant species

- big bluestem (*Andropogon gerardii*), grass

- Indiangrass (*Sorghastrum nutans*), grass
- little bluestem (*Schizachyrium scoparium*), grass
- sunflower (*Helianthus*), other herbaceous

State 2
Fire Suppressed Scrub State

A mostly open grassland with sporadic shrubs and trees. As soon as fire is suppressed tree and shrub species invade this ES and various tree and shrub species may take hold resulting in a grassland with sparse and sporadic tree and shrub cover.

Community 2.1
Fire Suppressed Scrub Phase

Fire Suppressed Scrub is a tree and shrub invaded grassland. The grassland species are similar to the reference state with the addition of various species of tree or shrub beginning to create a sparse canopy.

Dominant plant species

- quaking aspen (*Populus tremuloides*), tree
- red maple (*Acer rubrum*), tree
- oak (*Quercus*), tree
- pine (*Pinus*), tree
- big bluestem (*Andropogon gerardii*), grass
- bluejoint (*Calamagrostis canadensis*), grass
- sedge (*Carex*), grass

State 3
Stable Forest State

Stable Forest state is a forest community dominated by sugar maple (*Acer saccharum*) with American basswood (*Tilia americana*), and a mixture of Ashes (Fraxinus spp.), and Oaks (Quercus spp.). Depending on history of disturbance, two community phases can be distinguished largely by differences in dominance of tree species and community age structure. In some places sugar maple seed source may be missing leading to other dominant canopy species.

Community 3.1
Mature-Advanced Succession Phase

In the absence of any major disturbance, specifically fire, this community is dominated by Sugar maple. Common associates include American basswood, Ashes, and Oaks. Other species may be present in the canopy as well, including: Black Cherry, Red maple, and Shagbark hickory. The shrub layer is typically not well developed in this phase, but is likely to contain regenerating overstory species. The ground layer is often sparse but includes rich site species such as Virginia creeper, Enchanter’s nightshade, and Pointedleaf Ticktrefoil.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- ash (*Fraxinus*), tree
- American basswood (*Tilia americana*), tree
- Virginia creeper (*Parthenocissus quinquefolia*), other herbaceous
- American hogpeanut (*Amphicarpaea bracteata*), other herbaceous
- pointedleaf ticktrefoil (*Desmodium glutinosum*), other herbaceous

Community 3.2
Rejuvenated Community Phase

This community is dominated by a mixture of hardwoods including sugar maple, basswood, red oak, white oak, and

ashes. Associates may include shagbark hickory, and black cherry. The shrub (often more developed in this phase) and ground layers are similar to the advanced succession phase, but may include the establishment of new seedlings to include more shade intolerant species. This community phase will quickly return to the mature or advanced succession phase with limited disturbance.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- ash (*Fraxinus*), tree
- American basswood (*Tilia americana*), tree
- Virginia creeper (*Parthenocissus quinquefolia*), other herbaceous
- American hogpeanut (*Amphicarpaea bracteata*), other herbaceous
- pointedleaf ticktrefoil (*Desmodium glutinosum*), other herbaceous

Pathway 3.1A
Community 3.1 to 3.2

Natural mortality in the oldest age classes—sporadic small-scale blow-downs and ice storms—create openings for entry of shade mid-tolerant species such as red oak.

Pathway 3.2A
Community 3.2 to 3.1

In the absence of canopy reducing disturbances natural succession leads to community dominance by the most shade-tolerant species resulting in return to community phase 1.1

State 4
Pioneer Forest State

Post disturbance pioneer community of aspen and paper birch with mixtures of other species from available seed sources.

Community 4.1
Pioneer Forest Phase

These two species have a very narrow window of environmental and ecological conditions for successful establishment. Main requirements are exposed mineral soil and elimination, most effectively by fire, of on-site seed sources of potential competing vegetation. In addition, adequate soil moisture must be available for initial seedling development. Once seedlings are firmly established, height growth of both species is relatively rapid and able to outgrow most competitive species. Paper birch seedlings and saplings tolerate partial shade and often become members of mixed species communities. This is not true for aspen which requires continuous full-sun exposure for survival. Aspen stands are initially very dense due to sprouting from extensive lateral roots, but rapid natural thinning ensues as stems compete for available light.

Dominant plant species

- quaking aspen (*Populus tremuloides*), tree
- European white birch (*Betula pendula*), tree
- red maple (*Acer rubrum*), tree
- oak (*Quercus*), tree
- black cherry (*Prunus serotina*), shrub
- beaked hazelnut (*Corylus cornuta*), shrub
- Canada mayflower (*Maianthemum canadense*), other herbaceous

State 5
Agricultural State

Indefinite period of applying agricultural practices varying from crops to pasture or hay.

Community 5.1
Agricultural Phase

Indefinite period of applying agricultural practices. Crops likely include alfalfa, corn, soybeans, and hay or pasture. It is possible that some areas have been abandoned, but persist in a domesticated grassland condition having been previously pasture or hay ground.

Transition T1A
State 1 to 2

Suppression of fire leading to the encroachment of wood species. Continued suppression for 10+ years required for the establishment of woody species.

Restoration pathway R2A
State 2 to 1

Reintroduction of fire causing the mortality of encroaching trees and shrubs. This fire must then return at relatively short intervals to continue to suppress the growth of woody vegetation.

Transition T2A
State 2 to 4

Continued fire suppression for several decades will lead to a dominant woody cover on the site.

Transition T2B
State 2 to 5

Removal of forest cover and tilling for agricultural crop production

Transition T3A
State 3 to 4

Major stand-replacing disturbance. In pre-European settlement time, the event was most often a severe blow down, sometimes followed by fires. Such blow downs have been estimated to occur in this part of Wisconsin every 300 to 400 years (Schulte and Mladenoff, 2005). In post settlement virtually every acre has been logged either by clear cutting or successive cuts targeting species marketable at that time. Post logging slash fires also have been a significant factor in most areas. These disturbances created the environment suitable for natural regeneration of many shade-intolerant species and for commercial planting.

Restoration pathway R4A
State 4 to 2

Reintroduction of low intensity fire that kills fire intolerant species and most regeneration.

Restoration pathway R4B
State 4 to 3

A period of some 70-100 years without major stand disturbance, especially fire, leads to decreased presence, through natural mortality, of early successional species and the dominance of shade tolerant sugar maple with less tolerant associates of red oak and white ash.

Transition T5A
State 4 to 5

Removal of forest/shrub cover and tilling for agricultural crop production.

Additional community tables

Inventory data references

Plot and other supporting inventory data for site identification and community phases is located on a NRCS North Central Region shared and one drive folder. University of Wisconsin-Stevens Point described soils, took photographs, and inventoried vegetation data at community phases within the reference state. The data sources include WI ESD Plot Data Collection Form - Tier 2, Releve Method, NASIS pedon description, NRCS SOI 036, photographs, and Kotar Habitat Types.

Other references

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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	05/04/2024

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:

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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:**
