Ecological site F095XB008WI
Clayey Upland with Carbonates

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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): 095X–Eastern Wisconsin, Northern Illinois, and Upper Michigan Drift Plain

This MLRA is characterized by nearly level to rolling till plains, outwash plains, drumlin fields, and glacial lake plains. It is used to produce cash crops, feed grain, and livestock. It includes the shorelines of Lake Winnebago and Lake Michigan. This area is in Wisconsin (85 percent), Illinois (10 percent), and Michigan (5 percent). It makes up about 17,255 square miles (44,690 square kilometers). This area is in the Central Lowland province of the Interior Plains. Most of the area is in the Eastern Lake section. A narrow strip along the southwestern edge of the area is in the Wisconsin Driftless section. The southwestern quarter is in the Till Plains section. The nearly level to rolling till plains, glacial lake plains, and outwash plains are mixed with drumlin fields, ground moraines, end moraines, flood plains, lake terraces, beaches, dunes, swamps, and marshes. Most of the southern part of this area has belts of morainic hills and ridges and nearly level outwash terraces. Drumlins are prominent features in the central part of the area. Glaciokarst topography occurs in the east-central parts of the area influenced by underlying Niagara Dolomite. Lakes and streams are numerous, and streams generally form a dendritic drainage pattern. Elevation ranges from 530 to 1,580 feet (160 to 480 meters). Local relief is mainly 25 feet (8 meters), but the moraines, drumlins, and bedrock escarpments rise 80 to 330 feet (25 to 100 meters) above the adjacent valleys.

The annual precipitation ranges from 28 to 37 inches (700 to 950 millimeters) with a mean of 33 inches (840 millimeters). The annual temperature ranges from 41 to 48 degrees F (5.1 to 9.2 degrees C) with a mean of 46 degrees F (7.7 degrees C). The freeze-free period ranges from 115 to 185 days with a mean of 155 days. It decreases in length from south to north and from the shore of Lake Michigan inland. Lake Michigan helps to moderate the climate of the area.

This MLRA is mostly covered with glacial drift of Wisconsin age. Some of the higher areas are moraines that appear as arc-shaped ridges representing the retreat of the ice from south to north. Most of the bedrock in the area consists of Silurian, Ordovician, and Cambrian sandstone, limestone, and dolomite. Some igneous and metamorphic rocks underlie the northwestern edge of the area. Devonian limestone and shale occur at the far eastern edge in the Milwaukee area.

The dominant soil orders in this MLRA are Alfisols, Entisols, Histosols, Mollisols, and Spodosols. The soils in the area dominantly have a mesic or frigid temperature regime, an aquic or udic moisture regime, and mixed mineralogy. They are very deep, excessively drained to very poorly drained, and sandy to clayey. Areas of Spodosols and soils with a frigid soil temperature regime occur in the northern part of the MLRA.
The northern part of this MLRA supports natural stands of mixed northern hardwoods and pine. Sugar maple, oak, white ash, elm, yellow birch, white pine, red pine, and American beech are the principal species. Low-lying areas support both mixed hardwoods and conifers. Elm, soft maple, black ash, and northern white cedar are the major species. Brush and sedge meadows also occur in the low-lying areas.

The southern part of this MLRA supports hardwoods and prairie vegetation. Uplands support natural stands of oak, sugar maple, and hickory, and natural prairie vegetation is characterized by little bluestem and big bluestem. Many of the prairies have scattered oak and hickory trees. Low-lying areas support sedge and grass meadows and mixed

stands of hardwoods and conifers. Elm, ash, eastern cottonwood, soft maple, and white cedar are the major species in the low-lying areas. (USDA-NRCS, 2022)

LRU notes

The Southern Wisconsin and Northern Illinois Drift Plain LRU (Land Resource Unit) (95XB) corresponds closely to the Central Sand Hills and Southeast Glacial Plains Ecological Landscapes. Some of the following brief overview is borrowed from the Wisconsin Department of Natural Resources Ecological Landscape publication (2015).

The Southern Wisconsin and Northern Illinois Drift Plain MLRA is found in southeast Wisconsin and extends into northern Illinois. The Wisconsin portion of this LRU is approximately 6.3 million acres (9,900 square miles). This LRU was entirely glaciated – mostly formed by the Green Bay and Lake Michigan Lobes of the Wisconsin Glaciation except the southern part, which was covered by an earlier glaciation. The landscape is dominated by till plains with drumlins, but also has large areas of outwash, pitted outwash, and glaciolacustrine deposits. The LRUcontains the Kettle Interlobate Moraine—the end moraine system formed where the Green Bay and Lake Michigan lobes met. The thickness of glacial deposits is typically less than 15 meters deep throughout the LRU, but the eastern portion can reach up to 60 meters thick. Nearly all the LRU is covered in a loess cap ranging from 1.2 meters (in the west) to 15 centimeters (in the east).

The northwest portion of LRU 95XB is part of the Central Sand Hills Ecological Landscape. The area from Portage County south through Marquette is dominated by till plains covered in outwash. The Green Bay Lobe deposited the till and created a morainal system along the west margin. The Johnstown moraine is the terminal moraine, but smaller, lateral moraines are also prominent on the landscape. As the glacier receded, meltwaters covered the intermorainal till plain with sand and gravel outwash sediments, sometimes covering blocks of ice. As the temperatures rose, the ice melted and collapsed the surface, creating an extensive area of pitted outwash. Till in this area is sandy and lacks dolomite found in other tills of this LRU. It may be hard to distinguish from the sandy outwash of the area. The rest of the northwest portion is dominated by till plains and glacial lake sediments. Glacial Lake Wisconsin covered a portion of this LRU, but the Lewiston Basin is the most significant glacial lake in this region. The Lewiston Basin formed when glacial meltwaters were impounded behind the Johnstown Moraine. Most of the lake drained after a catastrophic breach of an ice dam that supported it. The rest of this region is a till plain covered in a thin layer of loess. This till is a sandy loam with dolomite from the Niagara Escarpment. The till plain is covered with drumlins and bedrock-cored knolls and hills where the overlying till has been eroded. Wetlands are common in the low-lying outwash and the fine-textured lake sediments.

The central portion of this LRU is dominated by a rolling till plain covered in drumlins. Terminal and recessional moraines show the extent of the Green Bay Lobe. The topography of the moraines is hummocky because the supraglacial till was deposited unevenly along the ice margin and the surface collapsed after buried ice melted. Glacial lakes formed on the ice margin from ice dams, bedrock ridges, and moraines. Glacial Lakes Scuppernong and Yahara were two significant lakes that deposited clay and silty clay in deep basins. Meltwater streams deposited outwash sediments over some areas of the till plain, creating pockets of outwash and pitted outwash. The till deposited here is gravelly, clayey, and silty sand with dolomite pebbles.

The Kettle Interlobate Moraine is a unique and significant feature along the eastern border this LRU. The Kettle Moraine is a complex range of ridges and hills that formed by the end moraine systems where the Green Bay and Lake Michigan lobes met. The area ranges from 1 to 30 miles wide and landforms up to 300 feet in elevation. The area experienced massive volumes of meltwater from the two glacial lobes, which deposited primarily sand and gravel, but morainal till is also present. There are two distinct portions for the Kettle Moraine. The south potion formed as the lobes receded and deposited a series of level outwash fans between the lobes. Buried ice melted and parts of the fan collapsed to form kettles—round depressions on the surface that often fill with water to become lakes when the water table is near the surface. In the northern section, debris collected in the ice where the two lobes flowed together. As the glaciers receded, meltwaters deposited outwash materials on top of ice. As the ice melted, the surface collapsed and created a mixture of collapsed outwash and till materials. The till was in and beneath the buried ice.

West of the Kettle Moraine lies a landscape dominated by till plains with drumlins and areas of outwash formed by the Lake Michigan Lobe. Braided proglacial streams deposited outwash and pitted outwash plains. A small extent of lake plains is present. Wetlands are abundant because of impeded drainage from the underlying till and lake sediments.

The southern portion of this LRU is comprised of older glacial sediment deposited before the Wisconsin Glaciation. In the east lie broad, flat to rolling till plains. In the west, an eroded and dissected, hilly bedrock-controlled landscape is present; this area is similar in appearance to the Driftless region. Some low areas have outwash deposited by proglacial streams from Green Bay Lobe meltwater. In some areas in the west, dissolution of bedrock has created karst topography. There is a small extent of lake plain sediments.

Historically, the vegetation in this LRU was dominated in the northwest by oak forest and opening with interspersed marsh and sedge wetlands. The southern portion was dominated by oak and mesic forests with abundant wetlands. Black oak (Quercus velutina), white oak (Quercus alba), and bur oak (Quercus macrocarpa) were significant tree species in all of the LRU. There were also many areas of prairie, maple-basswood upland forest, and small areas of tamarack (Larix laricina), northern white-cedar (Thuja occidentalis), and black spruce (Picea mariana) in the lowlands. Conifers were not significant in this LRU. Wetlands covered up to 17% of land area.

Classification relationships

Relationship to Established Framework and Classification Systems:

Biophysical Settings (Landfire, 2014): This ES is largely mapped as North-Central Interior Dry Oak Forest and Woodland, North-Central Interior Maple-Basswood Forest, Eastern Cool Temperate Row Crop, Eastern Cool Temperate Close Grown Crop, Eastern Cool Temperate Pasture and Hayland, Developed-Low Intensity, and Developed-Medium Intensity

Habitat Types of N. & S. Wisconsin (Kotar, 2002, 1996): The sites of this ES keyed out to *Acer saccharum*-Tilia-Fraxinus/Caulophyllum [ATiFrCa] and *Acer saccharum*-Tilia-Fraxinus/Viburnum(Cornus racemose) [ATiFrVb].

WDNR Natural Communities (WDNR, 2015): This ES is most similar to the Southern Mesic Forest described by the WDNR.

Hierarchical Framework Relationships:

Major Land Resource Area (MLRA): 095X–Eastern Wisconsin, Northern Illinois, and Upper Michigan Drift Plain

USFS Subregions: Central Wisconsin Moraines and Outwash (222Kb), Southern Green Bay Lobe (222Ke), Geneva-Darien Moraines and Till Plains (222Kf), Rock River Old Drift Country (222Kh)

DNR Ecological Landscapes: Southeastern Glacial Plains, Central Sand Hills

Ecological site concept

The Clayey Upland with Carbonates ecological site occurs in the northwest area of LRU 95B, where much of the area has bedrock contact within 60 inches (150 cm). These sites are represented by the Citypoint soil series—a Typic Haplosaprist. These sites consist of deep organic deposits formed from primarily herbaceous origin underlain by interbedded sandstone and shale. These soils are hydric; they are very poorly drained and remain saturated throughout the year. These sites receive water primarily through precipitation, runoff from adjacent uplands, and groundwater discharge. The water levels are strongly influenced by precipitation and runoff from surrounding uplands. These sites are extremely to very strongly acid. These sites are wetlands. Typical vegetation includes Acer rubrum, Betula papyrifera, Larix laricina, and Pinus strobus. Common ground cover includes Carex, spp., Sphagnum, spp., Spiraea tomentosa, Vaccinium, spp., and Rubus, spp.

These sites differ from other ecological sites because they are underlain by bedrock. These sites are more acidic, and the low pH is expressed in the vegetation.

Associated sites

F095XB004WI	**Wet Loamy or Clayey Lowland** These sites occur on depressions within loamy glacial landscapes including till plains and lake plains. They form in very deep, loamy alluvium, till, outwash, or lacustrine materials. They are sometimes underlain by clayey lacustrine deposits or sandy outwash. They are very poorly to poorly drained. They are found on the same landforms as Clayey Uplands with Carbonates but in lower, wetter landscape positions.
F095XB005WI	**Moist Loamy or Clayey Lowland** These sites consist of very deep, loamy or clayey materials deposited by flowing water, glacial ice, or ancient glacial lakes. Some sites are overlain or underlain by sandy outwash. They are somewhat poorly drained. They are often found adjacent to Clayey Uplands with Carbonates in slightly lower, wetter landscape positions.

Similar sites

F095XB007WI	**Loamy Upland with Carbonates** These sites consist of very deep, loamy materials deposited by flowing water, glacial ice, or ancient glacial lakes. Many are underlain by clayey lacustrine materials or sandy outwash. They have secondary carbonates, generally occupying at least 10% by volume, within the upper 47 inches (100 cm). They are moderately well to somewhat excessively drained. They occupy similar positions on the landscape and have similar drainage capabilities as Clayey Uplands with Carbonates but have somewhat coarser particle size classes.
F095XB010WI	**Loamy and Clayey Upland** These sites consist of very deep, sandy to clayey deposits of till, outwash, alluvium, colluvium, and lacustrine materials. They are moderately well to somewhat excessively drained. They occupy similar positions on the landscape, have similar drainage capabilities, and often share particle size classes with Clayey Uplands with Carbonates, but they have a smaller volume of secondary carbonates.

Table 1. Dominant plant species

Tree	(1) *Acer saccharum* (2) *Tilia americana*
Shrub	Not specified
Herbaceous	(1) *Circaea ×intermedia*

Physiographic features

This site occurs on till plains, lake plains, and moraines. It’s most common to areas that were covered by glacial lakes during Wisconsin’s most recent glaciation. Landform shape is usually convex or linear and sites are most often found in the backslope, shoulder, or summit position. Slope ranges from 0 to 35 percent.

Ponding is rare on these sites and generally lasts between two and seven days. Water table depth is variable but is usually found within 67 inches (170 centimeters) of the surface. Some sites have a perched water table (episaturation) generally found within 35 inches (90 centimeters) of the surface. Runoff potential is highest in sites with steep slopes and silt loam surfaces.

Table 2. Representative physiographic features

Hillslope profile	(1) Summit (2) Shoulder (3) Footslope (4) Backslope
Slope shape across	(1) Concave (2) Convex
Slope shape up-down	(1) Linear
Landforms	(1) Till plain (2) Lake plain (3) Moraine

Runoff class	Medium to high
Ponding duration	Brief (2 to 7 days)
Ponding frequency	None to rare
Elevation	200–320 m
Slope	0–35%
Ponding depth	0–15 cm
Water table depth	69–203 cm
Aspect	Aspect is not a significant factor

Climatic features

The continental climate of MLRA 95B is typical of southern Wisconsin – cold winters and warm summers. The MLRA spans over 2 degrees of latitude, or about 150 miles. The lowest latitudes have warmer summers, warmer winters, and high precipitation rates. The growing season decreases from south to north and from the shores of the thermal mass of Lake Michigan inland.

The average annual precipitation for this site is 35 inches. The average annual snowfall is 40 inches. The average annual maximum and minimum temperatures are 57oF and 36oF, respectively.

Table 3. Representative climatic features

Frost-free period (characteristic range)	113-123 days
Freeze-free period (characteristic range)	139-149 days
Precipitation total (characteristic range)	864-889 mm
Frost-free period (actual range)	103-131 days
Freeze-free period (actual range)	132-163 days
Precipitation total (actual range)	838-914 mm
Frost-free period (average)	117 days
Freeze-free period (average)	146 days
Precipitation total (average)	864 mm

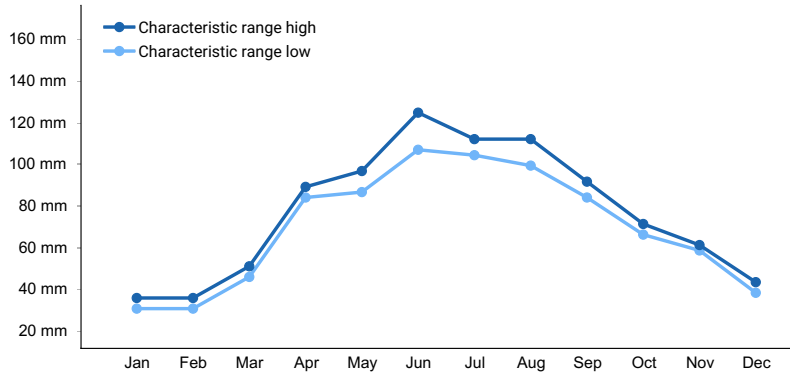


Figure 1. Monthly precipitation range

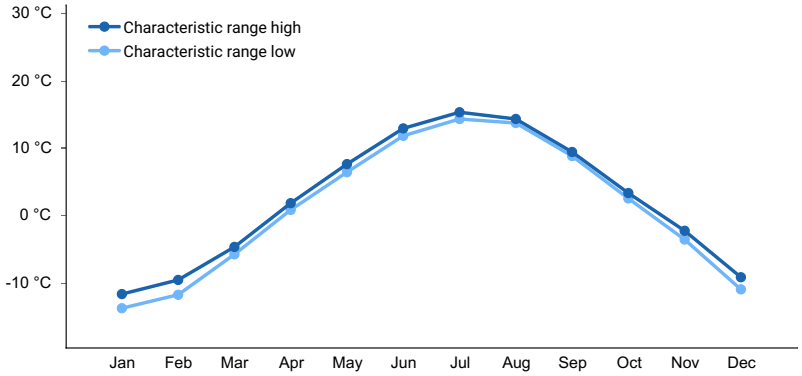


Figure 2. Monthly minimum temperature range

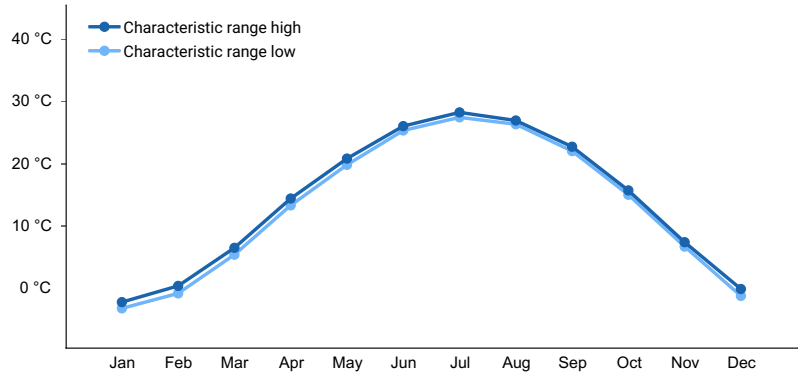


Figure 3. Monthly maximum temperature range

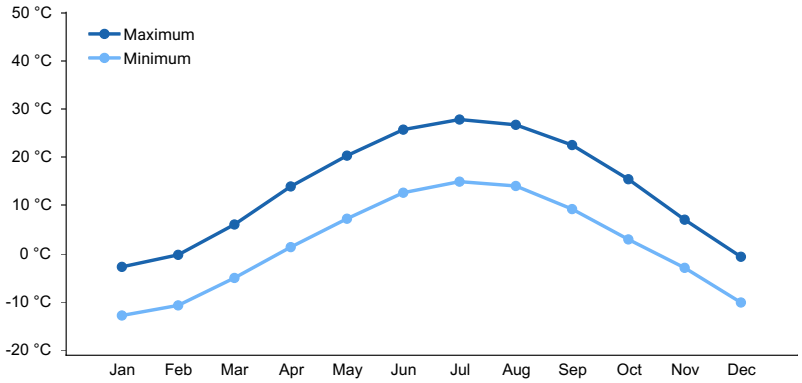


Figure 4. Monthly average minimum and maximum temperature

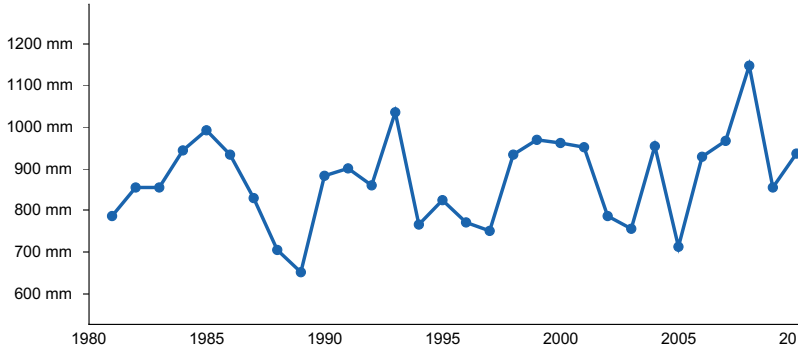


Figure 5. Annual precipitation pattern

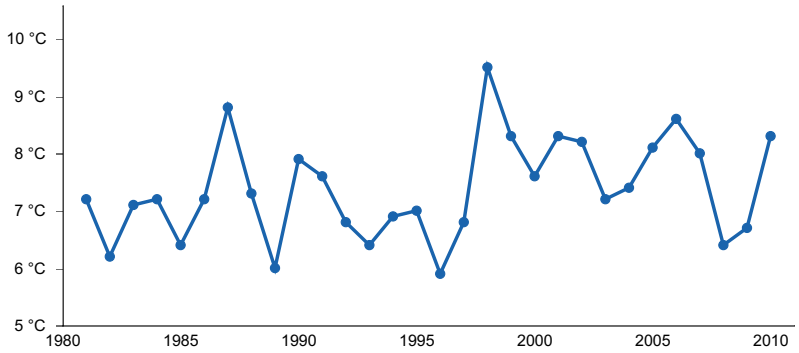


Figure 6. Annual average temperature pattern

Climate stations used

- (1) HARTFORD 2 W [USC00473453], Hartford, WI
- (2) MARKESAN [USC00475096], Markesan, WI
- (3) BARABOO [USC00470516], Baraboo, WI
- (4) AFTON [USC00470045], Janesville, WI
- (5) MONTELLO [USC00475581], Montello, WI
- (6) ARLINGTON UNIV FARM [USC00470308], De Forest, WI
- (7) WEST BEND [USC00479050], West Bend, 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. Presence of carbonates may increase pH of the water.

Permeability of the soil is impermeable to moderate. The hydrologic group of this site is C or D.

Wetland description

Hydrogeomorphic Wetland Classification: None
Cowardin Wetland Classification: None

Soil features

The soils of this site are represented by the Briggsville, Kewaunee, Markham, Montello, Morley, Ozaukee, Saylesville, Tustin, and Varna series. These soils are all classified as Hapludolls except for Montello, which is classified as an Argiudoll.

These soils form in very deep, loamy to clayey till or silty to clayey lacustrine deposits. Many have a mantle of silty loess. Sandy layers may be present as a mantle of outwash or stratified within lacustrine deposits. A horizon of significant clay accumulation (argillic horizon) is generally present in these soils.

These soils are moderately acid to moderately alkaline. Secondary carbonates are always present, usually within a meter of the surface, and usually occupy at least 10 percent volume. Subsurface rock fragments may be present in limited volumes. They’re most common in till. Fragments may be stratified (in the case of lacustrine deposits) or unstratified (in the case of till). Some of these fragments may be pieces of limestone and dolomite plucked from the bedrock by glacial ice and mixed in with the mineral glacial deposits, and others may be rounded, mixed rocks deposited by flowing water. These soils are moderately well to well drained. They do not meet hydric soil requirements.

Figure 7. Ozaukee soil series sampled on 06/09/2020 in Washington County, Wisconsin. Image courtesy of UWSP.

Table 4. Representative soil features

Parent material	(1) Till (2) Lacustrine deposits
Surface texture	(1) Loamy sand (2) Loam (3) Silt loam (4) Clay loam (5) Silty clay loam
Drainage class	Moderately well drained to well drained
Permeability class	Slow
Soil depth	203–254 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-150.1cm)	5.49–10.9 cm
Calcium carbonate equivalent (0-100.1cm)	5–50%
Soil reaction (1:1 water) (0-100.1cm)	5.8–8.1
Subsurface fragment volume <=3" (0-100.1cm)	0–8%
Subsurface fragment volume >3" (0-100.1cm)	0–3%

Ecological dynamics

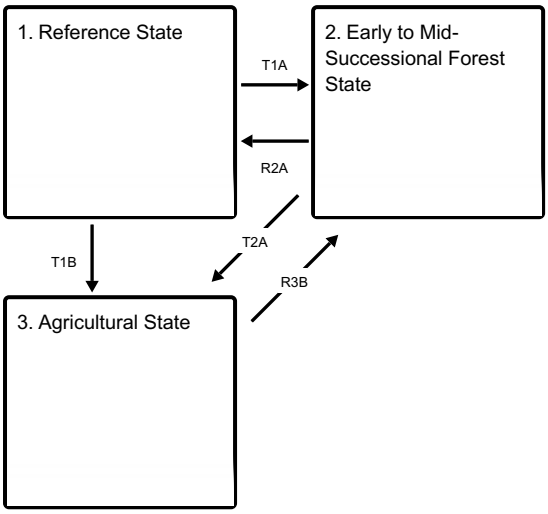
Historically, this site was dominated by mesic hardwoods in a landscape adapted to fire disturbance that allowed for a strong presence of oaks. In pre-European settlement time wildfire was the main controlling factor of forest community dynamics. Following a severe, stand-replacing fire, any of the species 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 sugar maple, basswood, American Beech, and Ashes although red oak, may be present as well. Some sites have a strong presence red oak and ashes where sugar maple seed source is absent. As long as fire is continually suppressed, maples and other mesic hardwoods will continue to dominate the canopy.

State and transition model

Ecosystem states



T1A - Stand replacing disturbance that includes fire.

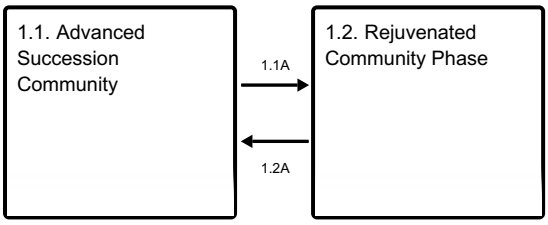
T1B - Removal of forest cover and tilling for agricultural crop production.

R2A - Deciduous forest community is slowly taken over by shade tolerant maples and other species.

T2A - Removal of forest cover and tilling for agricultural crop production.

R3B - Cessation of agricultural practices leads to natural reforestation, or site is replanted.

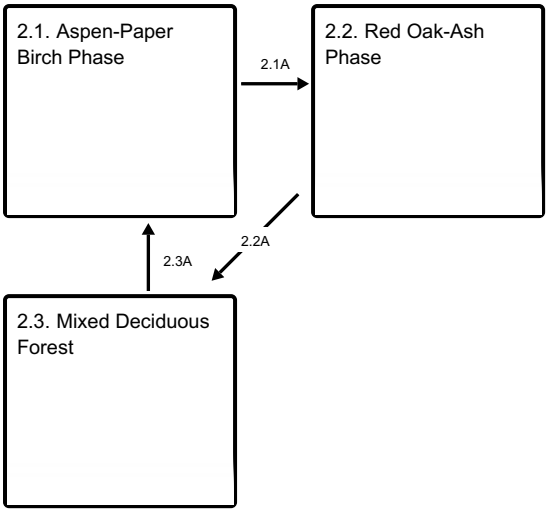
State 1 submodel, plant communities



1.1A - Light to moderate intensity fires, blow-downs, ice storms.

1.2A - Disturbance-free period for 30+ years.

State 2 submodel, plant communities



2.1A - Red oak and red maple regenerating under aspen -- paper birch canopy

2.2A - Time and natural succession.

2.3A - Clear cutting or stand-replacing fire.

State 1
Reference State

Reference state is a forest community dominated by sugar maple (*Acer saccharum*) with ashes, American Basswood and/or American Beech. Depending on history of disturbance, two community phases can be distinguished largely by differences in dominance of tree species and community age structure.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- American basswood (*Tilia americana*), tree
- American beech (*Fagus grandifolia*), tree
- enchanter's nightshade (*Circaea ×intermedia*), other herbaceous

Community 1.1
Advanced Succession Community

In the absence of any major disturbance, specifically fire, this community is dominated by sugar maple. Common associates include other mesic hardwoods like basswood (Tilia Americana), American beech (*Fagus grandifolia*), and green and white ash (*Fraxinus pennsylvanica* and americana), and on some sites may include red oak (*Quercus rubra*) and Shagbark hickory (*Carya ovata*). Red oak requires some disturbance to create gaps for regeneration; with the absence of disturbance, they are less common in the canopy. The shrub layer is not well developed and may contain various species likely including regenerating canopy species. The ground layer is similarly sparse with the exception of a large coverage of Sugar maple seedlings.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- American basswood (*Tilia americana*), tree
- American beech (*Fagus grandifolia*), tree
- enchanter's nightshade (*Circaea ×intermedia*), other herbaceous

Community 1.2
Rejuvenated Community Phase

Figure 8. Image courtesy of UWSP taken on 06/09/2020 in Washington County, Wisconsin.

This community is often dominated by sugar maple, basswood, America beech, ashes, and red oak. Shagbark hickory may be present as well. The shrub and ground layers are similar to the advanced succession phase, but may include the establishment of new seedlings and are likely to be of higher coverage due to more light penetrating the canopy.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- northern red oak (*Quercus rubra*), tree
- American basswood (*Tilia americana*), tree
- American beech (*Fagus grandifolia*), tree
- ash (*Fraxinus*), tree
- enchanter's nightshade (*Circaea ×intermedia*), other herbaceous

Pathway 1.1A
Community 1.1 to 1.2

Light intensity fires, crown breakage from ice and snow and small scale blow-downs create canopy openings, allowing gap regeneration of less shade tolerant species such as white ash, red oak, and white oak. These species may join the canopy composition.

Pathway 1.2A
Community 1.2 to 1.1

A long period without major canopy disturbance allows gradual replacement of oldest canopy trees by younger cohorts. Lacking a major disturbance, the canopy will likely be replaced primarily with sugar maple. Small scale disturbances may still occur periodically, but once second or third canopies are established there is minimal new regeneration taking place and the forest gradually returns to mature state.

State 2
Early to Mid-Successional Forest State

Following disturbances described in Transition T1A a wide range of forest community phases may come into temporary existence, the three most common ones are described here.

Community 2.1
Aspen-Paper Birch 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
- paper birch (*Betula papyrifera*), tree

Community 2.2
Red Oak-Ash Phase

This community phase occurs by invading and succeeding a pioneer aspen-birch community. Stand structure consists of dominant red oak and ashes in combination with a modest, or strong presence of mature, or decaying, aspen and/or paper birch. The shrub layer, dominated by Chokecherry and others (regenerating tree species), typically reaches its best development in this community phase.

Dominant plant species

- northern red oak (*Quercus rubra*), tree
- ash (*Fraxinus*), tree

Community 2.3
Mixed Deciduous Forest

Figure 9. Image courtesy of UWSP taken on 06/09/2020 in Fond Du Lac County, Wisconsin.

This community phase represents distinct transition into mid-successional state, by strong presence in second canopy, or in reproductive layers, of shade-tolerant species, sugar maple, basswood, and green ash. With a well established oak canopy this phase may persist for a long time. If there is a lack of sugar maple seed source this phase may persist as a Red oak dominated site.

Dominant plant species

- northern red oak (*Quercus rubra*), tree
- ash (*Fraxinus*), tree
- American basswood (*Tilia americana*), tree
- black cherry (*Prunus serotina*), tree
- sugar maple (*Acer saccharum*), tree
- chokecherry (*Prunus virginiana*), shrub
- enchanter's nightshade (*Circaea ×intermedia*), other herbaceous

Pathway 2.1A
Community 2.1 to 2.2

Time and the immigration, establishment, and growth of Red oak and Ashes. This pathway most likely includes small, but frequent disturbance that favors the somewhat shade intolerant Red oak and Ashes. Sugar maple may show up is seed source is present.

Pathway 2.2A
Community 2.2 to 2.3

Time and natural succession. Red oak have succeeded the aspen-birch community. Depending on seed source, sugar maple begins growth and establishment in the understory.

Pathway 2.3A
Community 2.3 to 2.1

Major stand replacing disturbance e.g. blow-down and fire, or clear-cutting, followed by fire.

State 3
Agricultural State

Indefinite period of applying agricultural practices. Crops likely include alfalfa, corn, soybeans, and hay or pasture.

Transition T1A
State 1 to 2

Clear cutting with initial control of competing vegetation, or stand-replacing fire, prepare the site for occupancy by shade intolerant species. This may occur through natural regeneration or by planting.

Transition T1B
State 1 to 3

Removal of forest cover, tilling and application of other agricultural techniques to grow agricultural crops.

Restoration pathway R2A
State 2 to 1

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 moderately shade tolerant red maple and red oak and a sub-canopy of shade tolerant sugar maple, returning the community to Reference State.

Transition T2A
State 2 to 3

Removal of forest cover, tilling and application of other agricultural techniques to grow agricultural crops.

Restoration pathway R3B
State 3 to 2

Cessation of agricultural practices leads to natural reforestation, or site is replanted.

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.

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Contributors

Jacob Prater, Associate Professor at University of Wisconsin Stevens Point
Bryant Scharenbroch, Assistant Professor at University of Wisconsin Stevens Point
John Kotar, Ecological Specialist Independent Contractor

Approval

Suzanne Mayne-Kinney, 11/16/2023

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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	05/12/2025
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):**

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:**
