

## Ecological site F095XA004WI Wet Loamy or Clayey Lowland

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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 Northeastern Wisconsin Drift Plain LRU (Land Resource Unit - 95XA) corresponds closely to the Northern and Central Lake Michigan Coastal Ecological Landscapes. Some of the following brief overview is borrowed from the Wisconsin Department of Natural Resources Ecological Landscape publication (2015).

The Northeastern Wisconsin Drift Plain LRU is located along Wisconsin's northeastern and central coast of Lake Michigan and the Door Peninsula. This glacial landscape is comprised of approximately 3.6 million acres (5,715 square miles). It is dominated by till plains and glacial lake deposits. The Green Bay and Lake Michigan Lobes are responsible for the formation of the landscape. The Green Bay Lobe covered most of the LRU, excluding the eastern edge where the Lake Michigan Lobe advanced. The glaciers were separated by the Niagara Escarpment, a 650-mile-long dolomite ridge that begins in Wisconsin near the Illinois border, extends into Michigan's Upper Peninsula and down through Canada's Bruce Peninsula into Rochester, New York. Within LRU 95XA, the escarpment runs from Lake Winnebago northeast through the Door Peninsula. Much of the topography of this LRU is bedrock-controlled. Bedrock is generally deeper than 150cm except in the Door Peninsula, where bedrock is much shallower. Wetlands are common throughout this MLRA where drainage is impeded by fine-textured materials and shallow bedrock.

The northern portion of this LRU is dominated by an undulating till plain, gently sloping to the east, formed entirely by the Green Bay Lobe. This glacial lobe centered over the present-day city of Green Bay and flowed out in a fan shape, moving both south-southwest and south-southeast over the Door Peninsula. The lobe deposited loamy and coarse-loamy till mixed with dolomite fragments plucked from the bedrock. In some areas, the till has been reworked by Glacial Lake Oshkosh or overlain by its lacustrine deposits. Numerous drumlins formed, orientated to the south-southwest in the direction of glacial flow. Some eskers are present. Much of this area has dolomite and limestone within 50 ft of the surface. Proglacial streams formed small areas of pitted and unpitted outwash plains, terraces, and fans.

The Door Peninsula was formed primarily by the early advances of the Green Bay Lobe. The till found here is comprised of relatively old, calcareous loamy materials mixed with dolomite and limestone fragments plucked by the glacial lobe from the shallow bedrock. The till is thinly draped over the Niagara Escarpment that lies 1 to 3 meters below the surface. A drumlin field is oriented south-southeast, the direction of the ice flow over the peninsula. The eastern shore of the peninsula is composed of lake sediments that were reworked and deposited by Lake Michigan Lobe. The northern tip of the peninsula has glaciolacustrine beach terrace and ridge deposits and eolian sand dunes, which are remnants of the intra- and postglacial lakes Nipissing and Algonquin.

The central portion of this LRU is dominated by lacustrine deposits from Glacial Lake Oshkosh. In its largest stage, Glacial Lake Oshkosh covered 1.4 million acres. The lake formed from meltwater as the Green Bay Lobe receded between ice sheet advances. The glacial lobe stalled between present day Lake Winnebago and the city of Green Bay, blocking the drainage of meltwater north to the Lake Michigan Basin. Glacial Lake Oshkosh continued to rise until it found other drainage pathways, eventually draining into the Wisconsin River Valley. Glacial Lake Oshkosh reworked the till deposits of the Green Bay Lobe. Silty and clayey lacustrine deposits formed in the deepest area of the lakes, whereas sandy beach ridges, terraces, and dunes formed along the ancient shore.

The area east of Glacial Lake Oshkosh and south along the shore of Lake Michigan are dominated by a thin till sheet over the Niagara Escarpment that was deposited by the Green Bay and Lake Michigan Lobes. The Green Bay Lobe deposited calcareous clay and silty till reworked from lake sediments. The Lake Michigan Lobe deposited silt loam, loam, and compacted sandy clay loam till. Remnants of the intra- and postglacial lakes Nipissing and Algonquin are also found along Lake Michigan shore. Proglacial streams formed small areas of pitted and unpitted outwash plains, terraces, and fans.

Historically, the vegetation in this LRU was dominated by northern and central hardwood forests and wetlands. The northern hardwoods were comprised of eastern hemlock (*Tsuga canadensis*) and American beech (*Fagus grandifolia*). The central hardwoods were dominated by sugar maple (*Acer saccharum*), American basswood (*Tilia Americana*), and American beech (*Fagus grandifolia*). Forested wetlands were a major part of the landscape, covering more than 25% in some areas.

## Classification relationships

Relationship to Established Framework and Classification Systems:

Habitat Types of N. & S. Wisconsin (Kotar, 2002, 1996): The sites of this ES keyed out to *Acer saccharum*-*Quercus/Viburnum acerifolium*-*Geranium* [AQVb-Gr], *Acer-Tilia-Fraxinus/Viburnum-Cornus racemose* [ATiFrVb(Cr)], and *Acer saccharum*-*Fagus/Arismaea* [AFAs].

Biophysical Settings (Landfire, 2014): This ES is largely mapped as Laurentian-Acadian Northern Hardwoods Forest, Laurentian-Acadian Alkaline Conifer-Hardwood Swamp Forest, Central Interior and Appalachian Herbaceous Wetlands, and Central Interior and Appalachian Swamp Forest

WDNR Natural Communities (WDNR, 2015): This ES is most similar to the Northern and Southern Dry-Mesic and/or Mesic Forests described by the WDNR.

Hierarchical Framework Relationships:

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

USFS Subregions: West Green Bay Till Plain (212Tb), Door Peninsula (212Tf), Outagamie Loamy Till and Silty Lake Plain (212Za), Green Bay Clayey and Silty Lake Plain (212Zb), Manitowoc Till Plain (212Zc), Lake Winnebago Clay Plain (222Kc)

DNR Ecological Landscapes: Northern Lake Michigan Coastal, Central Lake Michigan Coastal, Southeast Glacial Plains

## Ecological site concept

The Wet Loamy or Clayey Lowlands ecological site occurs throughout LRU 95XA. These sites are represented by a variety of soil components that are Aquents, Aquepts, and Aquolls. These sites consist of loamy to clayey deposits of till, alluvium, lacustrine, or outwash. These soils are hydric and many of these sites are wetlands. 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 slightly acid to moderately alkaline. These sites are wetlands. Typical vegetation includes *Acer saccharum* and *Acer rubrum*, *Fraxinus americana*, *Carpinus caroliniana*, and *Cornus racemose*. Common ground cover includes *Amphicarpa bracteata*, and *Laporteia canadensis*.

These sites differ from the Wet Sandy Lowlands ecological sites by being more nutrient rich and higher pH. These sites are thus more populated with plant species that are more competitive on richer sites.

## Associated sites

F095XA001WI	<b>Mucky Swamp</b> Mucky Swamps consist of deep, herbaceous organic materials. They are very poorly drained and remain saturated throughout the year. They occur in landscape depressions and are found in lower landscape positions along the same drainage sequence as Wet Loamy or Clayey Lowlands. These sites are wetlands.
F095XA006WI	<b>Moist Loamy Lowland</b> These sites consist of moderately deep to very deep, loamy lacustrine, till, or outwash deposits. Some have a loess mantle. Some are underlain by sandy outwash. They are somewhat poorly drained. They occur slightly higher on the drainage sequence than Wet Loamy or Clayey Lowlands.
F095XA007WI	<b>Moist Clayey Lowland</b> These sites consist of very deep, clayey deposits of various origin, primarily clayey glacial till but also clayey lacustrine materials. They are often mantled with loess. They are somewhat poorly drained. They occur slightly higher on the drainage sequence than Wet Loamy or Clayey Lowlands.

F095XA010WI	<p><b>Loamy Upland</b></p> <p>These sites consist of very deep loamy deposits, primarily glacial till. Some sites have a sandy eolian or loess mantle. Some are underlain by coarser-textured material. They are moderately well to somewhat excessively drained. They occur much higher on the drainage sequence than Wet Loamy or Clayey Lowlands.</p>
F095XA011WI	<p><b>Clayey Upland</b></p> <p>These sites consist of very deep, clayey till or lacustrine deposits. Some have a sandy eolian or loess mantle. Some are underlain by coarser-textured materials. They are moderately well to well drained. They occur much higher on the drainage sequence than Wet Loamy or Clayey Lowlands.</p>

### Similar sites

F095XA001WI	<p><b>Mucky Swamp</b></p> <p>Mucky Swamps consist of deep, herbaceous organic materials. They are very poorly drained and remain saturated throughout the year. They occur in landscape depressions and occupy the lowest points on their drainage sequences.</p>
F095XA002WI	<p><b>Wet Floodplain</b></p> <p>These sites occur exclusively on floodplains and form in very deep, loamy to clayey materials, primarily alluvial in origin. Most sites are subject to flooding events of varying frequency, duration, and intensity. They are poorly to moderately well drained. Like Wet Loamy or Clayey Lowlands, they support vegetation that are tolerant of prolonged periods of wetness.</p>
F095XA003WI	<p><b>Wet Sandy Lowland</b></p> <p>These sites consist of very deep, sandy materials, primarily glacial outwash. Some are underlain by finer-textured materials. They are very poorly to poorly drained. They occupy the same position on the landscape as Wet Loamy or Clayey Lowlands but have coarser particle size classes.</p>

**Table 1. Dominant plant species**

Tree	(1) <i>Acer saccharum</i> (2) <i>Fraxinus americana</i>
Shrub	(1) <i>Carpinus caroliniana</i> (2) <i>Cornus racemosa</i>
Herbaceous	(1) <i>Amphicarpaea bracteata</i> (2) <i>Laportea canadensis</i>

### Physiographic features

This site occurs on drainageways, depressions, and swales across the glacial landscapes throughout this MLRA. Sites are in the toeslope position and landform shape is concave or linear. Slopes range from 0 to 2 percent.

Most sites are subject to frequent ponding. Inundation by water may last two days to over a month. Soils have an apparent seasonally high water table (endosaturation) within 9 inches (22 cm) of the surface. Some sites with heavy clay layers have a perched water table (episaturation). Runoff potential is negligible to very high. The highest runoff potential is found where the family particle size class is finest on depressions and drainageways in the clayey lake plain of ancient Glacial Lake Oshkosh, mostly in Winnebago, Waushara, and Waupaca counties.

**Table 2. Representative physiographic features**

Hillslope profile	(1) Toeslope
Slope shape across	(1) Concave
Slope shape up-down	(1) Linear
Landforms	(1) Lake plain > Depression (2) Till plain > Drainageway (3) Fan piedmont > Swale (4) Flood plain (5) Moraine
Runoff class	Negligible to very high

Flooding duration	Brief (2 to 7 days) to long (7 to 30 days)
Flooding frequency	None to frequent
Ponding duration	Brief (2 to 7 days) to very long (more than 30 days)
Ponding frequency	None to frequent
Elevation	656–951 ft
Slope	0–2%
Ponding depth	0–12 in
Water table depth	0–9 in
Aspect	Aspect is not a significant factor

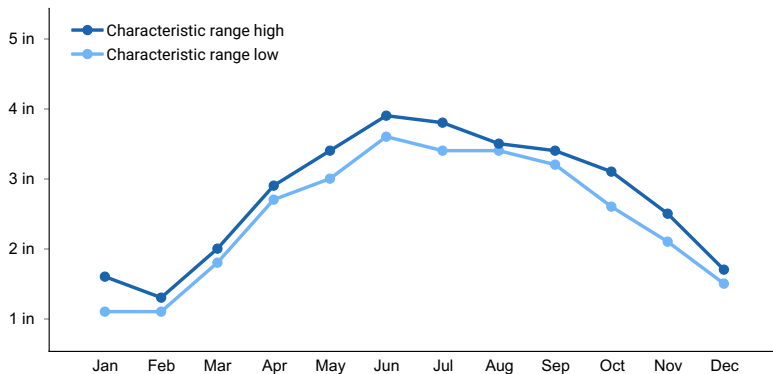
## Climatic features

The continental climate of the Northeastern Wisconsin Drift Plain is typical of central Wisconsin – cold winters and warm summers. The climate is moderated by the thermal mass of Lake Michigan, especially in coastal areas. Fall and early winter temperatures are slightly warmer and spring and early summer temperatures are slightly cooler along the Lake Michigan coastline. Lake effect snow occurs along the coastline.

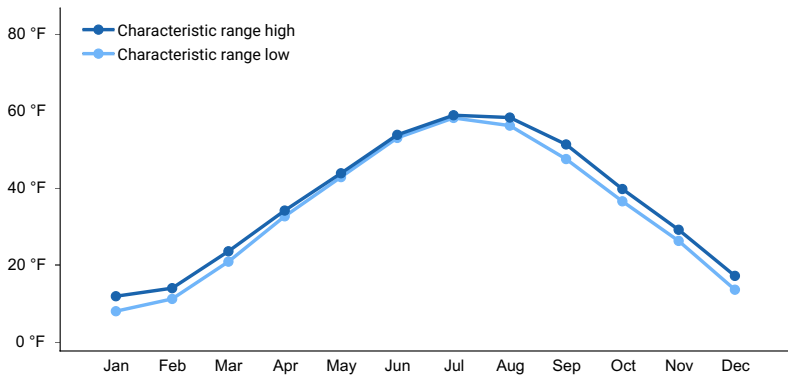
The average annual precipitation for this site is 31 inches. The average annual snowfall is 45 inches. The average annual maximum and minimum temperatures are 54oF and 35oF, respectively.

**Table 3. Representative climatic features**

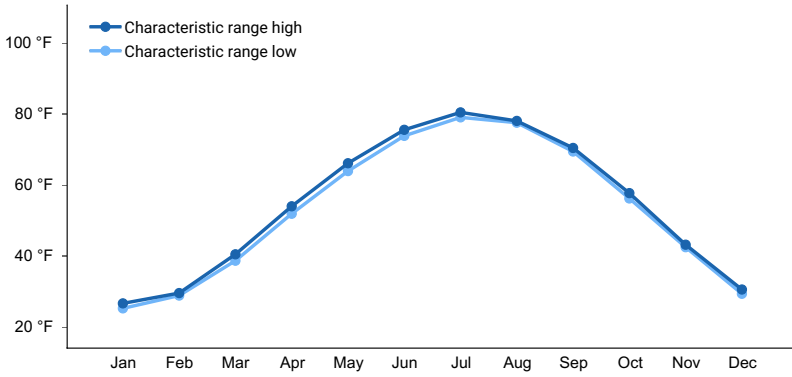
Frost-free period (characteristic range)	115-127 days
Freeze-free period (characteristic range)	157-159 days
Precipitation total (characteristic range)	31-32 in
Frost-free period (actual range)	111-128 days
Freeze-free period (actual range)	139-161 days
Precipitation total (actual range)	30-33 in
Frost-free period (average)	122 days
Freeze-free period (average)	154 days
Precipitation total (average)	31 in



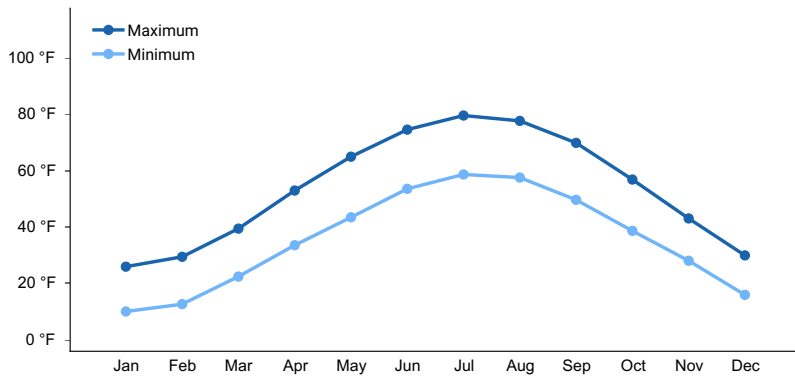
**Figure 1. Monthly precipitation range**



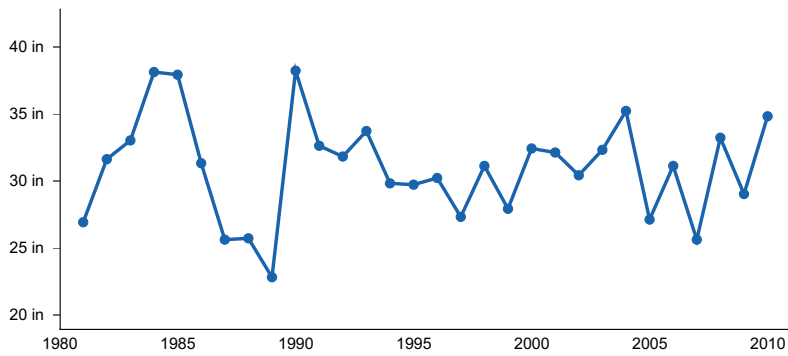
**Figure 2. Monthly minimum temperature range**



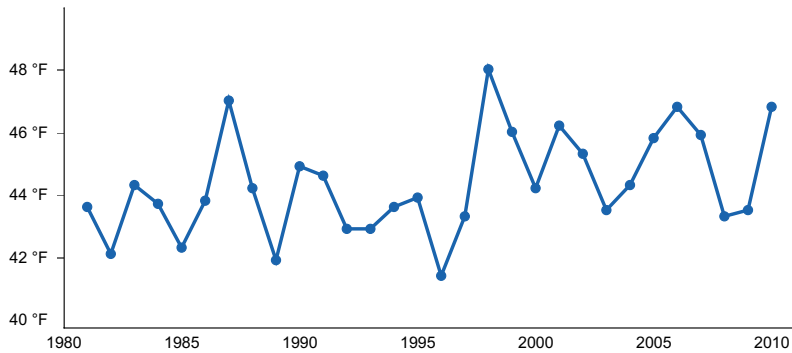
**Figure 3. Monthly maximum temperature range**



**Figure 4. Monthly average minimum and maximum temperature**



**Figure 5. Annual precipitation pattern**



**Figure 6. Annual average temperature pattern**

### Climate stations used

- (1) GREEN BAY [USW00014898], Green Bay, WI
- (2) STURGEON BAY EXP FARM [USC00478267], Sturgeon Bay, WI
- (3) EPHRAIM 1NE-WWTP [USC00472626], Sister Bay, WI
- (4) SHEBOYGAN CO MEM AP [USW00004841], Sheboygan Falls, WI
- (5) NEW LONDON [USC00475932], Hortonville, WI
- (6) OCONTO 4 W [USC00476208], Oconto, WI
- (7) KEWAUNEE [USC00474195], Kewaunee, WI

### Influencing water features

Water is received primarily through precipitation, runoff from adjacent uplands, and groundwater discharge. Water levels are greatly influenced by rates of precipitation and runoff from upland sites. Water leaves the site primarily through evapotranspiration and groundwater recharge. Some sites may be wetlands.

### Wetland description

Under the Cowardin System of Wetland Classification, or National Wetlands Inventory (NWI), the wetlands can be classified as:

- 1) Palustrine, forested, broad-leaved deciduous, saturated, or
- 2) Palustrine, forested, needle-leaved evergreen, saturated, or
- 3) Palustrine, scrub-shrub, broad-leaved deciduous, saturated, or
- 4) Palustrine emergent, persistent, saturated

Under the Hydrogeomorphic Classification System (HGM), the wetlands can be classified as:

- 1) Depressional, forested/organic, or
- 2) Depressional, scrub-shrub/organic, or
- 3) Depressional, herbaceous/organic

Permeability of the soil is impermeable to moderately slow. The hydrologic group of this site is B/D.

### Soil features

The soils of this site are represented by the Angelica, Bach, Brookston, Colwood, Ensley, Keowns, Menasha, Minocqua, Mussey, Nahma, Navan, Pella, Poy, Ruse, Sebewa, Waupaca, Wauseon, Will, and Yahara series. Brookston, Mussey, Navan, and Sebewa are Argiaquolls, Colwood, Pella, Ruse, Will, and Yahara are Endoaquolls, Wauseon is an Epiaquoll, Angelica, Bach, Ensley, and Keowns are Endoaquepts, Nahma is a Humaquept, and Waupaca is a Fluvaquent. Most of the acreage of this site is in Endoaquepts or Endoaquolls. These sites are also classified as Argiaquolls, Fluvaquents, Haplaquepts, Haplaquolls, and Epiaquolls.

These soils formed in shallow to deep loamy to clayey till, lacustrine, alluvium, or outwash deposits. The loamy deposits are sometimes underlain by clayey till, sandy to clayey lacustrine deposits (often stratified), or sandy and gravelly outwash. Contact with the dolomitic bedrock may occur within 60 inches (150 cm) in sites on the Door

Peninsula, where the bedrock is relatively shallow. Soils are poorly to very poorly drained and meet hydric soil requirements.

The surfaces of these soils are loamy or clayey. Subsurface textures are diverse. Sandy and gravelly subsurface textures may be found in sites that formed along the outwash channels that dissect the landscape. Stratified textures, usually ranging between silty clay loam and very fine sand, may be found where the loamy mantle is underlain by glaciolacustrine deposits. Heavy clays are found where sites formed in depressions on a morainal landscape of clayey till deposits.

Soils are slightly acid to moderately alkaline. Surface fragments are generally absent in these soils. Subsurface fragments smaller than 3 inches in diameter may occupy up to 22 percent volume. Larger fragments may occupy up to 9 percent volume. Fragments may be stratified (in the case of outwash or 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. Secondary carbonates are usually present and may be found as high as the soil surface. Soils with carbonates have a CaCO<sub>3</sub> equivalency up to 40 percent.



Figure 7. Waupaca Soil Series sampled on 06/25/2020 in Waupaca County, Wisconsin.

Table 4. Representative soil features

Parent material	(1) Till (2) Lacustrine deposits (3) Outwash (4) Alluvium (5) Loess (6) Residuum
Surface texture	(1) Mucky loam (2) Sandy loam (3) Loam (4) Clay loam (5) Silty clay loam (6) Silty clay (7) Clay
Drainage class	Very poorly drained to poorly drained
Permeability class	Moderately slow
Soil depth	14–80 in
Surface fragment cover ≤3"	0%
Surface fragment cover >3"	0%
Available water capacity (0–59.1 in)	0.81–4.77 in



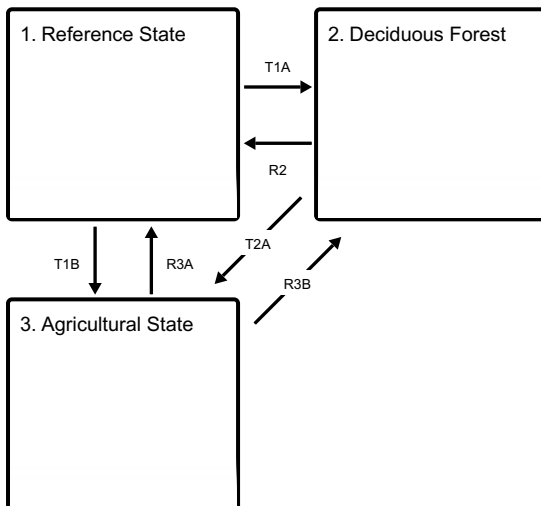
Soil reaction (1:1 water) (0-39.4in)	6.2–8.2
Subsurface fragment volume <=3" (0-39.4in)	0–22%
Subsurface fragment volume >3" (0-39.4in)	0–9%

## Ecological dynamics

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. Red maple is sensitive to fire, but in its absence, it has the ability to dominate sites based on its shade tolerance and prolific seed production.

## State and transition model

### Ecosystem states



**T1A** - Stand replacing disturbance that includes fire.

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

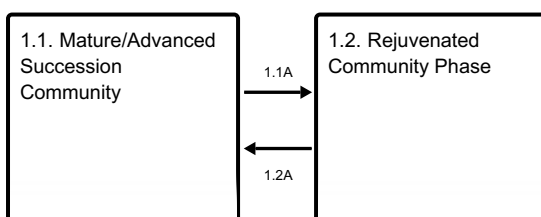
**R2** - Deciduous forest community is slowly taken over by shade tolerant maples and other species.

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

**R3A** - Cessation of agricultural practices leads to natural reforestation, or site is replanted.

**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

2.1. Deciduous Forest  
Phase

## State 1 Reference State

Reference state is a forest community dominated by Sugar and red maple (*Acer saccharum* and *Acer rubrum*) with White ash (*Fraxinus americana*), Basswood (*Tilia americana*), and Red and White oak (*Quercus rubra* and *Quercus alba*). Depending on history of disturbance, two community phases can be distinguished largely by differences in dominance of tree species and community age structure.

## Community 1.1 Mature/Advanced Succession Community

In the absence of major disturbance—particularly fire—these sites are dominated by a canopy of Sugar and red maple with an admixture of White ash and Basswood (Seed source for these northern mesic species may be missing at many locations). The shrub layer is not well developed and dominated by generating saplings and Gray dogwood (*Cornus racemosa*). The ground layer is highly variable but often contains Hogpeanut (*Amphicarpa bracteata*), Jack in the pulpit (*Arisaema triphyllum*) and various wet herbaceous plants (jewelweed, *Rhibes* spp.). Less common but notable plants would include Mayapple, Trilliums, various ferns (Cinnamon, Interrupted, Royal, Wood), and Virginia creeper.

### Dominant plant species

- sugar maple (*Acer saccharum*), tree
- red maple (*Acer rubrum*), tree
- American hogpeanut (*Amphicarpaea bracteata*), other herbaceous
- Jack in the pulpit (*Arisaema triphyllum*), other herbaceous
- jewelweed (*Impatiens capensis*), other herbaceous

## Community 1.2 Rejuvenated Community Phase



Figure 8. Image courtesy of UWSP taken on 06/28/2020 in Waupaca County, Wisconsin.

The canopy of the rejuvenated community may still be dominated by original species, but it is far more likely that Red and White oak may have a much stronger representation. If seed source for the dominant species (Sugar maple, Red maple, and White ash) is missing then the site will remain as an advanced succession Red oak and White oak forest as an alternative stable state. The understory now also includes a well-established younger cohort and perhaps a few additional seedlings and saplings of less shade tolerant species.

#### **Dominant plant species**

- northern red oak (*Quercus rubra*), tree
- white oak (*Quercus alba*), tree
- sugar maple (*Acer saccharum*), tree
- red maple (*Acer rubrum*), tree

#### **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, releasing advanced regeneration and stimulating new seedling establishment. Some additional less shade tolerant species such as red oak may be able to enter the community.

#### **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. 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**

## **Deciduous Forest**

Pure, or mixed, aspen – paper birch community replaces the reference state community. If seed source is present, red maple and young cohorts of balsam fir readily becomes member of this community.

### **Dominant plant species**

- quaking aspen (*Populus tremuloides*), tree
- paper birch (*Betula papyrifera*), tree
- red maple (*Acer rubrum*), tree

## **Community 2.1**

### **Deciduous Forest Phase**

Pure, or mixed, aspen – paper birch community. Understory plants may be only weakly expressed when aspen and paper birch are closely growing and dominant. If seed source is present and canopy openings allow, red maple will readily become member of this community. Depending on age within this phase the canopy varies from pure (young) to mixed (older) aspen – paper birch. Disturbance history and seed source will dictate whether aspen or birch dominate this phase.

### **Dominant plant species**

- quaking aspen (*Populus tremuloides*), tree
- paper birch (*Betula papyrifera*), tree
- red maple (*Acer rubrum*), tree

## **State 3**

### **Agricultural State**

Hay or cultivated crop production.

## **Transition T1A**

### **State 1 to 2**

Stand replacing disturbance that must include fire to create conditions for aspen and paper birch to colonize the site.

## **Transition T1B**

### **State 1 to 3**

Removal of forest cover by whatever means, followed by tilling for agricultural crop production. Establishment of agricultural crops, hay, or pasture following the disturbance.

## **Restoration pathway R2**

### **State 2 to 1**

Deciduous forest community slowly ages out and is invaded by shade tolerant species.

## **Transition T2A**

### **State 2 to 3**

Removal of forest cover by whatever means, followed by tilling for agricultural crop production. Establishment of agricultural crops, hay, or pasture following the disturbance.

## **Restoration pathway R3A**

### **State 3 to 1**

Cessation of agricultural practices leads to natural reforestation, or site is replanted. Initial species is seed source dependent unless planted. Most likely initial species are Aspen and Red Maple.

## **Restoration pathway R3B**

### **State 3 to 2**

Cessation of agricultural practices leads to natural reforestation, or site is replanted. Initial species is seed source dependent unless planted. Most likely initial species are Aspen and Red Maple.

### **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 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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## Approval

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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	04/18/2024
Approved by	Suzanne Mayne-Kinney
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

## Indicators

1. **Number and extent of rills:**

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2. **Presence of water flow patterns:**

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3. **Number and height of erosional pedestals or terracettes:**

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

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

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

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7. **Amount of litter movement (describe size and distance expected to travel):**

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

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11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

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12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

Dominant:

Sub-dominant:

Other:

Additional:

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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:**

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