USDA Natural Resources Conservation Service

Ecological site F095XA009WI
Sandy Uplands

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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-Tsuga/Athyrium-Onoclea [ATAtOn], Acer-Tsuga/Dryopteris-Hydrophyllum [ATDH], and *Acer saccharum*-Fraxinus americana/Desmodium-Osmorhiza [AFrDeO].

Biophysical Settings (Landfire, 2014): This ES is largely mapped as Laurentian-Acadian Northern Hardwoods Forest, Laurentian Oak Barrens, Eastern Cool Temperate Close Grown Crop, Eastern Cool Temperate Close Grown Crop, Managed Tree Plantation-Northern and Central Hardwood and Conifer Plantation Group, and Developed-Low Intensity

WDNR Natural Communities (WDNR, 2015): This ES is most similar to the Northern Dry-Mesic or Dry Forest and/or the Southern Dry-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: West Green Bay Till Plain (212Tb), Door Peninsula (212Tf), Outagamie Loamy Till and Silty Lake Plain (212Za)

DNR Ecological Landscapes: Northern Lake Michigan Coastal, Central Lake Michigan Coastal

Ecological site concept

The Sandy Uplands ecological site occurs mostly in the northwest area of MLRA 95A. This site is represented by a wide variety of soils. These soils primarily formed in sandy outwash or sandy lacustrine deposits (eolian deposits are possible along Lake Michigan) and have surface textures of sand or loamy sand. Subsurface textures are generally sandy or loamy, though clayey substratum can be found in the Fox River Valley and the Door Peninsula. Soils are very deep and are extremely acid to moderately alkaline. Soils are moderately well to excessively drained and do not meet hydric soil requirements.

Typical vegetation includes *Acer saccharum*, Acer rubrum, Quercus spp., and Fraxinus Americana. Common ground cover includes Maianthemum canadense, Carex spp., Pteridium aquilinum, and others.

Associated sites

F095XA003WI	**Wet Sandy Lowland** 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 are found on the same landform features and share their particle size classes with Sandy Uplands, but are found in the lower, wetter positions on the landscape.
F095XA005WI	**Moist Sandy Lowland** These sites consist of deep sandy outwash or lacustrine deposits, sometimes underlain by finer-textured materials. They are somewhat poorly drained. They are found on the same landform features and share their particle size classes with Sandy Uplands, but are found in somewhat lower, wetter positions on the landscape.

Similar sites

F095XA008WI	**Shallow Upland** These sites consist of very shallow to deep materials of various particle size and origin. Bedrock contact occurs within 47 inches (120 cm) on all sites. They are most common to the Door Peninsula, where the bedrock is relatively shallow. They are moderately well to well drained. They occupy the same position on the landscape as Sandy Uplands and sometimes share particle size classes, but they have bedrock contact within 6.5 feet (2 meters).
F095XA010WI	**Loamy Upland** 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 occupy the same position on the landscape as Sandy Uplands but have finer particle size classes.
F095XA011WI	**Clayey Upland** 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 occupy the same position on the landscape as Sandy Uplands but have much finer particle size classes.

Table 1. Dominant plant species

Tree	(1) *Acer saccharum*
Shrub	Not specified
Herbaceous	(1) *Maianthemum canadense* (2) *Pteridium aquilinum*

Physiographic features

This site is most common to the outwash plains that dissect the northwest portion of the Northeastern Wisconsin Drift Plain. Sites are also found within the basin of ancient Glacial Lake Oshkosh along its former shorelines, on dunes and beach ridges along the Lake Michigan shoreline, and on various glacial landforms in the morainal landscapes on this MLRA. Sites are found in higher landscape positions.

These sites are not subject flooding or ponding. They have an apparent seasonally high water table (endosaturation) that is primarily found below 47 inches (150 cm) but may be as high as 24 inches (60 cm). Runoff is negligible to very high. Runoff potential is highest where slopes are steep.

Table 2. Representative physiographic features

Hillslope profile	(1) Backslope (2) Shoulder (3) Summit
Slope shape across	(1) Linear
Slope shape up-down	(1) Convex
Landforms	(1) Outwash plain (2) Beach ridge (3) Dune (4) Stream terrace (5) Flat (6) Lake plain (7) Till plain (8) Moraine (9) Esker (10) Kame
Runoff class	Negligible to very high
Elevation	170–305 m
Slope	0–35%
Water table depth	61–119 cm
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.

Table 3. Representative climatic features

Frost-free period (characteristic range)	124-142 days
Freeze-free period (characteristic range)	157-181 days
Precipitation total (characteristic range)	787-838 mm
Frost-free period (actual range)	122-146 days
Freeze-free period (actual range)	151-182 days
Precipitation total (actual range)	762-864 mm
Frost-free period (average)	132 days
Freeze-free period (average)	166 days
Precipitation total (average)	813 mm

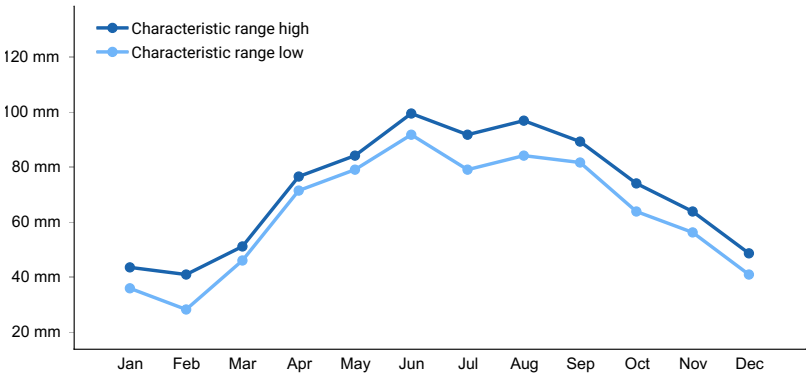


Figure 1. Monthly precipitation range

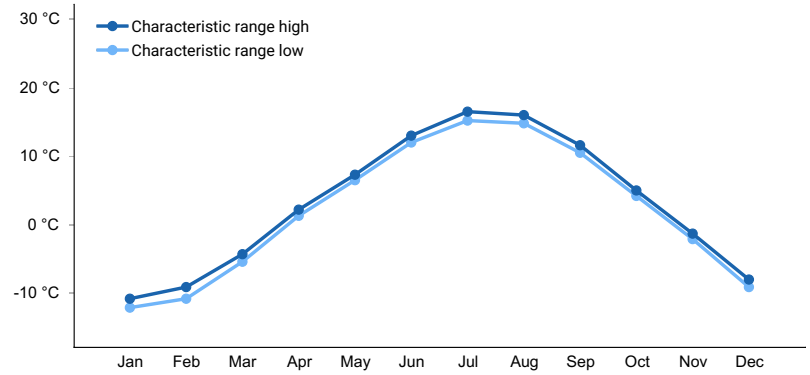


Figure 2. Monthly minimum temperature range

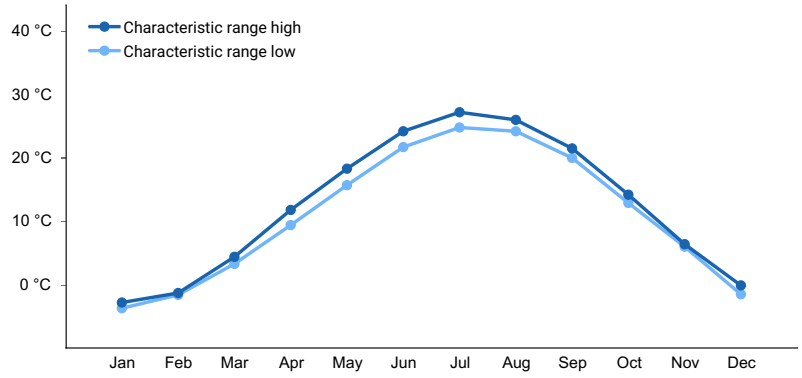


Figure 3. Monthly maximum temperature range

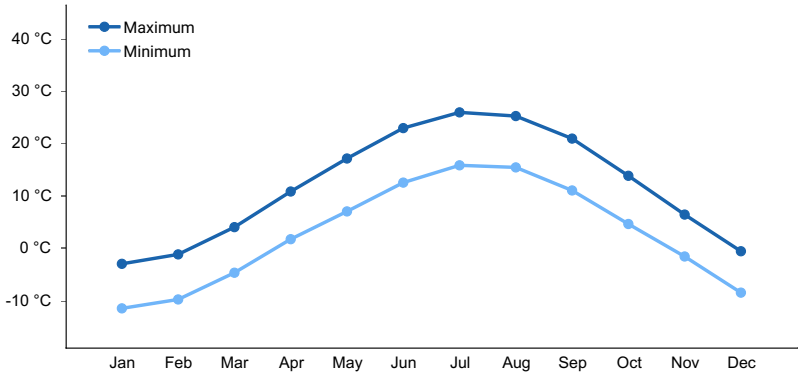


Figure 4. Monthly average minimum and maximum temperature

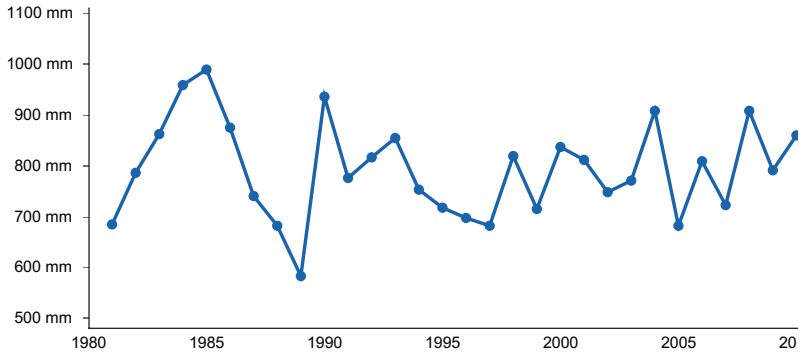


Figure 5. Annual precipitation pattern

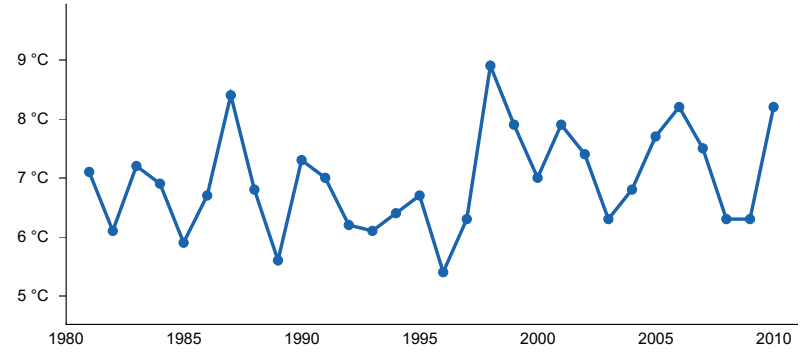


Figure 6. Annual average temperature pattern

Climate stations used

- (1) APPLETON [USC00470265], Appleton, WI
- (2) CITY OF SHEBOYGAN WWTP [USC00471605], Sheboygan, WI
- (3) TWO RIVERS [USC00478672], Two Rivers, WI

- (4) DENMARK WWTP [USC00472055], Denmark, WI
- (5) KEWAUNEE [USC00474195], Kewaunee, WI
- (6) STURGEON BAY EXP FARM [USC00478267], Sturgeon Bay, WI
- (7) SHEBOYGAN [USC00477725], Sheboygan, 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 moderately slow to rapid. The hydrologic soil group of these sites is A or B.

Wetland description

Hydrogeomorphic Wetland Classification: None
Cowardin Wetland Classification: None

Soil features

The soils of this site are represented by the Alpena, Brems, Croswell, Kiva, Mahtomedi, Mancelona, Manistee, Menahga, Menominee, Oakville, Plainfield, Rodman, Rousseau, and Shawano series. Croswell, Duel, Kiva, Mancelona, Manistee, Menominee, and Rousseau are Haplorthods; Brems, Mahtomedi, Menahga, Oakville, Plainfield, and Shawano are Udipsamments; Alpena and Rodman are Hapludolls. Haplorthods and Udipsamments each make up roughly 48% of the acreage of this site. The remaining 4% is made up of Udorthents, Hapludolls, and Fluvaquents.

These soils primarily formed in sandy outwash or sandy lacustrine deposits. Some sites have a sandy loam mantle of alluvium or drift. Some are underlain by loamy till. Sites situated on morainal landscapes are sometimes formed in sandy eolian deposits. Sites formed in beach sands are found along the Lake Michigan shoreline. Soils are very deep and are extremely acid to moderately alkaline. Soils are moderately well to excessively drained and do not meet hydric soil requirements.

The surface texture of these soils is usually sand or loamy sand. Subsurface textures are generally sandy or loamy, though clayey substratum can be found in the Fox River Valley and the Door Peninsula.

Surface fragments are generally absent in these soils. Subsurface fragments smaller than 3 inches in diameter are often present and may occupy up to 28 percent volume. Larger fragments may occupy up to 16 percent volume. Fragments may be stratified (in the case of outwash and 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 sometimes present. Most soils with carbonates have a CaCO3 equivalency somewhere around 15 percent, but equivalency can be as high as 28 percent.

Figure 7. Menominee Soil Series sampled on 06/06/2020 in Marinette County,

Table 4. Representative soil features

Parent material	(1) Outwash (2) Eolian deposits (3) Beach sand (4) Drift (5) Alluvium (6) Lacustrine deposits
Surface texture	(1) Sand (2) Loamy sand (3) Sandy loam
Drainage class	Moderately well drained to somewhat excessively drained
Permeability class	Moderately slow to rapid
Soil depth	201 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-150.1cm)	2.31–8.38 cm
Soil reaction (1:1 water) (0-100.1cm)	4.2–8.2
Subsurface fragment volume <=3" (0-100.1cm)	0–28%
Subsurface fragment volume >3" (0-100.1cm)	0–16%

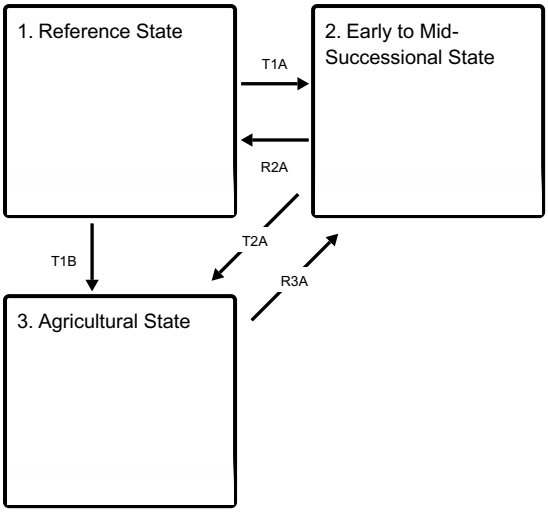
Ecological dynamics

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 although red oak, and other mesic hardwoods may be present as well. Some sites have a strong presence of red oak, and white pine is successfully reinvading the landscape in some areas. 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 and white pine. 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 - Clear cutting or stand-replacing fire.

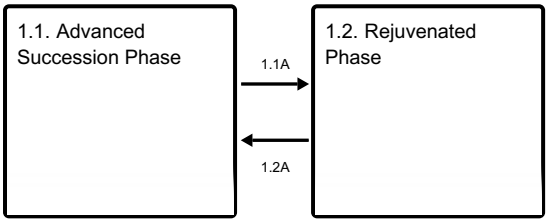
T1B - Removal of forest vegetation and tilling.

R2A - Disturbance-free period 70+ years.

T2A - Removal of forest vegetation and tilling.

R3A - Cessation of agricultural practices, natural or artificial afforestation.

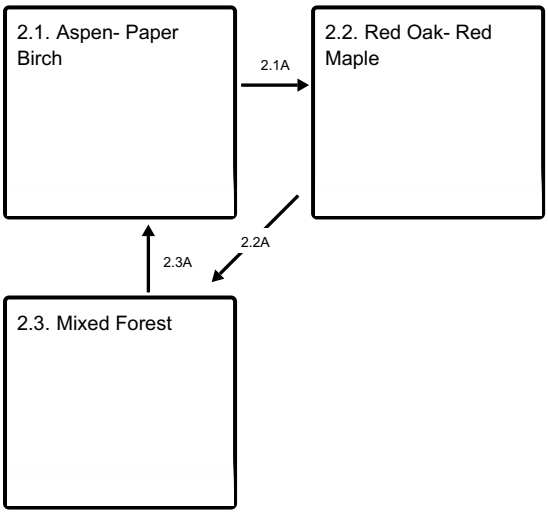
State 1 submodel, plant communities



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

1.2A - Disturbance-free period 30+ years

State 2 submodel, plant communities



2.1A - Immigration and establishment of red oak and red maple.

2.2A - Immigration and establishment of red oak and red maple.

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, and various oaks. Depending on history of disturbance, two community phases can be distinguished largely by differences in dominance of tree species and community age structure. The sandiness of the soils composing this site may limit the total growth potential and canopy closure.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- ash (*Fraxinus*), tree
- oak (*Quercus*), tree

Community 1.1
Advanced Succession Phase

Figure 8. Image courtesy of UWSP taken on 06/25/2020 in Marathon County, Wisconsin.

In the absence of any major disturbance, specifically fire, this community is dominated by Sugar maple. Common associates include Red maple, Ashes, Oaks, Basswood, and American Beech. Other species may be present in the canopy as well, including: Red pine, Black Cherry, and Hophornbeam. 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 Canada mayflower and brackenfern.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- Canada mayflower (*Maianthemum canadense*), other herbaceous
- western brackenfern (*Pteridium aquilinum*), other herbaceous

Community 1.2

Rejuvenated Phase

This community is dominated by a mixture of hardwoods including sugar maple, red oak and ashes. Associates may include basswood, American Beech, 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.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- northern red oak (*Quercus rubra*), tree
- ash (*Fraxinus*), tree
- Canada mayflower (*Maianthemum canadense*), other herbaceous
- western brackenfern (*Pteridium aquilinum*), 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 others. 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 State

Following disturbances such as clear cutting and/or fire a wide range of forest community phases may come into temporary existence, the three most common ones are described in the phases of this state. Variation within this state is largely a product of seed source availability and intensity and type of disturbance leading to the successional state. Due to the sandy nature of the soils in this site; it is more likely that fire could be a part of the disturbance leading to this state.

Community 2.1
Aspen- Paper Birch

Figure 9. Image courtesy of UWSP taken on 06/06/2020 in Marinette County, Wisconsin.

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. It is possible in some cases for this phase to have a representation of (or possible transition through) Balsam fir and White spruce.

Dominant plant species

- quaking aspen (*Populus tremuloides*), tree
- paper birch (*Betula papyrifera*), tree

Community 2.2
Red Oak- Red Maple

This community phase occurs by invading and succeeding a pioneer aspen-birch community.

Dominant plant species

- northern red oak (*Quercus rubra*), tree
- red maple (*Acer rubrum*), tree

Community 2.3
Mixed Forest

Figure 10. Image courtesy of UWSP taken on 06/06/2020 in Marinette County, Wisconsin.

Stand structure consists of dominant red oak and red maple in combination with a modest, or strong presence of mature, or decaying, aspen and/or paper birch. The shrub layer typically reaches its best development in this community phase. Depending on seed source, sugar maple (and hemlock where possible) has become established and a young cohort exists in the subcanopy. This mixed forest may also contain any of White ash, Basswood, Hemlock, Yellow birch, and Balsam fir.

Dominant plant species

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

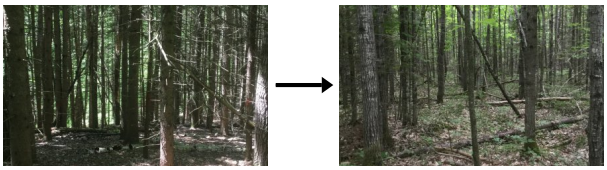
Pathway 2.1A
Community 2.1 to 2.2

Time and the immigration, establishment, and growth of red oak and red maple seedlings. These moderately shade tolerant species seed in beneath the aspen and birch and eventually outcompete these intolerant species.

Pathway 2.2A
Community 2.2 to 2.3

Time and natural succession. Red oak and red maple 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



Mixed Forest | Aspen- Paper Birch

Clear cutting or major fire disturbance allows for the reinvasion of the shade intolerant aspen-birch community.

State 3
Agricultural State

Indefinite period of applying agricultural practices.

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 vegetation and tilling.

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 shade tolerant sugar maple and Hemlock with less tolerant associates of American Beech and White ash, 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 R3A
State 3 to 2

Abandonment of agricultural practices and allowing natural vegetation to colonize the site or apply artificial afforestation.

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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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	07/18/2024
Approved by	Suzanne Mayne-Kinney
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

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):

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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:**
