USDA Natural Resources Conservation Service

Ecological site F095XB010WI
Loamy and Clayey Upland

Last updated: 11/16/2023
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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-Mesic Oak Forest and Woodland, North-Central Interior Dry Oak Forest and Woodland, North-Central Interior Maple-Basswood Forest, Eastern Cool Temperate Row Crop, Eastern Cool Temperate Pasture and Hayland, Eastern Cool Temperate Urban Shrubland, 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/Viburnum(Cornus racemose) [ATiFrVb(Cr)], *Acer saccharum*-Tilia-Fraxinus/Caulophyllum(Osmorhiza) [ATiFrCa(O)], *Acer saccharum*-Tilia-Fraxinus/Circaea [ATiFrCi], *Acer saccharum*-Tilia-Fraxinus/Caulophyollum [ATiFrCa], and Acer rubrum/Desmodium [ArDe].

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), South Central Wisconsin Prairie and Savannah (222Kd), Southern Green Bay Lobe (222Ke), Rock River Old Drift Country (222Kh), Kickapoo-Wisconsin River Ravines (222Ld)

DNR Ecological Landscapes: Southeastern Glacial Plains, Central Sand Hills

Ecological site concept

The Loamy and Clayey Upland ecological site occurs throughout LRU 95XB, but is less common in the eastern reaches of the LRU. This is the second-most extensive site in LRU 95XB, occupying over one million acres (20% of the total land area). These are upland sites but may occur on a wide variety of landforms. These soils formed in very deep, sandy to clayey deposits of till, outwash, alluvium, colluvium, and lacustrine materials. Many of these sites have a silty loess mantle. These soils are strongly acid to moderately alkaline and are moderately well to somewhat excessively drained. They do not meet hydric soil requirements.Typical vegetation includes *Acer saccharum*, Acer rubrum, *Tilia americana*, and Fraxinus americana with a varied, but thin shrub layer, and rich site plants such as Desmodium glutinosum, Parthenocissus quinquefolia, and Circaea lutetiana in the understory.

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 Loamy and Clayey Upland 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 found adjacent to Loamy and Clayey Upland in slightly lower, wetter landscape positions.

Similar sites

F095XB006WI	**Shallow Upland** These sites consist of shallow to deep, sandy to clayey deposits of various origin. They are moderately well to excessively drained. Some sites may be share particle size classes with Loamy and Clayey Upland, but they have root-restrictive bedrock contact within 150 cm.
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 100cm. They are moderately well to somewhat excessively drained. Loamy and Clayey Uplands are found on similar landforms and have similar drainage capabilities as Loamy Uplands with Carbonates. Some sites also share their particle size classes, but Loamy Uplands with Carbonates have higher volumes of secondary carbonates.
F095XB008WI	**Clayey Upland with Carbonates** These sites consist of very deep, clayey till or lacustrine deposits, sometimes mantled with sandy outwash. Secondary carbonates usually occupy at least 10% volume in the upper 100cm. They are moderately well to well drained. Loamy and Clayey Upland are found on similar landforms and have similar drainage capabilities as Clayey Upland with Carbonates. Some sites also share their particle size classes, but Clayey Upland with Carbonates have higher volumes of secondary carbonates.
F095XB009WI	**Sandy Upland** These sites consist of very deep, sandy outwash, till, or eolian deposits. Some are mantled with loamy outwash or alluvium. They are primarily found in the Central Sand Hills in the northwestern portion of the MLRA. They are moderately well to excessively drained. They are found in similar landscape positions and have similar drainage capabilities as Loamy and Clayey Upland but have coarser particle size classes.

Table 1. Dominant plant species

Tree	(1) *Acer saccharum* (2) *Fraxinus*
Shrub	(1) *Tilia*
Herbaceous	(1) *Circaea ×intermedia* (2) *Desmodium glutinosum*

Physiographic features

This extensive site is found on a diverse array of landforms throughout the MLRA. It’s generally found on upland landscape positions but may occasionally be found on footslopes. Landform shape is concave to convex. Slope ranges from 0 to 45 percent.

Inundation by water is rare on these sites and generally lasts less than a week. Depth to water table varies considerably. Endosaturated sites typically have water tables below 60 inches (150 centimeters) from the surface. Sites with perched water tables (episaturation) may have evidence of a seasonally high water table at the surface. Runoff potential ranges from very low to very high, with the highest potential found on steep sites with silt loam surfaces.

Table 2. Representative physiographic features

Hillslope profile	(1) Summit (2) Backslope (3) Footslope (4) Toeslope
Slope shape across	(1) Concave (2) Convex
Slope shape up-down	(1) Linear
Landforms	(1) Moraine (2) Till plain (3) Outwash plain (4) Lake plain (5) Lake terrace (6) Stream terrace (7) Drainageway
Runoff class	Very low to very high
Flooding duration	Brief (2 to 7 days)
Flooding frequency	None to occasional
Ponding duration	Brief (2 to 7 days)
Ponding frequency	None to rare
Elevation	180–365 m
Slope	0–45%
Ponding depth	0–15 cm
Water table depth	0–203 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 41 inches. The average annual maximum and minimum temperatures are 56oF and 36oF, respectively.

Table 3. Representative climatic features

Frost-free period (characteristic range)	116-141 days
Freeze-free period (characteristic range)	141-170 days
Precipitation total (characteristic range)	889-914 mm
Frost-free period (actual range)	108-144 days
Freeze-free period (actual range)	135-173 days
Precipitation total (actual range)	838-965 mm
Frost-free period (average)	129 days
Freeze-free period (average)	156 days
Precipitation total (average)	889 mm

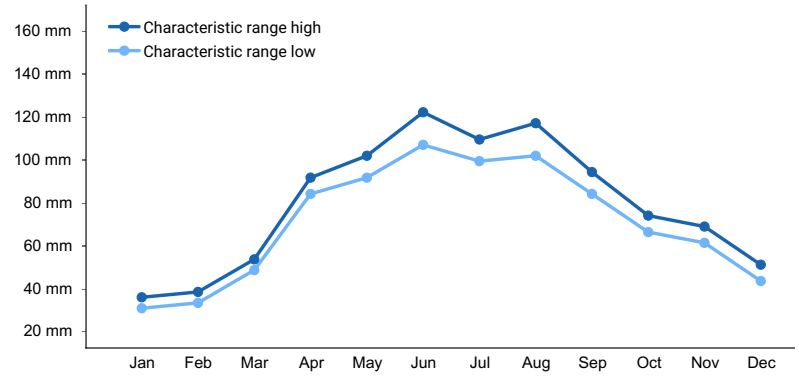


Figure 1. Monthly precipitation range

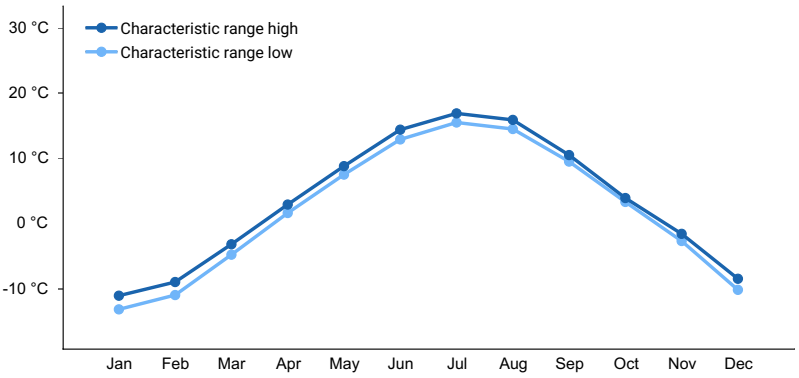


Figure 2. Monthly minimum temperature range

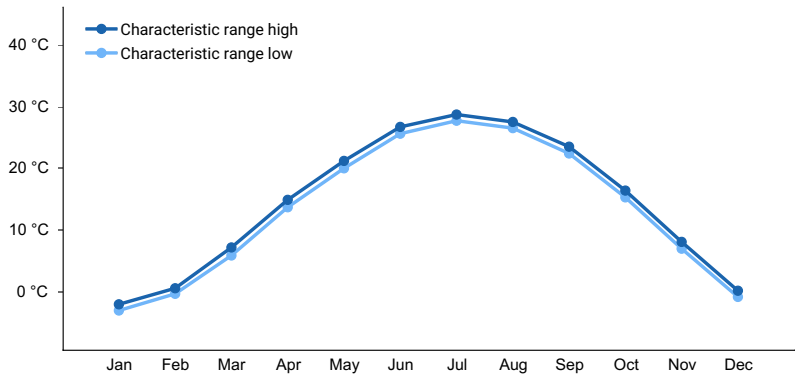


Figure 3. Monthly maximum temperature range

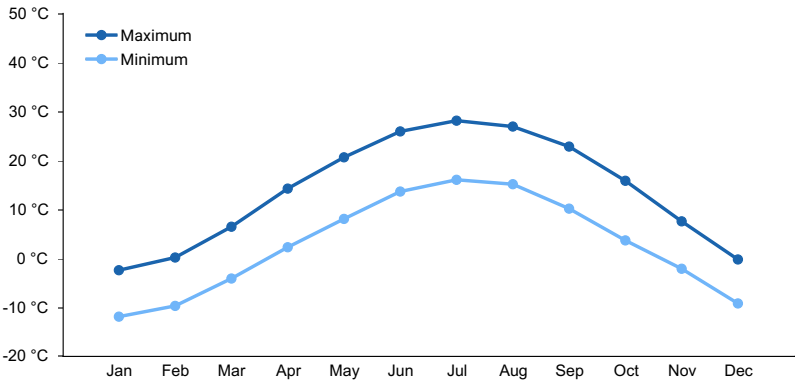


Figure 4. Monthly average minimum and maximum temperature

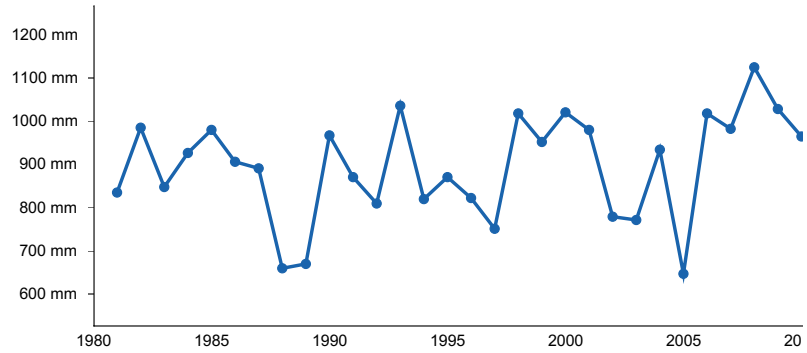


Figure 5. Annual precipitation pattern

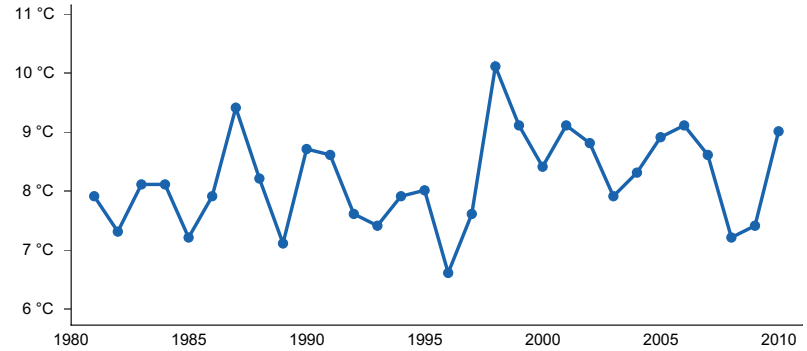


Figure 6. Annual average temperature pattern

Climate stations used

- (1) AFTON [USC00470045], Janesville, WI
- (2) ROCKFORD GTR ROCKFORD AP [USW00094822], Rockford, IL
- (3) FREEPORT WASTE WTP [USC00113262], Freeport, IL
- (4) MONTELLO [USC00475581], Montello, WI
- (5) MCHENRY-WG STRATTON LD [USC00115493], McHenry, IL
- (6) WHITEWATER [USC00479190], Whitewater, WI
- (7) BELOIT [USC00470696], Beloit, WI
- (8) MONROE 1 W [USC00475573], Monroe, WI
- (9) ELGIN [USC00112736], Elgin, IL
- (10) MADISON DANE RGNL AP [USW00014837], Madison, WI
- (11) LODI [USC00474790], Lodi, WI
- (12) BARABOO [USC00470516], Baraboo, WI
- (13) RIPON 5 NE [USC00477209], Pickett, WI
- (14) TOWN OF WESTFORD [USC00478540], Beaver Dam, WI
- (15) WEST BEND [USC00479050], West Bend, WI
- (16) WAUKESHA [USC00478937], Waukesha, WI
- (17) JEFFERSON WWTP [USC00474108], Jefferson, WI
- (18) WATERTOWN [USC00478919], Watertown, WI
- (19) BURLINGTON [USC00471205], Burlington, 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

Wetland description

Permeability of the soil is impermeable to rapid.
Hydrologic Group: A, B, C, A/D, B/D
Hydrogeomorphic Wetland Classification: None

Cowardin Wetland Classification: None

Soil features

The soils of this site are represented by the Ankeny, Batavia, Brems, Briggsville, Cadiz, Delton, Dickinson, Dodge, Downs, Durand, Fayette, Festina, Flagg, Fox, Friesland, Gotham, Grellton, Griswold, Hebron, Hennepin, Jasper, Juda, Juneau, Kegonsa, Kidder, Lindstrom, Lorenzo, McHenry, Mecan, Meridian, Metea, Mt. Carroll, Myrtle, Oakville, Ockley, Ogle, Osco, Oshtemo, Pardeeville, Pecatonica, Pillot, Plano, Puchyan, Richford, Rosholt, Salter, Seaton, St. Charles, Tell, Thackery, Troxel, Westville, Winnebago, Worthen, and Wyocena series. These soils are classified as Hapludalfs, Glossudalfs, Hapludolls, Argiudolls, Eutrudepts, Udipsamments, and Udifluvents.

These soils formed in very deep, sandy to clayey deposits of till, outwash, alluvium, colluvium, and lacustrine materials. Many have a silty loess mantle.

These soils are strongly acid to moderately alkaline. Secondary carbonates are generally absent, though they may be present at the surface in some soils. Presence of rock fragments is variable. Small fragments may occupy up to 36 percent volume. They 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. These soils are moderately well to somewhat excessively drained. They do not meet hydric soil requirements.

Figure 7. Wyocena soil series photograph courtesy of UWSP taken on 6/4/2020 in Waushara County, WI.

Table 4. Representative soil features

Parent material	(1) Till (2) Outwash (3) Alluvium (4) Eolian deposits (5) Lacustrine deposits
Surface texture	(1) Sand (2) Loamy sand (3) Sandy loam (4) Loam (5) Silt loam
Drainage class	Moderately well drained to excessively drained
Permeability class	Rapid
Soil depth	201–249 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%

Available water capacity (0-150.1cm)	3.91–12.88 cm
Calcium carbonate equivalent (0-100.1cm)	0–28%
Soil reaction (1:1 water) (0-100.1cm)	5.3–8.2
Subsurface fragment volume <=3" (0-100.1cm)	0–36%
Subsurface fragment volume >3" (0-100.1cm)	0–7%

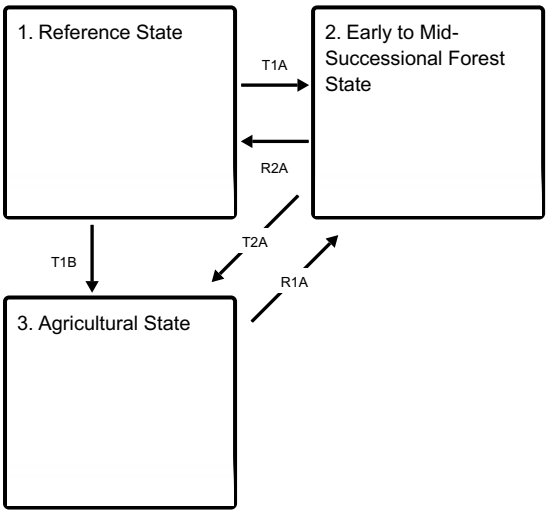
Ecological dynamics

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 white oak. These sites have the conditions to support shade tolerant mesic hardwoods, but historically had significant wind throw and fire disturbance that allowed for a strong presence of oak species. As long as fire is continually suppressed, maples and other mesic hardwoods will continue to dominate the canopy.

State and transition model

Ecosystem states



T1A - Clear cutting or stand-replacing fire.

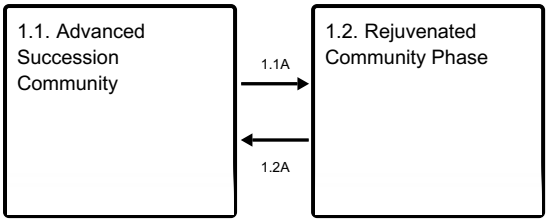
T1B - Removal of forest cover and tilling for agricultural crop production.

R2A - Disturbance-free period 70+ years.

T2A - Removal of forest vegetation and tilling.

R1A - Cessation of agricultural practices, natural or artificial afforestation.

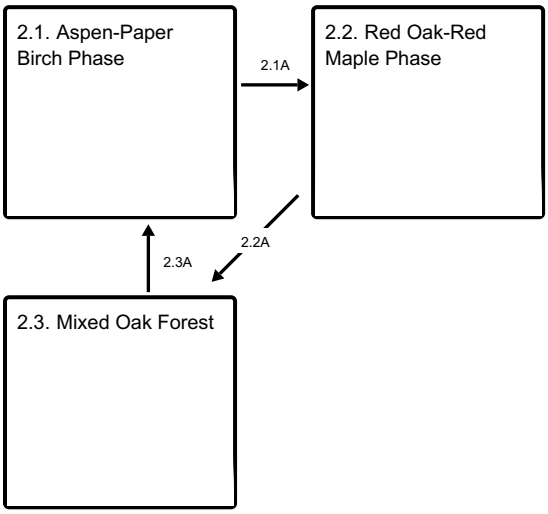
State 1 submodel, plant communities



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

1.2A - Disturbance-free period 30+ years

State 2 submodel, plant communities

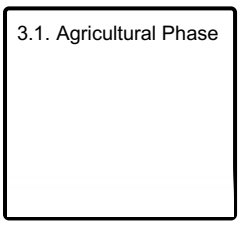


2.1A - Immigration and establishment of red oak and red maple.

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

2.3A - Clear cutting or stand-replacing fire.

State 3 submodel, plant communities



State 1
Reference State

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

Community 1.1
Advanced Succession Community

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

Pointedleaf Ticktrefoil.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- ash (*Fraxinus*), tree
- basswood (*Tilia*), tree
- Virginia creeper (*Parthenocissus quinquefolia*), other herbaceous
- enchanter's nightshade (*Circaea ×intermedia*), other herbaceous
- pointedleaf ticktrefoil (*Desmodium glutinosum*), other herbaceous

Community 1.2
Rejuvenated Community Phase

Figure 8. Photo courtesy of UWSP taken on 8/14/2020 in Sauk County, WI.

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.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- ash (*Fraxinus*), tree
- basswood (*Tilia*), tree
- Virginia creeper (*Parthenocissus quinquefolia*), other herbaceous
- enchanter's nightshade (*Circaea ×intermedia*), other herbaceous
- pointedleaf ticktrefoil (*Desmodium glutinosum*), 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 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. The mixed oak forest phase represents an alternative stable state in the absence of seed source of the dominant mesic hardwoods.

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-Red Maple Phase

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.

Dominant plant species

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

Community 2.3
Mixed Oak Forest

Figure 9. Photo courtesy of UWSP taken on 6/4/2020 in Wasuapa County, WI.

Stand structure consists of dominant white oak, red oak and red maple in combination with a modest, or strong presence of mature, or decaying, aspen and/or paper birch. A wide variety of tree species may be present with white oak, red oak and red maple in the canopy (Black cherry, Hickory, Ashes). The shrub layer typically reaches its best development in this community phase. Depending on seed source, sugar maple has become established and a young cohort exists in the subcanopy. If sugar maple seeds are not present the site may persist in this state/phase for a long time.

Dominant plant species

- northern red oak (*Quercus rubra*), tree
- white oak (*Quercus alba*), tree
- sugar maple (*Acer saccharum*), tree
- red maple (*Acer rubrum*), tree
- ash (*Fraxinus*), tree
- bigleaf aster (*Eurybia macrophylla*), other herbaceous
- Canada mayflower (*Maianthemum canadense*), other herbaceous

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 White 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

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.

Community 3.1
Agricultural Phase

The agricultural phase constitutes tillage and the planting of row crops or 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 shade tolerant sugar maple with less tolerant associates of red oak 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 R1A
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 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.
Biophysical Settings (Landfire, 2014): This ES is largely mapped as North-Central Interior Dry-Mesic Oak Forest and Woodland, North-Central Interior Dry Oak Forest and Woodland, North-Central Interior Maple-Basswood Forest, Eastern Cool Temperate Row Crop, Eastern Cool Temperate Pasture and Hayland, Eastern Cool Temperate Urban Shrubland, 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/Viburnum(Cornus racemose) [ATiFrVb(Cr)], *Acer saccharum*-Tilia-Fraxinus/Caulophyllum(Osmorhiza) [ATiFrCa(O)], *Acer saccharum*-Tilia-Fraxinus/Circaea [ATiFrCi], *Acer saccharum*-Tilia-Fraxinus/Caulophyollum [ATiFrCa], and Acer rubrum/Desmodium [ArDe].
WDNR Natural Communities (WDNR, 2015): This ES is most similar to the Southern Mesic Forest described by the WDNR.

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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	05/22/2024
Approved by	Suzanne Mayne-Kinney
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

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

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

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

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

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

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

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

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

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

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

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

    Dominant:

    Sub-dominant:

    Other:

    Additional:

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**

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14. **Average percent litter cover (%) and depth (in):**

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):**

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16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:**

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17. **Perennial plant reproductive capability:**
