# Ecological site F095XB009WI
# Sandy Upland

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## General information

**Provisional**. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

## MLRA notes

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

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

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

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

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

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

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

## LRU notes

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

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

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

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

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

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

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

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

## Classification relationships

Relationship to Established Framework and Classification Systems:

Biophysical Settings (Landfire, 2014): This ES is largely mapped as North-Central Interior Dry Oak Forest and Woodland, North-Central Interior Dry-Mesic Oak Forest and Woodland, North-Central Interior Maple-Basswood Forest, Eastern Cool Temperate Pasture and Hayland, and Managed Tree Plantation-Northern and Central Hardwood and Conifer Plantation Group

Habitat Types of N. & S. Wisconsin (Kotar, 2002, 1996): The sites of this ES keyed out to Pinus/Vaccinium-Gaultheria [PVG] and Pinus strobus/Euphorbia corollata [PEu].

WDNR Natural Communities (WDNR, 2015): This ES is most similar to the Southern Dry Forest and 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: Central Wisconsin Moraines and Outwash (222Kb), South Central Wisconsin Prairie and Savannah (222Kd)

DNR Ecological Landscapes: Central Sand Hills

## Ecological site concept

The Sandy Uplands ecological site occurs mostly in the northwest area of LRU 95XB. This site is represented by a wide variety of soils occurring on outwash plains, stream terraces, dunes, pediments, and sandy till plains or moraines. These soils generally form in very deep sandy outwash, sandy till, or sandy eolian deposits. Some have a mantle of loamy outwash or loamy alluvium. Some sites formed in eolian deposits have fine bands of accumulated clay (lamellae) in their substratum. A major characteristic of these sites is their limited ability to supply water and nutrients to plants.

These soils are very strongly acid to moderately alkaline. Some sites formed in eolian materials may have secondary carbonates. These soils are moderately well to excessively drained. They do not meet hydric soil requirements.

Typical vegetation includes Pinus strobus, *Quercus rubra*, *Quercus alba*, *Acer rubrum*, Prunus serotina, Amelanchier spp., and Maianthemum canadense.

## Associated sites

| | |
|---|---|
| F095XB003WI | **Wet and Moist Sandy Lowland**<br>These sites occur on depressions in sandy outwash plains and stream terraces, primarily in the northwestern portion of the MLRA. They form in very deep, sandy outwash or lacustrine materials, sometimes underlain or overlain by finer-textured materials. Generally, they lack secondary carbonates and are very poorly to somewhat poorly drained. They are found on the same landforms as Sandy Uplands in lower, wetter landscape positions. |

## Similar sites

| | |
|---|---|
| F095XB010WI | **Loamy and Clayey Upland**<br>These sites consist of very deep, sandy to clayey deposits of till, outwash, alluvium, colluvium, and lacustrine materials. They are moderately well to somewhat excessively drained. They are found in similar landscape positions and have similar drainage capabilities as Sandy Uplands but have finer particle size classes. |

**Table 1. Dominant plant species**

| | |
|---|---|
| Tree | (1) *Pinus strobus*<br>(2) *Acer rubrum* |
| Shrub | (1) *Prunus serotina*<br>(2) *Amelanchier* |
| Herbaceous | Not specified |

## Physiographic features

This site occurs in outwash plains, stream terraces, dunes, pediments, and sandy till plains or moraines, primarily in the northwest portion of this MLRA. Landform shape is concave, linear or convex. They may be found on any position on the landscape except toeslope (the lowest position). Slope ranges from 0 to 45 percent. Landform elevation ranges from 215 to 425 meters above sea level.

These sites are subject to neither flooding nor ponding. Soils have a deep apparent seasonally high water table (endosaturation) that is usually below a meter of the surface but may be has high as 84 cm from the surface. Runoff potential is negligible to very high. The highest runoff potential is found in the steepest sites.

**Table 2. Representative physiographic features**

| | |
|---|---|
| Hillslope profile | (1) Summit<br>(2) Shoulder<br>(3) Backslope<br>(4) Footslope |
| Slope shape across | (1) Concave<br>(2) Convex |
| Slope shape up-down | (1) Linear |
| Landforms | (1) Outwash plain<br>(2) Till plain<br>(3) Stream terrace<br>(4) Moraine |
| Runoff class | Negligible to very high |
| Elevation | 215–425 m |
| Slope | 0–45% |
| Water table depth | 84–203 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 34 inches. The average annual snowfall is 43 inches. The average annual maximum and minimum temperatures are 56oF and 35oF, respectively.

**Table 3. Representative climatic features**

| | |
|---|---|
| Frost-free period (characteristic range) | 114-125 days |
| Freeze-free period (characteristic range) | 139-150 days |
| Precipitation total (characteristic range) | 864-889 mm |
| Frost-free period (actual range) | 113-128 days |
| Freeze-free period (actual range) | 138-152 days |
| Precipitation total (actual range) | 864-914 mm |
| Frost-free period (average) | 120 days |
| Freeze-free period (average) | 145 days |
| Precipitation total (average) | 889 mm |

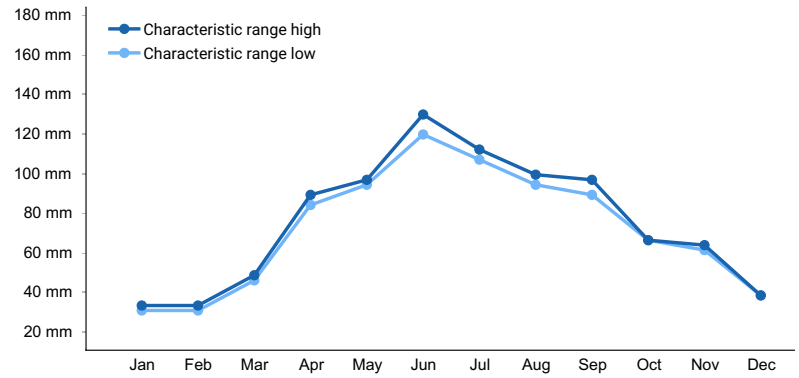



**Figure 1. Monthly precipitation range**

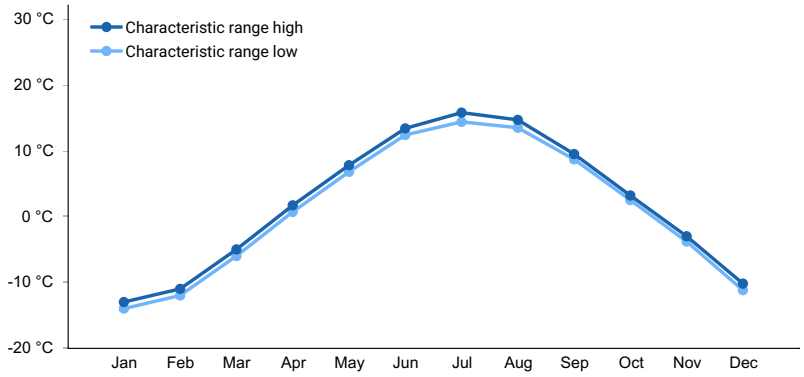



**Figure 2. Monthly minimum temperature range**

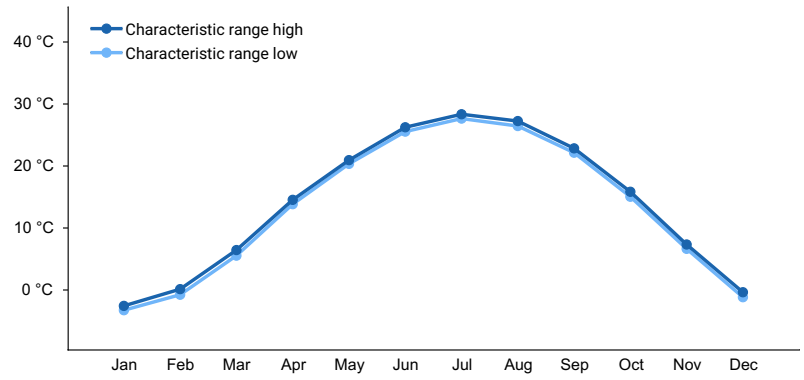



**Figure 3. Monthly maximum temperature range**

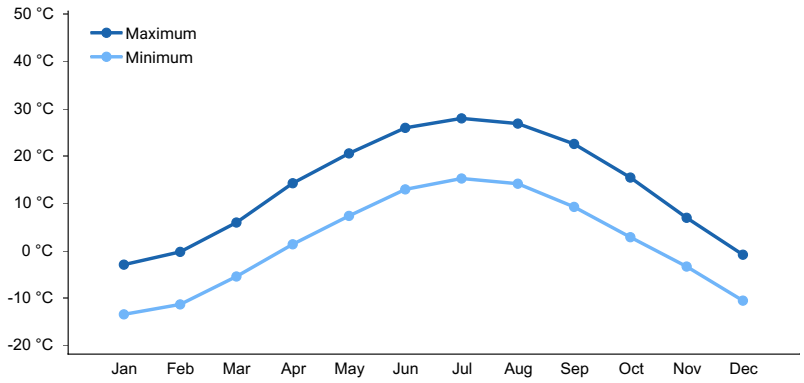



**Figure 4. Monthly average minimum and maximum temperature**

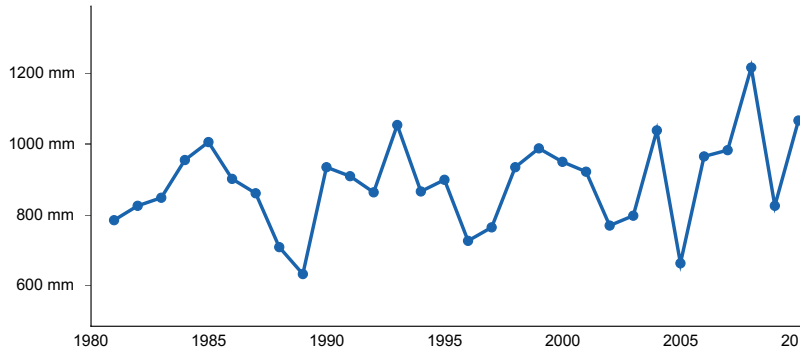



**Figure 5. Annual precipitation pattern**

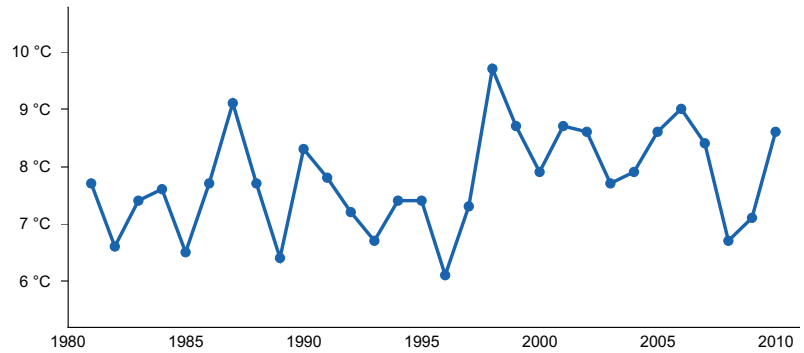



**Figure 6. Annual average temperature pattern**

## Climate stations used

- (1) PORTAGE [USC00476718], Portage, WI
- (2) DALTON [USC00471970], Dalton, WI
- (3) MARKESAN [USC00475096], Markesan, WI

- (4) MONTELLO [USC00475581], Montello, WI
- (5) ARLINGTON UNIV FARM [USC00470308], De Forest, 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 soil is impermeable to moderate. The hydrologic group of this site is A.

## Wetland description

Hydrogeomorphic Wetland Classification: None
Cowardin Wetland Classification: None

## Soil features

The soils of this site are represented by the Chelsea, Coloma, Dickman, Kranski, Mecosta, Moundville, Plainfield, Rodman, and Sparta series. These soils are classified as Udipsamments, Udorthents, Hapludalfs, and Hapludolls.

These soils generally form in very deep sandy outwash, sandy till, or sandy eolian deposits. Some have a mantle of loamy outwash or loamy alluvium. Some sites formed in eolian deposits have fine bands of accumulated clay (lamellae) in their substratum.

These soils are very strongly acid to moderately alkaline. Some sites formed in eolian materials may have secondary carbonates that occupy up to 13 percent volume. Small, rounded rock fragments of mixed origin are common in the soils, except for those whose materials were deposited by wind. These soils are moderately well to excessively drained. They do not meet hydric soil requirements.

**Figure 7. Plainfield soil series sampled on 06/03/2020 in Waushara County, Wisconsin. Image courtesy of UWSP.**

**Table 4. Representative soil features**

| | |
|---|---|
| Parent material | (1) Outwash<br>(2) Till<br>(3) Alluvium<br>(4) Eolian deposits |
| Surface texture | (1) Sand<br>(2) Loamy sand<br>(3) Sandy loam<br>(4) Loam |
| Drainage class | Moderately well drained to excessively drained |

| | |
|---|---|
| Permeability class | Moderate to rapid |
| Soil depth | 203–254 cm |
| Surface fragment cover <=3" | 0% |
| Surface fragment cover >3" | 0% |
| Available water capacity (0-150.1cm) | 1.96–6.12 cm |
| Calcium carbonate equivalent (0-100.1cm) | 0–28% |
| Soil reaction (1:1 water) (0-100.1cm) | 4.9–7.9 |
| Subsurface fragment volume <=3" (0-100.1cm) | 0–42% |
| Subsurface fragment volume >3" (0-100.1cm) | 0–7% |

## Ecological dynamics

Perhaps the most important ecological characteristic of this Ecological Site, in terms of its influence on forest community dynamics, is its lack of capacity to support the high to moderate soil moisture and nutrient requiring species such as sugar maple, basswood and white ash, the shade-tolerant species, that typically dominate the more productive sites throughout Wisconsin.

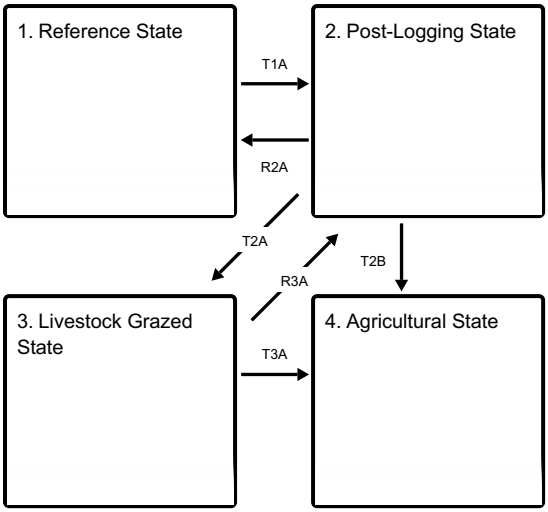
In pre-European settlement time wild fire was the main controlling factor of forest community dynamics. Following a severe, stand-replacing fire, any of the species present on the landscape could become established, depending on seed source availability and specific conditions of post-fire seedbed. The 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. White pine is best adapted for long-term success on this Ecological Site. Although vulnerable to damage or elimination by fire in early life it eventually develops thick fire-resistant bark which helps to extend its longevity, in some cases for up to four centuries or more. These survival properties assure the species' relatively continuous seed source in the region as a whole. White pine is also moderately shade-tolerant in early life which means that it can become established in some pioneer communities, such as aspen – white birch stands, or in poorly stocked oak and red maple dominated communities. Red pine had in the past been a common associate of white pine stands. It shares some of the fire-resisting properties of white pine, but it lacks shade-tolerance and does not become established in the understory. For this reason, it has not maintained its presence in current stands and its seed source has been greatly reduced throughout its natural range following the unset of fire suppression. Several species of oak are common members of forest communities on this ecological site. Northern pin oak (*Q. ellipsoidalis*) and, to a lesser degree, black oak (*Q. velutina*), are intolerant of shade and do not reproduce from seed under existing canopies. However, following fire or clear cutting they respond by sprouting from stumps. In the absence of disturbance, they are replaced—through succession—by more shade-tolerant white pine, red maple (*Acer rubrum*), or white oak (*Quercus alba*) and red oak (*Quercus rubra*).

Red maple has not been identified by Finley (1976) as an important component of pre-settlement pine or oak forests, but it is a prominent member in current stands. Absence of fire since the original logging era is probably the main reason. Red maple is extremely sensitive to fire damage, but is a prolific and early seed producer. Stems of 2-4 inches in diameter can produce large amounts of seed (USDA For. Serv. 1990). It is sufficiently shade-tolerant to become established in the understories of most communities on sandy soils. On this Ecological Site it behaves similarly to white pine, but because of its much smaller size at maturity, it does not compete with white pine in the upper canopy.

Some portions of this ES may support grassland or oak savanna and restoration/establishment efforts have had some success.

## State and transition model

**Ecosystem states**




**T1A** - Stand replacing disturbance e.g., blow-down and fire, or clear-cutting followed by fire. Regeneration by natural seeding or planting.

**R2A** - Fire control, time, natural succession.

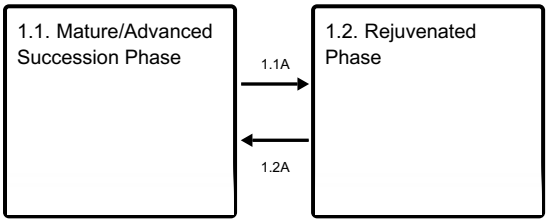
**T2A** - Grazing by livestock. Disruption of tree regeneration and ground vegetation.

**T2B** - Removal of natural vegetation, plowing, fertilizing, irrigating, planting agricultural crops.

**R3A** - Removal of livestock from stands.

**T3A** - Removal of natural vegetation, plowing, fertilizing, irrigating, planting agricultural crops.

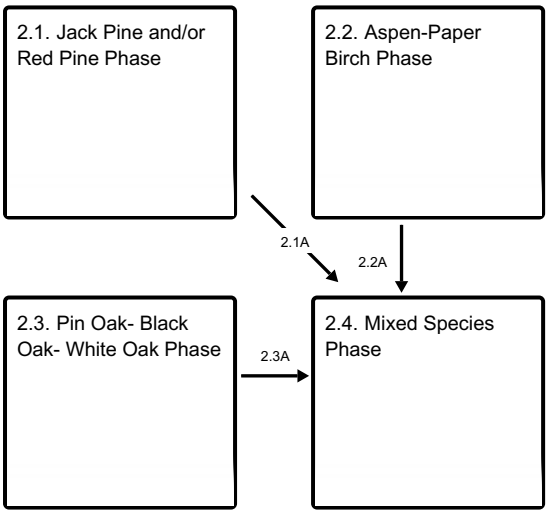
**State 1 submodel, plant communities**




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

**1.2A** - Disturbance-free period 30+ years

**State 2 submodel, plant communities**




**2.1A** - Immigration and establishment of white pine and red maple.

**2.2A** - Immigration and establishment of white pine and red maple.

**2.3A** - Immigration and establishment of white pine and red maple.

**State 3 submodel, plant communities**

3.1. Grazed Land

**State 4 submodel, plant communities**

4.1. Cultivated Agricultural Crops

## State 1
## Reference State

In absence of stand-leveling disturbances the Reference State Community oscillates between two easily definable community phases, a mature, or late successional, community phase and a rejuvenated community phase. The major difference between these two states being the level and degree of small scale disturbance leading to canopy openings and the resulting abundance and age of canopy tree species as well as the shrub layer. Typically this state is characterized by a mixed forest of White pine, Red and White Oak, and Red maple. A mixed presence of Red pine, Jack pine, Pin oak, and Black oak could occur as well.

### Community 1.1
### Mature/Advanced Succession Phase

A mature forest community contains a super-canopy, or a scattering, of large white pine trees. In pre-European settlement time such trees would have been anywhere from 80 to more than 300 years old (Sterns, 1950). Common associates have been red pine (P. resinosa), red oak (*Q. rubra*) and white oak (*Q. alba*). However, only white pine and white oak are moderately shade-tolerant and able to reproduce in small canopy openings and remain as permanent members of mature community in absence of moderate to severe disturbance. Red maple (*Acer rubrum*) had not been an important species in pre-settlement forests, but is today the most successful reproducing tree species in forest communities on this Ecological Site.

**Dominant plant species**

- eastern white pine (*Pinus strobus*), tree
- red maple (*Acer rubrum*), tree
- black cherry (*Prunus serotina*), shrub
- serviceberry (*Amelanchier*), shrub

### Community 1.2
### Rejuvenated Phase

**Figure 8. Image courtesy of UWSP taken on 06/03/2020 in Waushara County, Wisconsin.**

The canopy of the rejuvenated community is still dominated by original species, but 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**

- eastern white pine (*Pinus strobus*), tree
- red maple (*Acer rubrum*), tree
- northern red oak (*Quercus rubra*), tree
- white oak (*Quercus alba*), tree
- black cherry (*Prunus serotina*), shrub
- serviceberry (*Amelanchier*), shrub

## 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 advance 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

## Post-Logging State

Post-logging state may consist of considerable diversity of pioneer and mid-successional community phases. Here we are describing four, most commonly found under current conditions.

## Community 2.1
## Jack Pine and/or Red Pine Phase

Jack pine and red pine have historically been almost entirely dependent on fire for regeneration. Jack pine is a predominantly a northern species and in southern part of Wisconsin seldom approaches its growth potential. Everywhere it occurs it is a pronounce pioneer, highly light demanding and resistant to drought and frost. It has low requirements for soil organic matter and nutrients. It is a prolific producer of seed and it often colonizes burnt over areas. Forest fires speed natural regeneration by opening the cones. However, today, jack pine is regenerated mostly by planting. Without disturbance jack pine does not regenerate and is readily succeeded by various species, even those of only moderate shade tolerance, such as white pine and red oak. Historically, red pine has often occurred in mixtures with jack pine. In terms of light, soil moisture and nutrient requirements it is intermediate between jack and white pines. In contrast to jack pine, natural red pine regeneration is often found in moderately dense pure or mixed pine stands, although not to the same extent as is white pine. Under current ecological and economic conditions red pine is regenerated almost entirely by planting.

### Dominant plant species

- jack pine (*Pinus banksiana*), tree
- red pine (*Pinus resinosa*), tree

## Community 2.2
## Aspen-Paper Birch Phase

Although a ubiquitous species, quaking aspen (*Populus tremuloides*) is far more characteristic of northern rather than southern forest regions. Its most notable ecological characteristic is the ability to rapidly invade cut-over and burned-over areas. However, its perpetuation depends entirely on recurrence of disturbance. Because of its extreme intolerance to shade, it is readily replaced by many tree species in the absence of disturbance. Once in place, aspen reproduces entirely by sprouting from extensive, superficial root systems (root suckering). Most aspen stands on this Ecological Site resulted from sprouting following clear cutting of mixed stands of pine and/or oak, in which some aspen trees were still present. Paper birch (*Betula papyrifera*) is often a member of aspen stands. It shares aspen's intolerance of shade and also produces small, winged seeds that readily disperse by wind. It does not sucker from root sprouts, but it readily sprouts from stumps upon clear cutting. It also has greater ability than does aspen of reproducing from seed under favorable seedbed conditions and in presence of large canopy openings. However in absence of disturbance it also succeeds to other species.

### Dominant plant species

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

## Community 2.3
## Pin Oak- Black Oak- White Oak Phase

**Figure 9. Image courtesy of UWSP taken on 08/14/2020 in Waushara County, Wisconsin.**

On this Ecological Site these three oak species occur in mixtures dominated by any of them. In some stands there also occur red oak, bur oak (*Q. macrocarpa*) or shagbark hickory (Carya ovvata). Community composition and structure is a function of composition of the preceding, cut-over, or burned-over community and time since the disturbance. Time since disturbance is an important factor because of significant differences in sprouting abilities and success of regeneration from seed, among the participating species. Pin and black oak typically exist in current stands as multy-stem clusters resulting from stump sprouting, while white oak often reproduces from seed and gradually gains canopy dominance because of its greater shade tolerance than that of other oak species.

**Dominant plant species**

- pin oak (*Quercus palustris*), tree
- black oak (*Quercus velutina*), tree
- white oak (*Quercus alba*), tree

## Community 2.4
## Mixed Species Phase

This community phase is considered a mid-successional community between the pioneering communities 2.1, 2.2, 2.3 and the Reference State. The community is characterized by canopy dominance of any of the early - succession species (i.e.: oaks, aspen - birch, jack pine) and strong presence in the understory of white pine and/or red maple seedlings and saplings.

**Dominant plant species**

- jack pine (*Pinus banksiana*), tree
- red pine (*Pinus resinosa*), tree
- quaking aspen (*Populus tremuloides*), tree
- white oak (*Quercus alba*), tree
- northern red oak (*Quercus rubra*), tree

- eastern white pine (*Pinus strobus*), tree
- red maple (*Acer rubrum*), tree

### Pathway 2.1A
### Community 2.1 to 2.4

Immigration and establishment of relatively shade tolerant white pine and red maple into shade – intolerant communities of aspen – birch, oaks or jack pine.

### Pathway 2.2A
### Community 2.2 to 2.4

Immigration and establishment of relatively shade tolerant white pine and red maple into shade – intolerant communities of aspen – birch, oaks or jack pine.

### Pathway 2.3A
### Community 2.3 to 2.4

Immigration and establishment of relatively shade tolerant white pine and red maple into shade – intolerant communities of aspen – birch, oaks or jack pine.

## State 3
## Livestock Grazed State

Livestock grazed forests are more often referred to as woodlands rather than forests because this long-term land use significantly changes some soil characteristics and nature of vegetative community. Species composition is altered by selective browsing and grazing as well as by distribution of seeds and other propagules by grazing animals. In addition, soil compaction differentially affects germination and establishment of plant species, including trees.

### Community 3.1
### Grazed Land

Site phase consists of various grasses and forbs impacted by livestock grazing.

## State 4
## Agricultural State

Production of agricultural crops. Routine usage of tillage, fertilizer, and other field practices.

### Community 4.1
### Cultivated Agricultural Crops

Sites phase consists of various crops being grown.

### Transition T1A
### State 1 to 2

Stand-replacing disturbance, such as blow-down, or ice storm, followed by fire, or clear-cut logging, followed by natural regeneration or site preparation and planting.

### Restoration pathway R2A
### State 2 to 1

Time (50-100 years) and natural succession by white pine will lead back to the reference state. Minimal disturbance during the successional period.

### Transition T2A
### State 2 to 3

Prolonged grazing by livestock

### Transition T2B
### State 2 to 4

Elimination of forest cover and introduction of tilling, fertilizing an/or irrigation.

### Restoration pathway R3A
### State 3 to 2

Removal of livestock, natural succession. Results may be sped up by planting and initial outcomes will be heavily influenced by seed source and adjacent plant communities.

### Transition T3A
### State 3 to 4

Elimination of forest cover and introduction of tilling, fertilizing an/or irrigation.

## Additional community tables

## Inventory data references

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

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## Contributors

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

## Approval

Suzanne Mayne-Kinney, 11/16/2023

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## Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

| | |
|---|---|
| Author(s)/participant(s) | |
| Contact for lead author | |
| Date | 08/17/2024 |
| 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:**

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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:

---

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):**

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

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:**

17. **Perennial plant reproductive capability:**