

## **Ecological site F090BY015WI Loamy Upland with Carbonates**

Last updated: 11/16/2023  
Accessed: 12/04/2024

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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): 090B—Central Wisconsin Thin Loess Dissected Till Plain

The Wisconsin and Minnesota Thin Loess MLRA, Northern and Southern Parts (90A and 90B) correspond closely to the North Central Forest and the Forest Transition Ecological Landscapes, respectively. Some of the following brief overview is borrowed from the Wisconsin Department of Natural Resources ecological landscape publications (2015).

The Wisconsin and Minnesota Thin Loess MLRA, Northern and Southern Parts (90A and 90B) is an extensive glacial landscape that comprised of over 11.1 million acres (17,370 sq mi) throughout central and northern Wisconsin – about 27% of the total land area in the state. This glacial landscape is comprised of a heterogeneous mix of loess-capped ground moraines, end moraines with eskers and ice-walled lake plains, and pitted, unpitted, and collapsed outwash plains sometimes interspersed with drumlins from the Illinoian and Pre-Illinoian glaciations. The entire area has been glaciated and nearly all of it is underlain by dense glacial till that impedes drainage. An extensive morainal system – the Perkinstown end moraine – spans most of the width of northern Wisconsin and divides the Northern and Southern Parts of this large landscape. This moraine, which has been sliced by outwash in many places, marks the southernmost extent of the Wisconsin glaciation (Wisconsin's most recent glacial advance).

North of the Perkinstown morainal system is a loess plain, with a loess mantle 6-24 inches thick. The northernmost edge of this landscape is an undulating till and outwash plain with materials deposited by the Chippewa Lobe. Drumlins are common in the northern and northeastern portions. The drumlins are oriented towards the southwest and formed during a glacial episode prior to the most recent glacial advance. Some are covered with glacial till. Pitted, unpitted, and collapsed outwash plains fill the spaces between drumlins. Detached from the major land mass to the northeast is the hummocky Hayward collapsed end moraines, where swamps, ice-walled lake plains, and eskers are common.

Most of the MLRA to the south of the Perkinstown morainal system is an extensive ground moraine with some proglacial stream features including pitted outwash plains, terraces, and fans. A layer of loess 6-47 inches thick covers much of the area. Like the Northern Part, all areas of the Southern Part of this MLRA were glaciated, although the southcentral portion is a relatively older till plain with materials from the Illinoian and pre-Illinoian glaciations, not the most recent Wisconsin glaciation. The landforms in the southcentral portion are highly variable. Much of the area topography is controlled by underlying bedrock. Sandstone outcrops and pediments can be found here. Some of the most southern portions of the MLRA are mixed glacial deposits and residuum.

The land surface of the southeastern portion was formed by many small glacial advances and retreats. Morainal ridges protrude through an erosional, pitted outwash-mantled surface. These parallel ridges run in a northeast to southwest orientation and are dissected by many streams.

The continental climate of this MLRA is typical of northcentral Wisconsin, with cold winters and warm summers. The southern boundary of this MLRA straddles Wisconsin's Tension Zone, a zone of transition between

Wisconsin's northern and southern ecological landscapes. Historically, the mesic forests were dominated by eastern hemlock (*Tsuga canadensis*), sugar maple (*Acer saccharum*), and yellow birch (*Betula alleghaniensis*).

Classification relationships

Major Land Resource Area (MLRA): Wisconsin and Minnesota Thin Loess and Till (Northern and Southern Parts - 90A and 90B)

USFS Subregions: Mille Lacs Uplands (212Kb), Rosemont Baldwin Plains and Moraines (222Md), Lincoln Formation Till Plain - Mixed Hardwoods (212Qb)

Wisconsin DNR Ecological Landscape: Northwest Lowlands, Western Prairie, Forest Transition

Ecological site concept

The Loamy Upland with Carbonates ecological site is found on the western border of MLRAs 90A and 90B, located on till plains, moraines, lake plains, and sometimes outwash plains and stream terraces. These sites are characterized by very deep, moderately well to well drained soils that formed in loamy deposits including till colluvium, alluvium, loess, and residuum. Some sites may have a sandy mantle or underlying sandy outwash. Soils have carbonates present in soil profile. Precipitation and runoff are the primary source of water. Soils range from strongly acid to moderately alkaline.

Loamy Upland with Carbonates is distinguished from other ecological sites by its deep loamy deposits with a strong presence of carbonates and moderately well and well drained soils. The carbonates raise or buffer pH, which can promote vegetative growth. Other moderately well or well drained sites have sandy or clayey deposits. Loams often have higher pH and available water capacity than sands, but lower than clays. The moderately well to well drained soils of this site differentiates it from other loamy sites.

Associated sites

F090BY010WI	<b>Moist Loamy Lowland with Carbonates</b> Moist Loamy Lowland with Carbonates consists of deep loamy till, sometimes with a loess mantle. Carbonates are present in these soils. The finer textures allow the soil to stay moist - but not saturated - for sustained periods during the growing season. They are drier and occur lower on the drainage sequence than Loamy Upland with Carbonates.
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Similar sites

F090BY014WI	<b>Loamy Bedrock Upland</b> Loamy Bedrock Upland consist of loamy till, alluvium, or eolian deposits underlain by sandy to loamy residuum. Some sites may also contain sandy outwash or clayey pedisediment. Bedrock contact occurs within two meters of the surface. They have a seasonally high water table within one meter of the surface, though they don't remain saturated for extended periods of time. They occur on similar landscape positions and share both particle size and drainage class with Loamy Upland with Carbonates. They differ in that they have bedrock contact with two meters and often lack free carbonates.
F090BY016WI	<b>Loamy Upland</b> Loamy Upland consist of deep loamy till, alluvium, residuum, lacustrine, or eolian deposits. Sandy deposits of these parent materials, plus outwash, may also be present. The depth to the seasonally high water table ranges from as high as the surface to as low as almost two meters below the surface. A few sites are on floodplains and upland drainageways, where very brief flooding is rare but possible. They occur on similar landscape positions and share both particle size and drainage class with Loamy Upland with Carbonates, but they lack free carbonates within two meters.

Table 1. Dominant plant species

Tree	(1) <i>Acer saccharum</i> (2) <i>Fraxinus americana</i>
Shrub	(1) <i>Ribes missouriense</i>

Herbaceous	(1) <i>Amphicarpaea</i> (2) <i>Actaea rubra</i>
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## Physiographic features

These sites formed on outwash plains, lake plains, till plains, moraines, and stream terraces. Slopes range from 0 to 60 percent.

These sites are not subject to ponding or flooding. Some sites have seasonally high water table at depth of 18 to 80 inches, but the water table can drop below 80 inches during dry conditions. Surface runoff is very low to very high. This range of runoff is mostly caused by the wide range in slope.

**Table 2. Representative physiographic features**

Hillslope profile	(1) Summit (2) Shoulder (3) Backslope
Slope shape across	(1) Convex
Slope shape up-down	(1) Linear
Landforms	(1) Outwash plain (2) Lake plain (3) Till plain (4) Moraine (5) Stream terrace
Runoff class	Very low to very high
Flooding frequency	None
Ponding frequency	None
Elevation	180–350 m
Slope	0–60%
Water table depth	46–201 cm
Aspect	Aspect is not a significant factor

## Climatic features

The climate of the expansive Wisconsin and Minnesota Thin Loess and Till Plain is highly variable. The eco-climatic zone (the “Tension Zone”) that runs southeast-northwest across the state splits the MLRA. In general, the MLRA has cold winters and warm summers with an adequate amount of precipitation. Near Lake Superior, precipitation and temperature tend to increase. The far western section of the MLRA, known as the western prairie ecological landscape by the Wisconsin DNR, has warmer temperatures compared to the rest of the MLRA because it falls below the eco-climatic zone. The soil moisture regime of MLRA is udic (humid climate). The soil temperature regime is frigid and cryic.

The average annual precipitation for this ecological site is 31 inches. The average annual snowfall is 44 inches. The annual average maximum and minimum temperatures are 54°F and 34°F, respectively.

**Table 3. Representative climatic features**

Frost-free period (characteristic range)	91-113 days
Freeze-free period (characteristic range)	118-138 days
Precipitation total (characteristic range)	737-838 mm
Frost-free period (actual range)	46-116 days
Freeze-free period (actual range)	90-146 days

Precipitation total (actual range)	711-889 mm
Frost-free period (average)	93 days
Freeze-free period (average)	125 days
Precipitation total (average)	787 mm

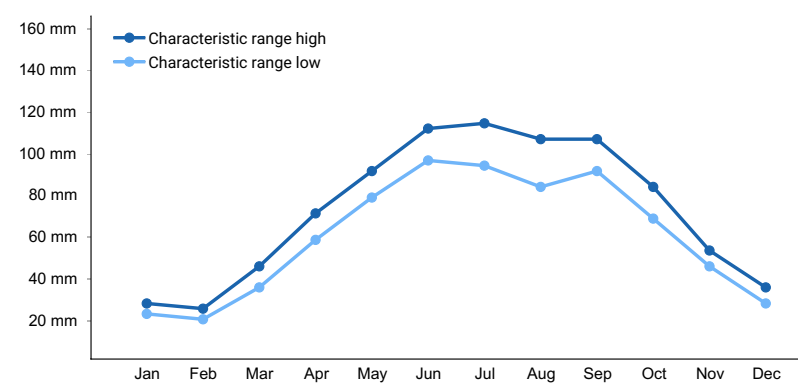


Figure 1. Monthly precipitation range

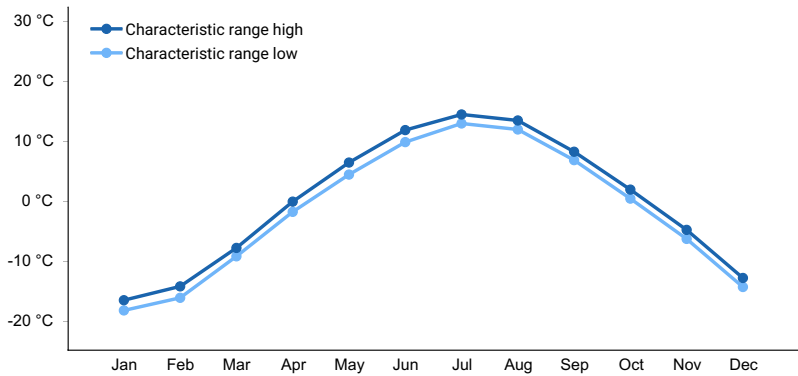


Figure 2. Monthly minimum temperature range

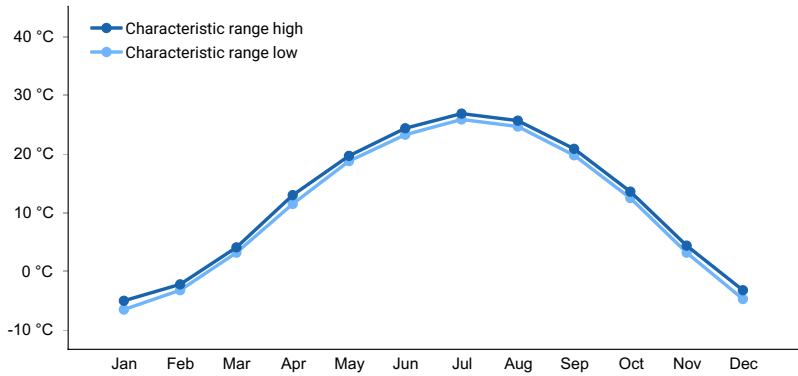
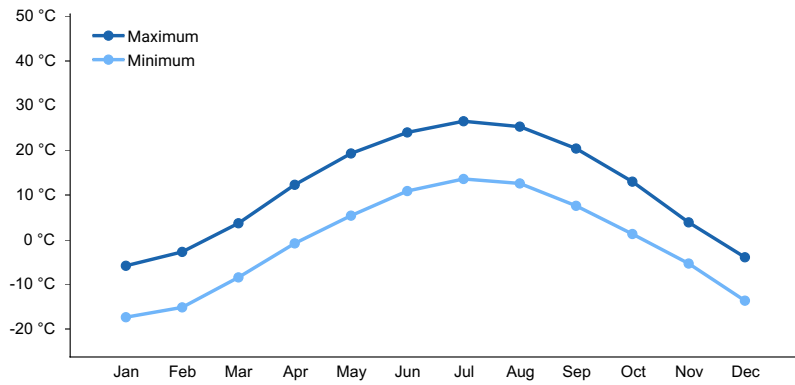
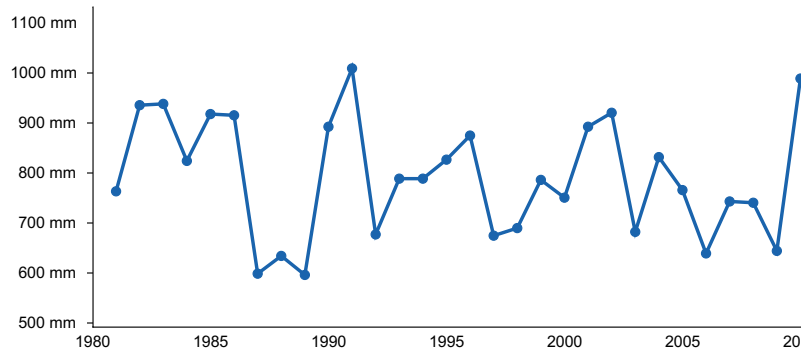


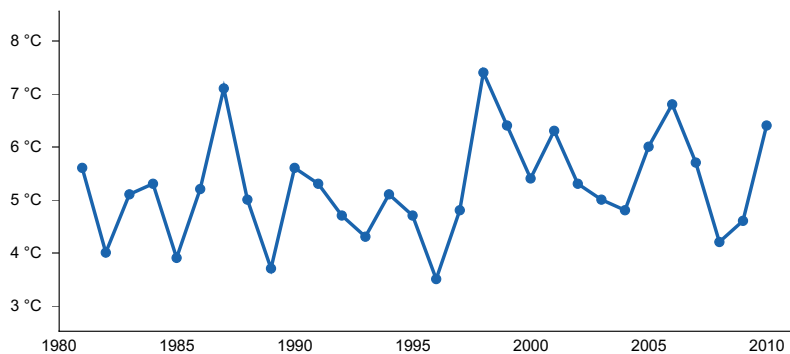
Figure 3. Monthly maximum temperature range



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



**Figure 5. Annual precipitation pattern**



**Figure 6. Annual average temperature pattern**

## Climate stations used

- (1) HOLCOMBE [USC00473698], Holcombe, WI
- (2) ROSHOLT 9 NNE [USC00477349], Wittenberg, WI
- (3) STAMBAUGH 2SSE [USC00207812], Iron River, MI
- (4) BIG FALLS HYDRO [USC00470773], Glen Flora, WI
- (5) COUDERAY 7 W [USC00471847], Stone Lake, WI
- (6) ISLE 12N [USC00214103], Isle, MN
- (7) MOOSE LAKE 1 SSE [USC00215598], Moose Lake, MN
- (8) MILACA [USC00215392], Milaca, MN
- (9) WINTER [USC00479304], Ojibwa, WI
- (10) LAKEWOOD 3 NE [USC00474523], Lakewood, WI
- (11) MINONG 5 WSW [USC00475525], Minong, WI
- (12) AMERY [USC00470175], Amery, WI
- (13) BRUNO 7ENE [USC00211074], Bruno, MN

## Influencing water features

Water is received through precipitation, runoff from adjacent uplands, and groundwater discharge. Water levels are

greatly influenced by precipitation rates and runoff from upland sites. Water leaves the site primarily through runoff, evapotranspiration, and groundwater recharge.

## Wetland description

Permeability of these sites is very slow to moderate.

Hydrologic Group: A, B, C, B/D

Hydrogeomorphic Wetland Classification: None

Cowardin Wetland Classification: None

## Soil features

These sites are represented by the Annalake, Billett, Branstad, Churchtown, Cushing, Dakota, Huntsville, Kasson, Milaca, Vlasaty soil series. Annalake is classified as an Alfic Oxyaquic Haplorthod; Billett and Churchtown are Mollic Hapludalfs; Cushing is a Haplic Glossudalf; Dakota is a Typic Argiudoll; Huntsville is a Cumulic Hapludoll; Kasson is a Mollic Oxyaquic Hapludalf; Branstad and Milaca are Oxyaquic Glossudalfs; Vlasaty is an Oxyaquic Hapludalf.

These sites formed in various parent materials including loamy till; loamy colluvium; loamy residuum; loamy or silty alluvium; loamy drift; loess; sandy eolian deposits; and sandy and gravelly outwash. Soils are moderately well or well drained. They do not meet hydric soil requirements.

The surface of these sites is sandy loam, silt loam, clay loam, loam, loamy sand, and highly decomposed plant material. Some sites have fine sands, and some have cobbly modifier. Subsurface textures consist of sandy loam, silt loam, clay loam, loam, silty clay, clay, loamy sand, and sand. Some soils have fine or very fine sand, and some have gravelly and cobbly modifiers. Soil pH ranges from strongly acid to moderately alkaline with values of 5.3 to 7.9. Carbonates can be present up to 10 percent beginning at 25 inches.

**Table 4. Representative soil features**

Parent material	(1) Alluvium (2) Outwash (3) Till (4) Sandstone and shale (5) Residuum (6) Eolian deposits (7) Limestone, sandstone, and shale (8) Igneous and metamorphic rock
Surface texture	(1) Loamy sand (2) Sandy loam (3) Loam (4) Silt loam (5) Clay loam
Drainage class	Moderately well drained to well drained
Permeability class	Very slow to moderate
Soil depth	201–249 cm
Surface fragment cover ≤3"	0–7%
Surface fragment cover >3"	0–4%
Available water capacity (0–154.9cm)	5.56–12.7 cm
Calcium carbonate equivalent (0–100.1cm)	0–10%
Soil reaction (1:1 water) (0–100.1cm)	5.3–7.9
Subsurface fragment volume ≤3" (Depth not specified)	1–16%

Subsurface fragment volume >3" (Depth not specified)	0–20%
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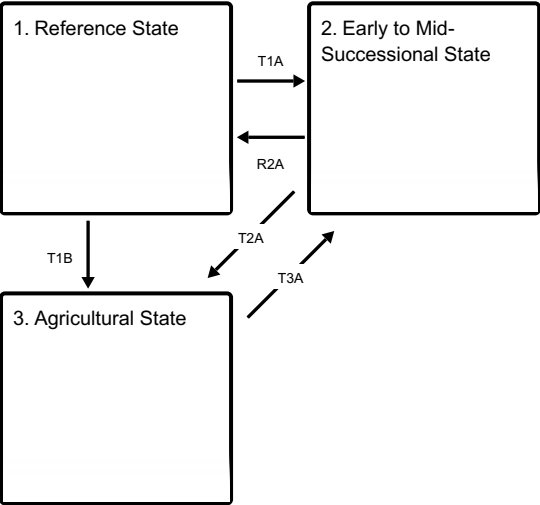
Ecological dynamics

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, red maple, and other mesic hardwoods. 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.

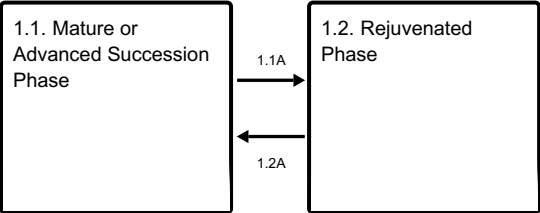
State and transition model

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 cover and tilling for agricultural crop production.
- T3A** - Removal of forest vegetation and tilling.

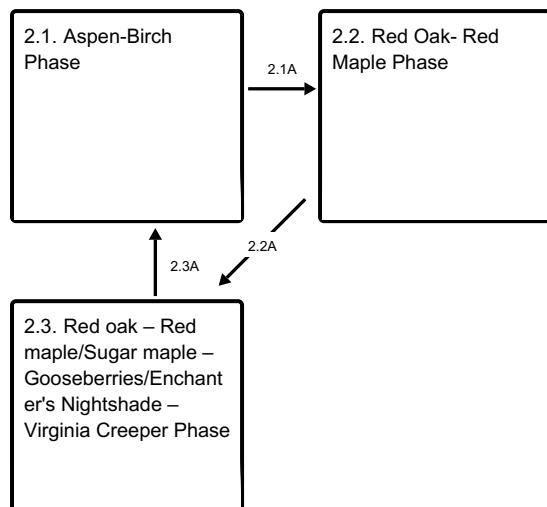
State 1 submodel, plant communities



**1.1A** - Natural mortality in the oldest age classes, sporadic small-scale blow-downs and ice storms, create openings for entry of mid-tolerant species, such as red oak and red maple.

**1.2A** - Time and natural succession.

#### State 2 submodel, plant communities

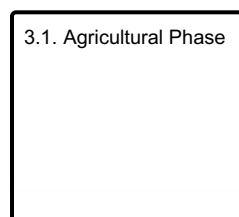


**2.1A** - Red oak and red maple regenerating under aspen -- paper birch canopy

**2.2A** - Time and natural succession.

**2.3A** - Clear cutting or stand-replacing fire.

#### State 3 submodel, plant communities



### State 1 Reference State

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

### Community 1.1 Mature or Advanced Succession Phase

In the absence of any major disturbance, specifically fire, this community is dominated by sugar maple. Common associates include other mesic hardwoods like basswood (*Tilia Americana*) and white ash (*Fraxinus americana*), and on some sites may include red oak (*Quercus rubra*) and white pine (*Pinus strobus*). Red oak and white pine require some disturbance to create gaps for regeneration; with the absence of disturbance, they are less common in the canopy. The shrub layer is often dominated by gooseberries (*Ribes*, spp.) and maple saplings. The ground layer is dominated by enchanter's nightshade (*Circaea lutetiana*), Virginia creeper (*Parthenocissus quinquefolia*), bedstraw (*Gallium*, spp.), Jack-in-the-pulpit (*Arisaema triphyllum*), and other species commonly found in medium to rich soils.

#### Dominant plant species

- sugar maple (*Acer saccharum*), tree
- white ash (*Fraxinus americana*), tree
- basswood (*Tilia*), tree



- Missouri gooseberry (*Ribes missouriense*), shrub
- enchanter's nightshade (*Circaea*), other herbaceous
- Virginia creeper (*Parthenocissus quinquefolia*), other herbaceous

## **Community 1.2**

### **Rejuvenated Phase**

This community is often dominated by sugar maple, red oak, and red maple. The shrub and ground layers are similar to the advanced succession phase, but may include the establishment of new seedlings.

#### **Dominant plant species**

- sugar maple (*Acer saccharum*), tree
- northern red oak (*Quercus rubra*), tree
- red maple (*Acer rubrum*), tree
- Missouri gooseberry (*Ribes missouriense*), shrub
- common pricklyash (*Zanthoxylum americanum*), shrub
- enchanter's nightshade (*Circaea xintermedia*), other herbaceous
- Virginia creeper (*Parthenocissus quinquefolia*), 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, releasing advance regeneration and stimulating new seedling establishment. Some additional less shade tolerant species such as red oak and white pine 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. Lacking a major disturbance, the canopy will likely be replaced with red and 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 described in Transition T1A a wide range of forest community phases may come into temporary existence, the three most common ones are described here.

## **Community 2.1**

### **Aspen-Birch Phase**

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

#### **Dominant plant species**

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

## **Community 2.2**

### **Red Oak- Red Maple Phase**

This community phase occurs by invading and succeeding a pioneer aspen-birch community. 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, dominated by beaked hazelnut (*Corylus cornuta*), typically

reaches its best development in this community phase.

#### **Dominant plant species**

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

### **Community 2.3**

#### **Red oak – Red maple/Sugar maple – Gooseberries/Enchanter's Nightshade – Virginia Creeper Phase**

This community phase represents distinct transition into mid-successional state, by strong presence in second canopy, or in reproductive layers, of shade-tolerant species, sugar maple, basswood, white ash. Sporadic occurrence of individual white pine trees also is common.

#### **Dominant plant species**

- northern red oak (*Quercus rubra*), tree
- red maple (*Acer rubrum*), tree
- sugar maple (*Acer saccharum*), tree
- Missouri gooseberry (*Ribes missouriense*), shrub
- enchanter's nightshade (*Circaea xintermedia*), other herbaceous
- Virginia creeper (*Parthenocissus quinquefolia*), other herbaceous

### **Pathway 2.1A**

#### **Community 2.1 to 2.2**

Time and the immigration, establishment, and growth of white and red pine seedlings. This pathway most likely includes small, but frequent fire disturbance that favors the shade intolerant, and fire adapted red pine, and moderately tolerant white pine.

### **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**

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**

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

## **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.

## **Transition T3A**

### **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.

Habitat Types of N. & S. Wisconsin (Kotar, 2002 & 1996): The sites of this ES keyed out to four habitat types: *Acer saccharum*/Caulophyllum-Circaea (ACaCi); *Acer saccharum*/Athyrrium (AAt); *Acer rubrum*/Circaea (ArCi)

Biophysical Settings (Landfire, 2014): This ES is largely mapped as Laurentian-Acadian Northern Hardwoods Forest, Eastern Cool Temperate Pasture and Hayland, Eastern Cool Temperate Row Crop, and Eastern Cool Temperate Close Grown Crop

WDNR Natural Communities (WDNR, 2015):

### **Other references**

Cleland, D.T.; Avers, P.E.; McNab, W.H.; Jensen, M.E.; Bailey, R.G., King, T.; Russell, W.E. 1997. National Hierarchical Framework of Ecological Units. Published in, Boyce, M. S.; Haney, A., ed. 1997. Ecosystem Management Applications for Sustainable Forest and Wildlife Resources. Yale University Press, New Haven, CT. pp. 181-200.

County Soil Surveys from St. Croix, Polk, Barron, Rusk, Chippewa, Clark, Marathon, Taylor, Price, Sawyer, Burnett, Washburn, Douglas, Bayfield, Ashland, Lincoln, Oneida, Langlade, Shawano, Menominee, Forest, Florence, Marinette, and Pierce Counties.

Curtis, J.T. 1959. Vegetation of Wisconsin: an ordination of plant communities. University of Wisconsin Press, Madison. 657 pp.

Davis, R.B. 2016. Bogs and Fens, A Guide to the Peatland Plants of Northeastern United States and Adjacent Canada. University Press of New England, Hanover and London. 296 pp.

Finley, R. 1976. Original vegetation of Wisconsin. Map compiled from U.S. General Land Office notes. U.S. Forest

Service, North Central Forest Experiment Station, St. Paul, Minnesota.

Hvizdak, David. Personal knowledge and field experience.

Jahnke, J. and Gienccke, A. 2002. MLRA 92 Clay Till Field Investigations. Summary of field day investigations by Region 10 Soil Data Quality Specialists.

Kotar, J. 1986. Soil – Habitat Type relationships in Michigan and Wisconsin. *J. For. and Water Cons.* 41(5): 348-350.

Kotar, J., J.A. Kovach and G. Brand. 1999. Analysis of the 1996 Wisconsin Forest Statistics by Habitat Type. U.S.D.A. For. Serv. N.C. Res. Stn. Gen. Tech. Rept. NC-207.

Kotar, J., J. A. Kovach, and T. L. Burger. 2002. A Guide to Forest Communities and Habitat Types of Northern Wisconsin. Second edition. University of Wisconsin-Madison, Department of Forest Ecology and Management, Madison.

Kotar, J., and T. L. Burger. 2017. Wetland Forest Habitat Type Classification System for Northern Wisconsin: A Guide for Land Managers and landowners. Wisconsin Department of Natural Resources, PUB-FR-627 2017, Madison.

Martin, L. 1965. The physical geography of Wisconsin. Third edition. The University of Wisconsin Press, Madison.

McNab, W.H. and P.W. Avers. 1994. Ecological Subregions of the United States: Section Descriptions. USDA For. Serv. Pun. WO-WSA-5, Washington, D.C.

NatureServe. 2018. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S.A. Data current as of 28 August 2018.

Radeloff, V.C., D.J. Mladenoff, H.S. He and M.S. Boyce. 1999. Forest landscape change in Northwestern Wisconsin Pine Barrens from pre-European settlement to the present. *Can. J. For. Res.* 29: 1649-1659.

Schulte, L.A., and D.J. Mladenoff. 2001. The original U.S. public land survey records: their use and limitations in reconstructing pre-European settlement vegetation. *Journal of Forestry* 99:5–10.

Schulte, L.A., and D.J. Mladenoff. 2005. Severe wind and fire regimes in northern forests: historical variability at the regional scale. *Ecology* 86(2):431–445.

Soil Survey Staff. Input based on personal experience. Tim Miland, Scott Eversoll, Ryan Bevernitz, and Jason Nemecek.

Stearns, F. W. 1949. Ninety years change in a northern hardwood forest in Wisconsin. *Ecology*, 30: 350-58.

United States Department of Agriculture, Forest Service. 1989. Proceedings – Land Classification Based on Vegetation: Applications for Management. Gen. Tech. Report INT-527.

United States Department of Agriculture, Forest Service. 1990. Silvics of North America, Vol. 1, Hardwoods. Agricultural Handbook 654, Washington, D.C.

United States Department of Agriculture, Forest Service. 1990. Silvics of North America, Vol. 2, Conifers. Agricultural Handbook 654, Washington, D.C.

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land Resource and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296.

United States Department of Agriculture, Natural Resources Conservation Service. 2008. Hydrogeomorphic Wetland Classification System: An Overview and Modification to Better Meet the Needs of the Natural Resources

Conservation Service. Technical Note No. 190-8-76. Washington D.C.

Wilde, S.A. 1933. The relation of soil and forest vegetation of the Lake States Region. Ecology 14: 94-105.

Wilde, S.A. 1976. Woodlands of Wisconsin. University of Wisconsin Cooperative Extension, Pub. G2780, 150 pp.

Wisconsin Department of Natural Resources. 2015. The ecological landscapes of Wisconsin: An assessment of ecological resources and a guide to planning sustainable management. Wisconsin Department of Natural Resources, PUB-SS-1131 2015, Madison.

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## Acknowledgments

NRCS contracted UWSP to write ecological sites in MLRA 90B, completed in 2021.

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

## Indicators

### 1. Number and extent of rills:

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### 2. Presence of water flow patterns:

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

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

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