Ecological site F090AY015WI
Loamy Upland with Carbonates

Last updated: 10/02/2023
Accessed: 05/10/2025

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): 090A–Wisconsin and Minnesota Thin Loess and Till

MLRA 90A is part of the recently glaciated till and outwash plains of central Minnesota and northern Wisconsin. The area was covered with loamy alluvium or loess after glaciation. It is in Wisconsin (56 percent), Minnesota (40 percent), and Michigan (4 percent). It makes up about 21,967 square miles (56,901 square kilometers).

This MLRA has distinct boundaries to the north where it borders tills of a dissimilar origin on the less morainic landscapes of MLRAs 88, 92, and 93A. The boundary to the west is where the MLRA transitions to the calcareous tills of the Des Moines Lobe, in MLRA 57. To the south, MLRA 90A borders MLRA 90B, which has older soils and better-defined drainage patterns, and MLRA 91, which has the distinct lower landscape relief of an outwash channel.

The part of this area in Minnesota is mostly in the Western Lake section of the Central Lowland province of the Interior Plains. Nearly all the parts in Wisconsin and Michigan are in the Superior Upland province of the Laurentian Upland. Four distinct lobes of the Laurentide Ice Sheet (Rainy, Superior, Chippewa, and Green Bay) played major roles in shaping the landscape in this area. The landscape is characterized by gently undulating to rolling, loess-mantled till plains, drumlin fields, and end moraines mixed with outwash plains associated with major glacial drainageways, swamps, bogs, and fens. In some areas lake plains and ice-walled lakes are significant. Steeper areas occur mostly as valley side slopes along flood plains and as escarpments along the margins of lakes.

Lakes, ponds, and marshes are common throughout the area, and streams generally have a dendritic pattern. The major rivers in this area are the Chippewa, St. Croix, Mississippi, and Wisconsin Rivers. Elevation ranges from 1,100 to 1,950 feet (335 to 595 meters). Local relief is mainly less than 10 feet to 20 feet (3 to 6 meters), but some major valleys and hills are 200 feet (60 meters) above the adjacent lowland.

Precambrian-age bedrock underlies most of the glacial deposits in this MLRA. The bedrock is a complex of folded and faulted igneous and metamorphic rocks. The bedrock terrain has been modified by glaciation and is covered in most areas by Pleistocene deposits and windblown silts. The glacial deposits form an almost continuous cover in most areas. The drift is several hundred feet thick in many areas. Loess covered the area shortly after the glacial ice melted.

Ground water is abundant in deep glacial deposits in most of this area. It also occurs in sedimentary and volcanic rock in the western part of the area. It is scarce where the layer of drift is thin. The water meets the domestic, agricultural, municipal, industrial, rural, and irrigation needs of the area. The content of dissolved solids in the ground water from all the various aquifers in this area is low, and the water generally is moderately hard or hard. The level of total dissolved solids in some of the water can be much higher because of a high content of limestone in some of the glacial deposits. Most of this area obtains ground water from unconsolidated glacial sand and gravel deposits on or very near the surface. Some wells tap the Cambrian sandstone in the southwestern part of the area, in Wisconsin.

In northwest Wisconsin (Ashland and Bayfield Counties) where there are no glacial deposits and in much of the part of this area in Minnesota, ground water from sedimentary and volcanic rock aquifers is used. This water is of very good quality; however, many soils have very porous layers that are poor filters of domestic waste and agricultural chemicals, so there is a risk of contamination from development and agriculture. Minor water concerns are hardness and, in some areas, high concentrations of iron. Yields of water from the glacial deposits vary.

The dominant soil orders are Alfisols, Entisols, Histosols, and Spodosols. The soils in the area have a frigid temperature regime, a udic or aquic moisture regime, and mixed mineralogy.

This area has a significant acreage of public and private forestland used to support the paper and lumber industry Sap collection from sugar maple and syrup production are important forestry enterprises. Agricultural enterprises include row crops, dairy farms, and beef operations. Crops include corn, soybeans, oats, wheat, and alfalfa. Tourism, recreation, and wildlife management are important. Hunting, fishing, snowmobiling, hiking, and skiing are popular activities because of the area's abundance of water, the many acres of national and county forests, and public hunting grounds. (United States Department of Agriculture, Natural Resources Conservation Service, 2022)

Classification relationships

Major Land Resource Area (MLRA 90A): Wisconsin and Minnesota Thin Loess and Till

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 MLRA 90A, 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.

Associated sites

F090AY010WI	**Moist Loamy Lowland with Carbonates** 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.

Similar sites

F090AY014WI	**Loamy Bedrock Upland** 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.

F090AY016WI	**Loamy Upland** 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) *Acer saccharum* (2) *Fraxinus americana*
Shrub	(1) *Ribes missouriense*
Herbaceous	(1) *Amphicarpaea* (2) *Actaea rubra*

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	591–1,148 ft
Slope	0–60%
Water table depth	18–79 in
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)	29-33 in
Frost-free period (actual range)	46-116 days
Freeze-free period (actual range)	90-146 days
Precipitation total (actual range)	28-35 in
Frost-free period (average)	93 days
Freeze-free period (average)	125 days
Precipitation total (average)	31 in

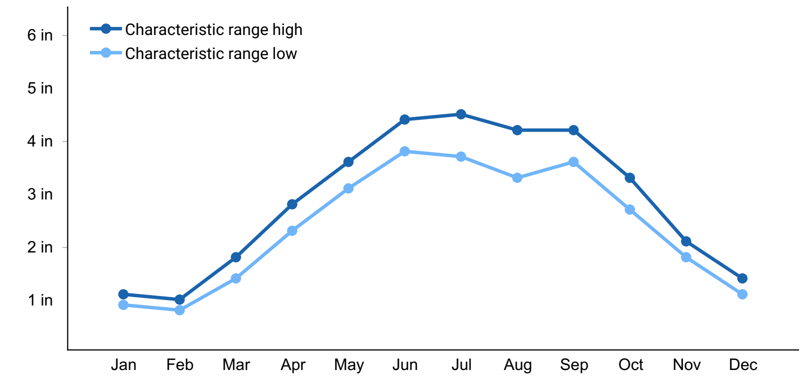


Figure 1. Monthly precipitation range

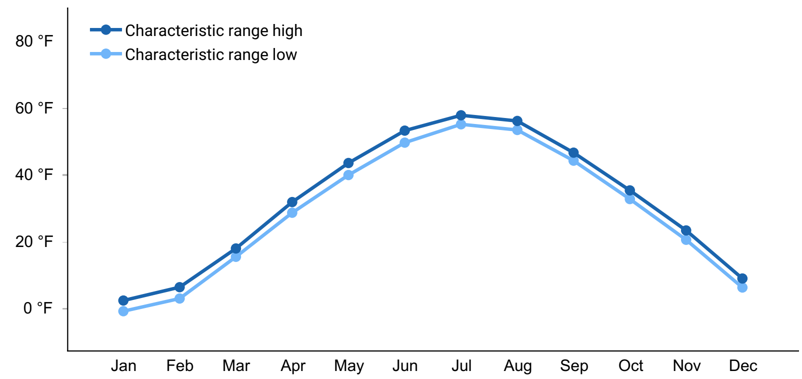


Figure 2. Monthly minimum temperature range

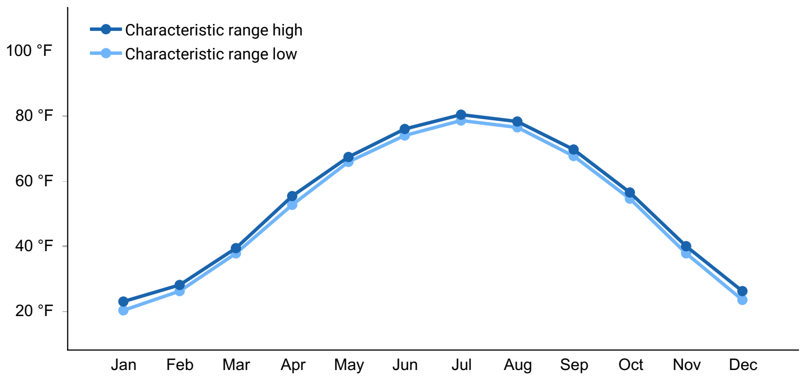


Figure 3. Monthly maximum temperature range

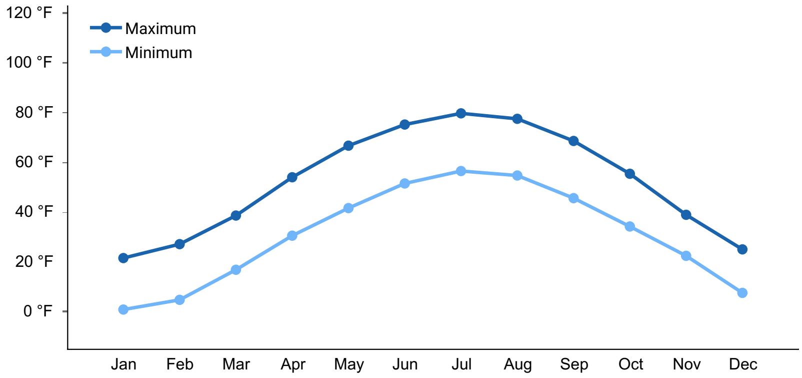


Figure 4. Monthly average minimum and maximum temperature

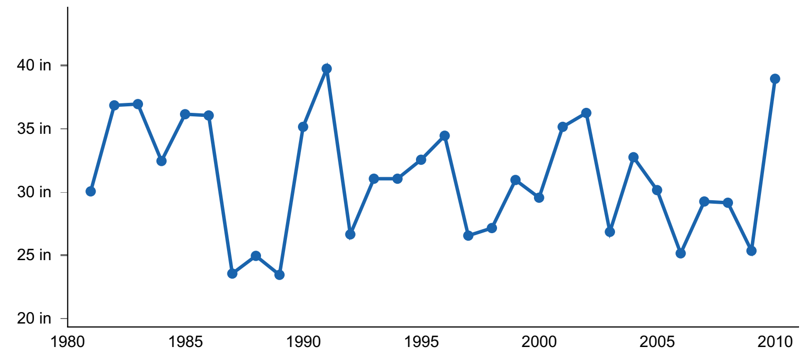


Figure 5. Annual precipitation pattern

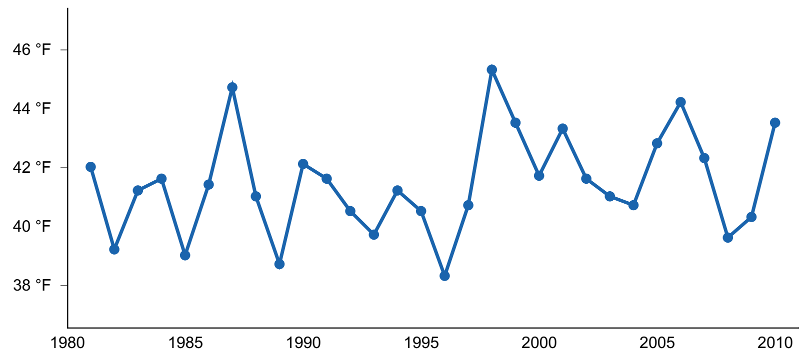


Figure 6. Annual average temperature pattern

Climate stations used

- (1) 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.

Figure 7. Huntsville soil series photograph courtesy of UWSP taken on 7/25/2019 in St. Croix County, WI.

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	79–98 in
Surface fragment cover <=3"	0–7%
Surface fragment cover >3"	0–4%
Available water capacity (0-61in)	2.19–5 in
Calcium carbonate equivalent (0-39.4in)	0–10%
Soil reaction (1:1 water) (0-39.4in)	5.3–7.9
Subsurface fragment volume <=3" (Depth not specified)	1–16%
Subsurface fragment volume >3" (Depth not specified)	0–20%

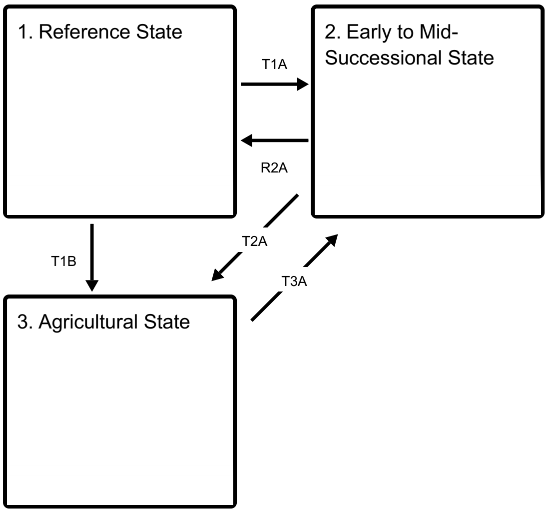
Ecological dynamics

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.

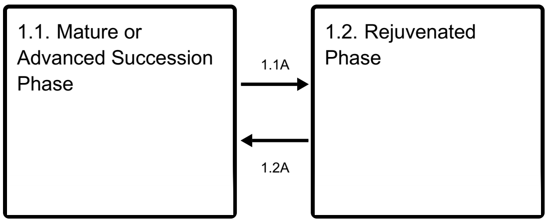
T1B - Removal of forest cover and tilling for agricultural crop production.

R2A - Disturbance-free period 70+ years.

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

T3A - Stopping of agricultural practices and allowing to natural revegetation, or site is replanted.

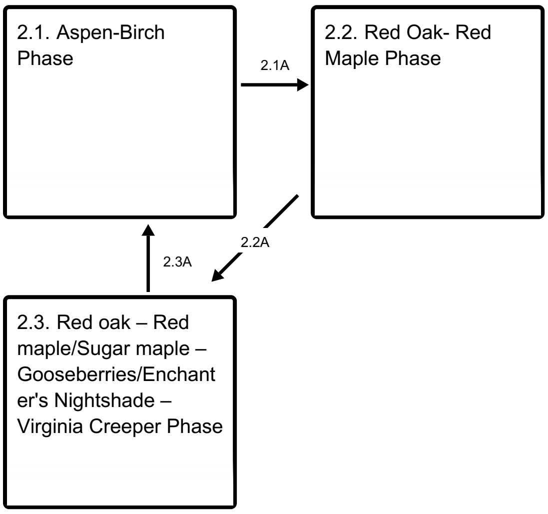
State 1 submodel, plant communities



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

3.1. Agricultural Phase

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

Figure 8. Photo courtesy of UWSP taken on 8/1/2019 in Polk County, WI.

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

Figure 9. Photo courtesy of UWSP taken on 8/1/2019 in Polk County, WI.

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 ×intermedia*), other herbaceous
- Virginia creeper (*Parthenocissus quinquefolia*), other herbaceous

Pathway 1.1A
Community 1.1 to 1.2

Mature or Advanced Succession Phase

Rejuvenated Phase

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

Rejuvenated Phase

Mature or Advanced Succession Phase

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

Figure 10. Photo courtesy of UWSP taken on 7/26/2019 in St. Croix County, WI.

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 ×intermedia*), 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

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.

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*/Athyrium (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

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 Satandard: Terrestrial Ecological Classifications. NautreServe Centreal 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. 2022. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture, 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.

Contributors

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

Approval

Suzanne Mayne-Kinney, 10/02/2023

Acknowledgments

NRCS contracted UWSP to write ecological sites in MLRA 90A, 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	05/10/2025
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:

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:**