

Ecological site F090BY014WI Loamy Bedrock 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): 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: Rib Mountain Rolling Ridges (212Qd), Lincoln Formation Till Plain - Hemlock Hardwoods (212Qc), Lincoln Formation Till Plain - Mixed Hardwoods (212Qb), Brule and Paint Rivers Drumlinized Ground Moraine (212Xc), Rosemont Baldwin Plains and Moraines (222Md)

Small sections occur in Crystal Falls Till and Outwash (212Xq), Perkinstown End Moraine (212Xe), Hayward Stagnation Moraines (212Xf), Mille Lacs Uplands (212Kb)

Wisconsin DNR Ecological Landscapes: Forest Transition, Western Prairie, North Central Forest, Northwest Lowlands

Ecological site concept

The Loamy Bedrock Upland ecological site is common to the southern portion of MLRAs 90A and 90B, located on till plains. These sites are characterized by moderately deep to very deep, moderately well to well drained soils that formed primarily in loamy till deposits over bedrock, but also include loess, alluvium, outwash, and pedisegment. Bedrock types include granite, quartzite, gneiss, basalt, sandstone, interbedded sandstone and shale, limestone, and igneous and metamorphic rock. Precipitation and runoff from adjacent uplands are the primary sources of water. Soils range from very strongly acid to slightly alkaline.

Loamy Bedrock Upland is distinguished from other sites based on drainage and moderately deep profile. The underlying bedrock can perch water and cause limitations to growth, acting as a root restricting layer. These sites may be more vulnerable to tree tips. The loamy materials differentiate this site from other moderately well and well drained sites that have sandy or clayey deposits. Loamy materials often have higher pH and available water capacity than sand, but less than clay. The drainage differentiates this site from other loamy sites.

Associated sites

| | |
|-------------|---|
| F090BY007WI | Wet Clayey Lowland Wet Clayey Lowland form in deep, loamy to clayey deposits derived from a mixture of alluvium, residuum, till, or lacustrine sources. These sites have a seasonally high water table at the surface, and some are subject to occasional ponding. Sustained saturation is enough for hydric conditions to occur. They are wetter and occur lower on the drainage sequence than Loamy Bedrock Upland. |
| F090BY008WI | Moist Sandy Bedrock Upland Moist Bedrock Lowland sites consist of sandy to clayey alluvium, till, or eolian deposits over residuum weathered from bedrock. Bedrock contact occurs within two meters of the surface. Sites have seasonally high water table within a meter of the surface. Perching of the water table may occur as a result of bedrock contact. They are wetter and occur lower on the drainage sequence than Loamy Bedrock Upland. |
| F090BY021WI | Dry Loamy Upland Dry Loamy Upland consist of deep sandy to loamy outwash, alluvium, or till. The water table is deeper than two meters year-round. They are drier and occur higher on the drainage sequence than Loamy Bedrock Upland. |

Similar sites

| | |
|-------------|--|
| F090BY017WI | Clayey Upland Clayey Upland consist of loamy to clayey residuum or lacustrine deposits overlain by loess or sandy outwash. Bedrock contact may occur within two meters of the surface. These sites have a seasonally high water table within one meter of the surface, though they are not saturated for sustained periods. They occupy the same landscape positions and have the same drainage class as Loamy Bedrock Upland but have finer textures. |
|-------------|--|

| | |
|-------------|--|
| F090BY016WI | <p>Loamy Upland</p> <p>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 occupy the same landscape positions and have the same drainage class an particle size as Loamy Bedrock Upland, but they lack bedrock contact within two meters.</p> |
| F090BY015WI | <p>Loamy Upland with Carbonates</p> <p>Loamy Upland with Carbonates consist of deep loamy till, colluvium, alluvium, residuum, or eolian deposits. Some sites may also have sandy outwash or eolian deposits. Carbonates are present in these soils. 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 occupy the same landscape positions and have the same drainage class an particle size as Loamy Bedrock Upland, but they lack bedrock contact within two meters.</p> |

Table 1. Dominant plant species

| | |
|------------|--|
| Tree | (1) <i>Acer saccharum</i> (2) <i>Fraxinus americana</i> |
| Shrub | (1) <i>Ostrya virginiana</i> |
| Herbaceous | (1) <i>Amphicarpaea</i> (2) <i>Actaea rubra</i> |

Physiographic features

These sites formed on till plains. Slope is 0 to 60 percent.

These sites are not subject to ponding or flooding. Sites have a seasonally high water table at a depth of 24 to 80 inches. The water table may drop below 90 inches during dry conditions on these sites. Surface runoff is low to very high.

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) Till plain |
| Runoff class | Low to very high |
| Flooding frequency | None |
| Ponding frequency | None |
| Elevation | 180–305 m |
| Slope | 0–60% |
| Water table depth | 61–201 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 49 inches. The annual average maximum and minimum temperatures are 53°F and 33°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 |

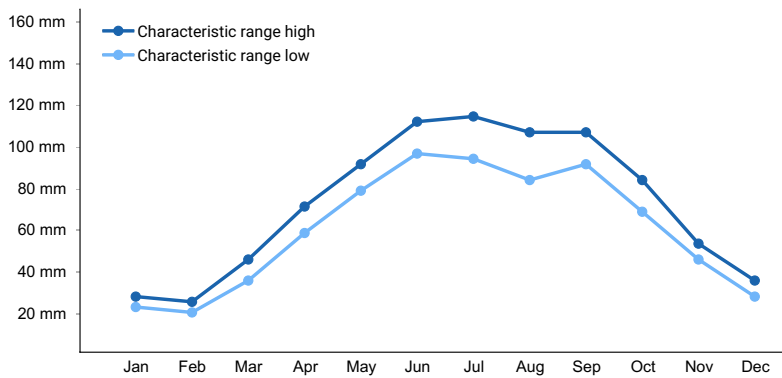


Figure 1. Monthly precipitation range

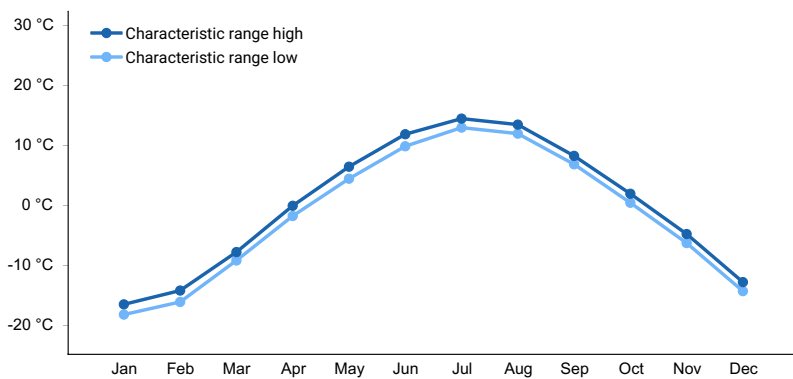


Figure 2. Monthly minimum temperature range

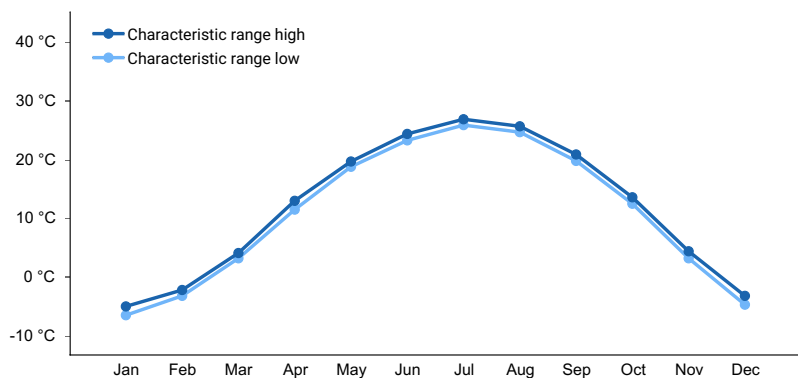


Figure 3. Monthly maximum temperature range

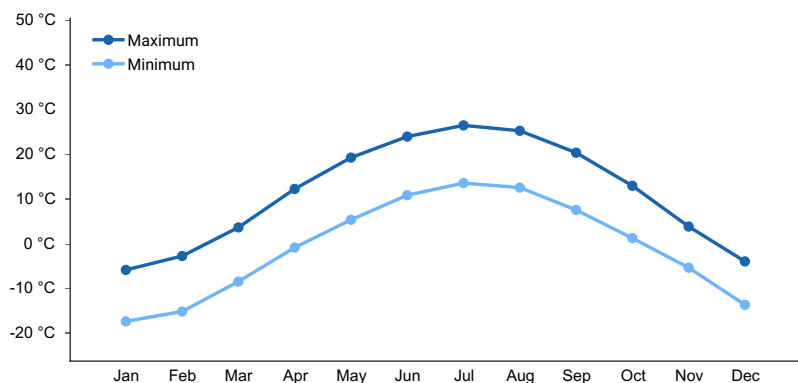


Figure 4. Monthly average minimum and maximum temperature

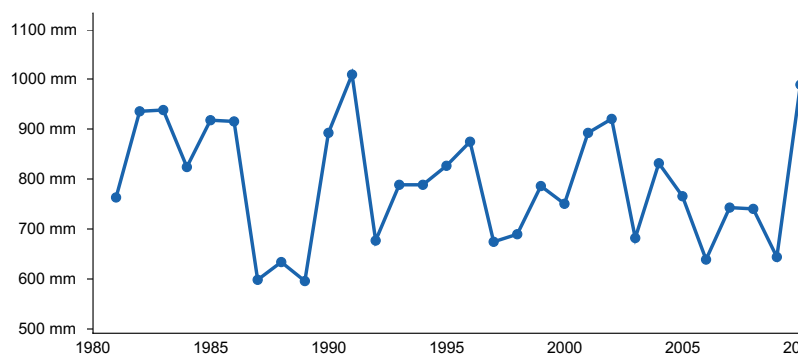


Figure 5. Annual precipitation pattern

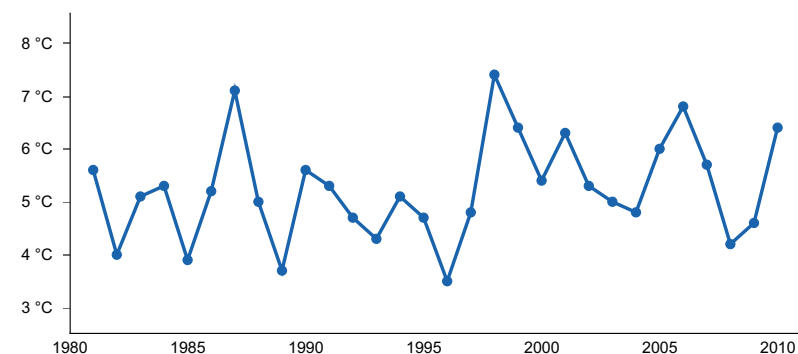


Figure 6. Annual average temperature pattern

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. Subsurface flow may occur where water perches on bedrock.

Wetland description

Permeability of these sites is impermeable to moderately slow.

Hydrologic Group: A, B, C, D

Hydrogeomorphic Wetland Classification: None

Cowardin Wetland Classification: None

Soil features

These sites are represented by the Arland, Dakota, Eaupleine, Eaupleine Variant, Elevasil, Fenwood, Hiles, Hixton, Humbird, Marathon, Mequithy, Metonga, Milaca, Mosinee, Norgo, Norgo Variant, Ribhill, Ritchey, Rockton, and Whalan soil series. Arland, Eaupleine, Eaupleine Variant, Fenwood, Marathon, and Ribhill are classified as Haplic Glossudalfs; Mequithy is an Alfic Haplorthod; Metonga and Rosholt Variant are Entic Haplorthods; Lundeen is a Humic Dystrudept; Norgo and Ritchey are Lithic Hapludalfs; Hiles and Milaca are Oxyaquic Glossudalfs; Humbird is an Oxyaquic Ultic Haplorthod; Dakota and Rockton are Typic Argiudolls; Mosinee is a Typic Dystrudept; Norgo Variant, Rosholt Variant, Hixton, and Whalan are Typic Hapludalfs; Elevasil is an Ultic Hapludalf.

These sites formed in various parent materials including loess; loamy or silty alluvium; loamy till; loamy, sandy, or silty residuum; sandy and gravelly outwash; clayey pedisidment; and silty or loamy drift. Soil depth to bedrock ranges from 17 to 72 inches. Soils are moderately well and well drained and do not meet hydric soil requirements.

The surfaces textures of these sites are sandy loam, silt loam, or loam. Some horizons have fine or very fine sand, and cobbly modifiers. Subsurface horizons consist of sandy loam, silt loam, clay loam, loam, and clay, loamy sand, and sand textures. Some horizons have fine or very fine sand, and gravelly or cobbly modifiers. Soil pH ranges from very strongly acid to slightly alkaline with values from 4.5 to 7.5. Carbonates may be present up to 10 percent beginning at 10 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) Silt loam (2) Sandy loam (3) Loam |
| Drainage class | Moderately well drained to well drained |

| | |
|---|------------------------------|
| Permeability class | Very slow to moderately slow |
| Soil depth | 43–183 cm |
| Surface fragment cover <=3" | 0–6% |
| Surface fragment cover >3" | 0–5% |
| Available water capacity (0-154.9cm) | 3.33–10.46 cm |
| Calcium carbonate equivalent (0-100.1cm) | 0–10% |
| Soil reaction (1:1 water) (0-100.1cm) | 4.5–7.5 |
| Subsurface fragment volume <=3" (Depth not specified) | 2–22% |
| Subsurface fragment volume >3" (Depth not specified) | 0–22% |

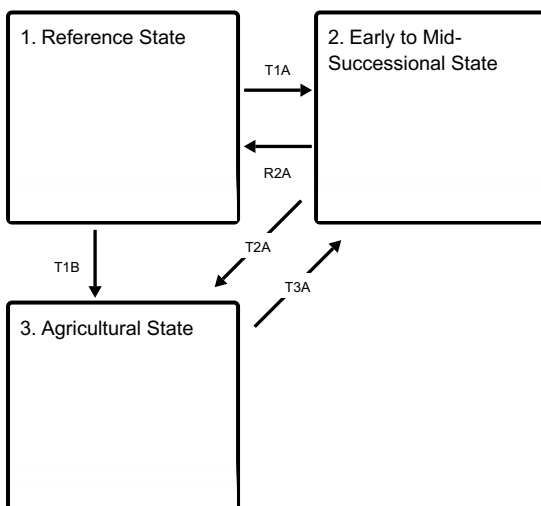
Ecological dynamics

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, they 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.

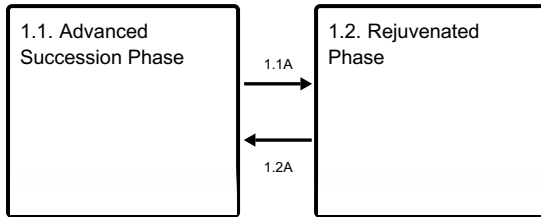
T1B - Removal of forest vegetation and tilling.

R2A - Disturbance-free period 70+ years.

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

T3A - Removal of forest vegetation and tilling.

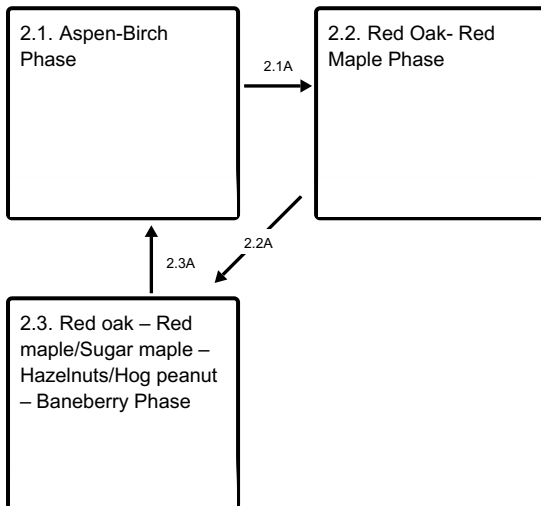
State 1 submodel, plant communities



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

1.2A - Disturbance-free period for 30+ years.

State 2 submodel, plant communities

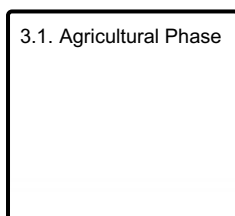


2.1A - Immigration and establishment of red oak and red maple.

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

2.3A - Clear cutting or stand-replacing fire.

State 3 submodel, plant communities



State 1 Reference State

Reference state is a forest community dominated by sugar maple (*Acer saccharum*) and white ash. 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 Advanced Succession Phase

In the absence of any major disturbance, specifically fire, this community is dominated by sugar maple. Common associates include moderately shade tolerant white ash, basswood, and red oak. Some sites may be dominated by red oak but is unlikely without any disturbance. The shrub layer is often dominated by ironwood, witch hazel, and hazelnuts. The ground layer is dominated by hog peanut and baneberry, with goldenrod, Enchanter's nightshade, and wood ferns also common.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- white ash (*Fraxinus americana*), tree
- American hornbeam (*Carpinus caroliniana*), shrub
- hogpeanut (*Amphicarpaea*), other herbaceous
- baneberry (*Actaea*), other herbaceous

Community 1.2 Rejuvenated Phase

This community is dominated by a mixture of hardwoods including sugar maple, red oak and white ash. Associates may include basswood and black cherry. 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
- white ash (*Fraxinus americana*), tree
- witchhazel (*Hamamelis*), shrub
- hazelnut (*Corylus*), shrub
- hogpeanut (*Amphicarpaea*), other herbaceous
- baneberry (*Actaea*), other herbaceous

Pathway 1.1A Community 1.1 to 1.2

Light intensity fires, crown breakage from ice and snow and small scale blow-downs create canopy openings, allowing gap regeneration of less shade tolerant species such as white ash red oak. These species may join the canopy composition.

Pathway 1.2A Community 1.2 to 1.1

A long period without major canopy disturbance allows gradual replacement of oldest canopy trees by younger cohorts. Lacking a major disturbance, the canopy will likely be replaced primarily with sugar maple. Small scale disturbances may still occur periodically, but once second or third canopies are established there is minimal new regeneration taking place and the forest gradually returns to mature state.

State 2 Early to Mid-Successional State

Following disturbances 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.

Dominant plant species

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

Community 2.3

Red oak – Red maple/Sugar maple – Hazelnuts/Hog peanut – Baneberry Phase

Stand structure consists of dominant red oak and red maple in combination with a modest, or strong presence of mature, or decaying, aspen and/or paper birch. The shrub layer typically reaches its best development in this community phase. Depending on seed source, sugar maple has become established and a young cohort exists in the subcanopy.

Dominant plant species

- northern red oak (*Quercus rubra*), tree
- red maple (*Acer rubrum*), tree
- sugar maple (*Acer saccharum*), tree
- hazelnut (*Corylus*), shrub
- hogpeanut (*Amphicarpaea*), other herbaceous
- baneberry (*Actaea*), other herbaceous

Pathway 2.1A

Community 2.1 to 2.2

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

Pathway 2.2A

Community 2.2 to 2.3

Time and natural succession. Red oak and 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 nine habitat types: *Acer saccharum*/Hydrophyllum (AH); *Acer saccharum*-Tsuga/Maianthemum (ATM); *Acer saccharum*/Hydrophyllum-Viburnum (AHVb); *Acer saccharum*/Vaccinium-Desmodium (AVDe); *Acer saccharum*/Athyrium (AAt); *Acer rubrum*/Circaea (ArCi); Pinus-*Acer rubrum*/Vaccinium-Hamamelis (PArVHa); Pinus/Vaccinium-Hamamelis (PVHa); Pinus/Vaccinium-Cornus (PVCr)

Biophysical Settings (Landfire, 2014): This ES is largely mapped as Laurentian-Acadian Northern Hardwoods Forest, North-Central Interior Dry-Mesic Oak Forest and Woodland, Eastern Cool Temperate Pasture and Hayland, Eastern Cool Temperate Close Grown Crop, and Eastern Cool Temperate Row 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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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 | 05/18/2024 |
| Approved by | Suzanne Mayne-Kinney |
| Approval date | |
| Composition (Indicators 10 and 12) based on | Annual Production |

Indicators

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

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

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

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

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

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

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

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

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

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

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

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:**
