USDA Natural Resources Conservation Service

Ecological site F090BY011WI
Moist Loamy Lowland

Last updated: 11/16/2023
Accessed: 05/02/2024

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 an 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 an 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 heterogenous 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 steams.

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 an 90B)

USFS Subregions: Rib Mountain Rolling Ridges (212Qd), Central-Northwest Wisconsin Loess Plains (212Xd), Glidden Loamy Drift Plain (212Xa), St. Croix Moraine (212Qa), Lincoln Formation Till Plain - Mixed Hardwoods (212Qb), Lincoln Formation Till Plain - Hemlock Hardwoods (212Qc), Green Bay Lobe Stagnation Moraine (212Ta), Brule and Paint Rivers Drumlinized Ground Moraine (212Xc), Perkinstown End Moraine (212Xe), Mille Lacs Uplands (212Kb), Rosemont Baldwin Plains and Moraines (222Md)

Small sections occur in Hayward Stagnation Moraines (212Xf) and Crystal Falls Till and Outwash (212Xq)

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

Ecological site concept

The Moist Loamy Lowland ecological site is found throughout MLRAs 90A an 90B, located in depressions, drainageways, and flats on till plains, moraines, valley trains, lake plains, and sometimes outwash plains and stream terraces. These sites are characterized by very deep, somewhat poorly drained soils that formed in loamy deposits including lacustrine, eolian, glacial till and outwash, alluvium, and residuum. Precipitation, runoff from adjacent uplands, and groundwater discharge are the primary sources of water. Soils range from very strongly acid to slightly alkaline.

Moist Loamy Lowland is distinguished from other ecological sites by its deep loamy deposits and somewhat poorly drained soils. This site lacks the elevated percentage of free carbonates found in Moist Loamy Lowland with Carbonates. Other somewhat poorly drained sites have sandy or clayey deposits. The loamy material often has a higher pH and available water capacity than sandy material, but less than clayey material. The somewhat poor drainage differentiates this site from other loamy sites.

Associated sites

F090BY002WI	**Mucky Swamp** Mucky Swamp sites consist of deep, highly decomposed herbaceous organic materials. Some sites have mineral soil contact. They are very poorly drained and are neutral to slightly acid. These sites are permanently saturated wetlands. They are much wetter and occur lower on the drainage sequence than Moist Loamy Lowland.
F090BY006WI	**Wet Loamy Lowland** Wet Loamy Lowland sites consist primarily of deep loamy deposits derived from a mixture of outwash, alluvium, loess, and lacustrine sources. Some sites may have bedrock contact within two meters of the surface. These sites are seasonally ponded depressions that remain saturated for sustained periods, allowing hydric conditions to occur. They are wetter and occur lower on the drainage sequence than Moist Loamy Lowland.
F090BY016WI	**Loamy Upland** Loamy Upland Sites 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 are drier and occur higher on the drainage sequence than Moist Loamy Lowland.
F090BY021WI	**Dry Loamy Upland** Dry Loamy Bedrock Upland sites consist of deep sandy to loamy outwash, alluvium, or till. The water table is deeper than two meters year-round. They are much drier and occur higher on the drainage sequence than Moist Loamy Lowland.

Similar sites

F090BY010WI	**Moist Loamy Lowland with Carbonates** Moist Loamy Lowland with Carbonates sites consist 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. These sites share their particle size and drainage class with Moist Loamy Lowland.
F090BY012WI	**Moist Clayey Lowland** Moist Clayey Lowland sites consist of deep clayey lacustrine deposits. The finer textures perch the water table. These soils remain moist - but not saturated - throughout much of the growing season. They are found in similar landscape positions with the same drainage class as Moist Loamy Lowland, but with finer textures.
F090BY009WI	**Moist Sandy Upland** Moist Sandy Lowland sites primarily consist of deep, sandy deposits from outwash, alluvium, lacustrine, and till. They sandy deposits may have a loamy mantle or be underlain by loamy deposits. The finer materials can cause episaturation and allow the site to remain moist for some of the growing season. They are found in similar landscape positions with the same drainage class as Moist Loamy Lowland, but with coarser textures.
F090BY004WI	**Loamy Floodplain** Loamy Floodplain are found exclusively on floodplains in loamy alluvium, sometimes underlain by sandy alluvium. Soils are very poorly to moderately well drained and are subject to flooding. Some sites may be saturated for long enough for hydric conditions to occur. They share particle size and sometimes drainage class with Moist Loamy Lowland.
F090BY008WI	**Moist Sandy Bedrock Upland** Moist Sandy Bedrock Upland 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 share drainage class and often particle size with Moist Loamy Lowland.

Table 1. Dominant plant species

Tree	(1) *Acer saccharum* (2) *Acer rubrum*
Shrub	(1) *Ribes*
Herbaceous	(1) *Parthenocissus quinquefolia* (2) *Geranium maculatum*

Physiographic features

This site occurs on depressions, drainageways, and flats in outwash plains, lake plains, till plains, valley trains, stream terraces, and moraines. Slopes range from 0 to 6 percent.

Sites are not subject to ponding or flooding. The soils have an apparent seasonally high water table at a depth of 6 to 24 inches, but the water table may drop below 80 inches during dry conditions. Runoff is negligible to high.

Table 2. Representative physiographic features

Hillslope profile	(1) Summit (2) Backslope (3) Footslope
Slope shape across	(1) Concave
Slope shape up-down	(1) Linear

Landforms	(1) Depression (2) Drainageway (3) Flat (4) Outwash plain (5) Lake plain (6) Till plain (7) Valley train (8) Stream terrace (9) Moraine
Runoff class	Negligible to high
Flooding frequency	None
Ponding frequency	None
Elevation	591–951 ft
Slope	0–6%
Water table depth	6–24 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 32 inches. The average annual snowfall is 45 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)	94-108 days
Freeze-free period (characteristic range)	125-136 days
Precipitation total (characteristic range)	32 in
Frost-free period (actual range)	93-114 days
Freeze-free period (actual range)	121-137 days
Precipitation total (actual range)	32 in
Frost-free period (average)	102 days
Freeze-free period (average)	130 days
Precipitation total (average)	32 in

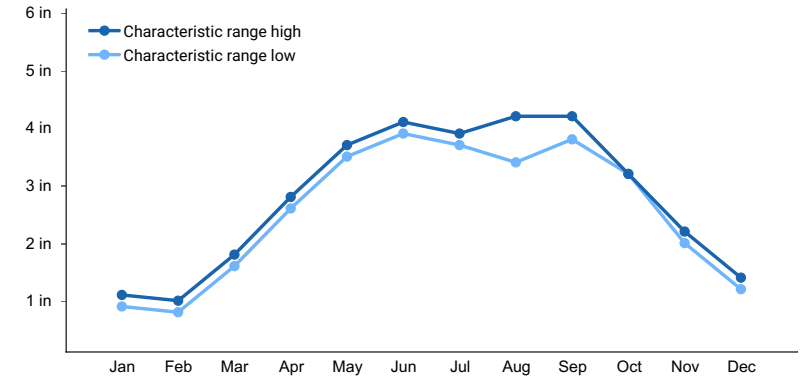


Figure 1. Monthly precipitation range

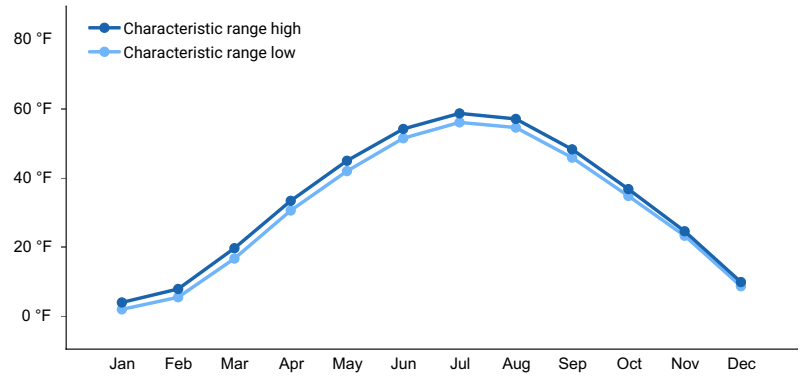


Figure 2. Monthly minimum temperature range

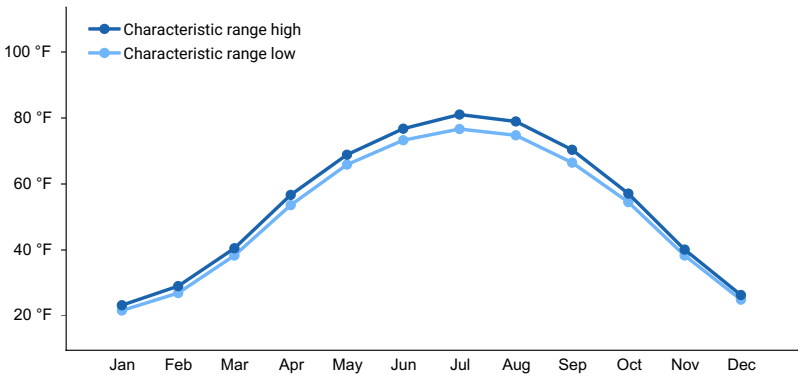


Figure 3. Monthly maximum temperature range

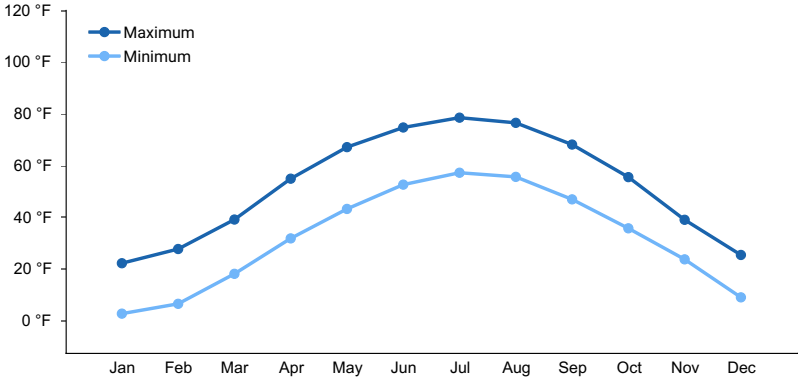


Figure 4. Monthly average minimum and maximum temperature

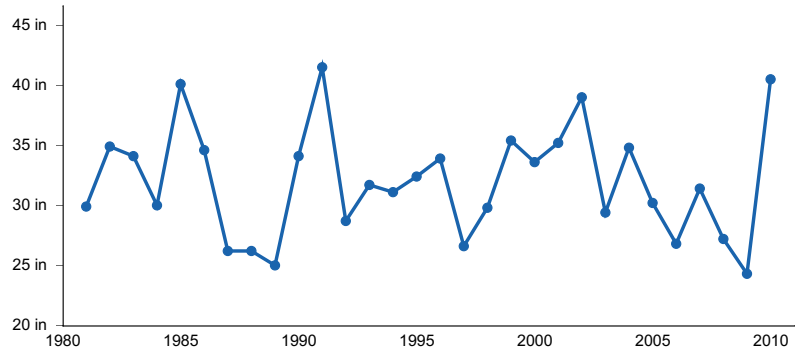


Figure 5. Annual precipitation pattern

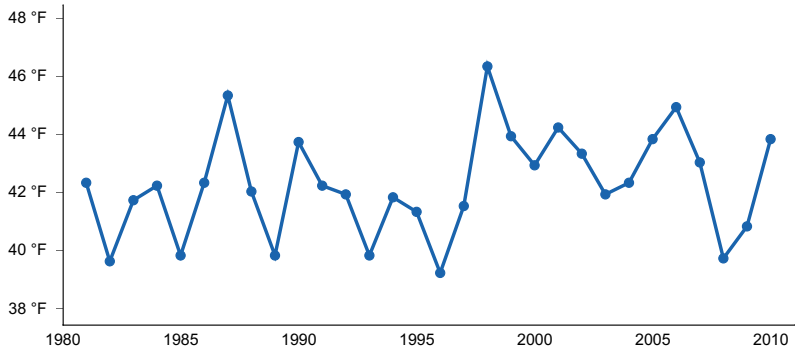


Figure 6. Annual average temperature pattern

Climate stations used

- (1) LUCK [USC00474894], Luck, WI
- (2) BIG FALLS HYDRO [USC00470773], Glen Flora, WI
- (3) LAONA 6 SW [USC00474582], Laona, WI

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 impermeable to slow.
Hydrologic Group: C, A/D, B/D, C/D
Hydrogeomorphic Wetland Classification: None
Cowardin Wetland Classification: None

Soil features

These sites are represented by the Comstock, Comstock Variant, Dakota Variant, Dolph, Fallcreek, Glendenning, Halder, Hatley, Lawler, Magnor, Maincreek, Maplehurst, Meadland, Milladore, Monico, Moodig, Mora, Mudlake, Mylrea, Parkfalls, Peeksville, Pesabic, Plover, Point, Poskin, Robago, Rockers, Shiffer, Skyberg, Smestad, Stinnett, Torch, Whisklake, and Worwood soil series. Comstock, Comstock variant, Fallcreek, Glendenning, Hatley, Magnor, Maincreek, Maplehurst, Meadland, Milladore, Mora, Oesterle, Ossmer, Plover, Point, Poskin, Stinnett, and Withee are classified as Aquic Glossudalfs; Dolph is an Aeric Glossaqualf; Moodig, Mudlake, Parkfalls, Peeksville, Pesabic, Torch, and Worwood are Alfic Epiaquods; Dakota Variant and Smestad are Aquic Argiudolls; Mylrea is an Aquic Dystrudept; Lawler is an Aquic Hapludoll; SHiffer is an Aquollic Hapludalf; Robago, Rockers, Whisklake, and Worcester are Argic Endoaquods; Monico is an Entic Haplaquod; Skyberg is a Mollic Epiaqualf.

These soils formed in various parent materials including sandy outwash; sandy, silty, or loamy alluvium; sandy or

loamy till; sandy, silty, or loamy lacustrine deposits; sandy or loamy drift; loess; and loamy residuum. Soils are very deep. Sites are somewhat poorly drained. They do not meet hydric soil requirements.

The surfaces of these sites are sandy loam, silt loam, loam, loamy sand, and slightly, moderately, and highly decomposed plant material. Some sites have fine and very fine sand modifiers. Subsurface textures include sandy loam, silt loam, clay loam, sandy clay loam, silty clay loam, loam, clay sand, loamy sand, and silt. Many horizons have fine or very fine sands, and gravelly to extremely gravelly and cobbly modifiers. Soil pH ranges from strongly acid to slightly alkaline with values of 4.6 to 7.6. Carbonates may be present up to 18 percent beginning at 34 inches.

Table 4. Representative soil features

Parent material	(1) Outwash (2) Lacustrine deposits (3) Eolian deposits (4) Alluvium (5) Till
Surface texture	(1) Loamy sand (2) Sandy loam (3) Loam (4) Silt loam
Drainage class	Somewhat poorly drained
Permeability class	Very slow to slow
Soil depth	80–100 in
Surface fragment cover <=3"	0–8%
Surface fragment cover >3"	0–2%
Available water capacity (Depth not specified)	1.77–4.51 in
Calcium carbonate equivalent (Depth not specified)	0–18%
Soil reaction (1:1 water) (Depth not specified)	4.6–7.6
Subsurface fragment volume <=3" (Depth not specified)	0–58%
Subsurface fragment volume >3" (Depth not specified)	0–10%

Ecological dynamics

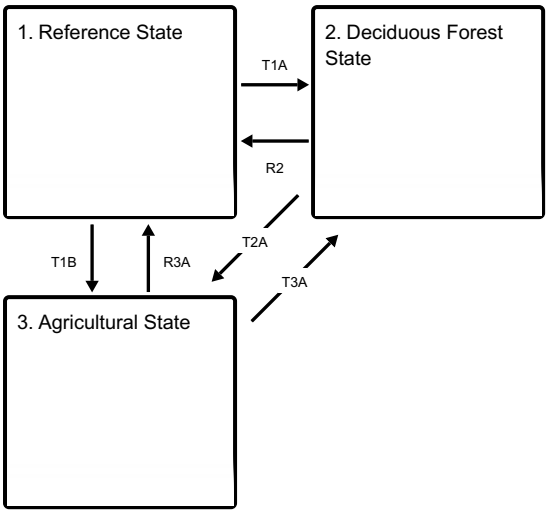
Historically, mature forests on this ecological site were dominated by shade tolerant sugar maple and hemlock, often with an admixture of yellow birch (Wilde, 1933, Finley, 1976). This association was self-maintained with new cohorts of advance regeneration gaining canopy status through gaps formed by small-scale disturbances and natural mortality in the dominant canopy. Scattered large individuals of less shade tolerant white pine also were a common component of mesic hardwood forests. These presumably became established following relatively rare disturbances that included fire (Schulte and Mladenoff, 2005).

Current stands on this Ecological Site represent the entire array of potential successional stages from pure aspen, or aspen-white birch, stands to sugar maple dominated mixed northern hardwoods stands. Succession to sugar maple dominance is evident everywhere that seed sources are present. However, hemlock regeneration is scarce. In old forests, hemlock finds optimal conditions for germination and seedling establishment on rotten logs, stumps and mounds that normally have warmer surfaces and better moisture retention than the forest floor (USDA, 1990). Most present forest communities lack these conditions.

This ES is similar to Moist Sandy Bedrock Upland but contains a greater abundance of Green ash and Basswood in the canopy. It likely has greater net primary production as well due to the deeper soil.

State and transition model

Ecosystem states



T1A - Stand replacing disturbance that includes fire.

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

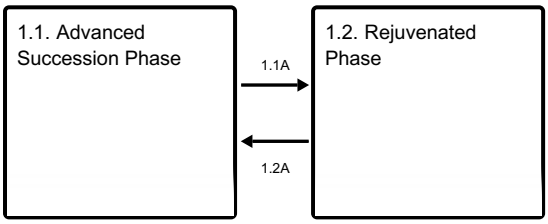
R2 - Deciduous forest community is slowly invaded by conifers.

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

R3A - Cessation of agricultural practices leads to natural reforestation, or site is replanted.

T3A - Cessation of agricultural practices leads to natural reforestation, or site is replanted.

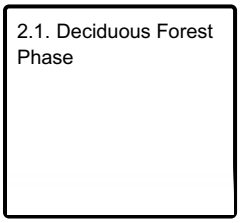
State 1 submodel, plant communities



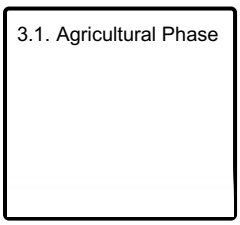
1.1A - Light to moderate intensity fires, blow-downs, ice storms.

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

State 2 submodel, plant communities



State 3 submodel, plant communities



State 1
Reference State

The reference plant community is categorized as mesic forest community dominated by mixed deciduous species, primarily sugar maple (*Acer saccharum*), and sporadic occurrence of several conifer species. Although forest communities can vary greatly in terms of species composition and stand structure, depending on type, degree, and frequency of disturbance, two common phases predominate:

Community 1.1
Advanced Succession Phase

In the absence of major, stand-replacing disturbance this community is dominated by sugar maple, yellow birch (*Betula alleghaniensis*) and eastern hemlock (*Tsuga canadensis*. This was the most common condition in pre-European settlement forests. Though not dominant community members Basswood and Ash may be present. The tree sapling and shrub layer in this community is not well developed due to dense shade created by multi-story tree canopy. Sugar maple saplings dominate the shrub layer, but other shrubs including beaked hazelnut (*Corylus cornuta*) and cherries (Prunus, spp.) are common with low coverage. The herb layer is relatively species rich, but moderate in abundance. The dominant herbs typically include Jack-in-the-pulpit (*Arisaema triphyllum*) and Canada mayflower (*Maianthemum canadense*). Other species include Virginia creeper (*Parthenocissus quinquefolia*) and hairy Solomon's seal (*Polygonatum pubescens*). It is important to note that in most current mature stands, hemlock is significantly under-represented compared to historic conditions. Apparently, this lack of hemlocks is due to seed source elimination during the early logging era and herbivory by currently high white tail deer populations.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- red maple (*Acer rubrum*), tree
- green ash (*Fraxinus pennsylvanica*), tree
- basswood (*Tilia*), tree
- currant (*Ribes*), shrub
- sedge (*Carex*), grass
- Virginia creeper (*Parthenocissus quinquefolia*), other herbaceous

Community 1.2
Rejuvenated Phase

Disturbances described in Pathway 1.1A lead to increased species and structural diversity of the forest community. Depending on seed source, red oak and red maple regenerate in the canopy openings and in time join sugar maple and hemlock in the dominant canopy. Basswood is also commonly present. The relative density of the shrub and herb layers also increases during this stage. Species composition remains relatively unchanged, but abundance changes can be significant. Particularly beaked hazelnut can form dense thickets. Many other herb species that were present with very low abundance in the advanced-succession community typically form much larger population clusters as there is more light penetrating the canopy.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- red maple (*Acer rubrum*), tree
- green ash (*Fraxinus pennsylvanica*), tree
- basswood (*Tilia*), tree
- currant (*Ribes*), shrub
- sedge (*Carex*), grass
- Virginia creeper (*Parthenocissus quinquefolia*), other herbaceous

Pathway 1.1A
Community 1.1 to 1.2

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.

Pathway 1.2A
Community 1.2 to 1.1

In the absence of canopy reducing disturbances natural succession leads to community dominance by the most shade-tolerant species resulting in return to community phase 1.1.

State 2
Deciduous Forest State

Post disturbance pioneer community of aspen and paper birch with mixtures of other species from available seed sources. This state can have broad variation depending on what seed sources are available as these sites readily supply water and nutrients in quantities that many species can thrive with.

Community 2.1
Deciduous Forest Phase

Pure, or mixed, aspen – paper birch community replaces the reference state community. If seed source is present, red maple and red oak readily becomes member of this community.

Dominant plant species

- quaking aspen (*Populus tremuloides*), tree
- European white birch (*Betula pendula*), tree
- red maple (*Acer rubrum*), tree
- Canadian gooseberry (*Ribes oxyacanthoides*), shrub
- sedge (*Carex*), grass
- Virginia creeper (*Parthenocissus quinquefolia*), other herbaceous

State 3
Agricultural State

Indefinite period of applying agricultural practices. Cropping systems vary on these sites and likely include tillage, row crops, hay or pasture, and specialty crops.

Community 3.1
Agricultural Phase

Indefinite period of applying agricultural practices. Crops likely include alfalfa, corn, soybeans, and hay or pasture. It is possible that some areas are or have been in ginseng production as well.

Transition T1A
State 1 to 2

Major stand-replacing disturbance. In pre-European settlement time, the event was most often a severe blow down, sometimes followed by fires. Such blow downs have been estimated to occur in this part of Wisconsin every 300 to 400 years (Schulte and Mladenoff, 2005). In post settlement virtually every acre has been logged either by clear cutting or successive cuts targeting species marketable at that time. Post logging slash fires also have been a significant factor in most areas. These disturbances created the environment suitable for natural regeneration of many shade-intolerant species and for commercial planting.

Transition T1B
State 1 to 3

Removal of forest cover, tilling and application of other agricultural techniques to grow agricultural crops.

Restoration pathway R2
State 2 to 1

Deciduous forest community is slowly invaded by conifers.

Transition T2A
State 2 to 3

Removal of forest cover, tilling and application of other agricultural techniques to grow agricultural crops.

Restoration pathway R3A
State 3 to 1

Abandonment of agricultural practices and allowing natural vegetation to colonize the site or apply artificial afforestation. The time required for forest community to reach the reference state conditions may exceed 100 years.

Transition T3A
State 3 to 2

Abandonment of agricultural practices and allowing natural vegetation to colonize the site or apply artificial afforestation. The site can return much more quickly to the Deciduous Forest State as compared to the Reference State.

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-Tsuga/Athyrium-Onoclea (ATAtOn); Acer-Tilia/Sanguinaria-Desmodium variant (ATiSa-De); Acer rubrum/Desmodium (ArDe); Pinus-Acer rubrum/Vaccinium-Rubus hispidus (PArVRh)
Biophysical Settings (Landfire, 2014): This ES is largely mapped as North-Central Interior Maple-Basswood Forest, Laurentian-Acadian Northern Hardwoods Forest, 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 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. 2006. Land Resource and Major Land Resource Areas of the United Sates, 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	05/02/2024
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:

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17. **Perennial plant reproductive capability:**
