# Ecological site F090AY008WI
# Moist Sandy Bedrock Upland

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: Rib Mountain Rolling Ridges (212Qd), Lincoln Formation Till Plain - Hemlock Hardwoods (212Qc), Lincoln Formation Till Plain - Mixed Hardwoods (212Qb), Rosemont Baldwin Plains and Moraines (222Md)

Wisconsin DNR Ecological Landscapes: Forest Transition, Western Prairie

## Ecological site concept

The Moist Sandy Bedrock Upland ecological site is located on ground moraines, hills, and rock pediments. It's found primarily in the southeast corner of MLRA 90A where bedrock is shallower. These sites are characterized by moderately deep to deep, somewhat poorly drained soils that formed in a variety of parent materials including alluvium, till, and residuum. Soils are underlain with bedrock including shale, mica schist, interbedded sandstone and shale, greenstone and/or granite, and igneous and metamorphic rock. Precipitation, runoff from adjacent uplands, and groundwater discharge are the primary sources of groundwater. Soils range from extremely acid to neutral.

Moist Sandy Bedrock Upland is differentiated from other ecological sites based on drainage and moderately deep profile. Other somewhat poorly drained sands have soils that are greater than 80 inches in depth. The bedrock both perches the water table and restricts root growth. These sites are more vulnerable to tree tips. Other somewhat poorly drained sites have loamy or clayey deposits. Sands have lower pH and available water capacity than loamy and clayey sites, which can limit vegetative growth.

## Associated sites

| | |
|---|---|
| F090AY007WI | **Wet Clayey Lowlands**<br>Wet Clayey Lowlands 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 Moist Sandy Bedrock Uplands. |
| F090AY014WI | **Loamy Bedrock Upland**<br>Loamy Bedrock Uplands 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 are drier and occur higher on the drainage sequence than Moist Sandy Bedrock Uplands. |
| F090AY021WI | **Dry Loamy Upland**<br>Dry Loamy Uplands 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 Moist Sandy Bedrock Uplands. |

## Similar sites

| | |
|---|---|
| F090AY011WI | **Moist Loamy Lowland**<br>Moist Loamy Lowland consist of deep sandy and loamy deposits derived from a mixture of alluvium, residuum, till, or lacustrine sources. The finer textures allow the soil to stay moist - but not saturated - for sustained periods during the growing season. They share their particle size and drainage class with Moist Sandy Bedrock Upland. The vegetative communities they support are very similar. |
| F090AY010WI | **Moist Loamy Lowland with Carbonates**<br>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. These sites share their particle size and drainage class. |
| F090AY012WI | **Moist Clayey Lowland**<br>Moist Clayey Lowland 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 share landscape position and drainage class with Moist Sandy Bedrock Upland, sometime with similar textures. The vegetative communities they support are very similar. |
| F090AY004WI | **Loamy Floodplain**<br>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 their particle size and sometimes their drainage class with Moist Sandy Bedrock Upland. The vegetative communities they support are very similar. |

**Table 1. Dominant plant species**

| | |
|---|---|
| Tree | (1) *Acer saccharum*<br>(2) *Tsuga canadensis* |
| Shrub | (1) *Corylus cornuta* |
| Herbaceous | (1) *Arisaema*<br>(2) *Maianthemum canadense* |

## Physiographic features

These sites formed on ground moraines, hills, and rock pediments. Slopes range from 0 to 8 percent. Sites are in the footslope position.

These sites are not subject to ponding or flooding. Some soils have an apparent seasonally high water table (endosaturation) at a depth of 6 to 36 inches. Other sites have a perched seasonally high water table (episaturation) at a depth of 6 to 18 inches. The water table may drop below 80 inches during dry conditions on all sites. Runoff is negligible to very high.

**Table 2. Representative physiographic features**

| | |
|---|---|
| Hillslope profile | (1) Footslope |
| Slope shape across | (1) Concave |
| Slope shape up-down | (1) Linear |
| Landforms | (1) Ground moraine<br>(2) Hill<br>(3) Rock pediment |
| Runoff class | Low to very high |
| Flooding frequency | None |
| Ponding frequency | None |
| Elevation | 591–902 ft |
| Slope | 0–8% |

| | |
|---|---|
| Water table depth | 6–36 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 50 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) | 95-116 days |
| Freeze-free period (characteristic range) | 129-140 days |
| Precipitation total (characteristic range) | 31-32 in |
| Frost-free period (actual range) | 93-117 days |
| Freeze-free period (actual range) | 119-147 days |
| Precipitation total (actual range) | 27-33 in |
| Frost-free period (average) | 104 days |
| Freeze-free period (average) | 134 days |
| Precipitation total (average) | 31 in |

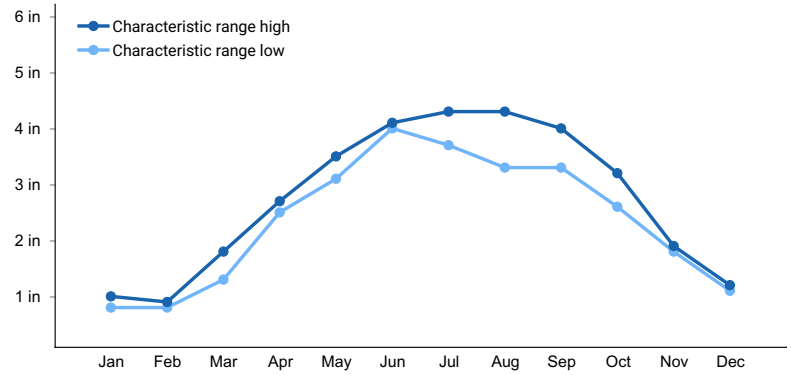



**Figure 1. Monthly precipitation range**

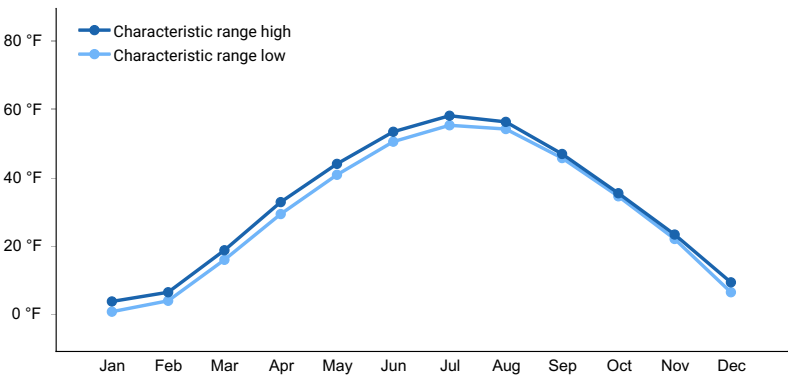



**Figure 2. Monthly minimum temperature range**

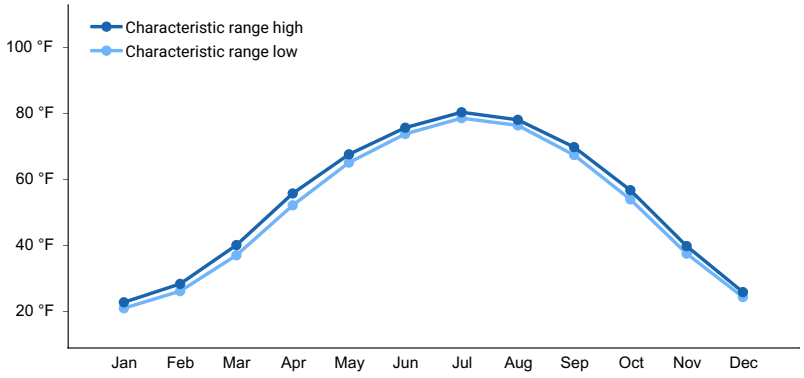



**Figure 3. Monthly maximum temperature range**

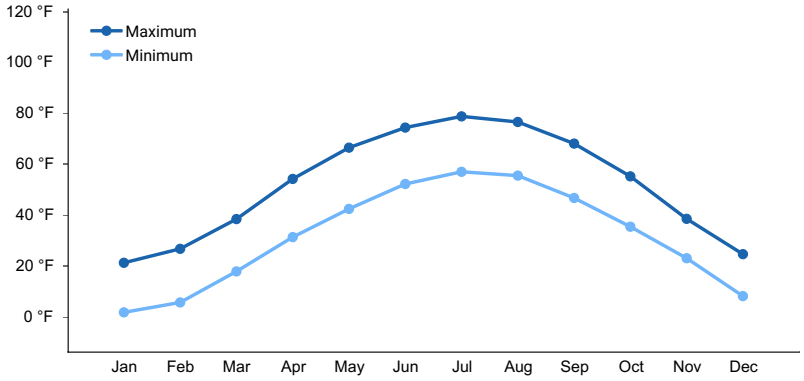



**Figure 4. Monthly average minimum and maximum temperature**

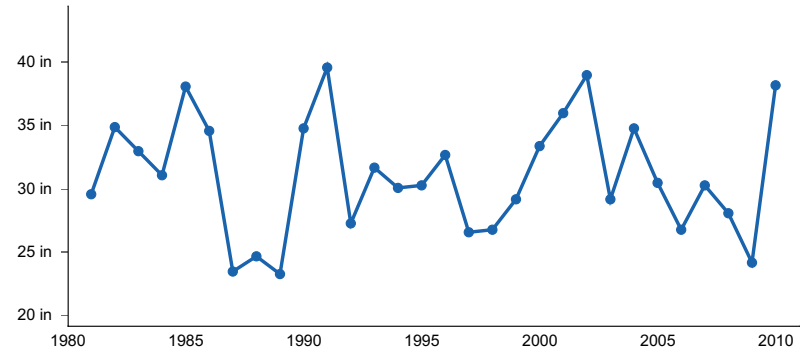



**Figure 5. Annual precipitation pattern**

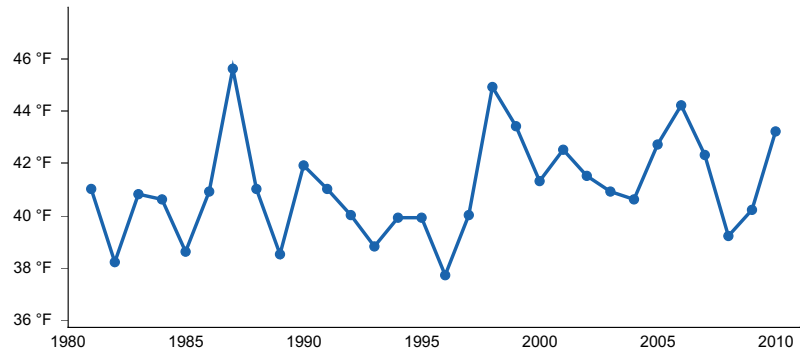



**Figure 6. Annual average temperature pattern**

## Climate stations used

- (1) WINTER [USC00479304], Ojibwa, WI
- (2) LUCK [USC00474894], Luck, WI
- (3) HOLCOMBE [USC00473698], Holcombe, WI

- (4) LAONA 6 SW [USC00474582], Laona, WI
- (5) SANDSTONE 6 W [USW00054932], Hinckley, MN
- (6) ISLE 12N [USC00214103], Isle, 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 outflow may occur when water perches on bedrock.

## Wetland description

Permeability of the soils is impermeable to moderately slow.
Hydrologic Group: D, A/D, B/D, C/D
Hydrogeomorphic Wetland Classification: None
Cowardin Wetland Classification: None

## Soil features

These sites are represented by the Derinda Variant, Dolph, Kert, Magroc, Merrillan, Mora, Rietbrock, and Shullsburg soil series. Derinda Variant is classified as an Aquollic Hapludalf; Dolph is an Aeric Glossaqualf; Kert, Magroc, Mora, and Rietbrock are Aquic Glossaqualfs; Merrillan is an Ultic Epiaquod; Shullsburg is an Aquic Argiudoll.

These soils formed in various parent materials including loess, sandy, loamy, and clayey residuum, sandy or silty alluvium, and loamy till. Soils are moderately deep to very deep with bedrock contact occurring between 66 and 165 cm. Sites are somewhat poorly drained.

The surface of these sites is silt loam or moderately decomposed plant material. Subsurface horizon textures include silt loam, sandy loam, fine sandy loam, clay loam, sandy clay loam, silty clay loam, loam, silty clay, clay, loamy sand, and sand. Soil pH ranges from extremely acid to neutral with values of 3.60 to 7.20. Surface fragments less than 3 inches may be present up to 7 percent cover, and fragments greater than 3 inches may be present up to 3 percent cover. Subsurface fragments less than 3 inches may be present up to 21 percent volume, and fragments greater than 3 inches may be present up to 18 percent. Carbonates may be present up to 10 percent beginning at 74 cm.

**Figure 7. Rietbrock soil series photograph courtesy of UWSP taken on 8/9/2019 in Burnett County, WI.**

**Table 4. Representative soil features**

| | |
|---|---|
| Parent material | (1) Alluvium<br>(2) Eolian deposits<br>(3) Till<br>(4) Sandstone and shale<br>(5) Igneous and metamorphic rock |
| Surface texture | (1) Silt loam |
| Drainage class | Somewhat poorly drained |
| Permeability class | Very slow to moderately slow |
| Soil depth | 26–65 in |
| Surface fragment cover <=3" | 0–7% |
| Surface fragment cover >3" | 0–5% |
| Available water capacity (0-61in) | 1.22–3.51 in |
| Calcium carbonate equivalent (0-39.4in) | 0–10% |
| Soil reaction (1:1 water) (0-39.4in) | 3.6–7.2 |
| Subsurface fragment volume <=3" (Depth not specified) | 0–21% |
| Subsurface fragment volume >3" (Depth not specified) | 0–18% |

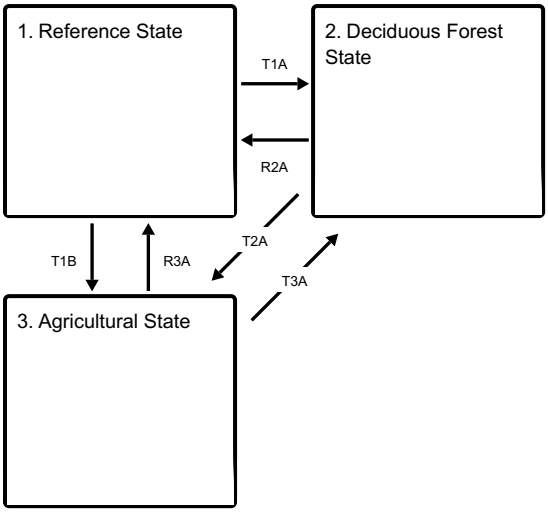
## Ecological dynamics

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 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.

## State and transition model

**Ecosystem states**




**T1A** - Stand replacing disturbance that includes fire.

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

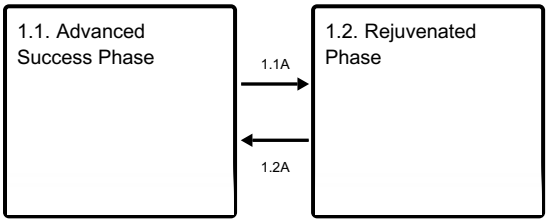
**R2A** - Conifers slowly increase in abundance in the deciduous forest community.

**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.

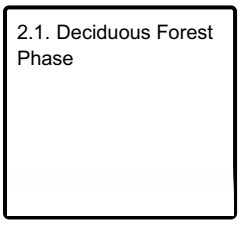
**State 1 submodel, plant communities**



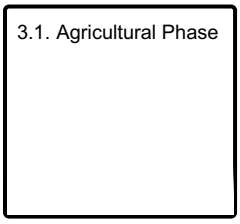

**1.1A** - Light to moderate intensity fires, blow-downs, ice storms.

**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 Success Phase

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

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. 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
- eastern hemlock (*Tsuga canadensis*), tree
- yellow birch (*Betula alleghaniensis*), tree
- beaked hazelnut (*Corylus cornuta*), shrub
- Jack in the pulpit (*Arisaema*), other herbaceous
- Canada mayflower (*Maianthemum canadense*), 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. 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.

**Dominant plant species**

- sugar maple (*Acer saccharum*), tree
- red maple (*Acer rubrum*), tree
- northern red oak (*Quercus rubra*), tree
- beaked hazelnut (*Corylus cornuta*), shrub
- Jack in the pulpit (*Arisaema*), other herbaceous
- Canada mayflower (*Maianthemum canadense*), 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.

## Community 2.1
## Deciduous Forest Phase

**Figure 9. Photo courtesy of UWSP taken on 9/5/2019 in Marathon County, WI.**

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
- red maple (*Acer rubrum*), tree
- northern red oak (*Quercus rubra*), tree
- beaked hazelnut (*Corylus cornuta*), shrub
- Canada mayflower (*Maianthemum canadense*), other herbaceous
- goldenrod (*Oligoneuron*), other herbaceous

## State 3
## Agricultural State

Indefinite period of applying agricultural practices.

## 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). Blow downs may occur more frequently on these sites because of the shallow bedrock. 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 R2A
### State 2 to 1

Conifers slowly increase in abundance in the deciduous forest community.

### 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.

## 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. Wisconsin (Kotar, 2002): The sites of this ES keyed out to three habitat types: Acer/Hydrophyllum-Impatiens (AHI); Acer-Tsuga/Athyrium-Onoclea (ATAtOn); Acer-Tsuga/Maianthemum (ATM)

Biophysical Settings (Landfire, 2014): This ES is largely mapped as Laurentian-Acadian Northern Hardwoods Forest, 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:**