USDA Natural Resources Conservation Service

Ecological site F090BY001WI
Poor Fen

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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 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

Relationship to Established Framework and Classification Systems:
Wetland Forest Habitat Type Classification System for Northern Wisconsin (Kotar and Burger, 2017): All four visited sites in this ES keyed out to one habitat type: *Picea mariana - Larix laricina* [PmLLe]

Biophysical Settings (Landfire, 2014): Much of this site is mapped as Boreal Acidic Peatland Forest, Boreal Acidic Peatland Herbaceous, Boreal Acidic Peatland Shrubland, Central Interior and Appalachian Swamp Shrubland, and Laurentian-Acadian Alkaline Conifer-Hardwood Swamp Forest

WDNR Natural Communities (WDNR, 2015): This ES is most similar to the Black Spruce Swamp, Northern Wet Forest, and Northern Tamarack Swamp communities

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

USFS Subregions: St. Croix Moraine (212Qa), Hayward Stagnation Moraines (212Xf), Glidden Loamy Drift Plain (212Xa), Central-Northwest Wisconsin Loess Plains (212Xd), Perkinstown End Moraine (212Xe), Brule and Paint Rivers Drumlinized Ground Moraine (212Xc), Green Bay Lobe Stagnation Moraine (212Ta)
Small sections occur in Green Bay Lobe Stagnation Moraine (212Ta), Central Wisconsin Moraines and Outwash (222Kb), Bayfield Sand Plains (212Ka), Athelstane Sandy Outwash and Moraines (212Tc)

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

Ecological site concept

The Poor fen ecological site is scattered throughout MLRA 90A and 90B in drainageways and depressions on moraines, outwash, lake, and till plains. These sites are characterized by very deep, very poorly drained soils formed in thick organic deposits underlain by glacial till, glacial outwash, or alluvium. Sites are subject to frequent ponding in the spring and fall. Soils remain saturated during the growing season and meet hydric soils requirements. Water is primarily received form precipitation and runoff from adjacent uplands with little groundwater discharge and stream inflow. Soils range from extremely acid to strongly acid.

Poor fen sites have low pH that differentiates it from Organic ecological sites. The low pH is caused by limited interaction with groundwater that may be enriched with carbonates. In addition, the groundwater discharging into Poor fen sites is likely passing through surrounding parent materials that are acidic (i.e. outwash sand). Sites that are acid bogs have very little interaction with groundwater and receive most of their water from precipitation and runoff from adjacent uplands, both of which tend to be quite acidic. The low pH limits vegetative growth.

Associated sites

F090BY005WI	**Wet Sandy Lowland** Wet Sandy Lowland consist of deep sandy deposits derived from a mixture of outwash, alluvium, and lacustrine sources. They form in seasonally ponded depressions and are saturated long enough for hydric conditions to occur. Some sites are wetlands. These sites occur slightly higher on the drainage sequence than Poor fen sites.
F090BY009WI	**Moist Sandy Upland** Moist Sandy Lowland 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 drier and occur higher on the drainage sequence than Poor fen sites.

F090BY013WI	**Sandy Upland** Sandy Upland consist of deep sandy and loamy deposits of outwash, alluvium, till, and residuum. Soils are primarily sand and loamy sand and have a seasonally high water table within 80 inches, though they don't remain saturated for extended periods. They are much drier and occur higher on the drainage sequence than Poor fen sites.
F090BY019WI	**Dry Sandy Upland** Dry Sandy Upland consist of primarily sandy deposits of various origin. Loamy deposits are also present in many soils. They may have a seasonally high water table within two meters of the surface, though they do not remain saturated for sustained periods. They are much drier and occur higher on the drainage sequence than Poor fen sites.

Similar sites

F090BY002WI	**Mucky Swamp** Like Poor fen sites, Mucky Swamp sites consist of herbaceous organic materials, sometimes with mineral soil contact. They are also very poorly drained, permanently saturated wetlands. Organic Nonacid sites are more alkaline than Poor fen sites because they receive more stream and groundwater. Additionally, adjacent sites may have more calcareous parent materials than those adjacent to Poor fen sites. These differences are reflected in the vegetative communities, with Organic Nonacid having improved growing conditions over Poor fen.
F090BY003WI	**Sandy Floodplain** Sandy Floodplain sites are found exclusively on floodplains in sandy and sometimes silty alluvium. These sites are somewhat poorly to poorly drained and are subject to flooding. Some sites may be saturated for long enough for hydric conditions to occur. Unlike Poor fen sites, they receive most of their water from streamflow. They are much less acidic and slightly drier than Poor fen sites. Growing conditions are improved.
F090BY005WI	**Wet Sandy Lowland** Wet Sandy Lowland consist of deep sandy deposits derived from a mixture of outwash, alluvium, and lacustrine sources. They form in seasonally ponded depressions and are saturated long enough for hydric conditions to occur. These sights occupy slightly higher landscape positions than Poor fen sites. The vegetative communities they support are slightly drier and more nutrient-demanding than those supported by Poor fen sites.

Table 1. Dominant plant species

Tree	(1) *Picea mariana* (2) *Larix laricina*
Shrub	(1) *Ledum groenlandicum*
Herbaceous	(1) *Sphagnum*

Physiographic features

This site occurs in drainageways and depressions on moraines, outwash, lake, and till plains. Landform shape is concave or linear, and sites are in the toeslope position. Slopes range from 0 to 2 percent.

These sites are subject to rare to frequent ponding throughout much the year. The ponding duration is brief to long with depths up to 6 inches above the surface. These sites do not flood. These soils have an apparent seasonally high water table (endosaturation) at the surface but the water table may drop during dry conditions. Runoff is negligible.

Table 2. Representative physiographic features

Hillslope profile	(1) Toeslope
Slope shape across	(1) Concave
Slope shape up-down	(1) Linear

Landforms	(1) Drainageway (2) Depression (3) Outwash plain (4) Till plain (5) Lake plain
Runoff class	Very low
Flooding frequency	None
Ponding duration	Very brief (4 to 48 hours) to long (7 to 30 days)
Ponding frequency	Rare to frequent
Elevation	558–1,148 ft
Slope	0–2%
Ponding depth	0–6 in
Water table depth	0 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 site is 32 inches. The average annual snow fall is 58 inches. The average annual maximum and minimum temperatures are 52oF and 30oF, respectively.

Table 3. Representative climatic features

Frost-free period (characteristic range)	90-115 days
Freeze-free period (characteristic range)	119-139 days
Precipitation total (characteristic range)	30-33 in
Frost-free period (actual range)	71-118 days
Freeze-free period (actual range)	105-150 days
Precipitation total (actual range)	29-34 in
Frost-free period (average)	97 days
Freeze-free period (average)	129 days
Precipitation total (average)	31 in

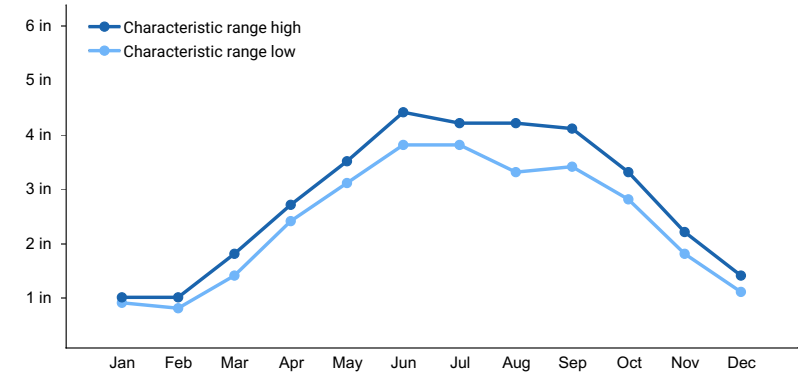


Figure 1. Monthly precipitation range

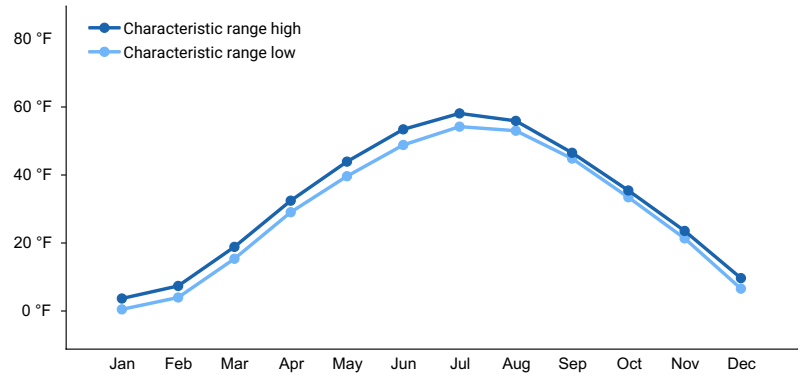


Figure 2. Monthly minimum temperature range

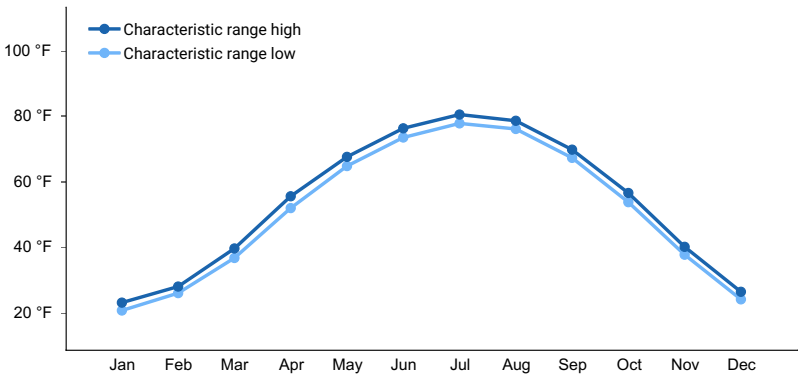


Figure 3. Monthly maximum temperature range

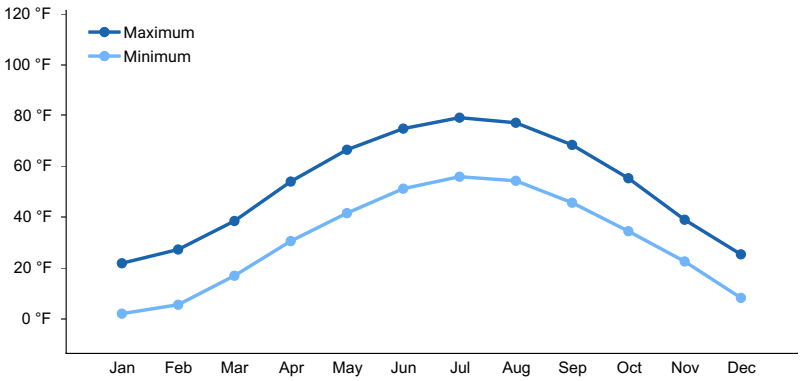


Figure 4. Monthly average minimum and maximum temperature

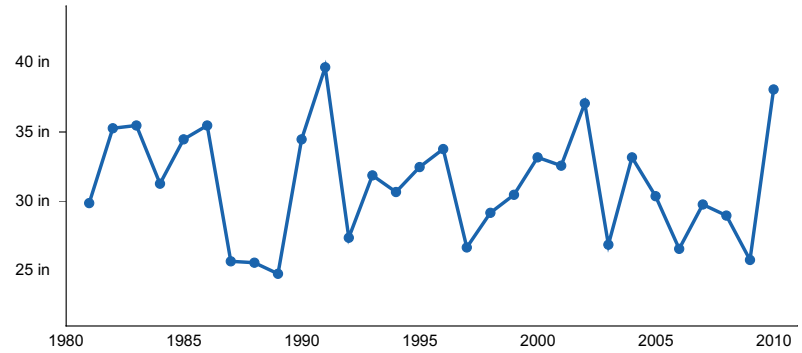


Figure 5. Annual precipitation pattern

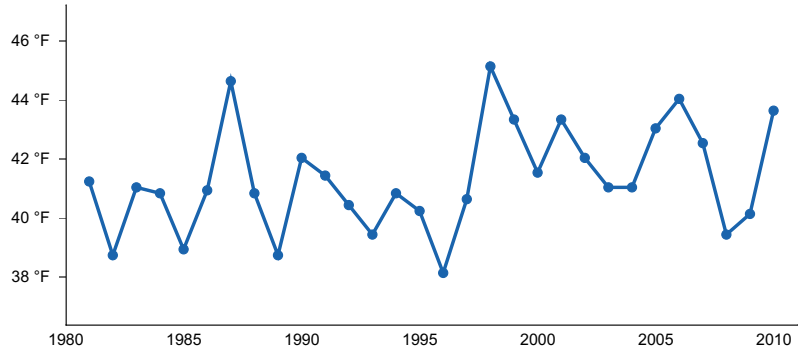


Figure 6. Annual average temperature pattern

Climate stations used

- (1) STAMBAUGH 2SSE [USC00207812], Iron River, MI
- (2) FLORENCE [USC00472826], Florence, WI
- (3) GOODMAN SANITARY DIST [USC00473174], Goodman, WI
- (4) LAONA 6 SW [USC00474582], Laona, WI
- (5) LAKEWOOD 3 NE [USC00474523], Lakewood, WI
- (6) ROSHOLT 9 NNE [USC00477349], Wittenberg, WI
- (7) WAUPACA [USC00478951], Waupaca, WI
- (8) JUMP RIVER 3E [USC00474080], Sheldon, WI
- (9) HOLCOMBE [USC00473698], Holcombe, WI
- (10) BIG FALLS HYDRO [USC00470773], Glen Flora, WI
- (11) WINTER [USC00479304], Ojibwa, WI
- (12) BUTTERNUT 3N [USC00471249], Butternut, WI
- (13) LUCK [USC00474894], Luck, WI
- (14) AMERY [USC00470175], Amery, WI
- (15) ISLE 12N [USC00214103], Isle, MN
- (16) SANDSTONE 6 W [USW00054932], Hinckley, MN
- (17) MILACA [USC00215392], Milaca, MN
- (18) CLOQUET [USC00211630], Cloquet, MN
- (19) AITKIN 2E [USC00210059], Aitkin, MN

Influencing water features

Water is received through precipitation, runoff from adjacent uplands, and groundwater. Water levels are greatly influenced by precipitation rates and runoff from upland sites. Water leaves the site primarily through evapotranspiration, groundwater recharge, and less often, stream outflow. These sites are wetlands.

The hydrology of Poor fen sites significantly impacts their ecological development. Groundwater movement into these sites brings in water that is exposed to surrounding acidic parent materials, such as sand deposits. This interaction keeps the soils acidic, but less acidic than if it had no groundwater discharge on the site, as it is in the case of acid bogs.

Wetland description

Under the Cowardin System of Wetland Classification, or National Wetlands Inventory (NWI), the wetlands can be classified as:
1) Palustrine, forested, needle-leaved evergreen, saturated, or
2) Palustrine, scrub-shrub, broad-leaved deciduous, saturated, or
3) Palustrine, scrub-shrub, broad-leaved evergreen, saturated, or
4) Palustrine, emergent, persistent, saturated

Under the Hydrogeomorphic Classification System (HGM), the wetlands can be classified as:
1) Depressional, acidic, forested/organic, or
2) Depressional, acidic, scrub-shrub/organic

Permeability of the soil is very slow to moderately slow.
Hydrologic Group: A/D, B/D, C/D
Hydrogeomorphic Wetland Classification: Depressional acidic forested/organic; Depressional acidic scrub-shrub/organic
Cowardin Wetland Classification: PFO4B, PSS4B, PSS3B, PEM1B

Soil features

The soils of this site are represented by the Beseman, Cathro, Daisybay, Dawson, Greenwood, and Loxley soil series. Besemen, Cathro, and Dawson are classified as Terric Haplosaprists; Daisybay is a Terric Haplohemist, Greenwood is a Typic Haplohemist, and Loxley is a Typic Haplosaprist.

These soils are formed in deep, highly decomposed organic material primarily of herbaceous origin. The organic material may be underlain by loamy till, sandy outwash, glacial drift, or loamy alluvium. The thickness of organic deposits ranges from 31 to 60 inches. These sites are very poorly drained and remain saturated throughout the year. They meet hydric soil requirements.

The surface horizon of these soils is muck, peat, or mucky peat. The subsurface horizons are highly decomposed muck—sapric materials. Underlying the muck is mineral soil with loam, sandy loam, silt loam, clay, and sand textures. Soil pH is extremely acid to strongly acidic with a range of 4.0 to 5.4. Surface horizons are absent of fragments, and subsurface fragments less than three inches may exist in the mineral soil material, up to 19 percent volume. Sites are often absent of carbonates, but may have up to 2 percent within 35 inches.

Table 4. Representative soil features

Parent material	(1) Organic material (2) Till (3) Outwash (4) Alluvium
Surface texture	(1) Mucky, peaty
Drainage class	Very poorly drained
Permeability class	Very slow to moderately slow
Soil depth	80–100 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (Depth not specified)	15–30.7 in
Calcium carbonate equivalent (Depth not specified)	0–2%
Soil reaction (1:1 water) (Depth not specified)	4–5.4

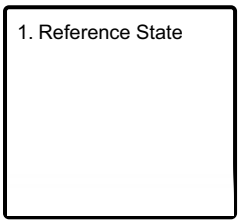
Subsurface fragment volume <=3" (Depth not specified)	0–19%
Subsurface fragment volume >3" (Depth not specified)	0–1%

Ecological dynamics

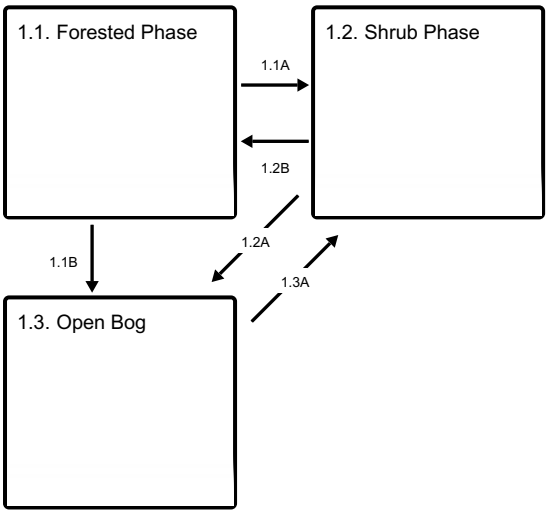
Vegetative communities on this ecological site develop over very long and slow processes. These sites are part of the acid peatlands of northern Wisconsin. Communities range from open bogs to black spruce swamps. These sites developed in wet depressions that allowed organic matter to build over time. These communities are distinct from other wetland communities by the dominance and total carpeting of Sphagnum moss and its effects on the hydrology, pH, and nutrient availability of the site. As Sphagnum moss dominates these sites, it develops thick layers that raise the surface and effectively isolates vegetation from groundwater interaction. Precipitation and runoff become the primary sources of water, which causes sites to become very acidic and poor in nutrients. These sites remain saturated throughout the year based on the moss' ability to retain water. Vegetation on these sites is limited by species that can tolerate saturation, high acidity, and low nutrient availability. Changes to the hydrology can cause severe changes. Drainage near the site that lowers the water table can allow for invasion of woody shrubs.

State and transition model

Ecosystem states



State 1 submodel, plant communities



State 1
Reference State

This community phase is best described as a poor fen. Sites in this ES are almost universally in the reference state owing to its wetness and low overall productivity. Due to wetness and low productivity this ES has almost exclusively been overlooked for logging and land use conversion or changes. This ES usually has a complete or near complete sphagnum ground cover with some woody low shrubs present, including leatherleaf, Labrador tea, and Bog Rosemary. Sedges and Blue bead lily may also be present in this ES. The dominant tree species in this ES are Black spruce and Tamarack. Other trees may be present but are unlikely to be successfully regenerating. Sporadic trees may include White pine, red maple, and others depending on seed dispersal by squirrels and other animals. Black spruce and tamarack present on these sites are likely to be stunted or partially stunted depending on available nutrient status and location within the site. If the site is very old it may have characteristics of (or be) a true bog. In this case most of the trees will be gone and the sphagnum will be the most dominant plant with the

previously mentioned low woody shrubs still being present. The reference state includes three community phases that are part of the mosaic of northern acid peatlands. We chose three distinct community phases to represent the Reference state: 1, a forested phase, 2, shrub phase, and 3, open bog phase. Other communities may exist within this ecological site if they lack similar hydrology. In addition, many sites may exhibit characteristics of multiple community phases. These community phases are not necessarily linear success but may develop in that fashion. While not always present this ES may at times contain some uncommon plants such as pitcher plants, sundews, and lady slippers.

Dominant plant species

- black spruce (*Picea mariana*), tree
- tamarack (*Larix laricina*), tree
- bog Labrador tea (*Ledum groenlandicum*), shrub
- bog rosemary (*Andromeda polifolia*), shrub
- leatherleaf (*Chamaedaphne calyculata*), shrub
- sedge (*Carex*), grass
- bluebead (*Clintonia*), other herbaceous
- sphagnum (*Sphagnum*), other herbaceous

Community 1.1
Forested Phase

This community phase consists forest communities tolerant of seasonal, brief ponding. Vegetation must also be tolerant of acidic soils. The presence of moisture and low pH cause these communities to be slow-growing and canopy trees may be stunted. Such forests are characterized by strong presence, or dominance of black spruce (*Picea mariana*), with tamarack (*Larix laricina*) as a common associate. Other tree species may be present on sites including red maple (*Acer rubrum*), white pine (Pinus storbus), and balsam fir (*Abies balsamea*), but these species will not persist because of the lack of nutrients and high acidity. The shrub layer may be well developed in some communities and often include Labrador tea (*Ledum groenlandicum*) and leatherleaf (*Chamaedaphne calyculata*). Characteristic understory plants include a total covering of Sphagnum moss, blueberries (Vaccinium, spp.), and sedges (Carex, spp.). If the site is very old (has persisted in this phase for a very long time) it may have characteristics of (or be) a true bog. In this case most of the trees will be gone or very stunted and the sphagnum will be the most dominant plant with the previously mentioned low woody shrubs still being present. This condition is distinct from the “Open Bog Phase” 1.3 hydrologically. Since this condition represents the conditions of a true bog (only precipitation as the water source). It is unlikely that there are very many of these Poor Fens that have reached this condition in this MLRA.

Dominant plant species

- black spruce (*Picea mariana*), tree
- tamarack (*Larix laricina*), tree
- bog Labrador tea (*Ledum groenlandicum*), shrub
- leatherleaf (*Chamaedaphne calyculata*), shrub
- blueberry (*Vaccinium*), shrub
- sedge (*Carex*), grass
- sphagnum (*Sphagnum*), other herbaceous

Community 1.2
Shrub Phase

This community phase is dominated by Labrador tea and leatherleaf, two species tolerant of extended ponding. The understory is dominated by Sphagnum and sedges. Sphagnum moss is developing thick layers and isolating site from groundwater.

Dominant plant species

- bog Labrador tea (*Ledum groenlandicum*), shrub
- leatherleaf (*Chamaedaphne calyculata*), shrub
- sedge (*Carex*), grass

- sphagnum (*Sphagnum*), other herbaceous

Community 1.3
Open Bog

This community is dominated by Sphagnum moss and sedges with a few very tolerant associates. These sites often have standing water throughout the growing season.

Dominant plant species

- sedge (*Carex*), grass
- sphagnum (*Sphagnum*), other herbaceous

Pathway 1.1A
Community 1.1 to 1.2

Mortality of canopy species from blow-downs, ice storms, or an increase in ponding frequency and duration. Lack of tree species may be increase ponding duration with the loss of transpiration. Increased connection to nutrient-rich groundwater.

Pathway 1.1B
Community 1.1 to 1.3

Ponding frequency and duration increases dramatically.

Pathway 1.2B
Community 1.2 to 1.1

Decrease in ponding frequency and duration. Sphagnum moss continues to grow and build up thicker layers, causing surface to be isolated from groundwater. Establishment of black spruce and tamarack.

Pathway 1.2A
Community 1.2 to 1.3

Increase in ponding frequency and duration. Mortality of some woody species intolerant to increased ponding. Increased connection to nutrient-rich groundwater.

Pathway 1.3A
Community 1.3 to 1.2

Decrease in ponding frequency and duration. Sphagnum moss continues to grow and build up thick layers, beginning to isolate surface from groundwater. Labrador tea and leatherleaf establishment.

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.
Wetland Forest Habitat Type Classification System for Northern Wisconsin (Kotar and Burger, 2017): All four visited sites in this ES keyed out to one habitat type: *Picea mariana* - *Larix laricina* [PmLLe]
Biophysical Settings (Landfire, 2014): Much of this site is mapped as Boreal Acidic Peatland Forest, Boreal Acidic Peatland Herbaceous, Boreal Acidic Peatland Shrubland, Central Interior and Appalachian Swamp Shrubland, and Laurentian-Acadian Alkaline Conifer-Hardwood Swamp Forest
WDNR Natural Communities (WDNR, 2015): This ES is most similar to the Black Spruce Swamp, Northern Wet

Forest, and Northern Tamarack Swamp communities

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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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	04/20/2024

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:

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

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14. **Average percent litter cover (%) and depth (in):**

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):**

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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:**
