Ecological site F091XY005WI
Wet Sandy and Loamy Lowland

Last updated: 9/27/2023
Accessed: 05/03/2024

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): 091X–Wisconsin and Minnesota Sandy Outwash

The Wisconsin and Minnesota Sandy Outwash MLRA is the most extensive glacial outwash system in the northern half of Wisconsin. The total land area of the Wisconsin portion is just under 1.4 million acres (2,170 sq miles). The northern half is a former spillway for Glacial Lake Duluth. The flowing meltwater from the draining lake has left behind thick deposits of drift and carved a terraced river valley now occupied by the St. Croix and Bois Brule Rivers.

The northeastern section – the Bayfield hills – is a collapsed outwash plain where drift deposits are thick. Lacustrine materials from Glacial Lake Duluth line the northeastern tip. Moving southwest, the landscape transitions into a large pitted outwash plain. This is an area of extensive kettle holes, and, where the underlying till is less permeable, kettle lakes with some interspersed morainic hills and ridges. The glacial drift deposits are thinner in the southwestern section, although there is still no documented surface bedrock within this MLRA.

The St. Croix and Bois Brule rivers share a channel that lines much of the northwestern border of this MLRA. In some places, the underlying reddish-brown sandy loam till of the Copper Falls Formation is exposed along cut riverbanks, though most of it is covered by a mantle of outwash. Glacial lakes deposited pockets of fine-textured lacustrine materials, most of which were washed away or buried by glacial outwash and meltwater flowing through the channel. East of the channel, some of the silty and clayey lakebed deposits are found near the surface, where they impede drainage and contribute to the formation of extensive wetlands.

Historically, the area supported extensive jack pine (Pinus banksiana), scrub, and oak forests and barrens. The northern portion also supported stands of red pine (Pinus resinosa) and eastern white pine (Pinus strobus) as well. Marsh and sedge meadow, wet prairies, and lowland shrubs dominated the extensive wetland complexes in the southern tip of this MLRA (Finley, R., 1976).

Classification relationships

Relationship to Established Framework and Classification Systems:
Biophysical Settings (Landfire, 2014): This ES is largely mapped as Laurentian-Acadian Herbaceous Wetlands, Laurentian-Acadian Northern Hardwoods Forest, Laurentian Oak Barrens, Laurentian Pine Barrens, and Boreal Hardwood Forest

Wetland Forest Habitat Type Classification System for N. Wisconsin (Kotar and Burger, 2017) and Habitat Types of N. Wisconsin (Kotar, 2002): The sites of this ES keyed out to four habitat types: Fraxinus nigra/Onoclea (FnOn); Larix-Acer rubrum/Ilex (LArIx); Picea mariana-Larix/Nemopanthus (PmLNe); Acer saccharum/Sanguinaria-Impatiens (ASaI)

WDNR Natural Communities (WDNR, 2015): This ES is most similar to Northern Hardwood Swamp described by the WDNR, but may coincide with and overlap some of the WDNR wetland communities in different states depending on past hydrology.

Hierarchical Framework Relationships:

Major Land Resource Area (MLRA): Wisconsin and Minnesota Sandy Outwash (91X)

USFS Subregions: Bayfield Sand Plains (212Ka)
Small sections occur in the Mille Lacs Uplands (212Kb) and Hayward Stagnation Moraines (212Xf) subregions

Wisconsin DNR Ecological Landscapes: Northwest Sands, Northwest Lowlands

Ecological site concept

The Wet Sandy and Loamy Lowland ecological site is scattered throughout MLRA 91X but is most common in the southwest portion in depressions and drainageways on outwash and lake plains. These sites are characterized by very deep, very poorly or poorly drained soils that formed primarily in alluvium, outwash, and lacustrine deposits. Some sites have underlying dense loamy till. Sites are subject to occasional to frequent ponding in the spring and fall. Soils remain saturated for long periods during the growing season and meet hydric soil requirements. Soils range from very strongly acid to neutral. These sites are differentiated from other ecological sites by their drainage and texture. They have coarser texture than the Wet Clayey Lowlands and poorer drainage than other sandy and loamy sites. Clayey textures often have higher pH and available water capacity than sandy and loamy materials.

Associated sites

F091XY001WI	**Poor Fen** Poor Fen sites consist of deep organic deposits from primarily herbaceous origin. They are poorly or very poorly drained and are strongly to extremely acid. These sites occur in depressions that receive little stream or groundwater discharge. They are wetlands. They may be found adjacent to Wet Sandy and Loamy Lowland sites lower on the drainage sequence.
F091XY002WI	**Mucky Swamp** Mucky Swamp sites consist of deep, highly decomposed organic matter, primarily of herbaceous origin. Some sites have mineral soil contact. They occur on drainageways, depressions, and floodplains that receive stream or groundwater discharge. They are very poorly drained and are neutral to strongly acid. They may be found adjacent to Wet Sandy and Loamy Lowland sites lower on the drainage sequence.
F091XY007WI	**Moist Sandy and Loamy Lowland** These soils formed in sandy outwash, sandy lacustrine deposits, sandy eolian deposits, or loess that is sometimes underlain by sandy or loamy till. Soils are very deep and somewhat poorly drained. They are slightly drier and occur higher on the drainage sequence than Wet Sandy and Loamy Lowlands.
F091XY011WI	**Sandy Upland** These soils formed primarily in sandy outwash or sandy eolian deposits, but some sites formed in sandy lacustrine or loamy alluvium underlain by sandy outwash. Soils are very deep and are moderately well or somewhat excessively drained. They are neutral to extremely acid and lack a spodic horizon. They are drier and occur higher on the drainage sequence than Wet Sandy and Loamy Lowlands.
F091XY012WI	**Loamy Upland** These soils formed in loamy lacustrine, loamy alluvium, loamy till, sandy outwash, sandy eolian, or loess deposits. Some sites have underlying lacustrine deposits, till, or basalt bedrock. They are moderately well or well drained. They are drier and occur higher on the drainage sequence than Wet Sandy and Loamy Lowlands.
F091XY015WI	**Dry Upland** These sites formed in sandy outwash or eolian deposits. Soils are very deep, excessively drained, and lack a spodic horizon. They are much drier and occur higher on the drainage sequence than Wet Sandy and Loamy Lowlands.

Similar sites

F091XY003WI	**Floodplain** These sites occur in depressions and flats on floodplains. They form in sandy to silty alluvium and are somewhat poorly to very poorly drained. They are subject to flooding. Their vegetative communities may be very similar to those found on Wet Sandy and Loamy Lowlands.

F091XY006WI	**Wet Clayey Lowland** These sites occur on depressions and drainageways on outwash plains and lake plains. They form in clayey lacustrine deposits overlain by sandy lacustrine or sandy outwash deposits. Like Wet Sandy and Loamy Lowlands, they are subject to some flooding. These are wetland soils. The vegetative communities they support may sometimes also be found on Wet Sandy and Loamy Lowlands.
F091XY002WI	**Mucky Swamp** Mucky Swamps consist of deep, highly decomposed organic matter, primarily of herbaceous origin. Some sites have mineral soil contact. They occur on drainageways, depressions, and floodplains that receive stream or groundwater discharge. They are very poorly drained and are neutral to strongly acid. They host vegetative communities that are sometimes similar to those found on Wet Sandy and Loamy Lowlands.
F091XY007WI	**Moist Sandy and Loamy Lowland** These soils formed in sandy outwash, sandy lacustrine deposits, sandy eolian deposits, or loess that is sometimes underlain by sandy or loamy till. Soils are very deep and somewhat poorly drained. The vegetative communities they support are somewhat similar to those found on Wet Sandy and Loamy Lowlands but with a preference for slightly drier conditions.

Table 1. Dominant plant species

Tree	(1) *Abies balsamea* (2) *Tabebuia heterophylla*
Shrub	Not specified
Herbaceous	(1) *Carex* (2) *Impatiens capensis*

Physiographic features

These sites formed in depressions and drainageways on outwash and lake plains. Slope ranges from 0 to 2 percent. Sites are positioned in footslopes and toeslopes.

These sites are subject to ponding with a frequency of occasional to frequent. The ponding duration is brief (2 to 7 days) to long (more than 30 days), with depths up to 12 inches above the soil surface. Sites are not subject to flooding. Sites have a seasonally high water table at the soil surface. Water table can drop to 37 inches during dry conditions. Runoff is negligible to low.

Table 2. Representative physiographic features

Hillslope profile	(1) Footslope (2) Toeslope
Slope shape across	(1) Linear
Slope shape up-down	(1) Concave
Landforms	(1) Depression (2) Drainageway
Runoff class	Negligible to low
Flooding frequency	None
Ponding duration	Brief (2 to 7 days) to very long (more than 30 days)
Ponding frequency	Occasional to frequent
Elevation	590–1,970 ft
Slope	0–2%
Ponding depth	0–30 in
Water table depth	0–36 in
Aspect	Aspect is not a significant factor

Climatic features

The continental climate of the Wisconsin and Minnesota Sandy Outwash MLRA is typical of northern Wisconsin – colder winters and warmer summers. In general, the northern latitudes have cooler summers, colder winters, lower precipitation, and shorter growing seasons than the south; however, neither average annual precipitation nor average annual minimum and maximum temperatures vary greatly within this MLRA. The climate of the northernmost tip is somewhat affected by Lake Superior and receives higher annual precipitation in the form of lake effect snow.

This site sometimes occurs on landscape depressions and its local topography is expected to influence its growing season length. The freeze-free and frost-free periods may be shorter than what is represented here.

Table 3. Representative climatic features

Frost-free period (characteristic range)	85-102 days
Freeze-free period (characteristic range)	117-130 days
Precipitation total (characteristic range)	30-33 in
Frost-free period (actual range)	75-115 days
Freeze-free period (actual range)	111-139 days
Precipitation total (actual range)	30-33 in
Frost-free period (average)	94 days
Freeze-free period (average)	124 days
Precipitation total (average)	31 in

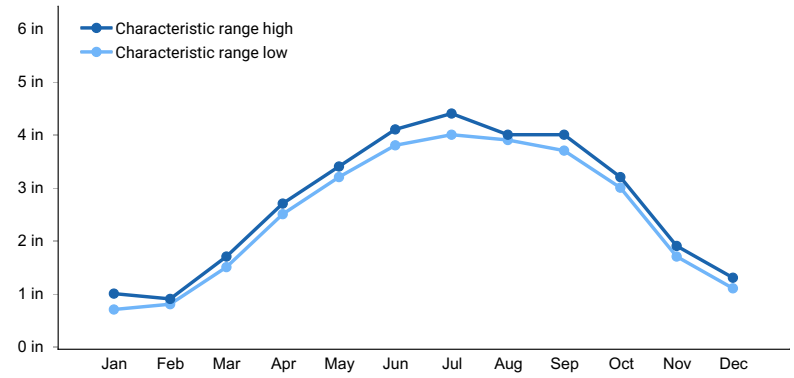


Figure 1. Monthly precipitation range

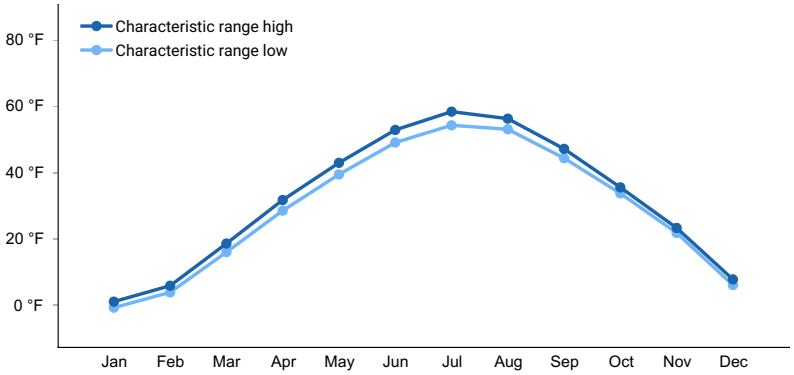


Figure 2. Monthly minimum temperature range

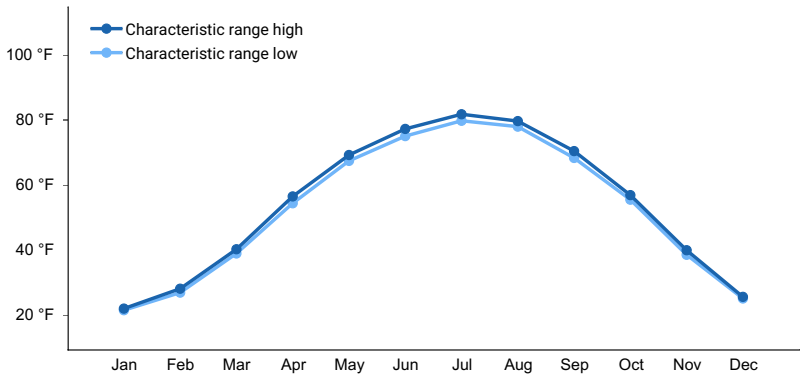


Figure 3. Monthly maximum temperature range

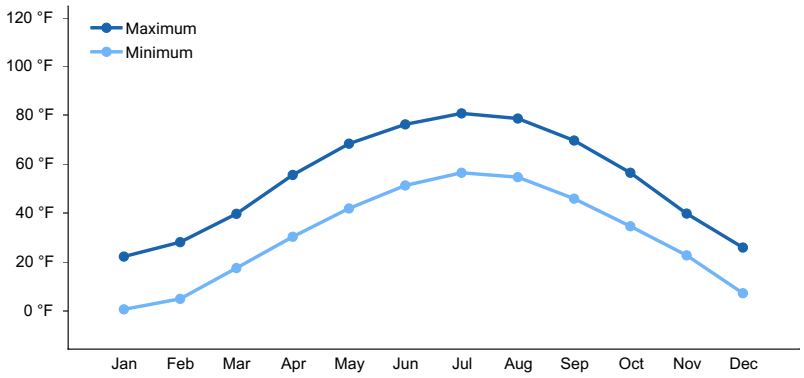


Figure 4. Monthly average minimum and maximum temperature

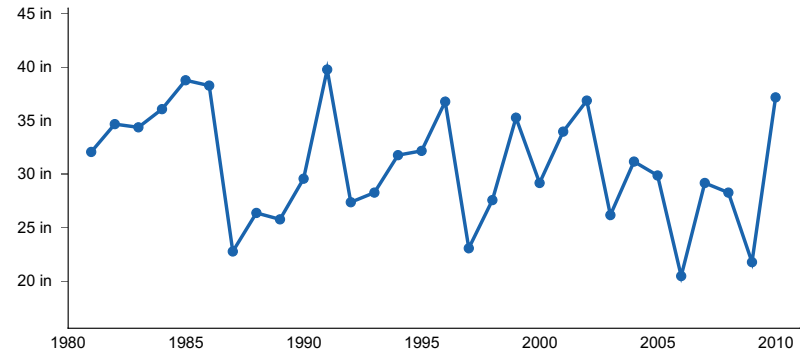


Figure 5. Annual precipitation pattern

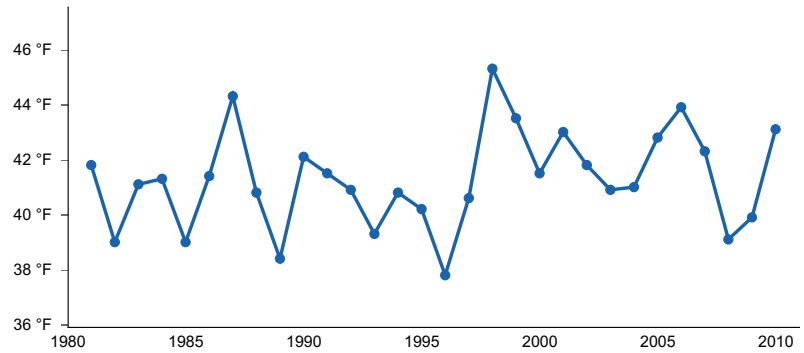


Figure 6. Annual average temperature pattern

Climate stations used

- (1) DANBURY [USC00471978], Danbury, WI
- (2) GRANTSBURG [USW00014995], Grantsburg, WI
- (3) HAYWARD RS [USC00473511], Hayward, WI

- (4) HAYWARD MUNI AP [USW00094973], Hayward, WI
- (5) BRULE RS [USC00471131], Brule, WI
- (6) SOLON SPRINGS [USC00477892], Solon Springs, 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 is lost from the site primarily through subsurface outflow, evapotranspiration, and groundwater recharge.

Wetland description

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

Under the Hydrogeomorphic Classification System (HGM), the wetlands can be classified as:
1) Depressional, acid, forested/loamy, or
2) Depressional, acid, forested/sandy, or
3) Depressional, acid, scrub-shrub/loamy, or
4) Depressional, acid, scrub-shrub/sandy

Permeability of the soils is very slow to rapid. The hydrologic group of these sites is A/D, B/D, or C/D.

Soil features

The Wet Sandy and Loamy Lowland ecological sites are represented by the Barronett, Fenander, Giese, Kinross, Newson, and Nokasippi soil series. Barronett is classified as a Mollic Epiaqualf; Fenander and Nokasippi are Udollic Epiaqualfs; Giese is a Typic Humaquept; Kinross is a Typic Endoaquod; and Newson is a Humaqueptic Psammaquent.

These soils formed primarily in sandy outwash, but some sites formed in silty and loamy glaciofluvial deposits. Some sites are underlain by sandy lacustrine deposits. Soils are very deep and poorly to very poorly drained. They are saturated for much of the year and meet hydric soil requirements.

The surface of these soils is primarily muck—highly decomposed organic material. Subsurface textures range from very fine sand to sandy clay loam. Soil pH ranges from extremely acid to neutral with values of 4.3 to 7.0. Carbonates are absent.

Figure 7. Newson soil series sampled on 06/19/2019 in Burnett County, WI. Courtesy of UWSP.

Table 4. Representative soil features

Parent material	(1) Outwash (2) Lacustrine deposits (3) Glaciofluvial deposits
Surface texture	(1) Muck (2) Sand (3) Loamy sand (4) Sandy loam (5) Silt loam
Drainage class	Poorly drained to very poorly drained
Permeability class	Very slow to rapid
Soil depth	80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0–2%
Available water capacity (0-60in)	5.72–11.33 in
Soil reaction (1:1 water) (0-40in)	4.3–7
Subsurface fragment volume <=3" (0-40in)	0–27%
Subsurface fragment volume >3" (0-40in)	0–5%

Ecological dynamics

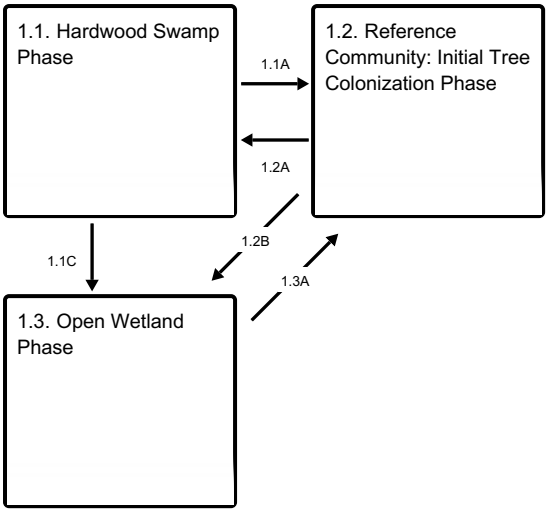
Plant community dynamics in the Wet Sandy and Loamy Lowland Ecological Site are driven by two primary processes: A cyclical and relatively short term effect of ponding and a slow, long-term progression of tree growth on the site. Since the Ecological Site itself is a result of herbaceous peat accumulation, the earliest emergent communities are dominated by sedges, grasses and some facultative-wetland herbaceous species. (‘Facultative-wetland’ species are those that occur primarily in wetlands, but also on some non-wetland sites, as opposed to ‘obligate wetland’ species, which occur only in wetlands). With time, herbaceous peat becomes firm enough to support some woody species These early woody communities tend to be unstable. Prolonged ponding, due either to compression of the substrate by increasing tree weight, or by rising water table, may cause partial, or complete mortality of the tree layer and the entire colonization cycle begins anew.

State and transition model

Ecosystem states

1. Reference State

State 1 submodel, plant communities



1.1A - Large-scale canopy disturbance, mortality in canopy layer.

1.1C - Large-scale natural disturbance or tree harvesting, causing swamping of the site.

1.2A - Slow accumulation of living and dead sphagnum moss layer.

1.2B - Large-scale natural disturbance or tree harvesting, causing swamping of the site.

1.3A - Colonization by trees with tolerance for prolonged ponding.

State 1
Reference State

The Reference State of this Ecological Site may be represented by any of three distinct community Phases, each reflecting the process of wetland formation, the history of natural disturbances and associated vegetation dynamics.

Community 1.1
Hardwood Swamp Phase

Figure 8. Image courtesy of UWSP taken on 06/18/2019 in Burnett County, WI.

This Phase develops over long periods of time, as trees are able to establish they effectively dry the site through increased transpiration. This increased transpiration together with a water table that is lowered or decreased flooding/ponding frequency lead to the establishment of a mixture of Balsam fir and White Cedar. Other species such as Yellow birch, Elms, and Tamarack may be present in small amounts as well. There may not be much in the way of a shrub layer, but if present it may include Alders and Ilex species. The herb layer likely consists of Sedges, Jewelweed, and Sensitive fern (other ferns may periodically be present as well, Cinnamon fern and Royal fern).

Dominant plant species

- balsam fir (*Abies balsamea*), tree
- white cedar (*Tabebuia heterophylla*), tree
- sedge (*Abildgaardia*), grass
- jewelweed (*Impatiens capensis*), grass
- sensitive fern (*Onoclea sensibilis*), grass

Community 1.2
Reference Community: Initial Tree Colonization Phase

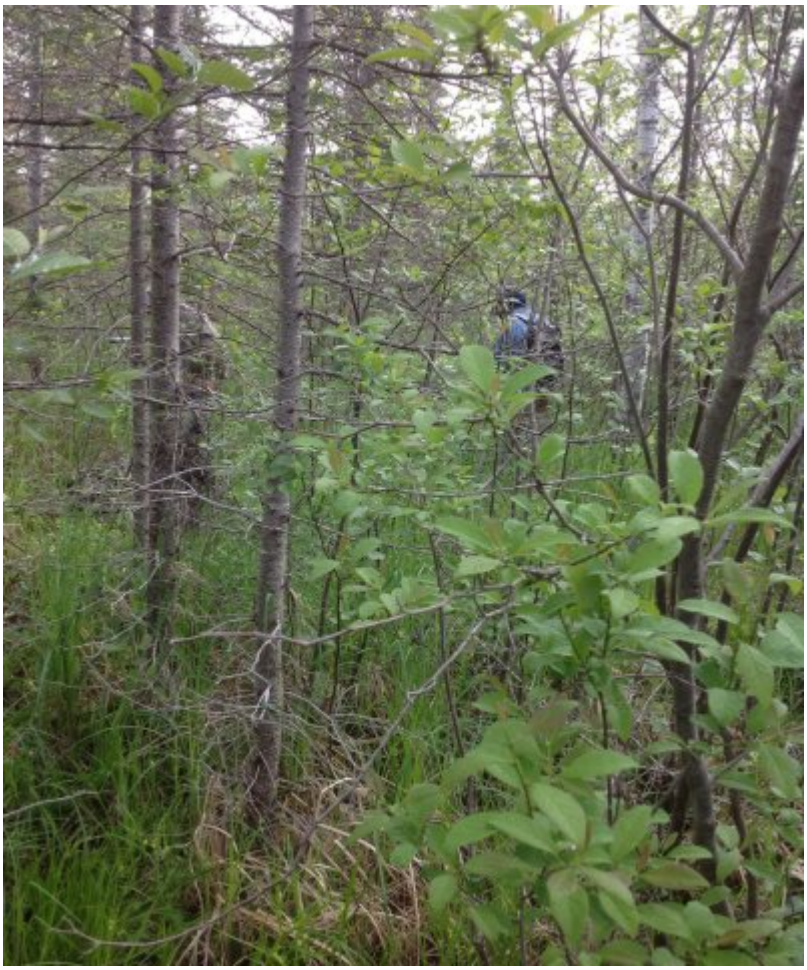


Figure 9. Image courtesy of UWSP taken on 06/19/2019 near the unincorporated town of Brule, WI.

This Community Phase was chosen as the Reference Community Phase because it appears to be the most common phase under current conditions. When, in the process of wetland formation, the herbaceous plant peat accumulation eventually reaches critical density and seasonal water table recedes enough to permit development of aerated rooting zone, a number of tree and shrub species find conditions suitable for growth. Early colonizing shrubs typically include tag alder (*Alnus incana*), willows (Salix spp.) and chokecherry (*Prunus virginiana*). The most common colonizing trees are red maple (A. rubrum) Oaks and Aspen. This condition is also achieved through community pathway 1.1B, described above.

Dominant plant species

- red maple (*Acer rubrum*), tree
- quaking aspen (*Populus tremuloides*), tree
- oak (*Quercus*), tree
- gray alder (*Alnus incana*), shrub
- willow (*Salix*), shrub
- chokecherry (*Prunus virginiana*), shrub

Community 1.3
Open Wetland Phase

Figure 10. Image courtesy of UWSP taken on 07/22/2019 in Burnett County, WI.

This community phase represents a transition in wetland formation where obligatory wetland species are being replaced, or outnumbered by the combined facultative wetland and facultative upland species. Sedges and grasses predominate, but characteristic species also include currants (Ribes spp.), jewelweed (*Impatiens capensis*), and sensitive fern (*Onoclea sensibilis*). Trees and tall shrubs are absent, or showing up only as sporadic seedlings or saplings. This condition also occurs through community phase pathways 1.1C and 1.2B described above.

Dominant plant species

- sedge (*Carex*), grass
- Grass, native (*Grass, native*), grass
- currant (*Ribes*), other herbaceous
- jewelweed (*Impatiens capensis*), other herbaceous
- sensitive fern (*Onoclea sensibilis*), other herbaceous

Pathway 1.1A
Community 1.1 to 1.2

Hardwood Swamp Phase **Reference Community: Initial Tree Colonization Phase**

Large scale disturbance, such as major blow-down, tree harvesting or fire, cause major changes in the substrate. Increased light and soil-surface temperature promote faster decomposition of sphagnum peat, increasing nutrient availability, thus making conditions suitable again for colonization by deciduous species.

Pathway 1.1C
Community 1.1 to 1.3

Hardwood Swamp Phase **Open Wetland Phase**

Major disturbances, such as blow-downs, tree harvesting, or fire, promote decomposition of surface layers of peat, while swamping, resulting from reduced transpiration due to removed woody vegetation, cause the return of community to Open Wetland Phase (Community Phase 1.3).

Pathway 1.2A
Community 1.2 to 1.1

Reference Community: Initial Tree Colonization Phase

Hardwood Swamp Phase

Very long periods without major disturbances and reduced flooding/ponding facilitate continuous growth of trees leading community development toward the Hardwood Swamp (Community Phase1.1).

Pathway 1.2B
Community 1.2 to 1.3

Reference Community: Initial Tree Colonization Phase

Open Wetland Phase

Major disturbances, such as blow-downs, tree harvesting, or fire, promote decomposition of surface layers of peat, while swamping, resulting from reduced transpiration due to removed woody vegetation, cause the return of community to Open Wetland Phase (Community Phase 1.3).

Pathway 1.3A
Community 1.3 to 1.2

Open Wetland Phase

Reference Community: Initial Tree Colonization Phase

Colonization by trees with tolerance for prolonged ponding.

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.

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 Douglas, Bayfield, Washburn, Burnett, Polk, and Sawyer.

Curtis, J.T. 1959. Vegetation of Wisconsin: an ordination of plant communities. University of Wisconsin Press,

Madison. 657 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.

NatureServe. 2018. International Ecological Classification Satandard: Terrestrial Ecological Classifications. NautreServe Centreal Databases. Arlington, VA. U.S.A. Data current as of 28 August 2018.

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.

Schulte, L.A., and D.J. Mladenoff. 2001. The original U.S. public land sur¬vey 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.

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.

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.

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

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

Approval

Suzanne Mayne-Kinney, 9/27/2023

Acknowledgments

NRCS contracted UWSP to write ecological sites in MLRA 91. 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	09/27/2023
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:**
