USDA Natural Resources Conservation Service

Ecological site F091XY002WI
Mucky Swamp

Last updated: 9/27/2023
Accessed: 04/23/2024

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, Boreal White Spruce-Fir Forest, Central Interior and Appalachian Herbaceous Wetlands, Boreal White Spruce-Fir Forest, Laurentian Pine Barrens, and Laurentian-Acadian Northern Hardwoods Forest

Wetland Forest Habitat Type Classification System for Northern Wisconsin (Kotar and Burger, 2017): The sites of this ES keyed out to three habitat types: *Fraxinus nigra*/Onoclea (FnOn); Thuja-Abies balsamea- *Fraxinus nigra*/Ilex (ThAbFnIx); *Fraxinus nigra*-Abies balsamea/Impatiens (FnAbI)

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), Mille Lacs Upland (212Kb)

Wisconsin DNR Ecological Landscapes: Northwest Sands, Northwest Lowlands

Ecological site concept

The Mucky Swamps ecological site is located throughout MLRA 91X in depressions and drainageways on lake, outwash, and till plains. These sites are characterized by very deep, very poorly drained soils formed in highly decomposed organic material primarily of herbaceous origin. In contrast to Peat Bog ecological sites, sphagnum moss typically is not present. On sites where it does occur, the live and dead moss thickness ranges only from 6 to 12 inches. The rest of the organic soil material is black muck. These sites are subject to frequent flooding and ponding during the spring and fall. Sites remain saturated throughout the growing season and meet hydric soil requirements. Precipitation, runoff from adjacent uplands, groundwater discharge, and stream inflow are the primary sources of water. Soils range from very strongly acid to slightly alkaline.

The vegetation does not appear to change fundamentally across this site with changes in the thickness of the organic soil material, until an aerated root zone reaches the mineral soil horizons. This condition crosses a boundary to a different ecological site. The water table periodically drops low enough and for long enough time periods, to allow for moderately productive forest growth. Most commonly present tree species range from elms, (Ulmus spp.), black ash (*Fraxinus nigra*), red maple (*Acer rubrum*) and paper birch (Betula papyrifera), on the more productive segments of the Site, to balsam fir (Abies balsamea), northern white cedar (Thuja occidentalis), tamarack (Larix laricina), black spruce (Picea mariana), and white pine (Pinus strobus), in locations with lower nutrient availability

Mucky Swamps sites receive significantly more groundwater and stream inflow than their Poor Fens counterpart. In addition, adjacent upland sites may be comprised of finer, more calcareous parent materials and the runoff and groundwater Mucky Swamps receives from these sites may buffer their acidity. They have improved growing conditions over Poor Fens.

Associated sites

F091XY005WI	**Wet Sandy and Loamy Lowland** These sites occur on depressions and drainageways on outwash plains and lake plains. They primarily form in sandy outwash are subject to some ponding and flooding. Soils are very deep and poorly or very poorly drained. They are saturated for much of the year. They may be adjacent to Mucky Swamps. They occur higher on the drainage sequence and are slightly drier.
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 occur higher on the drainage sequence and are drier than Mucky Swamps.
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 to somewhat excessively drained. They are neutral to extremely acid and lack a spodic horizon. They occur higher on the drainage sequence and are much drier than Mucky Swamps.
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 occur higher on the drainage sequence and are much drier than Mucky Swamps.
F091XY015WI	**Dry Upland** These sites formed in sandy outwash or eolian deposits. Soils are very deep, excessively drained, and lack a spodic horizon. They occur higher on the drainage sequence and are much drier than Mucky Swamps.

Similar sites

F091XY005WI	**Wet Sandy and Loamy Lowland** These sites occur on depressions and drainageways on outwash plains and lake plains. They primarily form in sandy outwash are subject to some ponding and flooding. Soils are very deep and poorly or very poorly drained. They are saturated for much of the year but are still drier than Mucky Swamp sites. They may be adjacent to Organic Lowlands. The vegetative communities supported by Wet Sandy And Loamy Lowlands are sometimes similar to those of Mucky Swamps.
F091XY001WI	**Poor Fen** Like Mucky Swamps, Poor Fens consist of deep organic deposits from primarily herbaceous origin. These sites are also wetlands. They are poorly or very poorly drained and are strongly to extremely acid. They receive less groundwater than Poor Fens and are therefore more acidic and have lesser growing conditions that Mucky Swamps.
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. The vegetative communities supported by Floodplains are sometimes similar to those of Mucky Swamps.

Table 1. Dominant plant species

Tree	(1) *Ulmus* (2) *Fraxinus nigra*
Shrub	(1) *Larix laricina* (2) *Picea mariana*
Herbaceous	Not specified

Physiographic features

Mucky Swamp sites occur in drainageways, depressions, and floodplains on till plains, outwash plains, and lake plains. Some sites may occur on valley trains and stream terraces. Landform shape is primarily concave, with some sites being linear. Sites are located on the toeslope position, while those in floodplains have no hillslope position. Slopes primarily range from 0 to 2 percent, but some sites reach 15 percent.

Some sites are subject to frequent flooding. Flooding duration is long (7 to 30 days). Ponding frequency may be none to frequent. Ponding duration is long, with depths up to 6 inches above the surface. Soils have an apparent seasonally high water table (endosaturation) at the surface. The water table can drop to greater than 60 inches during drought conditions. Runoff is negligible on most sites. Sites with high slope percentage have high runoff potential.

Table 2. Representative physiographic features

Slope shape across	(1) Concave
Slope shape up-down	(1) Linear
Landforms	(1) Drainageway (2) Depression (3) Flood plain
Runoff class	Negligible to high
Flooding duration	Long (7 to 30 days)
Flooding frequency	None to frequent
Ponding duration	Long (7 to 30 days) to very long (more than 30 days)
Ponding frequency	None to frequent
Elevation	590–2,000 ft
Slope	0–15%
Water table depth	0 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)	74-92 days
Freeze-free period (characteristic range)	108-124 days
Precipitation total (characteristic range)	30-32 in
Frost-free period (actual range)	72-97 days
Freeze-free period (actual range)	105-126 days
Precipitation total (actual range)	30-32 in
Frost-free period (average)	85 days
Freeze-free period (average)	116 days
Precipitation total (average)	31 in

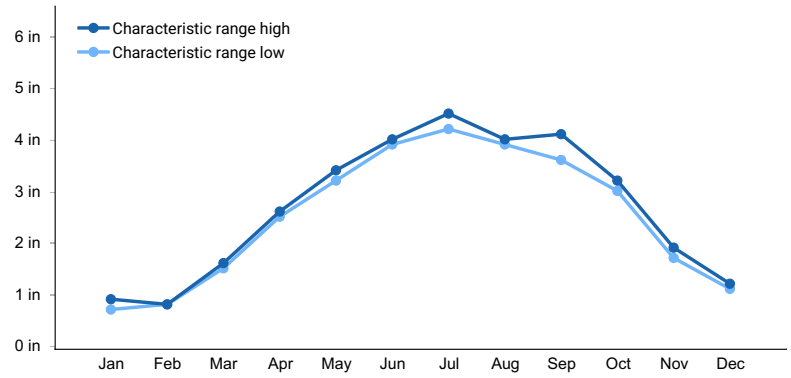


Figure 1. Monthly precipitation range

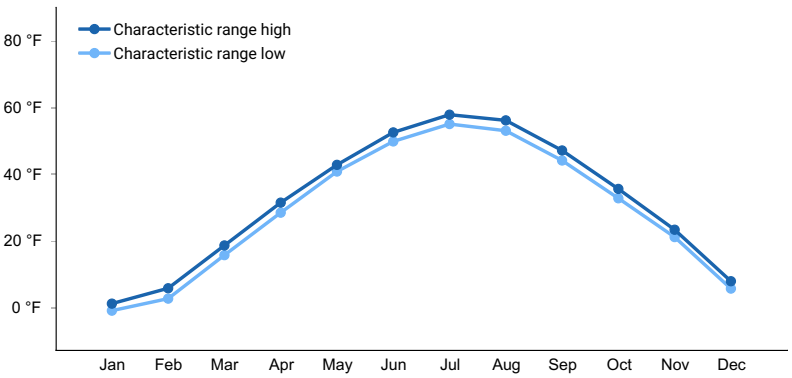


Figure 2. Monthly minimum temperature range

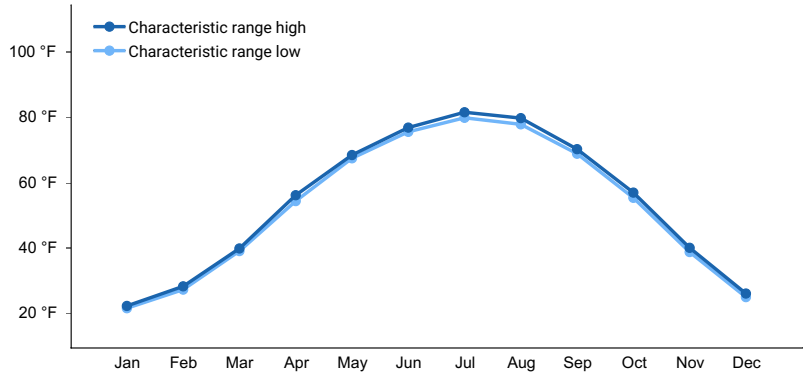


Figure 3. Monthly maximum temperature range

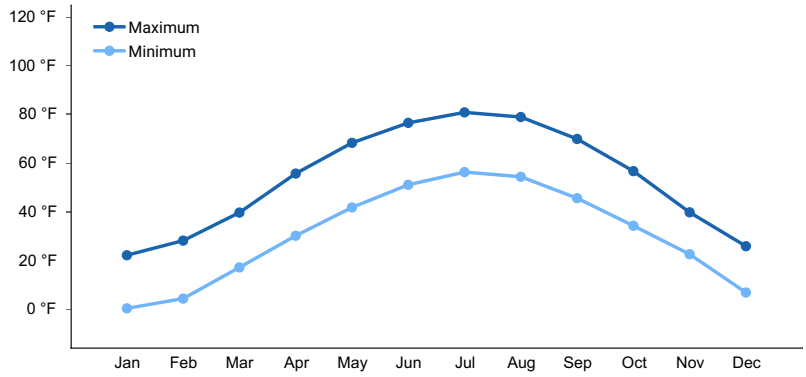


Figure 4. Monthly average minimum and maximum temperature

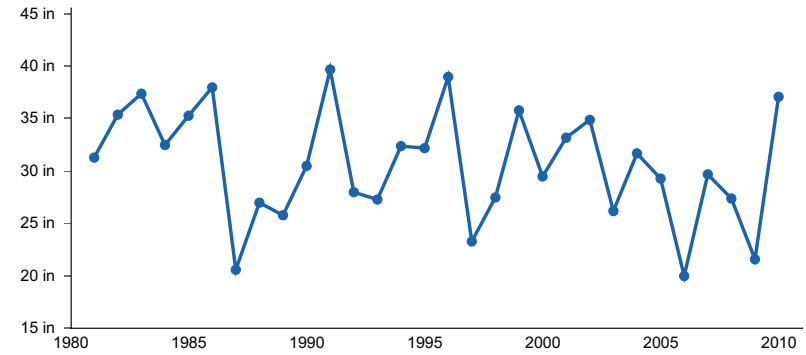


Figure 5. Annual precipitation pattern

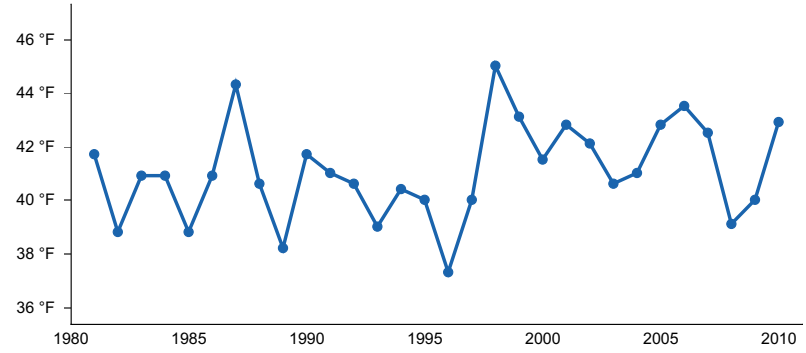


Figure 6. Annual average temperature pattern

Climate stations used

- (1) SOLON SPRINGS [USC00477892], Solon Springs, WI
- (2) GORDON [USC00473186], Gordon, WI
- (3) DANBURY [USC00471978], Danbury, WI

- (4) HAYWARD RS [USC00473511], Hayward, WI
- (5) HAYWARD MUNI AP [USW00094973], Hayward, WI

Influencing water features

Water is received through precipitation, runoff from adjacent uplands, stream inflow, and groundwater discharge. Water levels are greatly influenced by precipitation rates and runoff from upland sites. Water leaves the site primarily through stream outflow, subsurface outflow, evapotranspiration, and ground water recharge. The hydrology of the sites significantly impacts their ecological development. These sites have a strong connection with groundwater as a primary source of water. The groundwater discharging to these sites interact with surrounding materials that may deliver dissolved carbonates to these sites.

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, forested, needle-leaved evergreen, saturated, or
3) Palustrine emergent, persistent, saturated

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

Permeability of the sites is slow. Hydrologic groups of this site is A/D or B/D.

Soil features

These sites are represented by the Bowstring, Cathro, Lupton, Markey, Seelyeville, and Tawas soil series. The Bowstring soil series is classified as a Fluvaquentic Haplosaprist; Cathro, Lupton, and Seelyeville are Typic Haplosaprists; Markey and Tawas are Terric Haplosaprists.

These soils formed in deep, highly decomposed organic matter primarily of herbaceous origin. Some sites have mineral contact with loamy or sandy outwash within two meters. The soils are very poorly drained and remain saturated throughout the year. Soils meet hydric soil criteria.

The surface texture of these sites is muck. Subsurface horizons include sand, fine sand, loam, and sandy loam. Soils range in pH from very strongly acid to slightly alkaline with values of 4.5 to 7.8. Carbonates are absent.

Figure 7. Cathro Soil Series sampled on 06/18/2019 in Polk County, WI. Courtesy of UWSP.

Table 4. Representative soil features

Parent material	(1) Organic material
Surface texture	(1) Muck
Drainage class	Very poorly drained
Permeability class	Slow
Soil depth	80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-60in)	14.12–23.62 in
Soil reaction (1:1 water) (0-40in)	4.5–7.8
Subsurface fragment volume <=3" (0-40in)	0–14%
Subsurface fragment volume >3" (0-40in)	0–2%

Ecological dynamics

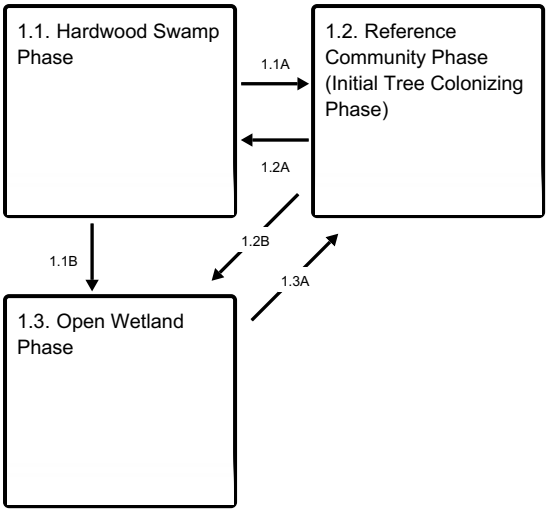
Plant community dynamics are driven by two primary processes: A cyclical and relatively short term effect of ponding and a slow, long-term progression of tree growth on the site. Since the Ecological Site itself is a result of herbaceous peat accumulation, the earliest emergent communities are dominated 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 such as black ash (*Fraxinus nigra*), red elm (*Ulmus rubra*), American elm (U. Americana) and red maple (*Acer rubrum*). 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.

1.1B - 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. Photo courtesy of UWSP taken on 07/22/2019 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 Ash, 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 var. balsamea*), tree
- ash (*Fraxinus*), tree
- white cedar (*Tabebuia heterophylla*), tree
- alder (*Alnus*), shrub
- jewelweed (*Impatiens capensis*), other herbaceous
- sensitive fern (*Onoclea sensibilis*), other herbaceous

Community 1.2
Reference Community Phase (Initial Tree Colonizing Phase)

Figure 9. Photo courtesy of UWSP taken on 06/25/2019 in Burnett County, 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 elms (Ulmus spp.), red maple (*A. rubrum*) and black and green ash (*Fraxinus nigra*, *F. pennsylvanica*). This condition is also achieved through community pathway 1.1B, described above.

Dominant plant species

- elm (*Ulmus*), tree
- red maple (*Acer rubrum var. rubrum*), tree
- green ash (*Fraxinus pennsylvanica*), tree
- black ash (*Fraxinus nigra*), tree
- gray alder (*Alnus incana*), shrub
- willow (*Salix*), shrub
- chokecherry (*Prunus virginiana*), shrub

Community 1.3
Open Wetland Phase

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
- jewelweed (*Impatiens capensis*), other herbaceous
- sensitive fern (*Onoclea sensibilis*), other herbaceous
- currant (*Ribes*), other herbaceous

Pathway 1.1A
Community 1.1 to 1.2

Hardwood Swamp Phase

Reference Community Phase (Initial Tree Colonizing 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 1.1B
Community 1.1 to 1.3

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 Phase (Initial Tree Colonizing 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

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

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.

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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):**

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

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

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

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

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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:**