USDA Natural Resources Conservation Service

Ecological site F093AY001MN
Flooded Peatland

Last updated: 9/06/2024
Accessed: 11/21/2024

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): 093A–Superior and Rainy Stony and Rocky Till Plains and Moraines

The Superior Stony and Rocky Loamy Plains and Hills, Western Part is located and completely contained in northeastern Minnesota. This area has both the highest and lowest elevations in the state, as well as some of the state's most rugged topography (Ojakangas and Matsch, 1982). The MLRA was glaciated by numerous advances of the Superior, Rainy, and Des Moines glacial lobes during the Wisconsin glaciation as well as pre-Wisconsin glacial periods. The geomorphic surfaces in this MLRA are geologically very young (i.e., 10,000 to 20,000 years) and dominated by drumlin fields, moraines, small lake plains, outwash plains, and bedrock-controlled uplands (USDA-NRCS, 2022).

There are thousands of lakes scattered throughout the region that were created by these glacial events. Most of these lakes are bedrock-controlled in comparison to adjacent glaciated regions where glacial drift deposits are much thicker and the lakes occur in depressions atop the glacial drift (Ojakangas and Matsch, 1982). In contrast to adjacent MLRAs, the depth to the predominantly crystalline or sandstone bedrock in MLRA 93A is relatively shallow because the most recent glacial events were more erosional than depositional (Ojakangas and Matsch, 1982).

Classification relationships

Major Land Resource Area (MLRA): Superior Stony and Rocky Loamy Plains and Hills, Western Part (93A)

USFS Subregions: Northern Superior Uplands Section (212L); North Shore Highlands Subsection (212Lb)

Relationship to Other Established Classifications:
Minnesota Department of Natural Resources (MN DNR), FPn63-Northern Cedar Swamp, Forested Rich Peatland System, Northern Floristic Region
MN DNR WFn53-Northern Wet Cedar Forest, Wet Forest System, Northern Floristic Region

Ecological site concept

This site is a conifer-dominated swamp on very poorly drained peat soils. Soils are saturated, very deep, very poorly drained and flooding occurs occasional to very frequent . Typical site settings include margin of streams and river channels plus lake basins and margins of large peatlands. The canopy is often dominated by northern white cedar, black spruce, and balsam fir. The understory includes ericaceous shrubs, multiple species of sedge, and sphagnum. The plant community structure and composition will vary depending on microtopography and the depth and frequency of flooding.

Associated sites

F093AY004MN	**Peatland** Peatland. This site characterized by a shrub-graminoid plant community. The site is potentially ponded. Does not typically occurs at the margin of stream and river channels.
F093AY003MN	**Acid Peatland** Acid Peatland. Ponding can occur and pH ranges from 3.5-5.5 at 20 inches in depth. Noticeable lack of diverse shrub and graminoid layer due to the acidic pH. Does not typically occurs at the margin of stream and river channels

Similar sites

F093AY004MN	**Peatland** Peatland. This site characterized by a shrub-graminoid plant community. The site is potentially ponded. Does not typically occurs at the margin of stream and river channels.
F093AY003MN	**Acid Peatland** Acid Peatland. Ponding can occur and pH ranges from 3.5-5.5 at 20 inches in depth. Noticeable lack of diverse shrub and graminoid layer due to the acidic pH. Does not typically occurs at the margin of stream and river channels

Table 1. Dominant plant species

Tree	(1) *Thuja occidentalis* (2) *Picea mariana*
Shrub	(1) *Ledum groenlandicum* (2) *Alnus incana ssp. rugosa*
Herbaceous	(1) *Carex* (2) *Sphagnum*

Physiographic features

Typical site settings include margin of streams and river channels plus lake basins and margins of large peatlands.

Table 2. Representative physiographic features

Landforms	(1) Flood plain (2) Flat (3) Drainageway
Runoff class	Very low
Flooding duration	Brief (2 to 7 days) to very long (more than 30 days)
Flooding frequency	Occasional to very frequent
Ponding duration	Very brief (4 to 48 hours) to very long (more than 30 days)
Ponding frequency	None to frequent
Elevation	200–600 m
Slope	0–1%
Water table depth	0 cm
Aspect	Aspect is not a significant factor

Climatic features

The average annual precipitation is 26-32 inches (66 to 81 centimeters). Measurable climatic variation (due to the lake effect) near some of Lake Superior may alter temperature and precipitation (Hillman & Nielsen, 2023). About 65 percent of the precipitation falls as rain during the growing season (May through September) and about 21 percent falls as snow. The freeze-free period averages about 130 days and ranges from 123 to 143 days (USDA-NRCS, 2022).

Table 3. Representative climatic features

Frost-free period (characteristic range)	90-109 days
Freeze-free period (characteristic range)	123-143 days
Precipitation total (characteristic range)	660-813 mm
Frost-free period (actual range)	44-114 days
Freeze-free period (actual range)	97-150 days
Precipitation total (actual range)	660-813 mm
Frost-free period (average)	93 days
Freeze-free period (average)	130 days
Precipitation total (average)	737 mm

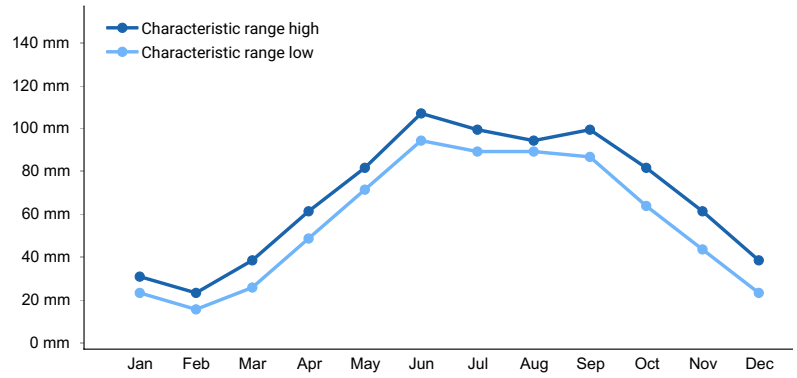


Figure 1. Monthly precipitation range

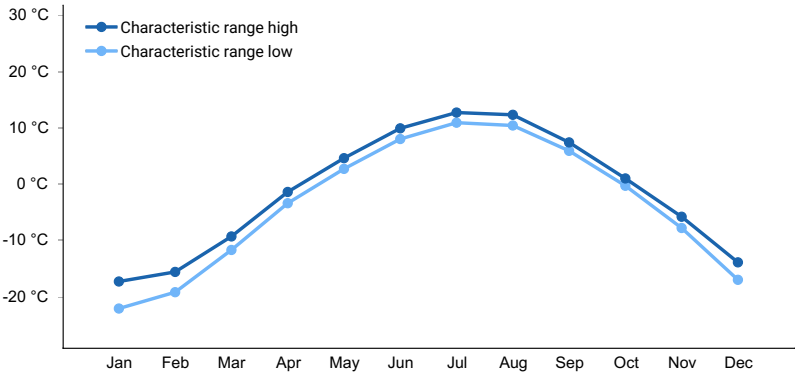


Figure 2. Monthly minimum temperature range

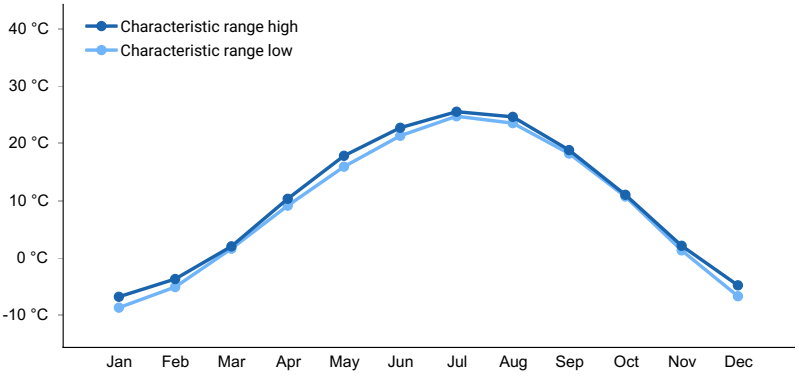


Figure 3. Monthly maximum temperature range

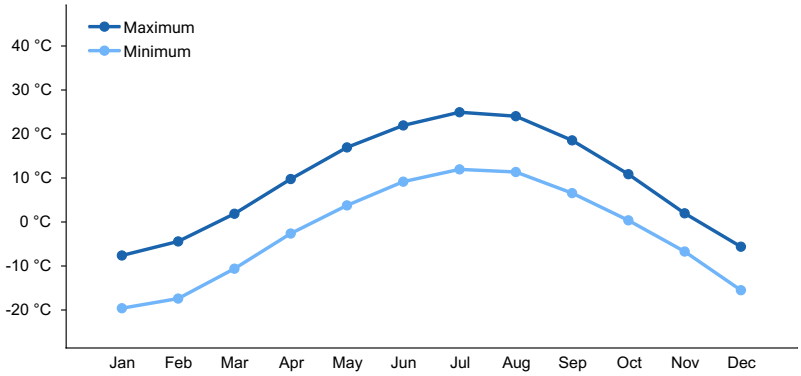


Figure 4. Monthly average minimum and maximum temperature

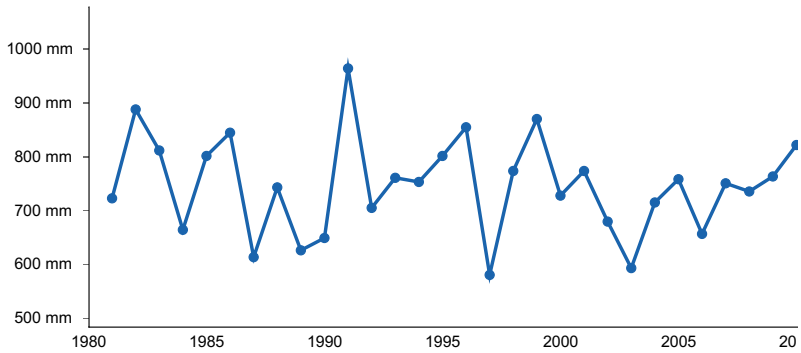


Figure 5. Annual precipitation pattern

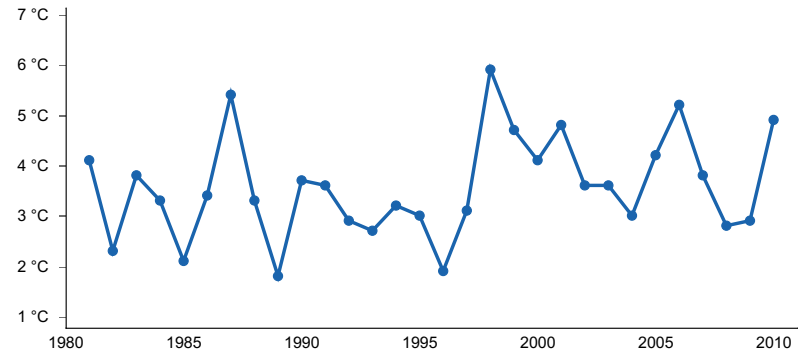


Figure 6. Annual average temperature pattern

Climate stations used

- (1) ELY 25E [USC00212555], Ely, MN
- (2) GRAND PORTAGE [USC00213296], Grand Portage, MN
- (3) KETTLE FALLS [USC00214306], Voyageurs Natl Park, MN
- (4) DULUTH [USW00014913], Duluth, MN
- (5) WOLF RIDGE ELC [USC00219134], Finland, MN
- (6) KABETOGAMA [USC00214191], Orr, MN
- (7) BRIMSON 2S [USC00210989], Brimson, MN

Influencing water features

This site receives water through precipitation, runoff from uplands, and subsurface flow including direct flooding from riparian features. Flooding occurs rarely to frequently and variations in flooding regimes will directly affect the plant community composition.

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), these sites could be classified as: Depressional, forested/organic or Depressional, scrub-shrub/organic.

Soil features

Soils representative of this site include Bowstring and Tacoosh. Parent materials are organic material mixed with alluvium, organic material over loamy drift, and organic material over glaciolacustrine deposits. Soils are muck, peat, or mucky peat, very deep, and very poorly drained.

Table 4. Representative soil features

Parent material	(1) Organic material (2) Herbaceous organic material (3) Alluvium
Surface texture	(1) Mucky peat (2) Muck (3) Peat
Drainage class	Very poorly drained
Permeability class	Moderately rapid to very rapid
Depth to restrictive layer	203 cm
Soil depth	203 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-152.4cm)	27.94–53.34 cm
Calcium carbonate equivalent (0-203.2cm)	0–10%
Soil reaction (1:1 water) (0-203.2cm)	5.6–7.3
Subsurface fragment volume <=3" (Depth not specified)	0%
Subsurface fragment volume >3" (Depth not specified)	0%

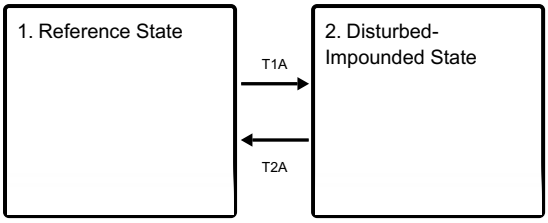
Ecological dynamics

This site is a wooded swamp on saturated, organic substrate of muck or mucky peat. This site is influenced by periodic flooding. Flooding intensity and frequency will result in variability in the plant community composition.

Historically, catastrophic disturbances were quite rare within this community. Stand replacing catastrophic storms occurred every 575 to 600 years. Catastrophic fires rarely occur, with an estimated occurrence every 920 years approximately (Minnesota Department of Natural Resources, 2005). Due to the saturated soils and shallow tree rooting systems, windthrow did cause smaller canopy-opening disturbances to occur at a shorter time interval. Hence, downed trees, displaced stumps, and sphagnum hummocks are characteristic for this site.

State and transition model

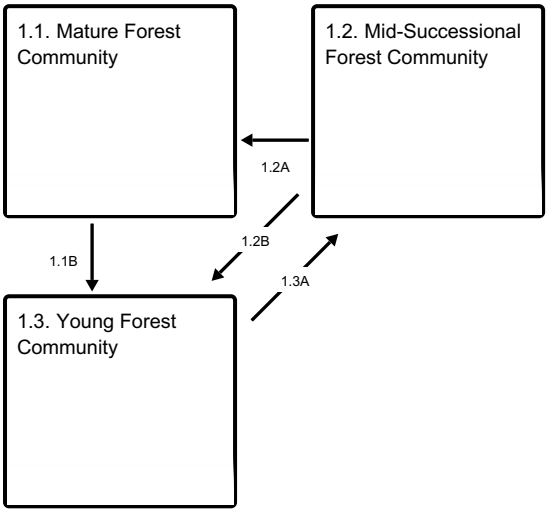
Ecosystem states



T1A - Disturbances such as roads or beaver activity occur that impound water. Increased stream bank degradation and/or invasive species may be observed.

T2A - Restoration of natural hydrology and reduction of invasive species through remediation.

State 1 submodel, plant communities



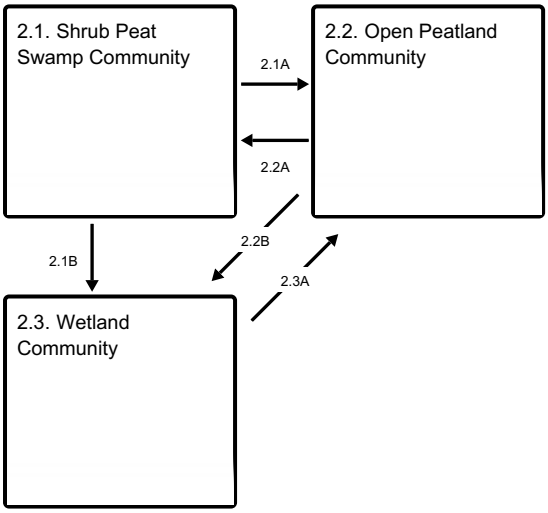
1.1B - Stand-replacing disturbance; canopy removal

1.2A - No severe site disturbances 70+ years

1.2B - Large-scale disturbance

1.3A - No major disturbance (35-75 years)

State 2 submodel, plant communities



2.1A - Increase in flooding/ponding length

2.1B - Beaver dam off-site restricts water flow or contributes to ponding on-site.

2.2A - Reduced flooding/ponding length.

2.2B - Increase in long-term flooding/ponding.

2.3A - Reduction of flooding/ponding occurrence and length.

MLRA 93A Key

State 1
Reference State

This state is a conifer-dominated swamp forest on very poorly drained peat soils. Species variability will occur depending on the depth, seasonality, and frequency of flooding/ponding. Catastrophic events are rare with fires occurring approximately every 920 years, stand-regenerating windthrow approximately every 600 years, and windthrow of small patches of canopy trees approximately every 380 years (Minnesota Department of Natural Resources. 2005.).

Dominant plant species

- balsam fir (*Abies balsamea*), tree
- arborvitae (*Thuja occidentalis*), tree
- black spruce (*Picea mariana*), tree
- paper birch (*Betula papyrifera*), tree
- tamarack (*Larix laricina*), tree
- black ash (*Fraxinus nigra*), tree
- gray alder (*Alnus incana*), shrub
- bog Labrador tea (*Ledum groenlandicum*), shrub
- alderleaf buckthorn (*Rhamnus alnifolia*), shrub
- softleaf sedge (*Carex disperma*), grass
- bristlystalked sedge (*Carex leptalea*), grass
- threeleaf goldthread (*Coptis trifolia*), other herbaceous
- sphagnum (*Sphagnum*), other herbaceous

Community 1.1
Mature Forest Community

This community is a mature, wet forest with a canopy cover generally between 50-80 percent. Trees on site include white cedar, black spruce, balsam fir, tamarack, birch, and black ash. Locally arborvitae (*Thuja occidentalis*) is commonly known as white cedar. Differences in flooding frequency and duration will influence the plant community. Understory plant diversity is often robust with numerous unique species such as showy lady's slipper (Cypripedium, reginae), small northern bog orchid (*Platanthera obtusata*), and tall northern bog orchid (*Platanthera hyperborea*).

Dominant plant species

- black spruce (*Picea mariana*), tree
- arborvitae (*Thuja occidentalis*), tree
- balsam fir (*Abies balsamea*), tree
- paper birch (*Betula papyrifera*), tree
- tamarack (*Larix laricina*), tree
- black ash (*Fraxinus nigra*), tree
- speckled alder (*Alnus incana ssp. rugosa*), shrub
- alderleaf buckthorn (*Rhamnus alnifolia*), shrub
- bog Labrador tea (*Ledum groenlandicum*), shrub
- softleaf sedge (*Carex disperma*), grass
- bristlystalked sedge (*Carex leptalea*), grass
- threeleaf goldthread (*Coptis trifolia*), other herbaceous
- sphagnum (*Sphagnum*), other herbaceous

Community 1.2
Mid-Successional Forest Community

A transition period marked with an increase in canopy cover of *Thuja occidentalis* and intermediate patches of

Picea mariana/*Abies balsamea*. The increase in canopy shading will benefit shade-tolerant ground layer species (*Rubus pubescens* and *Cornus canadensis*) and eventually reduce shrub density such as *Cornus sericea*.

Dominant plant species

- arborvitae (*Thuja occidentalis*), tree
- balsam fir (*Abies balsamea*), tree
- paper birch (*Betula papyrifera*), tree
- black spruce (*Picea mariana*), tree
- alder (*Alnus*), shrub
- bluejoint (*Calamagrostis canadensis*), grass
- sedge (*Carex*), grass
- dwarf red blackberry (*Rubus pubescens*), other herbaceous
- bunchberry dogwood (*Cornus canadensis*), other herbaceous

Community 1.3
Young Forest Community

A severe canopy-level disturbance such as fire or wind-throw alters the plant community in multiple ways. Sunlight to the forest floor increases dramatically and benefits plant species that prefer a higher level of light. Shrub density increases. Existing seed sources will determine the dominant tree seedlings and saplings initially on site.

Dominant plant species

- balsam fir (*Abies balsamea*), tree
- arborvitae (*Thuja occidentalis*), tree
- dogwood (*Cornus*), shrub
- blackberry (*Rubus*), shrub
- alder (*Alnus*), shrub
- sedge (*Carex*), grass
- bluejoint (*Calamagrostis canadensis*), grass
- fowl mannagrass (*Glyceria striata*), grass
- sphagnum (*Sphagnum*), other herbaceous

Pathway 1.1B
Community 1.1 to 1.3

Stand-replacing disturbance. Canopy layer removed.

Pathway 1.2A
Community 1.2 to 1.1

The successional community transition through time (70 + years) to a mature forest community.

Pathway 1.2B
Community 1.2 to 1.3

A large-scale disturbance can transition the community back to an earlier successional state.

Pathway 1.3A
Community 1.3 to 1.2

No major disturbances for multiple decades will allow for the increase in forest stand density and canopy cover.

State 2
Disturbed-Impounded State

This state is characterized by a long-term pattern of flooding/ponding extending beyond the spring season. This

alteration can be caused by anthropogenic (road construction) activities, or natural impoundments can be caused by beaver dams. Tree mortality occurs when flooding/ponding depth and duration increase. Water impoundment of varying depths and extended durations results in substantial variations in plant community composition. Due to an increased flooding/ponding duration a reduction in tree species occurs and an increased wetland plant composition.

Dominant plant species

- arborvitae (*Thuja occidentalis*), tree
- black spruce (*Picea mariana*), tree
- balsam fir (*Abies balsamea*), tree
- speckled alder (*Alnus incana ssp. rugosa*), shrub
- redosier dogwood (*Cornus sericea*), shrub
- currant (*Ribes*), shrub
- willow (*Salix*), shrub
- sedge (*Carex*), grass
- bluejoint (*Calamagrostis canadensis*), grass

Community 2.1
Shrub Peat Swamp Community

This community is characterized by a dominant shrub layer that includes speckled alder, redosier dogwood, and willows. Sedges and other graminoids tend to dominant the ground layer. Sun tolerant wetland forb species are common. Trees may be scattered but do not constitute a significant canopy cover.

Dominant plant species

- arborvitae (*Thuja occidentalis*), tree
- black spruce (*Picea mariana*), tree
- balsam fir (*Abies balsamea*), tree
- speckled alder (*Alnus incana ssp. rugosa*), shrub
- redosier dogwood (*Cornus sericea*), shrub
- willow (*Salix*), shrub
- currant (*Ribes*), shrub
- bluejoint (*Calamagrostis canadensis*), grass
- softleaf sedge (*Carex disperma*), grass
- bristlystalked sedge (*Carex leptalea*), grass
- hairy sedge (*Carex lacustris*), grass
- marsh marigold (*Caltha*), other herbaceous
- eastern marsh fern (*Thelypteris palustris*), other herbaceous

Community 2.2
Open Peatland Community

This site is characterized by a variable shrub layer and an increase in graminoid cover. Tree cover is sparse or absent.

Dominant plant species

- bog birch (*Betula pumila*), tree
- arborvitae (*Thuja occidentalis*), tree
- speckled alder (*Alnus incana ssp. rugosa*), shrub
- willow (*Salix*), shrub
- bluejoint (*Calamagrostis canadensis*), grass
- hairy sedge (*Carex lacustris*), grass

Community 2.3
Wetland Community

The wetland community is characterized by long term flooding/ponding. Depending on depth of water, there will be

areas with emergent and submergent aquatic vegetation, as well as scattered remnants of downed trees such as black spruce (*Picea mariana*) or arborvitae (*Thuja occidentalis*).

Dominant plant species

- hairy sedge (*Carex lacustris*), grass
- cattail (*Typha*), grass
- softstem bulrush (*Schoenoplectus tabernaemontani*), grass
- hardstem bulrush (*Schoenoplectus acutus*), grass
- shortspike watermilfoil (*Myriophyllum sibiricum*), other herbaceous
- broadleaf cattail (*Typha latifolia*), other herbaceous
- narrowleaf cattail (*Typha angustifolia*), other herbaceous
- northern wildrice (*Zizania palustris*), other herbaceous

Pathway 2.1A
Community 2.1 to 2.2

An increase in ponding/flooding length on the site continuing throughout much of the year will transition the plant community. Human activities, such as road building, or natural blockages, such as beaver dam construction, may be the causal mechanism.

Pathway 2.1B
Community 2.1 to 2.3

An increase in ponding/flooding duration to most of the year or year-round on the site will transition the plant community towards aquatic plant species. Human activities or natural blockages, such as beaver dams, substantially increases ponding depth on the site longer than the open community.

Pathway 2.2A
Community 2.2 to 2.1

Reduction of flooding/ponding length on site outside of the spring season. Due to hydrological changes such as a failing beaver dams, mechanically changing drainageways, or changes to roadways.

Pathway 2.2B
Community 2.2 to 2.3

Flooding/ponding occurrence increases throughout the year due to natural or human caused activities.

Pathway 2.3A
Community 2.3 to 2.2

Reduction of flooding/ponding occurrence and length. Due to hydrological changes such as a failing beaver dams, mechanically changing drainageways, or changes to roadways.

Transition T1A
State 1 to 2

State 2 describes the alteration of natural hydrology causing water impoundment. Multiple causal factors can impound water and result in altered plant communities. Road construction and beaver dams are a common causal mechanism. Stream bank degradation and increased invasive species establishment may also be observed.

Transition T2A
State 2 to 1

Restoration of natural hydrology through mechanical removal of beaver dams and hydrology altering roadways. Stream bank and channel restoration to a more natural state. With the potential for invasive species remediation to stabilize stream banks with native plant species.

Additional community tables

Inventory data references

No field plots were established for this project. A review of the scientific literature was used to approximate the plant communities for this ecological site. Information for the state-and-transition model was obtained from the same sources. All community phases are considered provisional. Future field verification will refine the plant communities described in this project.

References

. 1998. NRCS National Forestry Manual.

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.

Cowardin, L. M., V. Carter, F. C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. FWS/OBS-79/31, U.S. Department of Interior-Fish and Wildlife Service, Washington, D.C.

Eggers, S.D. and Reed, D.M. 2013. Wetland plants and plant communities of Minnesota and Wisconsin. Version 3.1.

Faber-Langendoen, D., editor. 2001. Plant communities of the Midwest: Classification in an ecological context. Association for Biodiversity Information, Arlington, VA. 61 pp. + appendix
(705 pp.).

Flaccus, E. and L.F. Ohmann. 1964. Old-growth Northern Hardwood Forests in Northeastern Minnesota. Ecology 45:3, 448-459.

Hillman, A., & Nielsen, S. E. (2023). Lake Superior's summer cooling of shorelines and adjacent inland forests: Implications for refugia of boreal forests and disjunct Arctic–Alpine plants. Ecology and Evolution, 13(12). doi:10.1002/ece3.10833

Minnesota Department of Natural Resources. 2005. Field Guide to the Native Plant Communities of Minnesota: the Laurentian Mixed Forest Province. Ecological Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research Program. St. Paul, Minnesota.

Minnesota Department of Natural Resources. System Summaries & NPC Factsheets. Available online at https://www.dnr.state.mn.us/npc/index.html; last accessed May 2022.

Mitsch, WJ. and J.G. Gosselink. 2007. Wetlands, fourth ed. John Wiley & Sons, Inc. New York, NY.

Ojakangas, R.W. and C.L. Matsch. 1982. Minnesota's Geology. University of Minnesota Press. Minneapolis, MN.

Smith, W.R. 2008. Trees and Shrubs of Minnesota. University of Minnesota Press. Minneapolis, MN.

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 Handbook 296.

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Approval

Suzanne Mayne-Kinney, 9/06/2024

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	09/06/2024
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):

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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:**
