USDA Natural Resources
Conservation Service

Ecological site F093AY004MN
Peatland

Last updated: 9/06/2024
Accessed: 05/20/2025

General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

MLRA notes

Major Land Resource Area (MLRA): 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 Resource (MN DNR), OPn81-Northern Shrub Shore Fen, Open Rich Peatland System, Northern Floristic Region
MN DNR, FPn62-Northern Rich Spruce Swamp, Northern Floristic Region
MN DNR, FPn63- Northern Cedar Swamp, Northern Floristic Region
MN DNR, FPn73- Northern Alder Swamp, Northern Floristic Region

Ecological site concept

This site is a peatland ecological site dominated by trees or tall shrubs, with a variable mosaic of wet-tolerant shrubs, grasses, and sedges. The Peatland ecological site is widespread throughout MLRA 93A and occurs on level to gently sloping surfaces on multiple landforms. Soils range in decomposition from mucky peat, to peat textures underlain by variable parent materials. This site is highly influenced by groundwater.

Associated sites

F093AY001MN	**Flooded Peatland** Flooded Peatland. Typically occurs at the margin of stream and river channels. pH is greater than 5.5 at 20 inch soil depth. Flooding can occur unlike other non-mineral sites.

Similar sites

F093AY003MN	**Acid Peatland** Acid Peatland. 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, but may pond.

Table 1. Dominant plant species

Tree	(1) *Larix laricina* (2) *Picea mariana*
Shrub	(1) *Betula pumila* (2) *Alnus*
Herbaceous	(1) *Carex lasiocarpa* (2) *Carex chordorrhiza*

Physiographic features

This site occurs on moraines, lake plains, depressions, outwash plains, and till plains. None to occasional ponding may occur. This site does not flood.

Table 2. Representative physiographic features

Landforms	(1) Upland > Moraine (2) Outwash plain (3) Lake plain (4) Till plain (5) Depression
Runoff class	Negligible to low
Flooding frequency	None
Ponding frequency	None to occasional
Elevation	1,099–1,899 ft
Slope	0–1%
Water table depth	0 in
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 97 to 150 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)	28-31 in
Frost-free period (actual range)	44-114 days
Freeze-free period (actual range)	97-150 days
Precipitation total (actual range)	26-32 in
Frost-free period (average)	93 days
Freeze-free period (average)	130 days
Precipitation total (average)	29 in

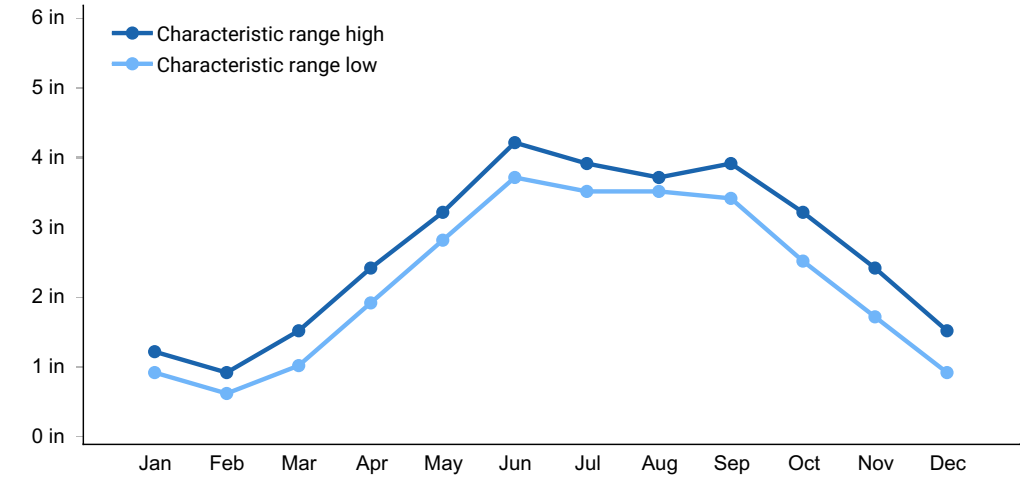


Figure 1. Monthly precipitation range

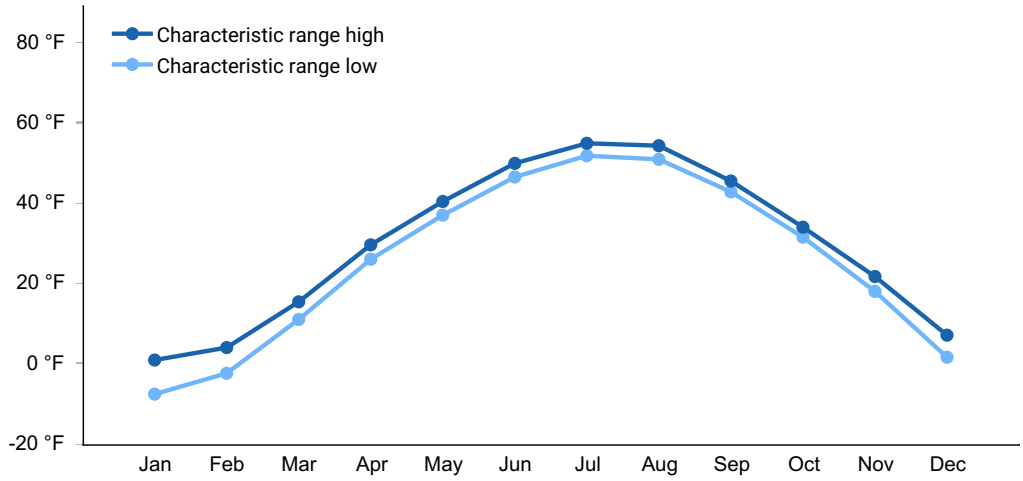


Figure 2. Monthly minimum temperature range

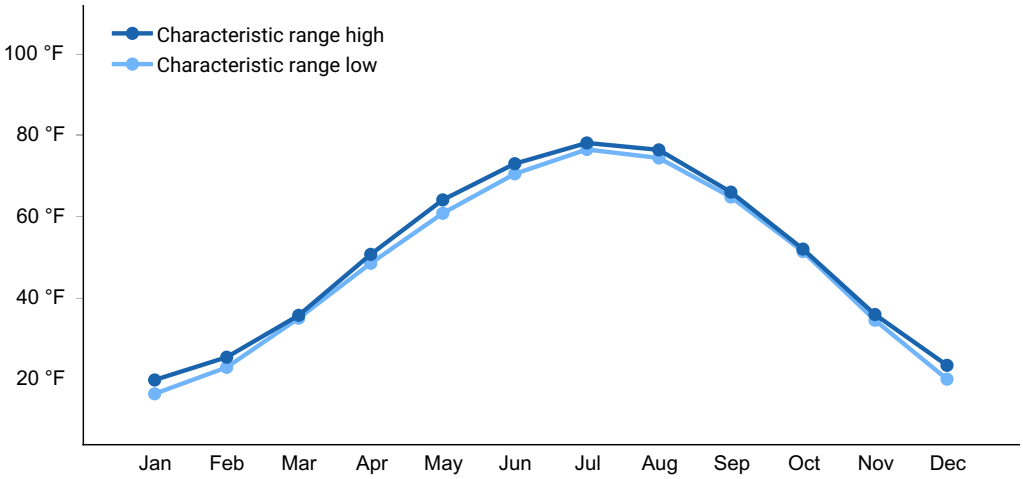


Figure 3. Monthly maximum temperature range

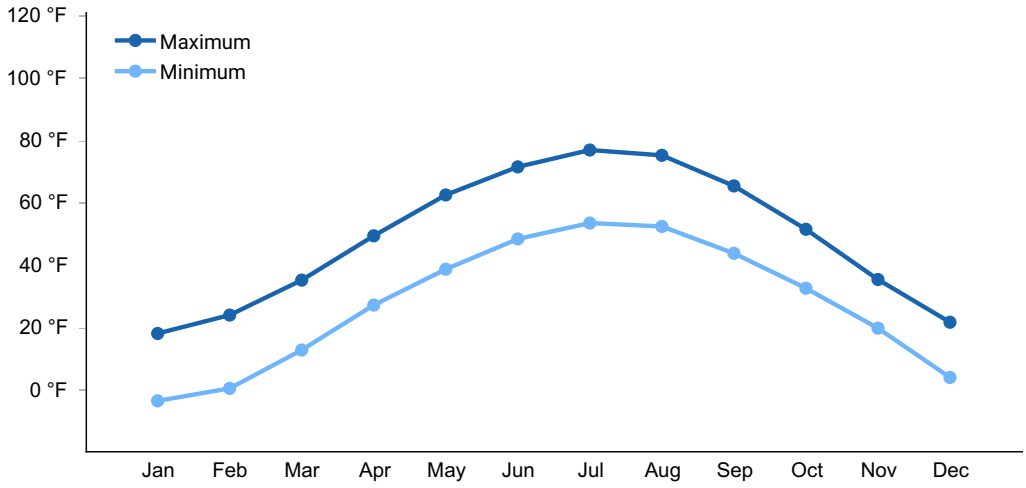


Figure 4. Monthly average minimum and maximum temperature

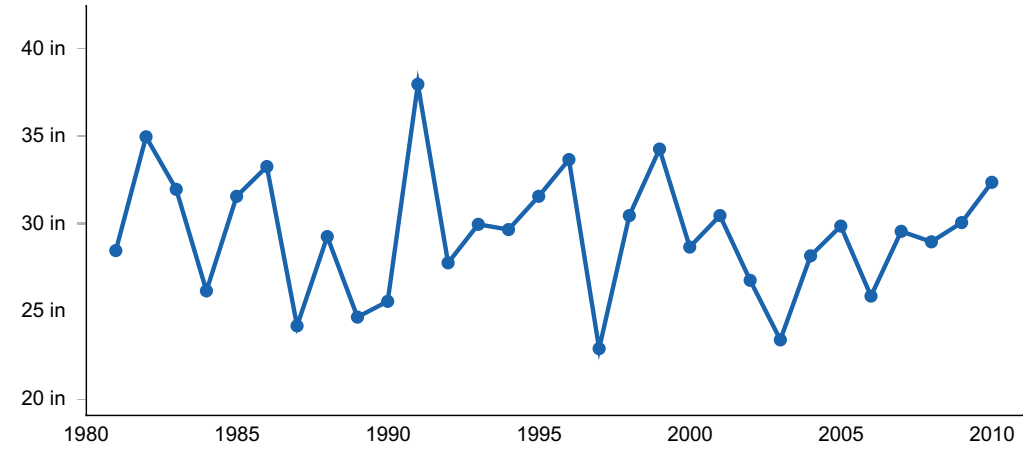


Figure 5. Annual precipitation pattern

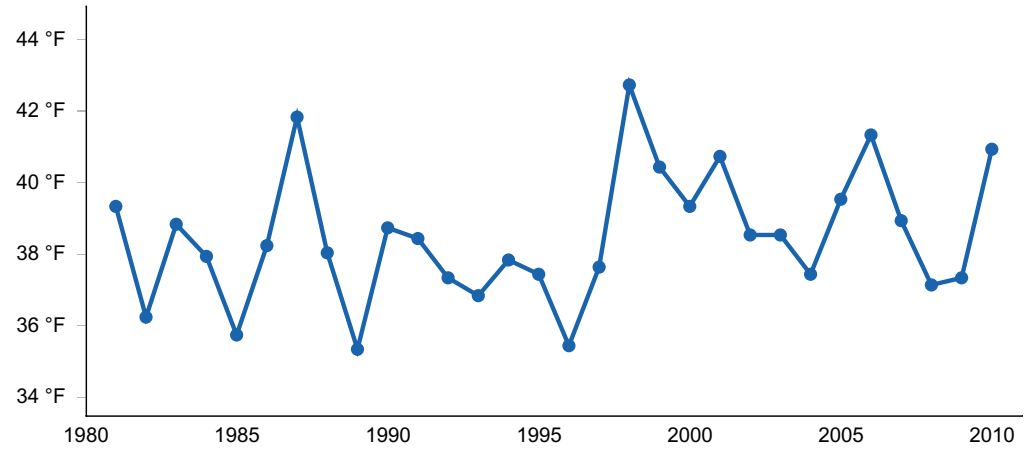


Figure 6. Annual average temperature pattern

Climate stations used

- (1) BRIMSON 2S [USC00210989], Brimson, MN
- (2) KABETOGAMA [USC00214191], Orr, MN
- (3) GRAND PORTAGE [USC00213296], Grand Portage, MN
- (4) DULUTH [USW00014913], Duluth, MN

- (5) WOLF RIDGE ELC [USC00219134], Finland, MN
- (6) ELY 25E [USC00212555], Ely, MN
- (7) KETTLE FALLS [USC00214306], Voyageurs Natl Park, MN

Influencing water features

Most areas of this site do not flood or pond; however, soils are saturated and occasional ponding may occur especially after heavy rainfall events.

Wetland description

Under the Cowardin System of Wetland Classification, or National Wetlands Inventory (NWI), these sites could be classified as:
1) Palustrine, scrub-shrub, broad-leaved deciduous, saturated, or
2) Palustrine, moss-lichen, saturated, or
3) Palustrine, scrub-shrub, broad-leaved evergreen, saturated, or
4) Palustrine emergent, persistent, saturated
NRCS Hydrologic group: A/D, B/D, C/D.
Many of these sites have hydric soils.

Soil features

Soils representative of this site include Mooselake, Rifle, and Uskabwanka. Taxonomic subgroups are lithic haplohemists, terric haplohemists, and hydric haplohemists. Soils are very poorly drained and have a wet layer depth at the surface. The site does not flood, but may pond occasionally to frequently. A 5.5-7.3 pH at 20 or more inches differentiates the peatland sites from acid peatland sites. A lower pH can be found above 20 inches.

Table 4. Representative soil features

Parent material	(1) Organic material (2) Herbaceous organic material (3) Woody organic material
Surface texture	(1) Mucky peat (2) Peat
Drainage class	Very poorly drained
Permeability class	Slow to rapid
Depth to restrictive layer	42–72 in
Soil depth	80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%

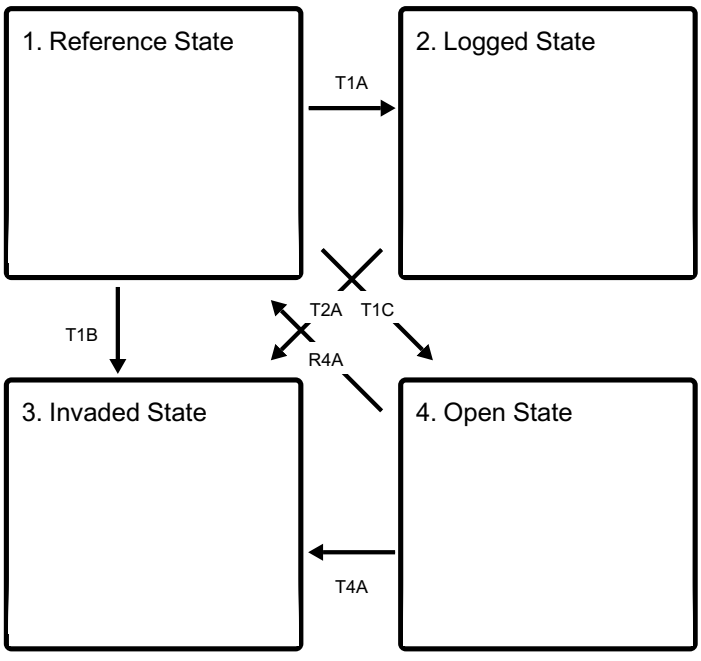
Available water capacity (0-60in)	15–21 in
Calcium carbonate equivalent (0-40in)	0–15%
Electrical conductivity (Depth not specified)	0 mmhos/cm
Sodium adsorption ratio (Depth not specified)	0
Soil reaction (1:1 water) (0-40in)	3.5–6.5
Subsurface fragment volume <=3" (Depth not specified)	0–18%
Subsurface fragment volume >3" (Depth not specified)	0–25%

Ecological dynamics

This site is a peatland characterized by a plant community dominated by shrub and fine-leaved graminoids. Tree cover is often present, but may be sparse. Shrub cover is variable ranging from sparse to dense. Graminoid cover is generally >50% and dominated by sedges. Sphagnum and brown mosses are present. In the absence of anthropogenic disturbances, these sites are relatively stable and maintain a mosaic of shrub, graminoid, or shrub-graminoid plant dominance.

State and transition model

Ecosystem states



T1A - Logging, seeding.

T1B - Impoundment or maintenance of water on-site, and/or establishment of invasive species.

T1C - Beaver activity, roads, drainage, and other alterations in hydrology.

T2A - Non-native plant species on site

R4A - Hydrological management

T4A - Non-native species on site

State 1 submodel, plant communities

1.1. Mature Spruce-Tamarack

1.2. Cedar Bog

1.3. Alder Swamp

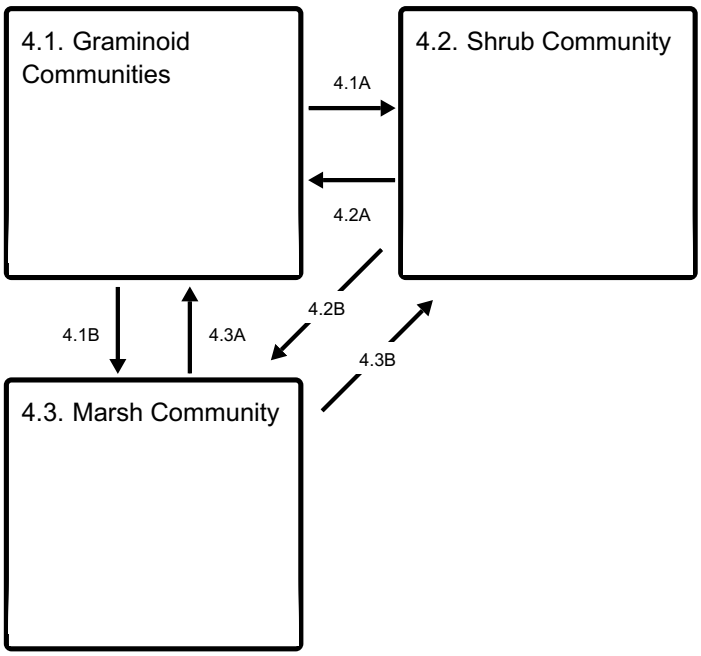
State 2 submodel, plant communities

2.1. Logged Community

State 3 submodel, plant communities

3.1. Disturbed State

State 4 submodel, plant communities



4.1A - Lack of fire and/or periodic drought

4.1B - Water restriction resulting in ponding

4.2A - Frequent surface fires or higher than average precipitation

4.2B - Increased ponding on-site

4.3A - Removal of water obstructions

4.3B - Reduced ponding; beaver dam removal

State 1
Reference State

The reference state is dominated by conifer or tall shrub communities. Soils are mucky peat or peat. The shrub layer is composed of speckled alder, shrubby cinquefoil, bog rosemary, alder, willows, Labrador tea, and bog laurel. The ground layer is predominately sphagnum moss with forbs and graminoids intermixed. Peat continues to form and accumulate over time. Species to the reference state are not mutually exclusive, but will have a higher productivity compared to acid peatlands.

Dominant plant species

- black spruce (*Picea mariana*), tree
- arborvitae (*Thuja occidentalis*), tree
- bog Labrador tea (*Ledum groenlandicum*), shrub
- bog laurel (*Kalmia polifolia*), shrub
- gray alder (*Alnus incana*), shrub
- bog rosemary (*Andromeda polifolia var. glaucophylla*), shrub
- common reed (*Phragmites australis*), grass
- bunchberry dogwood (*Cornus canadensis*), other herbaceous
- Canada mayflower (*Maianthemum canadense*), other herbaceous

- starflower (*Trientalis borealis*), other herbaceous
- bluebead (*Clintonia borealis*), other herbaceous

Community 1.1
Mature Spruce-Tamarack

This site has a canopy of mature black spruce and/or tamarack. In cases where tamarack is monotypic, it is usually due to a lack of seed source for black spruce, or mortality of black spruce caused by species-specific insects or disease (MN DNR Forestry). Sphagnum dominates the moss layer. The forb layer is dominated by bunchberry (*Cornus canadensis*) and starflower (*Trientalis borealis*) (MN DNR 2003). Both a tall shrub and low shrub layer commonly occur. Shrub layer is more prevalent than acid peatlands. Canopy cover exceeds 50%, more shade-tolerant species can be present in the understory, including creeping snowberry (*Gaultheria hispidula*), soft-leaved sedge (*Carex disperma*) , ferns (Dryopteris spp.), clubmosses (*Lycopodium annotinum*), and bunchberry (*Cornus canadensis*) (MN DNR 2003).

Dominant plant species

- black spruce (*Picea mariana*), tree
- tamarack (*Larix laricina*), tree
- gray alder (*Alnus incana*), shrub
- bog Labrador tea (*Ledum groenlandicum*), shrub
- creeping snowberry (*Gaultheria hispidula*), shrub
- threeseeded sedge (*Carex trisperma*), grass
- bunchberry dogwood (*Cornus canadensis*), other herbaceous
- starflower (*Trientalis borealis*), other herbaceous

Community 1.2
Cedar Bog

Cedar bogs are dominated by white cedar, balsam fir, and black spruce. Balsam fir and black spruce are rarely dominate in this community. The shrub and forb layer has a more diverse presence in this community compared to spruce dominated communities. Commonly occur adjacent of mineral areas and are influenced by mineral rich subsurface water flow (MN DNR 2003). Occurs where peat accumulation has started to limit direct access of shallowly rooted plants to nutrient rich soils with through flow present.

Dominant plant species

- bog birch (*Betula pumila*), shrub
- bog willow (*Salix pedicellaris*), shrub
- speckled alder (*Alnus incana ssp. rugosa*), shrub
- leatherleaf (*Chamaedaphne calyculata*), shrub
- sedge (*Carex*), grass
- bluejoint (*Calamagrostis canadensis*), grass

Community 1.3
Alder Swamp

Tall shrub wetlands dominated by speckled alder on peat soils and may be more prevalent along the margins of peatlands. Tree cover less than 25% and tall-shrub layer dominates. Shrub layer is dominated by speckled alder, red-osier dog wood, swamp gooseberry, common gooseberry, and swamp red currant (MN DNR 2003). Alder swamps communities are intermixed with other peatland communities commonly especially by drainageways.

Dominant plant species

- paper birch (*Betula papyrifera*), tree
- black ash (*Fraxinus nigra*), tree
- speckled alder (*Alnus incana ssp. rugosa*), shrub
- redosier dogwood (*Cornus sericea ssp. sericea*), shrub
- hairystem gooseberry (*Ribes hirtellum*), shrub
- red currant (*Ribes triste*), shrub
- skunk currant (*Ribes glandulosum*), shrub
- bluejoint (*Calamagrostis canadensis var. canadensis*), grass
- fowl mannagrass (*Glyceria striata*), grass
- softleaf sedge (*Carex disperma*), grass
- bristlystalked sedge (*Carex leptalea*), grass
- dwarf red blackberry (*Rubus pubescens*), other herbaceous
- crested woodfern (*Dryopteris cristata*), other herbaceous
- yellow marsh marigold (*Caltha palustris*), other herbaceous
- touch-me-not (*Impatiens*), other herbaceous

State 2
Logged State

This state describes the removal black spruce and some tamarack through logging. The natural plant community has been severely disturbed and the site has been impacted by heavy equipment. Compositional changes in canopy cover and soil/water disturbances impact all layers of the plant community. Best management practices can help reduce site damage and the implementation of post-logging timber stand improvement practices can enhance tree regeneration.

Dominant plant species

- bog birch (*Betula pumila*), shrub
- alder (*Alnus*), shrub
- reed canarygrass (*Phalaris arundinacea*), grass
- sedge (*Carex*), grass
- purple loosestrife (*Lythrum salicaria*), other herbaceous

Community 2.1
Logged Community

This state describes the removal of black spruce and some tamarack. With the disturbance of the site by heavy equipment. Canopy cover has been removed and shrub density will increase. Species composition will vary depending on the type, timing, and severity of disturbance.

Dominant plant species

- birch (*Betula*), shrub
- sedge (*Carex*), grass
- sphagnum (*Sphagnum*), other herbaceous
- Schreber's big red stem moss (*Pleurozium schreberi*), other herbaceous

State 3
Invaded State

The plant community is still an open peatland dominated by shrubs and graminoids; however, invasive species are now present on site and will increase with the absence of management inputs.

Dominant plant species

- bog birch (*Betula pumila*), shrub
- alder (*Alnus*), shrub
- reed canarygrass (*Phalaris arundinacea*), grass
- sedge (*Carex*), grass
- purple loosestrife (*Lythrum salicaria*), other herbaceous

Community 3.1
Disturbed State

Water ponding for a longer than normal duration results in canopy mortality of tamarack and spruce trees and opening of the understory to light. Alder and willow shrubs often remain on edge zones. Site disturbance such as logging often allows for the introduction of non-native vegetation on these sites. The plant community is dominated by shrubs and graminoids; however, invasive species are now present on site and will increase with the absence of management inputs.

Dominant plant species

- glossy buckthorn (*Frangula alnus*), shrub
- reed canarygrass (*Phalaris arundinacea*), grass
- purple loosestrife (*Lythrum salicaria*), other herbaceous

State 4
Open State

This community is dominated by fine-leaved sedges, graminoids, and shrubs. Soils are mucky peat or peat. The shrub layer is composed of bog birch, shrubby cinquefoil, bog rosemary, alder, willows, bog Labrador tea, and leatherleaf. Tamarack trees may be present but are scattered. The ground layer is predominately graminoids which includes multiple sedge species. Marsh cinquefoil (purple marshlocks), Labrador bedstraw, marsh bellflower, and eastern marsh fern are usually present.

Dominant plant species

- bog birch (*Betula pumila*), shrub
- gray alder (*Alnus incana*), shrub
- bog rosemary (*Andromeda polifolia*), shrub
- leatherleaf (*Chamaedaphne calyculata*), shrub
- willow (*Salix*), shrub
- common marsh bedstraw (*Galium palustre*), other herbaceous
- marsh bellflower (*Campanula aparinoides*), other herbaceous
- eastern marsh fern (*Thelypteris palustris var. pubescens*), other herbaceous

Community 4.1
Graminoid Communities

The peatland system of northeastern Minnesota forms a mosaic of plant community variations across the landscape. Dominated by a diversity of wet-tolerant graminoid species. Multiple species of native sedges are present on site. The shrub layer is variable but usually sparse to scattered.

Dominant plant species

- bog birch (*Betula pumila*), shrub
- sedge (*Carex*), grass
- purple marshlocks (*Comarum palustre*), other herbaceous
- eastern marsh fern (*Thelypteris palustris var. pubescens*), other herbaceous
- tufted loosestrife (*Lysimachia thyrsiflora*), other herbaceous

Community 4.2
Shrub Community

Numerous low and tall shrubs may be present in this community. Tall shrub species include bog willow (*Salix pedicellaris*), bog birch (*Betula pumila*), speckled alder (*Alnus incana*), balsam willow (*Salix pyrifolia*), slender willow (*Salix petiolaris*), and meadowsweet (*Spiraea alba*) . Common low shrubs include leatherleaf (*Chamaedaphne calyculata*), Labrador tea (*Ledum groenlandicum*), small cranberry (*Vaccinium oxycoccos*), bog rosemary (*Andromeda polifolia*), and sweetgale (*Myrica gale*). Tamarack seedling and

saplings are usually present. Multiple species of willow and sedges occur. Water depth, microtopography, peat depth, and other soil characteristics will influence the plant community composition.

Dominant plant species

- bog birch (*Betula pumila*), shrub
- bog willow (*Salix pedicellaris*), shrub
- speckled alder (*Alnus incana ssp. rugosa*), shrub
- leatherleaf (*Chamaedaphne calyculata*), shrub
- sedge (*Carex*), grass
- bluejoint (*Calamagrostis canadensis*), grass

Community 4.3
Marsh Community

Zones within this site may have areas that can be described as a sedge-cattail marsh. Cattail and sedges are dominant. Emergent forbs such as broad-leaved arrowhead (*Sagittaria latifolia*), marsh skullcap (*Scutellaria galericulata*), bedstraws (Galium spp.), and beggarticks (Bidens spp.) are common. Areas of open water may be present. Areas of deeper water will contain floating and submerged forbs such as duckweed (Lemna spp.), smartweed (Polygonum spp.), and American white water lily (*Nymphaea odorata*).

Dominant plant species

- cattail (*Typha*), grass
- bluejoint (*Calamagrostis canadensis*), grass
- rice cutgrass (*Leersia oryzoides*), grass
- sedge (*Carex*), grass
- broadleaf arrowhead (*Sagittaria latifolia*), other herbaceous
- marsh skullcap (*Scutellaria galericulata*), other herbaceous
- bedstraw (*Galium*), other herbaceous

Pathway 4.1A
Community 4.1 to 4.2

Lack of fire and/or periodic drought will allow shrub species to increase.

Pathway 4.1B
Community 4.1 to 4.3

An substantial increase in water levels including ponding will begin to transition the community to a more open structure. Tree death will occur as water deepens. This scenario can be caused by beaver dam construction.

Pathway 4.2A
Community 4.2 to 4.1

More frequent surface fires will reduce shrub density. Also, an increase in precipitation level with associated ponding can reduce shrub density.

Pathway 4.2B
Community 4.2 to 4.3

An increase in water levels such as long-term ponding such as caused by beaver dam construction.

Pathway 4.3A
Community 4.3 to 4.1

Removal of beaver dam and return to unobstructed hydrology.

Pathway 4.3B
Community 4.3 to 4.2

Removal of obstructions, such as beaver dams, will reduce ponding and increase areas for shrub regeneration.

Transition T1A
State 1 to 2

This transition involves logging, usually clearcutting, but with reserves for seed sources, site preparation, control for disease and invasive species, and seeding, in order to maintain the site as a viable commercial timber harvesting state. This transition is only possible, or desirable, when the management is applied to phases in which radial growth has been prolific and trees have reached maturity, exhibiting taller, more commercially viable trees.

Transition T1B
State 1 to 3

Impoundment or maintenance of water on-site, and/or establishment of invasive species. Beaver activity, roads, drainage, and other alterations in hydrology can transition the Acid Peatlands out of Reference to an Impounded State, where water is ponded on site for longer durations and receives excessive nutrients from overland surface flow.

Transition T1C
State 1 to 4

Impoundment or maintenance of water on-site. Beaver activity, roads, drainage, and other alterations in hydrology can transition the Acid Peatlands out of Reference to an Open State, where water is on site for longer durations and receives excessive nutrients from overland surface flow causing stunted tree growth.

Transition T2A
State 2 to 3

Introduction and establishment of non-native invasive species.

Restoration pathway R4A
State 4 to 1

Draining or maintenance of water on-site causing alterations in hydrology that can transition the Open state back to the Reference State, where water is on site for shorter durations and receives less nutrients from overland surface flow causing increased tree growth.

Transition T4A
State 4 to 3

Introduction and establishment of non-native invasive 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.

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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):**

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):**

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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:**
