USDA Natural Resources Conservation Service

Ecological site F057XY003MN
Peatland

Last updated: 10/03/2023
Accessed: 05/20/2024

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): 057X–Northern Minnesota Gray Drift

The Northern Minnesota Gray Drift (57) is located within the Northern Lakes Forest and Forage Region. This area is entirely in north-central Minnesota and makes up about 9,785 square miles (Figure 1). The entire area is covered by Wisconsin-age glacial drift. The glacial deposits are from four major ice lobes-Des Moines, Rainy, Superior, and Wadena. The landscape developed through a series of glaciations and the subsequent retreating and wasting of the ice sheets, which resulted in a complex pattern of moraines, outwash plains, drumlins, lake plains and drainages. Lakes, ponds and marshes are common. The thickness of the glacial till ranges from 90 to 185 meters. Some areas of these deposits are overlain by outwash or lacustrine sediments. Some depressional areas have an accumulation of organic matter. The organic deposits are more than 2.5 meters thick in some areas. Elevation ranges from 300 to 500 meters across the area. (USDA-NRCS 2006)

Prior to settlement, the vegetation in this area was mainly a mixture of deciduous trees and conifers. White Pine and red pine grew on moraines. Jack pine was dominant on outwash plains and sandy lake plains. Red oak, sugar maple, and basswood grew in sheltered areas close to lakes. Forested lowlands were dominated by black spruce, tamarack, white cedar, and black ash. Wetlands that were not forested were dominated by sedge meadow communities. The western part of the area was dominated by tall prairie grasses. Most of this area is still forested today, aspen as become the most common species both in pure stands and mixed stands with birch, maple, oak, white spruce, and red pine. (USDA-NRCS 2006)

The dominant soil orders in this MLRA are Alfisols, Entisols, and Histisols, with some Mollisols in the westernmost part of the area. The soils in the area have a frigid soil temperature regime; aquic or udic soil moisture regime, and mixed mineralogy. Their natural drainage class is related to landscape position. In general, the Alfisols formed in till on moraines, Entisols formed in outwash on moraines and outwash plains, and Histosols formed in organic material over outwash or till on moraines or outwash plains. (USDA-NRCS 2006)

Classification relationships

Major Land Resource Area (MLRA): Northern Minnesota Gray Drift (57) (USDA Handbook 296, 2006)

USFS Subregions: Northern Minnesota Drift & Lake Plain Section (212N); Chippewa Plains Subsection (212Na), Pine Moraines & Outwash Plains Subsections (212Nc), St. Louis Moraines Subsection (212Nb); Minnesota & NE Iowa Morainal Section (222M); Hardwood Hills Subsection (222Ma); Northern Superior Uplands Section (212L); Nashwauk Uplands Subsection (212Lc); Northern Minnesota & Ontario Peatlands Section (212M); Littlefork-Vermillion Uplands Subsection (212Ma) (Cleland et al. 2007).

US EPA Level IV Ecoregion: Itasca and St. Louis Moraines (50q); Chippewa Plains (50r); Nashwauk/Marcell Moraines and Uplands (50s); Alexandria Moraines and Detroit Lakes Outwash Plain (51j); McGrath Till Plain and Drumlins (51k); Wadena/Todd Drumlins and Osakis Till Plain (51l) (U.S. Environmental Protection Agency, 2013)

Ecological site concept

Peatlands are widespread throughout MLRA 57, and typically occur on the edges of shallow basins or drainageways, oftentimes adjacent to larger peatlands. Soils have 8 to 16” of organic material, and soil pH values are greater than 4.5.

Associated sites

F057XY002MN	**Wet Depressional Forest** Wet Depressional Forest occurs in shallow wetland basins, closed depressions, and generally in narrow transition zones between mineral uplands and peatlands. Soil surface layers are typically mucky-modified surface textures or muck less than 8” thick over variable parent materials.
R057XY005MN	**Open Peatland** Open Peatland occurs on level to gently sloping surfaces. Soils have greater than 16” of organic material and soil pH values are greater than 4.5. This site has a high water table that remain near the surface throughout the growing season, preventing the establishment of significant tree cover.

Similar sites

F057XY016MN	**Flood Plain Forest** Flood Plain Forest occurs on occasionally flooded terraces and floodplains. Soils consist of stratified alluvium vary widely from silty to fine sandy soils on the terraces to coarser textured alluvium on the active floodplain sites. Soils on the active floodplain positions are annually flooded with grey soil color indicative of high local water tables which are subject to scouring and deposition from floodwater.

Table 1. Dominant plant species

Tree	(1) *Fraxinus nigra* (2) *Ulmus americana*
Shrub	(1) *Salix* (2) *Alnus incana ssp. rugosa*
Herbaceous	(1) *Carex lacustris* (2) *Calamagrostis canadensis*

Physiographic features

Peatlands typically occur on the edges of shallow basins or drainageways, oftentimes adjacent to larger peatlands in depressions, moraines, or outwash plains. Slope is minimal and ranges from 0 to 1 percent. These sites are very poorly drained

Table 2. Representative physiographic features

Hillslope profile	(1) Footslope
Slope shape across	(1) Concave
Slope shape up-down	(1) Linear
Landforms	(1) Depression (2) Moraine (3) Lake plain
Runoff class	Very low
Flooding frequency	None
Ponding duration	Brief (2 to 7 days) to long (7 to 30 days)
Ponding frequency	Frequent to occasional
Elevation	183–518 m
Slope	0–1%

Water table depth	0 cm
Aspect	Aspect is not a significant factor

Climatic features

In general, MLRA 57 has cold winters and warm summers. About 65 percent of the annual precipitation falls as rain during the 5-month growing season (May through September), and an additional 18 percent falls as snow. The freeze-free period averages 150 days and ranges from 120 to 175 days.

Table 3. Representative climatic features

Frost-free period (characteristic range)	90-102 days
Freeze-free period (characteristic range)	130-132 days
Precipitation total (characteristic range)	635-711 mm
Frost-free period (actual range)	79-104 days
Freeze-free period (actual range)	123-134 days
Precipitation total (actual range)	635-711 mm
Frost-free period (average)	95 days
Freeze-free period (average)	130 days
Precipitation total (average)	660 mm

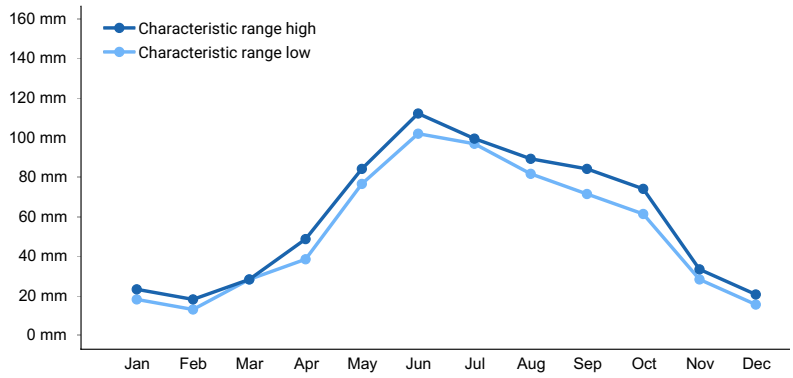


Figure 1. Monthly precipitation range

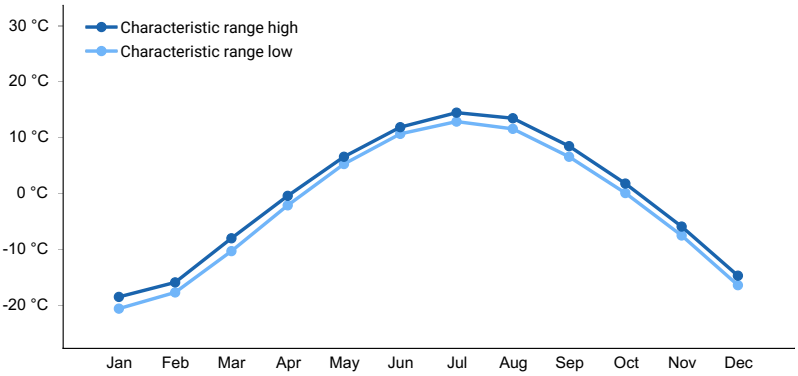


Figure 2. Monthly minimum temperature range

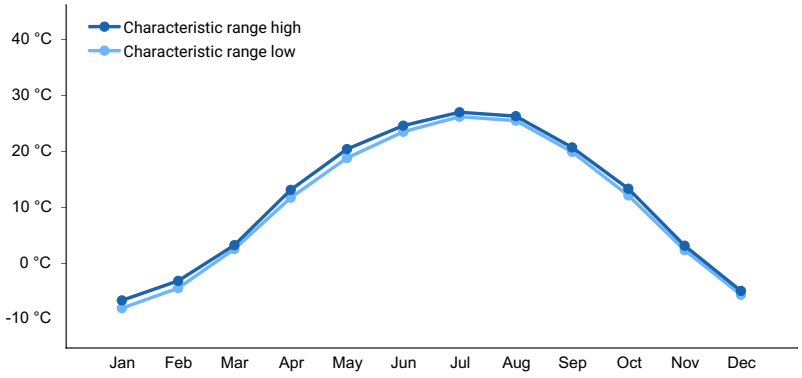


Figure 3. Monthly maximum temperature range

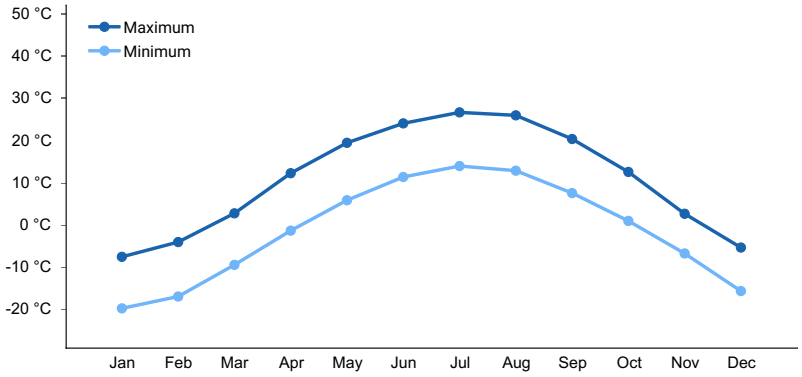


Figure 4. Monthly average minimum and maximum temperature

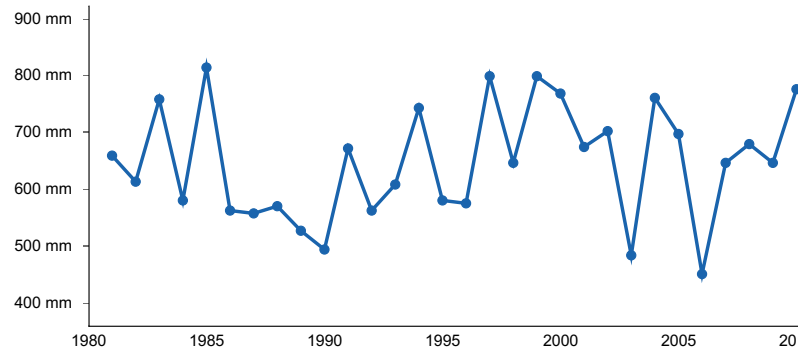


Figure 5. Annual precipitation pattern

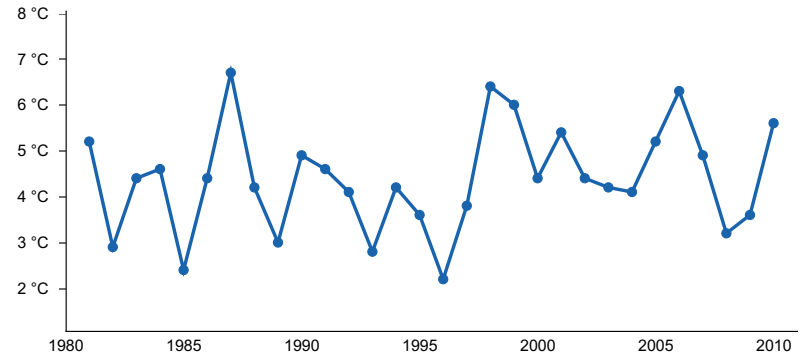


Figure 6. Annual average temperature pattern

Climate stations used

- (1) RED LAKE INDIAN AGCY [USC00216795], Ponemah, MN
- (2) FOSSTON 1 E [USC00212916], Fosston, MN
- (3) BLACKDUCK [USC00210809], Blackduck, MN

- (4) DEEP PORTAGE [USC00212050], Backus, MN
- (5) DETROIT LAKES 1 NNE [USC00212142], Detroit Lakes, MN

Influencing water features

Historically, Peatlands could have developed from other Ecological Sites, such as Wet Depressional Forest, because of long-term flooding from beaver activity, or from Forested Peatland, following catastrophic fire and severe droughts (MN DNR 2003). In these cases, the peat on-site may be deeper than what is normally associated with this site concept and should have evidence at depth of woody fragments in the peat. Peatlands could also have historically developed from Marshes that were subjected to lowered water levels due to prolonged beaver activity, and then accumulated sedimentary peat over time, leading to invasion of sedges over cattails. Otherwise, this Peatland site concept is usually found in transition areas surrounding deeper peatlands or more open bodies of water. In some cases, where the site is adjacent to peatlands where Sphagnum sp. are present, there can be an invasion of Sphagnum sp. resulting in a very rapid conversion of the Open Peatland to an Acid Peatland site, an acidification of the water chemistry, and a decline in nutrient status. This usually requires a shift in hydrology such that the water table stabilizes at a higher level. In the opposite case, where the water table and hydrology are altered to result in a systematically drier site, the Peatland can convert back to a Wet Depressional Forest, or other forested communities, as shrubs and eventually trees are able to establish.

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

Under the Hydrogeomorphic Classification System (HGM), these sites could be classified as:
1) Depressional, forested/organic, or
2) Depressional, scrub-shrub/organic

Permeability of the soil is moderately slow to slow
Hydrologic Group: A/D, B/D, C/D

Soil features

The dominant soil orders in this MLRA are Alfisols, Entisols, and Histisols, with some Mollisols in the westernmost part of the area. Possible soil series of this site include: Hamre, Leafriver, Blackhoof, Northwood, Deerwood, Haug and Sax. The soils in the area have a frigid soil temperature regime; aquic or udic soil moisture regime, and mixed mineralogy. There natural drainage class is related to landscape position. In general, the Alfisols formed in till on moraines, Entisols formed in outwash on moraines and outwash plains, and Histosols formed in organic material over outwash or till on moraines or outwash plains. (USDA-NRCS 2006)

Table 4. Representative soil features

Parent material	(1) Till (2) Outwash (3) Organic material (4) Not specified
Surface texture	(1) Muck
Family particle size	(1) Fine-loamy
Drainage class	Very poorly drained
Permeability class	Moderately slow to moderate
Soil depth	203 cm
Surface fragment cover <=3"	0%

Surface fragment cover >3"	0%
Available water capacity (0-152.4cm)	15.49–28.19 cm
Calcium carbonate equivalent (0-254cm)	0–15%
Soil reaction (1:1 water) (0-101.6cm)	5.1–8.4
Subsurface fragment volume <=3" (0-101.6cm)	0–11%
Subsurface fragment volume >3" (0-101.6cm)	0–2%

Ecological dynamics

Peatlands are widespread throughout MLRA 57, and typically occur on the edges of shallow basins or drainageways, oftentimes adjacent to larger peatlands. Soils have 8 to 16” of organic material, and soil pH values are greater than 4.5. The organic material ranges in decomposition from muck and mucky peat to peat textures underlain by variable parent material. Surface water on these sites is derived from surface flow and groundwater and is highly influenced by the abundant concentration of minerals such as calcium that has percolated through the highly calcareous parent material that typically occurs throughout the region. Water levels are usually high enough to preclude tree establishment on-site, although typically there is little to no ponding during the growing season. The water table on these sites is typically saturated to the surface following spring thaw and heavy rains but can periodically drop throughout the growing season to variable depths, resulting in alternating periods of anaerobic and aerobic conditions within the soil substrate (MN DNR 2003). Organic matter can be oxidized during these periods of drawdowns, and during extreme drought, can be burned in surface fires.

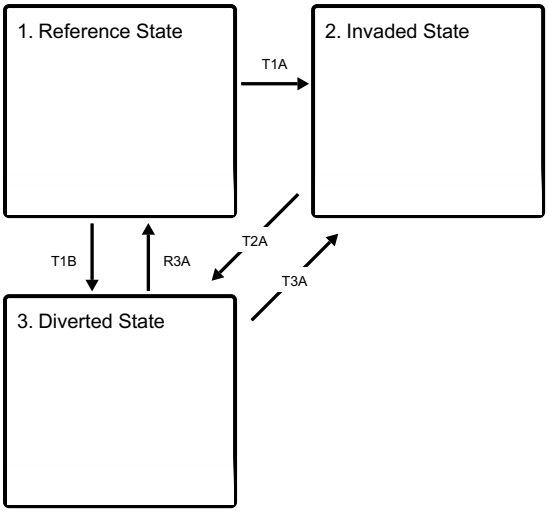
Typically, Peatlands are shrub or graminoid-dominated wetlands. Vegetation commonly includes broad-leaved sedges, willows, alders, and dogwoods. The vegetation associated with this site have adaptations that allow them to survive both waterlogged conditions and periods of drought, although they’re generally intolerant of long-term durations of either (MN DNR 2003). Plant adaptations, including aerenchyma cells, sclerenchyma cells, adventitious roots, and tussock-forming growth habits, are evident among plants endemic to this site. These are all ways that the plants can tolerate periods of both inundation and drought, although most endemic to this site cannot tolerate long periods of either.

Historically, Peatlands could have developed from other Ecological Sites, such as Wet Depressional Forest, because of long-term flooding from beaver activity, or from Forested Peatland, following catastrophic fire and severe droughts (MN DNR 2003). In these cases, the peat on-site may be deeper than what is normally associated with this site concept and should have evidence at depth of woody fragments in the peat. Peatlands could also have historically developed from Marshes that were subjected to lowered water levels due to prolonged beaver activity, and then accumulated sedimentary peat over time, leading to invasion of sedges over cattails.

Otherwise, this Peatland site concept is usually found in transition areas surrounding deeper peatlands or more open bodies of water. In some cases, where the site is adjacent to peatlands where Sphagnum sp. are present, this can lead to a conversion first to Open Peatland, and eventually to Acid Peatland, an acidification of the water chemistry, and a decline in nutrient status. This usually requires a shift in hydrology such that the water table stabilizes at a higher level. In the opposite case, where the water table and hydrology are altered to result in a systematically drier site, the Peatland can convert back to a Wet Depressional Forest, or other forested communities, as shrubs and eventually trees are able to establish.

State and transition model

Ecosystem states



T1A - Invasion by reed canarygrass or common reed, usually increases in water nutrient levels or alterations in hydrology.

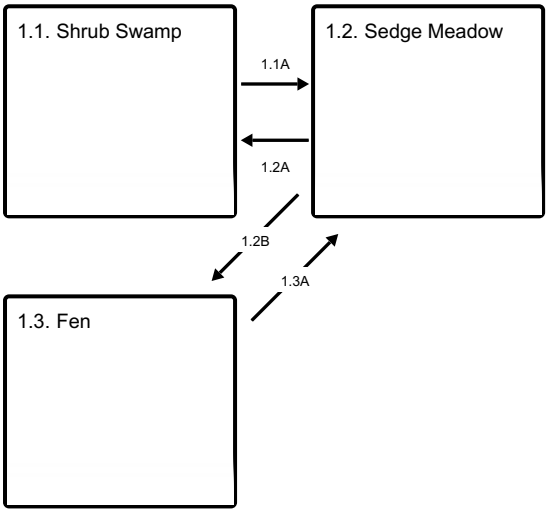
T1B - Long-term lowering of the water table, due to drainage, ditching, roads, etc.

T2A - Long-term lowering of the water table, due to drainage, ditching, roads, etc.

R3A - Return to reference hydrology.

T3A - Invasion by reed canarygrass or common reed, usually increases in water nutrient levels or alterations in hydrology.

State 1 submodel, plant communities



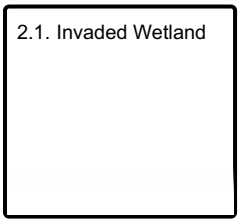
1.1A - Increase in water table, due to either beaver activity, fire or increased rates and amount of precipitation.

1.2A - Decrease in water table/short-term drought

1.2B - Stabilization of water levels on-site, invasion by Sphagnum sp.

1.3A - Beaver activity, return of higher and/or more variable water levels, increases in precipitation.

State 2 submodel, plant communities



State 3 submodel, plant communities

3.1. Wet Forest

State 1
Reference State

This site is typically an open wetland, with an abundance of broad-leaved sedges and frequent fluctuations in water table depth. High levels of water on-site typically preclude tree establishment, although sometimes tree seedlings of American elm, black ash, and red maple can be present (MN DNR 2003). Trees in the canopy layer are not common and when present have less than 25% cover, the most common occurrence including American elm and black ash (MN DNR 2003). Forbs can be found in all community phases, and can include marsh bellflower, tufted loosestrife, marsh skullcap, great water dock, eastern marsh fern, purple marshlocks, and Epilobium sp. In reference condition, these sites are an important habitat for many songbirds, ruffed grouse, American woodcock and small mammals, and are particularly important winter habitat for ring-necked pheasant, eastern cottontail and white-tailed deer (Eggers 1997).

Dominant plant species

- American elm (*Ulmus americana*), tree
- black ash (*Fraxinus nigra*), tree
- marsh bellflower (*Campanula aparinoides*), other herbaceous
- tufted loosestrife (*Lysimachia thyrsiflora*), other herbaceous

Community 1.1
Shrub Swamp

This community phase typically has greater than 25% shrub cover, including willows, speckled alder, redosier dogwood, and occasionally bog birch and white meadowsweet (MN DNR 2003). This phase is typically the result of a lack of fire or prolonged periods of lowered precipitation or water tables (due to beaver activity).

Dominant plant species

- willow (*Salix*), shrub
- speckled alder (*Alnus incana ssp. rugosa*), shrub
- bog birch (*Betula pumila*), shrub
- redosier dogwood (*Cornus sericea*), shrub
- white meadowsweet (*Spiraea alba*), shrub

Community 1.2
Sedge Meadow

This community phase is abundant with broad-leaved graminoids, with shrub cover typically being less than 25%. Typically associated with sedge meadows, this community type can also have more water-loving and shade-intolerant species such as Northwest Territory sedge, water smartweed, and a few cattails, when water levels are high or during increases in precipitation (MN DNR 2003). Common graminoid species include bluejoint, hairy sedge, and upright sedge.

Dominant plant species

- bluejoint (*Calamagrostis canadensis*), grass
- hairy sedge (*Carex lacustris*), grass
- upright sedge (*Carex stricta*), grass
- cattail (*Typha*), other herbaceous
- water smartweed (*Polygonum amphibium var. stipulaceum*), other herbaceous

Community 1.3
Fen

While not a true “fen”, this community phase is the result of brief periods where the water table becomes stabilized, and does not experience the high levels or drawdowns for a period of time, and then the site is invaded by Sphagnum sp. This can happen relatively quickly, and can lead to development of acidic water chemistry, or a richer plant community, depending on the source of the water. In Reference condition, this site concept typically has less than 5% moss cover, due to the alternating flooding and then drawdown of water levels. However, this community phase can sometimes have up to 75% moss cover, if Sphagnum sp. are invading after water levels have become temporarily stabilized, or when brown mosses are present. This process can be quickly reversed with a return of higher or more variable water levels, such as from beaver activity or a return to normal precipitation patterns (MN DNR 2003).

Dominant plant species

- sphagnum (*Sphagnum*), other herbaceous
- woollyfruit sedge (*Carex lasiocarpa*), other herbaceous
- tufted loosestrife (*Lysimachia thyrsiflora*), other herbaceous
- purple marshlocks (*Comarum palustre*), other herbaceous
- Fraser's marsh St. Johnswort (*Triadenum fraseri*), other herbaceous
- eastern marsh fern (*Thelypteris palustris*), other herbaceous
- cottongrass (*Eriophorum*), other herbaceous

Pathway 1.1A
Community 1.1 to 1.2

Increase in water table, due to either beaver activity, fire or increased rates and amount of precipitation.

Pathway 1.2A
Community 1.2 to 1.1

Decrease in water table/short-term drought

Pathway 1.2B
Community 1.2 to 1.3

Stabilization of water levels on-site, invasion by Sphagnum sp.

Pathway 1.3A
Community 1.3 to 1.2

Beaver activity, return of higher and/or more variable water levels, increases in precipitation. Also drought-caused fire causing elimination of sphagnum peat.

State 2
Invaded State

The invasive species reed canarygrass and common reed grass have become more abundant in recent decades, resulting in displacement of native vegetation and lowered species diversity on-site. Purple loosestrife is also a common invasive species. Typically, these invasions are the result of proximity to seed source, higher levels of nutrient loading (Nitrogen and Phosphorus) on-site, and human-induced alterations to fluctuations of the water table.

Dominant plant species

- reed canarygrass (*Phalaris arundinacea*), grass
- purple loosestrife (*Lythrum salicaria*), other herbaceous

Community 2.1
Invaded Wetland

The invasive species reed canarygrass and common reed grass have become more abundant in recent decades, resulting in displacement of native vegetation and lowered species diversity on-site. Purple loosestrife is also a common invasive species. Typically, these invasions are the result of proximity to seed source, higher levels of nutrient loading (Nitrogen and Phosphorus) on-site, and human-induced alterations to fluctuations of the water table.

Dominant plant species

- reed canarygrass (*Phalaris arundinacea*), grass
- European common reed (*Phragmites australis ssp. australis*), grass
- purple loosestrife (*Lythrum salicaria*), other herbaceous

State 3
Diverted State

In cases where the water table and hydrology are permanently altered; or altered for prolonged periods of time, there results an overall average lower water table and decrease in water level fluctuations. Due to this lack of water, the site may dry up enough to allow for tree establishment and recruitment. This often occurs when seed sources are available on adjacent landscape positions. American elm and black ash are the most common species to establish in this state (MN DNR 2003).

Dominant plant species

- American elm (*Ulmus americana*), tree
- black ash (*Fraxinus nigra*), tree

Community 3.1
Wet Forest

In cases where the water table and hydrology are permanently altered or altered for prolonged periods of time resulting in an overall average lower water table and decrease in water level fluctuations, the site may dry up enough to allow for tree establishment and recruitment, especially in cases where seed sources are available on adjacent landscape positions. American elm and black ash are the most common species to establish in this state (MN DNR 2003).

Dominant plant species

- black ash (*Fraxinus nigra*), tree
- American elm (*Ulmus americana*), tree

Transition T1A
State 1 to 2

Invasion by reed canarygrass or common reed, usually increases in water nutrient levels or alterations in hydrology.

Transition T1B
State 1 to 3

Long-term lowering of the water table, due to drainage, ditching, roads, etc. Can occur naturally also, as trees gradually establish and when abundant enough, can create enough evapotranspiration to permanently shift community into a wet forest. Much longer time scale than artificial draining.

Transition T2A
State 2 to 3

Long-term lowering of the water table, due to drainage, ditching, roads, etc. Can occur naturally also, as trees

gradually establish and when abundant enough, can create enough evapotranspiration to permanently shift community into a wet forest. Much longer time scale than artificial draining. Invasive species management, may be needed.

Restoration pathway R3A
State 3 to 1

Return to reference hydrology.

Transition T3A
State 3 to 2

Invasion by reed canarygrass or common reed, usually increases in water nutrient levels or alterations in hydrology.

Additional community tables

Inventory data references

Information presented was derived from Minnesota Department of Natural Resources Field Guide to the Native Plant Communities of Minnesota, USDA-NRCS soil survey information, and USDA Plants Database.

Relationship to Other Established Classifications:
MN DNR Native Plant Community (MN DNR, 2003); the reference community of this Provisional Ecological Site is most similar to:

MN DNR APn80 Northern Spruce Bog
MN DNR APn81 Northern Poor Conifer Bog
MN DNR APn91 Northern Poor Fen
MN DNR APn90, Northern Open Bog

Other references

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United States: Corvallis, Oregon, U.S. EPA, National Health and Environmental Effects Research Laboratory, map scale 1:3,000,000, https://www.epa.gov/eco-research/level-iii-and-iv-ecoregions-continental-united-states.

Contributors

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Approval

Suzanne Mayne-Kinney, 10/03/2023

Acknowledgments

MLRA 57 technical team completed in 2022.

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	05/20/2024
Approved by	Suzanne Mayne-Kinney
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

2. **Presence of water flow patterns:**

3. **Number and height of erosional pedestals or terracettes:**

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):**

5. **Number of gullies and erosion associated with gullies:**

6. **Extent of wind scoured, blowouts and/or depositional areas:**

7. **Amount of litter movement (describe size and distance expected to travel):**

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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:**