Ecological site F093AY014MN
Clayey Upland

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 Resource (MN DNR) MHn44 - Northern Wet-Mesic Boreal Hardwood Conifer Forest, Mesic Hardwood Forest System, Northern Floristic Region

Ecological site concept

This site is a mesic hardwood or hardwood-conifer forest located on moraines, lake plains, till plains and drumlins. Soils are moderately well drained to well drained. Soils have a restrictive layer between 25 -80 inches and may have a seasonal wet layer depth of 0 - 18 inches. There is a lack of natural disturbance on this site. Clayey Uplands have good tree canopy composition including quaking aspen, paper birch, balsam fir, and red maple. The majority of this ecological site is at the southern and western ends of MLRA 93A while also more common than the loamy upland site.

Associated sites

F093AY005MN	**Wet Floodplain**
	Soils wet layer depth is 0 - 15 inches (0 - 38 centimeters) and frequent flooding can occur in many areas. Dominant tree species include silver maple, black ash, green ash, and American elm.

F093AY006MN	**Depressional Wet Hardwood Forest** The Depressional Wet Hardwood Forest site is developed primarily from low lying mineral soils, but can have up to sixteen inches (41 centimeters) of organic surface. They occur on small to moderate sized closed depressions and shallow, low gradient drainage networks, surrounded by an upland forest matrix.

Similar sites

F093AY012MN	**Sandy Upland Forest** The Sandy Upland Forest ecological site is located on uplands with soils that are course textured and moderately well drained to somewhat excessively drained. Available water capacity ranges from 2-5 inches. This site is a dry to dry-mesic pine-hardwood woodland on sandy and loamy soils. Historically, fire was a common disturbance on this site unlike loamy upland sites. Soils are moderately well drained to somewhat excessively drained. Tree species include jack pine, red pine, white pine, spruce, and mixed hardwoods.
F093AY013MN	**Loamy Upland** Shade tolerant and fire intolerant species like sugar maple, yellow birch, and American basswood are the iconic tree species of this ecosystem. Sugar maple in particular is a dominant species and tends to accumulate in all layers of the overstory and understory. Later successional, shade tolerant conifers like northern white cedar and white spruce are also present, which in part distinguishes this site. Water table depth is usually 18+ inches as compared to 0-18 inches on the clayey upland site.

Table 1. Dominant plant species

Tree	(1) *Populus tremuloides* (2) *Betula papyrifera*
Shrub	(1) *Corylus cornuta* (2) *Prunus virginiana*
Herbaceous	(1) *Maianthemum canadense* (2) *Aralia nudicaulis*

Physiographic features

This site is generally located on lake plains, till plains, till mantled bedrock uplands, upland moraines and drumlins. Slopes range from 5-13%. This site does not flood or pond but may be influenced by a seasonal high water table.

Table 2. Representative physiographic features

Landforms	(1) Upland > Moraine (2) Till plain (3) Lake plain (4) Drumlin (5) Upland
Runoff class	Medium
Flooding frequency	None
Ponding frequency	None
Elevation	579–649 m
Slope	5–13%
Water table depth	0–46 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 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)	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
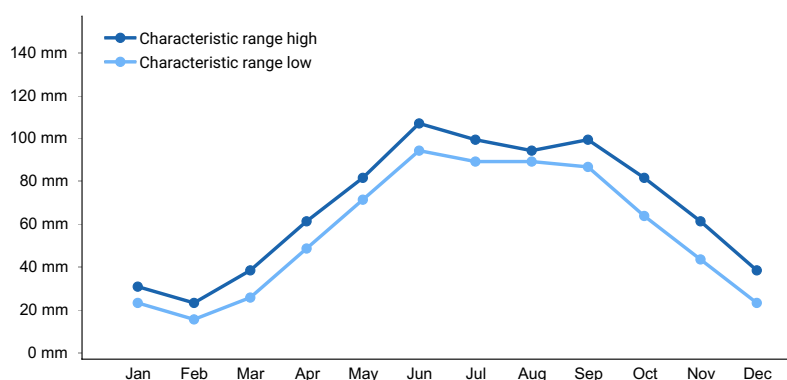
Figure 1. Monthly precipitation range
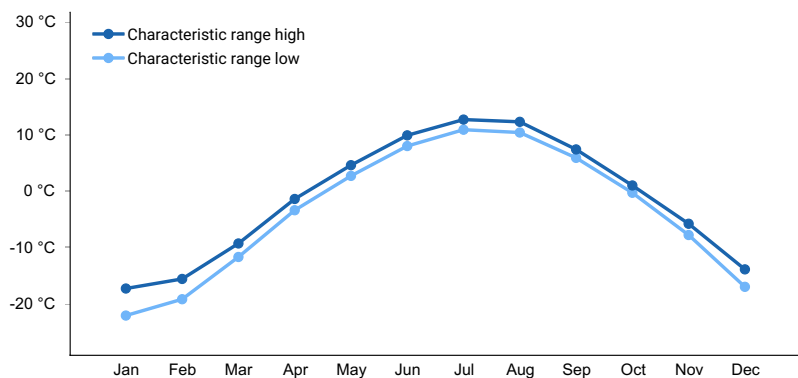
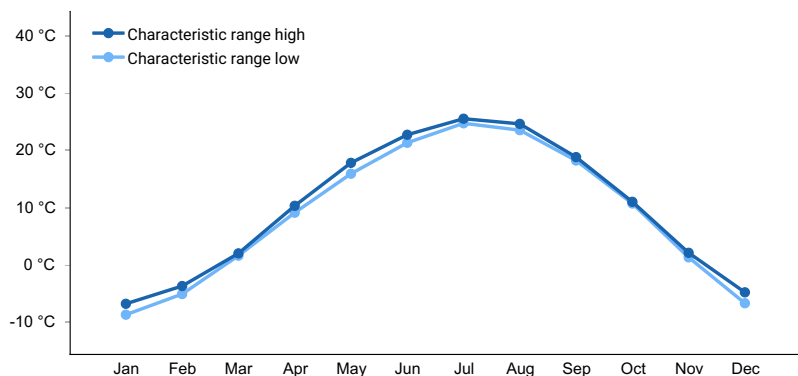**Figure 2. Monthly minimum temperature range**

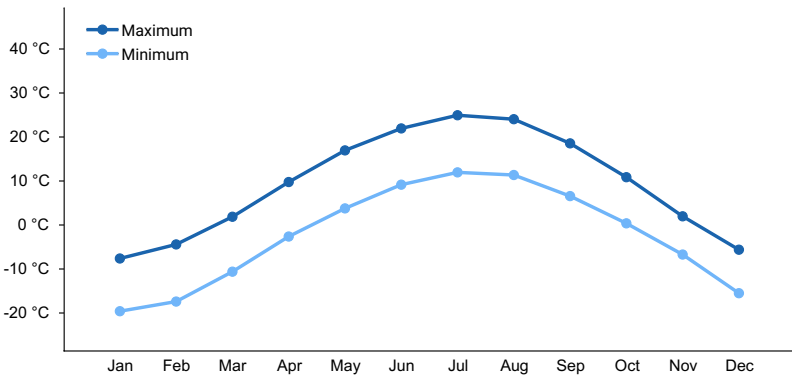**Figure 3. Monthly maximum temperature range**

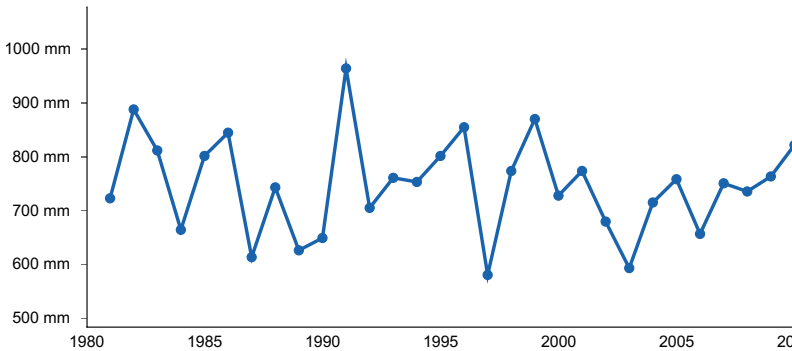**Figure 4. Monthly average minimum and maximum temperature**

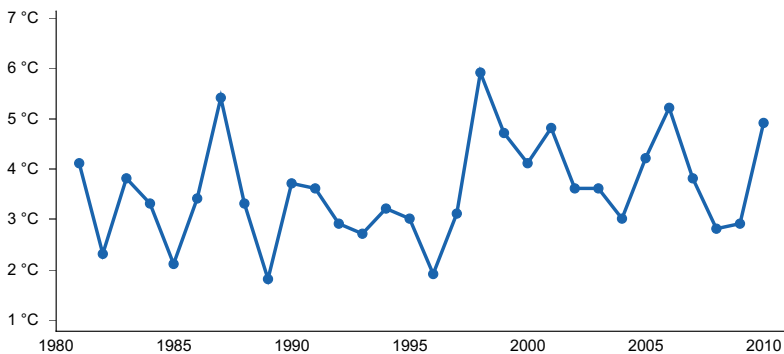**Figure 5. Annual precipitation pattern**

Figure 6. Annual average temperature pattern

Climate stations used

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

Influencing water features

This site is not influenced by riparian or wetland features.

Wetland description

N/A

Soil features

Representative soil series include Forbay, Augustana, Miskoaki, and Amnicon. Surface textures include silty clay loam, silt loam, stony loam, and fine sandy loam. These soils are Alfisols, and are moderately well drained to well drained. A restrictive layer above 80 inches may be present.

Table 4. Representative soil features

|	
Parent material	(1) Till
Surface texture	(1) Silty clay loam (2) Silt loam (3) Stony loam (4) Fine sandy loam
Drainage class	Moderately well drained to well drained
Permeability class	Very slow to moderately slow
Depth to restrictive layer	64–203 cm
Soil depth	203 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0–1%
Available water capacity (0-152.4cm)	15.24–22.86 cm
Calcium carbonate equivalent (0-101.6cm)	0%
Sodium adsorption ratio (Depth not specified)	0
Soil reaction (1:1 water) (0-101.6cm)	4.5–6.5
Subsurface fragment volume <=3" (Depth not specified)	0–25%
Subsurface fragment volume >3" (Depth not specified)	0–15%

Ecological dynamics

This site is a mesic to wet-mesic mixed hardwood-conifer forest dominated by quaking aspen, paper birch, and balsam fir. Red maple, white spruce, white pine, red pine, and/or jack pine are present. Dominant shrub species include beaked hazelnut, chokecherry, northern bush honeysuckle, and juneberry. The ground layer density is often variable. Dominant forbs commonly include Canada mayflower and wild sarsaparilla.

Surface fires and patchy windthrow were historically more common than large-scale catastrophic fires. Following a disturbance event, the early successional community is dominated by quaking aspen with lesser amounts of paper birch and balsam fir. As the community ages, balsam fir, white spruce, and paper birch increase and aspen decreases. Mature forests are characterize by a mix of dominant canopy species that include balsam fir, quaking aspen, paper birch and white spruce. (MN DNR, 2005)
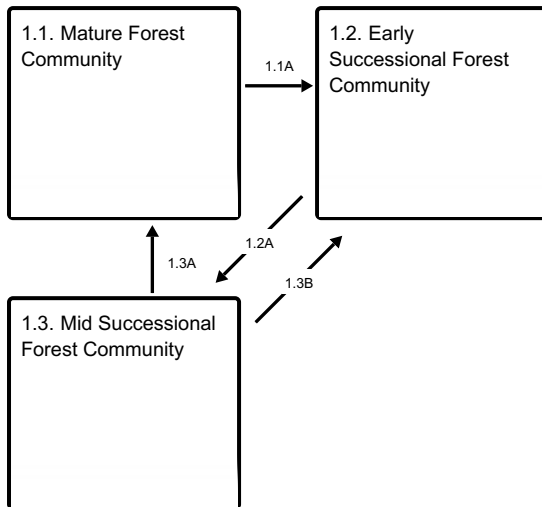
State and transition model

Ecosystem states
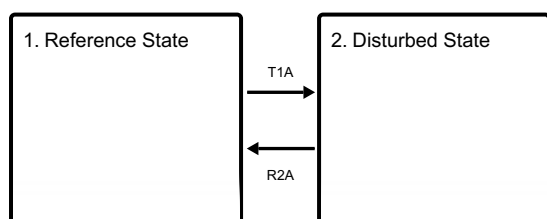
T1A - Site is logged

R2A - Restoration inputs; forest stand management

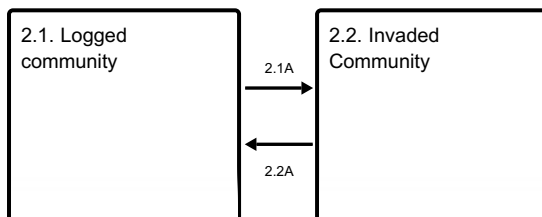**State 1 submodel, plant communities**

1.1A - Severe Disturbance

1.2A - Absence of disturbance (55-75 Years)

1.3A - No severe disturbance > 75 Years

1.3B - Severe site disturbance

State 2 submodel, plant communities

2.1A - Invasive species established

2.2A - Eradication of invasive species

State 1
Reference State

This state is a mesic, mixed mature forest on clayey soils with a highly variable canopy composition. Some sites may be predominately deciduous and other areas predominately coniferous depending on succession phase (MN DNR, 2005). Multiple tree species can be co-dominant on this site.

Dominant plant species

- quaking aspen (*Populus tremuloides*), tree
- paper birch (*Betula papyrifera*), tree
- balsam fir (*Abies balsamea*), tree
- beaked hazelnut (*Corylus cornuta*), shrub
- chokecherry (*Prunus virginiana*), shrub
- northern bush honeysuckle (*Diervilla lonicera*), shrub
- serviceberry (*Amelanchier*), shrub
- Canada mayflower (*Maianthemum canadense*), other herbaceous

Community 1.1

Mature Forest Community

This community is a mature hardwood-conifer forest. Dominant canopy species include quaking aspen, paper birch, and balsam fir. Other tree species include white spruce, red maple, basswood, and ash.

Dominant plant species

- quaking aspen (*Populus tremuloides*), tree
- paper birch (*Betula papyrifera*), tree
- balsam fir (*Abies balsamea*), tree
- white spruce (*Picea glauca*), tree
- red maple (*Acer rubrum var. rubrum*), tree
- American basswood (*Tilia americana*), tree
- ash (*Fraxinus*), tree
- beaked hazelnut (*Corylus cornuta*), shrub
- chokecherry (*Prunus virginiana*), shrub
- northern bush honeysuckle (*Diervilla lonicera*), shrub
- serviceberry (*Amelanchier*), shrub
- Canada mayflower (*Maianthemum canadense*), other herbaceous
- wild sarsaparilla (*Aralia nudicaulis*), other herbaceous

Community 1.2
Early Successional Forest Community

The community is a young forest (35 years or less) following a natural disturbance such as fire or wind storms. Aspen will usually be the dominant tree species on site with lesser amounts of balsam fir and paper birch. (MN DNR, 2005)

Dominant plant species

- quaking aspen (*Populus tremuloides*), tree
- balsam fir (*Abies balsamea*), tree
- paper birch (*Betula papyrifera var. papyrifera*), tree

Community 1.3
Mid Successional Forest Community

With an absence of further disturbances, the community will transition to a mid-successional stage dominated by balsam fir, paper birch, and white spruce. Aspen is still present, but no longer dominant. White pines may become established during this time. (MN DNR, 2005)

Dominant plant species

- balsam fir (*Abies balsamea*), tree
- paper birch (*Betula papyrifera*), tree
- white spruce (*Picea glauca*), tree
- eastern white pine (*Pinus strobus*), tree

Pathway 1.1A
Community 1.1 to 1.2

A severe disturbance, such as wind storms or large fire, will transition the reference community to an early successional stage.

Pathway 1.2A
Community 1.2 to 1.3

Time (approximately 35-95 years) will transition the site to community 1.3.

Pathway 1.3A
Community 1.3 to 1.1

Time and natural plant community succession will transition the community to a mature, established forest aged 95 plus years.

Pathway 1.3B
Community 1.3 to 1.2

A severe disturbance, such as a major fire event, will transition the community back to an earlier successional stage.

State 2
Disturbed State

Removal of canopy species for timber harvest creates an open canopy and a highly disturbed understory. Shrubs will dominate post logging. A very dense shrub layer can impede tree regeneration. Heavy machinery are a common seed source for introduction of non-native species.

Dominant plant species

- chokecherry (*Prunus virginiana*), shrub
- serviceberry (*Amelanchier*), shrub
- prickly rose (*Rosa acicularis*), shrub

Community 2.1
Logged community

With the canopy removed, the initial post-logging community will be dominated by shrubs and young tree saplings. Tree seedlings will depend on seed sources and commonly include aspen and paper birch. Understory conditions will vary depending on the logging methods and management. The site is highly vulnerable to the introduction of invasive species due to soil disturbance and the possibility of seed transfer.

Dominant plant species

- beaked hazelnut (*Corylus cornuta*), shrub
- chokecherry (*Prunus virginiana*), shrub
- northern bush honeysuckle (*Diervilla lonicera*), shrub
- serviceberry (*Amelanchier*), shrub

Community 2.2
Invaded Community

This community is identified by the presence of non-native plant species. Heavy machinery and soil disturbance provide an opportunity for invasives to become established. The invasive species on site will depend upon the seed source.

Dominant plant species

- common buckthorn (*Rhamnus cathartica*), shrub
- glossy buckthorn (*Frangula alnus*), shrub
- honeysuckle (*Lonicera*), shrub
- garlic mustard (*Alliaria petiolata*), other herbaceous
- Japanese knotweed (*Polygonum cuspidatum*), other herbaceous

Pathway 2.1A
Community 2.1 to 2.2

Invasive species are introduced to the site and become established post logging.

Pathway 2.2A
Community 2.2 to 2.1

Management inputs to eradicate non-native plant species.

Transition T1A
State 1 to 2

This transition represents the removal of canopy species and severe understory disturbance through logging.

Restoration pathway R2A
State 2 to 1

Restoration inputs, such as timber stand management activities and weed treatments where needed, can transition the Logged State back to State 1.

Additional community tables

Inventory data references

No field plots were not evaluated for this project. A review of the scientific literature and professional experience were used to approximate the plant communities for this provisional ecological site. Information for the state-and-transition model was obtained from the same sources. All community phases are considered provisional based on these plots and the sources identified in ecological site description. Future field verification will refine the plant communities described in this project.

References

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Contributors

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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	11/21/2024
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):**

14. **Average percent litter cover (%) and depth (in):**

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):**

16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:**

17. **Perennial plant reproductive capability:**