USDA Natural Resources Conservation Service

Ecological site F093AY012MN
Sandy Upland Forest

Last updated: 9/06/2024
Accessed: 09/27/2024

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:
FDn32 - Northern Poor Dry-Mesic Mixed Woodland, Fire-Dependent Forest/Woodland System, Northern Floristic Regions, Minnesota Department of Natural Resource

Ecological site concept

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. Soils are moderately well drained to well drained. Tree species include jack pine, red pine, white pine, spruce, and mixed hardwoods.

Associated sites

F093AY010MN	**Moist Sandy Forest** Moist Sandy Forest. This site occurs on sandy soils on outwash plains. Soils are somewhat poorly drained to moderately will drained and have a seasonal wet layer depth of 4-18 inches.

F093AY011MN	**Dry Sandy Upland Forest** The Dry Sandy Upland Forest occurs on course-textured soils that are well drained to excessively drained. Soils have a low available water capacity (2-4 inches). Usually a stonier surface texture comparatively and drier. Less common to find northern pin oak on this site.

Similar sites

F093AY011MN	**Dry Sandy Upland Forest** The Dry Sandy Upland Forest occurs on course textured soils that are well drained to excessively drained. Soils have a low available water capacity (2-4 inches). Usually a stonier surface texture comparatively and drier.

Table 1. Dominant plant species

Tree	(1) *Pinus banksiana* (2) *Quercus*
Shrub	(1) *Amelanchier* (2) *Vaccinium angustifolium*
Herbaceous	(1) *Maianthemum canadense* (2) *Cornus canadensis*

Physiographic features

This site is often located on outwash plains, moraines, and upland slopes. No flooding or ponding occurs. The seasonal high water table ranges from 30 - 42 inches (76 - 107centimeters).

Table 2. Representative physiographic features

Landforms	(1) Outwash plain (2) Flat (3) Esker
Runoff class	Low to high
Flooding frequency	None
Ponding frequency	None
Elevation	1,000–1,750 ft
Slope	0–35%
Water table depth	30–42 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)	26-32 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

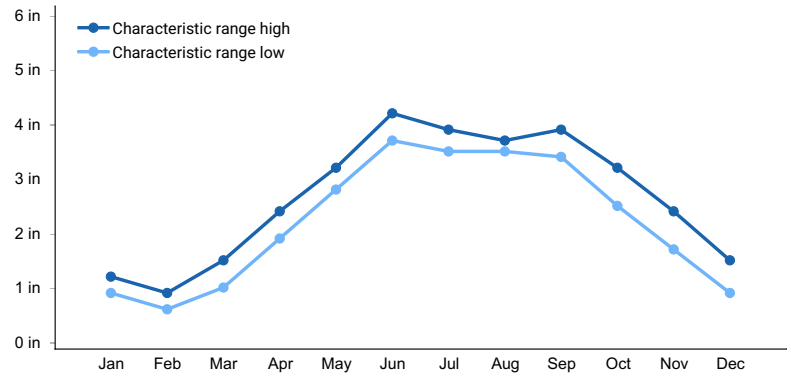


Figure 1. Monthly precipitation range

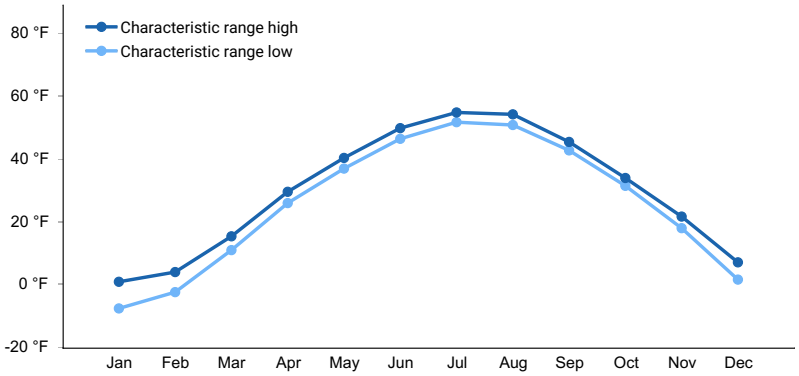


Figure 2. Monthly minimum temperature range

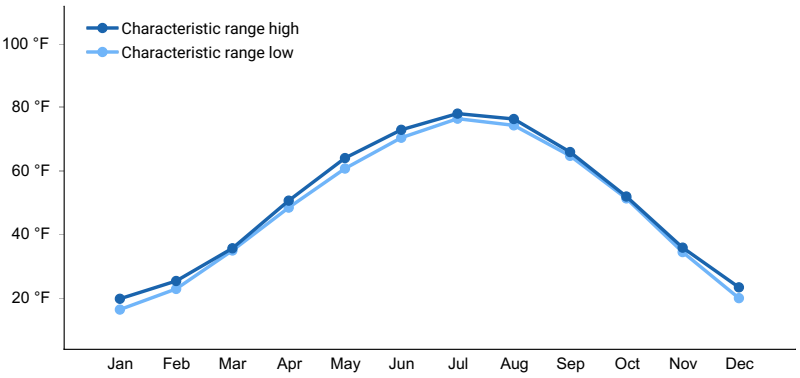


Figure 3. Monthly maximum temperature range

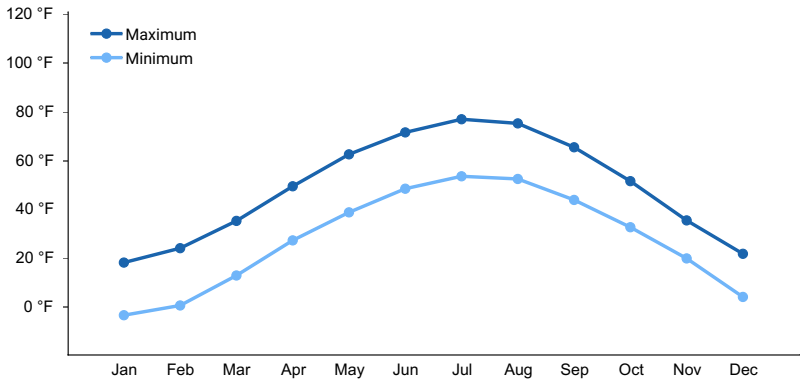


Figure 4. Monthly average minimum and maximum temperature

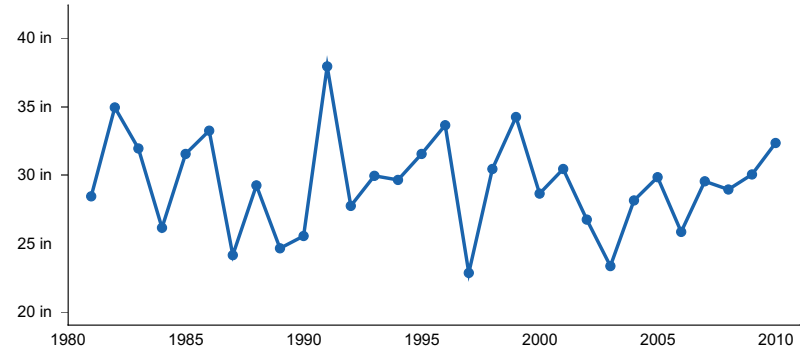


Figure 5. Annual precipitation pattern

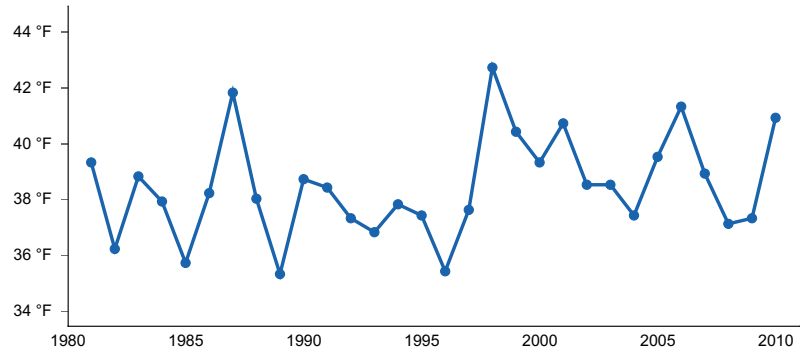


Figure 6. Annual average temperature pattern

Climate stations used

- (1) 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 Friendship, Grytal, Lavell, Oysterlake, Pequaywan, Slimlake, and Wurtsmith. These soils are course textured Entisols and Inceptisols. Parent materials include eolian sand, loamy drift, sandy outwash, and glaciofluvial deposits. Soil drainage is moderately well drained to well drained. Due to a loamy mantel on the Aldenlake and Cloquet soil series the hydrology is altered and those series are included in the Sandy Upland Forest site.

Table 4. Representative soil features

Parent material	(1) Eolian deposits (2) Drift (3) Glaciofluvial deposits (4) Outwash
Surface texture	(1) Sandy loam (2) Fine sandy loam (3) Loam (4) Loamy sand
Drainage class	Moderately well drained to well drained
Permeability class	Moderately rapid to rapid
Depth to restrictive layer	80 in
Soil depth	80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0–5%
Available water capacity (0-60in)	2–6 in
Calcium carbonate equivalent (0-40in)	0%
Sodium adsorption ratio (Depth not specified)	0
Soil reaction (1:1 water) (0-40in)	4.5–6.5
Subsurface fragment volume <=3" (Depth not specified)	0–53%
Subsurface fragment volume >3" (Depth not specified)	0–70%

Ecological dynamics

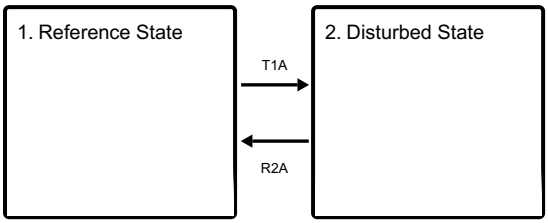
This site is a dry to dry-mesic conifer dominated woodland. Soils are sandy or loamy and have a low available water capacity. This site was historically was influenced by drought and reoccurring fire events. Numerous successional communities may occur on this site. Immediately following a disturbance event, the early successional community consists of red pine, white pine, balsam fir and quaking aspen. As the community matures in the absence of major disturbances, the canopy becomes co-dominated by red pine, jack pine, spruce, and oak. The rotation of all fires combined is estimated to be approximately 100 years, understory fire occurrence may have been more often pre-colonization and depending on fire regime (MN DNR, 2005).

Jack pine (*Pinus banksiana*) occurs over a broad range of glacially scoured bedrock and outwash sand plains, with cover ranging from sparse to dense, depending on habitat features. On sand plain habitats, the combination of physiognomy, floristics, and disturbance factors can be used to further distinguish the denser forests with blueberries
(Vaccinium spp.) and feathermoss (*Pleurozium schreberi*) from more open stands, maintained by a 25 to 50 year fire rotation, where oaks (Quercus spp.), little bluestem (*Schizachyrium scoparium*), and other prairie forbs may be common. Herbivores respond positively to the understory plants after fire has cycled through the stands. This

provides ideal browsing to moose and deer (Faber-Langendoen 2001). Young woodlands recovering from fire, are dominated by jack pine mixed with quaking aspen and paper birch. Followed by a transition period marked by a gradual decline in jack pine and quaking aspen. Red pine and paper birch are most abundant during this transition period. Spruce, balsam fir, and white pine invade and increase in abundance. At 95+ years mature woodlands form characterized by mixed canopies dominated by spruce with some paper birch, balsam fir, white pine, and old jack pine. Black spruce is the spruce species most associated with this community, but white spruce is also present (MN DNR 2005, MN DNR 2022).

State and transition model

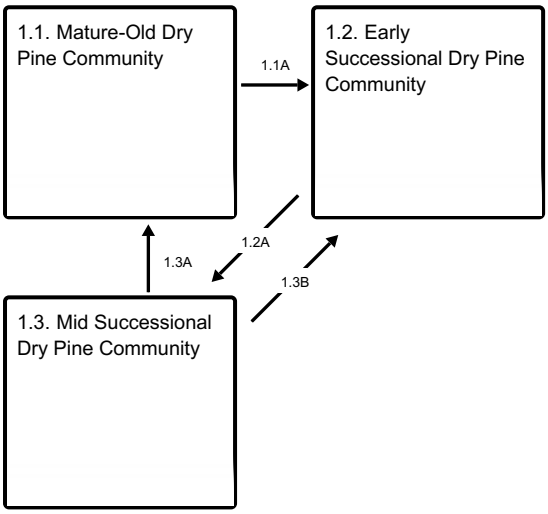
Ecosystem states



T1A - Site is logged and/or understory is burned.

R2A - Restoration inputs; forest stand management

State 1 submodel, plant communities



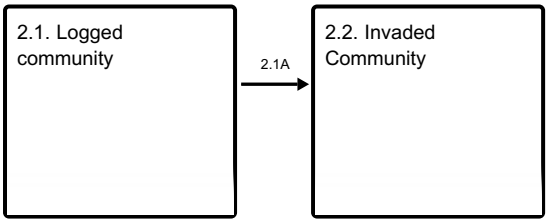
1.1A - Severe Disturbance

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

State 1
Reference State

This is a dry to dry-mesic conifer-hardwood woodland composed of jack pine, red pine, black spruce, white pine, paper birch, quaking aspen, and oak. The site occurs on sandy outwash plains, lake plains, and moraines. Historically, the site was influenced by fire events at a rotations of approximately 100+ years. Young woodlands (0-55 years) recovering from fire, are dominated by jack pine mixed with quaking aspen and paper birch. Followed by a transition period (55-75) marked by a gradual decline in jack pine and quaking aspen. Red pine and paper birch are most abundant during this transition period. Spruce, balsam fir, and white pine invade and increase in abundance. At 75+ years mature woodlands then form characterized by mixed canopies dominated by spruce with some paper birch, balsam fir, white pine, and old jack pine. Subsequently old growth woodlands occur at 100+ years and understory fires may cycle through as many tree species use this natural fire cycle to maintain dominance on this ecological site. Black spruce is the spruce species most associated with this community, but white spruce is also present (MN DNR 2005).

Dominant plant species

- jack pine (*Pinus banksiana*), tree
- red pine (*Pinus resinosa*), tree
- eastern white pine (*Pinus strobus*), tree
- lowbush blueberry (*Vaccinium angustifolium*), shrub
- serviceberry (*Amelanchier*), shrub
- northern bush honeysuckle (*Diervilla lonicera*), shrub
- roughleaf ricegrass (*Oryzopsis asperifolia*), grass
- Canada mayflower (*Maianthemum canadense*), other herbaceous
- bunchberry dogwood (*Cornus canadensis*), other herbaceous

Community 1.1
Mature-Old Dry Pine Community

This community is characterized by a lack of severe disturbance for 75 years or more. This community is dominated by a mixture of white spruce, red pine, and very old jack pine. Scattered old white pines are also present, with many white pine seedlings in the understory. The understory composition will be influenced by the presence or lack of ground fires. The important understory species included Canada mayflower (*Maianthemum canadense*), bunchberry (*Cornus canadensis*), twinflower (*Linnaea borealis*), and large-leaved aster (Aster macrophyllus). Mosses and lichens are important on sites with shallow soils over bedrock. The most frequent shrub species are juneberries (Amelanchier spp.), lowbush blueberry (*Vaccinium angustifolium*), and bush honeysuckle (*Diervilla lonicera*). Jack pine, red pine, white pine, and paper birch seedlings and saplings are common post-burn. White pine, white spruce, and balsam fir seedlings and saplings will be present on sites absence of fire. A sub canopy is rarely present in this community. (MN DNR, 2005)

Dominant plant species

- red pine (*Pinus resinosa*), tree
- eastern white pine (*Pinus strobus*), tree
- lowbush blueberry (*Vaccinium angustifolium*), shrub
- northern bush honeysuckle (*Diervilla lonicera*), shrub
- serviceberry (*Amelanchier*), shrub
- Canada mayflower (*Maianthemum canadense*), other herbaceous
- twinflower (*Linnaea borealis*), other herbaceous
- bunchberry dogwood (*Cornus canadensis*), other herbaceous

Community 1.2
Early Successional Dry Pine Community

This young woodland community is 0-55 years of age. Immediately after a large fire event, this site is usually dominated by red pine, jack pine, and paper birch seedlings. As the stand progressively ages (35-55 years), red pine and paper birch will become dominant. The important understory species included Canada mayflower (*Maianthemum canadense*), bunchberry (*Cornus canadensis*), twinflower (*Linnaea borealis*), and large-leaved aster (Aster macrophyllus). Mosses and lichens are important on sites with shallow soils over bedrock. The most frequent shrub species are juneberries (Amelanchier spp.), lowbush blueberry (*Vaccinium angustifolium*), and bush

honeysuckle (*Diervilla lonicera*). (MN DNR, 2005) Most trees on this site are naturally suited to be either fire-resistant or regenerate easily after a fire (MN DNR 2022).

Dominant plant species

- jack pine (*Pinus banksiana*), tree
- paper birch (*Betula papyrifera*), tree
- quaking aspen (*Populus tremuloides*), tree
- lowbush blueberry (*Vaccinium angustifolium*), shrub
- serviceberry (*Amelanchier*), shrub
- northern bush honeysuckle (*Diervilla lonicera*), shrub
- Canada mayflower (*Maianthemum canadense*), other herbaceous
- bunchberry dogwood (*Cornus canadensis*), other herbaceous
- twinflower (*Linnaea borealis*), other herbaceous

Community 1.3
Mid Successional Dry Pine Community

The mid successional woodland stage (55-75 years of age) is the transitional period approaching a mature woodland with multiple canopy species including red pine, white pine, and paper birch. Overstory canopy starts to become the most prevalent and sub canopy starts to recede. The important understory species included Canada mayflower (*Maianthemum canadense*), bunchberry (*Cornus canadensis*), twinflower (*Linnaea borealis*), and large-leaved aster (Aster macrophyllus). Mosses and lichens are important on sites with shallow soils over bedrock. The most frequent shrub species are juneberries (Amelanchier spp.), lowbush blueberry (*Vaccinium angustifolium*), and bush honeysuckle (*Diervilla lonicera*). (MN DNR, 2005)

Dominant plant species

- red pine (*Pinus resinosa*), tree
- eastern white pine (*Pinus strobus*), tree
- paper birch (*Betula papyrifera*), tree
- serviceberry (*Amelanchier*), shrub
- lowbush blueberry (*Vaccinium angustifolium*), shrub
- northern bush honeysuckle (*Diervilla lonicera*), shrub
- Canada mayflower (*Maianthemum canadense*), other herbaceous
- bunchberry dogwood (*Cornus canadensis*), other herbaceous
- twinflower (*Linnaea borealis*), other herbaceous

Pathway 1.1A
Community 1.1 to 1.2

A severe disturbance, such as a catastrophic fire, will transition the reference community to an early successional community.

Pathway 1.2A
Community 1.2 to 1.3

Time and natural plant community growth 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 woodland.

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 often dominate after canopy removal. A very dense shrub layer can impede tree regeneration. Heavy machinery are a common seed source for non-native species. Human and recreational activities can also lead to seed sources of non-native species being established (MN DNR 2005). This site offers a few options for crop trees, with six species having a fair, good, or excellent suitability. Jack pine, white pine, red pine, and northern pin oak are all ranked as excellent choices as crop trees by virtue of their frequent occurrence and moderately high cover (MN DNR 2022).

Dominant plant species

- serviceberry (*Amelanchier*), shrub
- prickly rose (*Rosa acicularis*), shrub
- smooth rose (*Rosa blanda*), shrub
- beaked hazelnut (*Corylus cornuta*), shrub
- prairie willow (*Salix humilis*), shrub
- blueberry (*Vaccinium*), shrub
- poverty oatgrass (*Danthonia spicata*), grass
- ricegrass (*Oryzopsis*), grass

Community 2.1
Logged community

With the canopy removed, the initial post-logging community will be dominated by shrubs. A dense shrub layer can impeded tree regeneration, so management inputs may be necessary to enhance stand regeneration. This site offers a few options for crop trees replanting post logging, with six species having a fair, good, or excellent suitability. Jack pine, white pine, red pine, and northern pin oak are all ranked as excellent choices as crop trees by virtue of their frequent occurrence and moderately high cover (MN DNR 2022).

Dominant plant species

- beaked hazelnut (*Corylus cornuta*), shrub
- serviceberry (*Amelanchier*), shrub
- American fly honeysuckle (*Lonicera canadensis*), shrub
- chokecherry (*Prunus virginiana*), shrub
- ricegrass (*Oryzopsis*), grass
- Canada mayflower (*Maianthemum canadense*), other herbaceous
- wild sarsaparilla (*Aralia nudicaulis*), other herbaceous

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 on the seed source. Some invasive species that may be present on site are leafy spurge (*Euphorbia esula*), purple loosestrife (*Lythrum salicaria* L.), and buckthorn (*Rhamnus cathartica*). If stands are to be silviculturally manipulated to favor one species over another, mean cover-when-present is the more important element of the index, with the higher covers more likely to result in higher stocking following treatment. Low frequency and high mean cover-when-present is the hallmark of trees with greater potential for the site than is commonly observed. The loss of seed trees due to historic over-exploitation, lower frequency of a historic disturbance like fire, the arrival of new diseases/pests or changes in their virulence, and species' range expansions due to climate change could all explain this pattern (MN DNR 2022).

Dominant plant species

- beaked hazelnut (*Corylus cornuta*), shrub

- serviceberry (*Amelanchier*), shrub
- buckthorn (*Rhamnus*), shrub
- buckthorn (*Frangula*), shrub
- cypress spurge (*Euphorbia cyparissias*), other herbaceous
- knotweed (*Polygonum*), other herbaceous

Pathway 2.1A
Community 2.1 to 2.2

Invasive species are introduced to the site and become established. This may be due to encroaching from machinery movement and some recreational human drive activities. The loss of seed trees due to historic over-exploitation, lower frequency of a historic disturbance like fire, the arrival of new diseases/pests or changes in their virulence, and species' range expansions due to climate change (MN DNR 2022).

Transition T1A
State 1 to 2

This transition represents the removal of canopy species and/or severe understory disturbance from fires prescribed or natural.

Restoration pathway R2A
State 2 to 1

Careful restoration and management of the site may transition the Logged State back to Reference State depending on invasive species seed bank accumulation. This restoration pathway will be cost prohibitive and difficult to scale if invasive species have become established in the seed bank.

Additional community tables

Inventory data references

No field plots were established 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.

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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	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:**

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

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

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

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

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

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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):**

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:**