Ecological site F093BY007MI
Sandy Uplands

Last updated: 9/27/2023
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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): 093B–Superior Stony and Rocky Loamy Plains and Hills

The Wisconsin portion of this MLRA is a mixture of high-relief moraines and flat till plains with interspersed glacial meltwater deposits. It is bordered on the north by glaciolacustrine deposits of Glacial Lake Duluth and on the south by extensive pitted and unpitted outwash plains. The approximate land area is just under 600,000 acres (935 sq miles).

The Penokee-Gogebic Iron Range runs through the middle of the Wisconsin portion of this MLRA and into Michigian. The range is a hilly, bedrock-controlled moraine. The bedrock outcropping is composed of igneous and metamorphic materials and was created by inland folding and faulting of the ancient Superior continent when it collided with the Marshfield continent about 1.8 billion years ago (Dott & Attig, 2004). Volcanic and intrusive bedrock occurs in some places. This bedrock is overlain by a thin layer of glacial till deposited by the Chippewa Lobe.

To the north of the range is a former spillway for Glacial Lake Ontonagon. The flowing meltwater cut deep channels into the morainal systems. Glaciofluvial landforms here include old beaches and dunes. South of the range, along the southern edge of this MLRA, are rolling collapsed end moraines, pushed to their extent by the Chippewa and Ontonagon Lobes. The landscape is dotted with abundant kettle lakes and swamps, especially in the eastern portion. Ice-walled lake plains and eskers are also found along these collapsed moraines.

The climate is influenced by Lake Superior in areas near the lake, resulting in cooler summers, warmer winters, and greater precipitation – especially snowfall – compared to more inland locations. Historically, mixtures of eastern hemlock (Tsuga canadensis), sugar maple (*Acer saccharum*), yellow birch (*Betula alleghaniensis*), eastern white pine (Pinus strobus), and red pine (Pinus resinosa) covered the area. In wetter pockets (such as the swamps that dot the moraines to the south) white cedar (Thuja occidentalis), black spruce (Picea mariana), and tamarack (Larix laricina) were common (Finley, R., 1976).

Classification relationships

Relationship to Established Frameworks and Classification Systems:
Habitat Types of N. Wisconsin (Kotar, 2002): Two sites key out to *Acer saccharum* – Tsuga canadensis/ *Maianthemum canadense* (ATM), though one is difficult to key and may also be represented by Pinus strobus – Acer rubrum/ Vaccinium angustifolium (PArV), and one site keys to *Acer saccharum*/ Vaccinium angustifolium – Viburnum acerifolium (AVVb).
Biophysical Setting (Landfire, 2014): This ES is mapped as Laurentian-Acadian Northern Pine(-Oak) Forest, Laurentian-Acadian Northern Hardwoods Forest – Hemlock, and Laurentian-Acadian Northern Hardwoods Forest; though, it is likely best represented by the latter.

WDNR Natural Communities (WDNR (2015): This ES is most similar to the Northern Dry-mesic, Mesic, and Boreal Forests.

Hierarchical Framework Relationships:
Major Land Resource Area (MLRA): Superior Stoney and Rocky Loamy Plains and Hills, Eastern Part (93B)

USFS Subregions: Winegar Moraines (212Jc)
Small sections occur in the Gogebic-Penokee Iron Range (212Jb) subregion

Wisconsin DNR Ecological Landscapes: North Central Forest

Ecological site concept

The Sandy Uplands ecological site found on outwash, till, and lake plains, moraines, hillslopes, and stream terraces. These sites are characterized by very deep, moderately well or well drained soils that formed in sandy glaciofluvial, alluvium, and outwash deposits. Precipitation and runoff from adjacent uplands are the primary sources of water. Soils range from very strongly acid to moderately acid.

Sandy Uplands lacks a layer of significant clay accumulation like those found in Alfic Sandy Uplands. These sites have a lower available water capacity than their Alfic counterparts, which limits the plant communities they can support. Other upland sites have loamy materials. Sandy materials often have a lower pH and available water capacity than loamy materials, which may limit vegetative growth.

Associated sites

F093BY004MI	**Wet Lowlands** Wet Lowlands occur on depressions and drainageways and form in loamy till or loamy alluvium underlain by dense sandy till or sandy and gravelly outwash. These sites are poorly drained and occur lower on the drainage sequence than Sandy Uplands.
F093BY005MI	**Moist Lowlands** Moist Lowlands occur on footslope positions across the landscape. They are not subject to flooding nor ponding. Soils form in till, lacustrine deposits, or outwash deposits and may be loamy to sandy. These sites are somewhat poorly drained and occur slightly lower on the drainage sequence than Sandy Uplands.
F093BY011MI	**Dry Uplands** Dry Uplands are found in the sandiest, most permeable soils on the driest landscape positions. They are very deep and excessively drained. These sites occur slightly higher on the drainage sequence than Sandy Uplands.

Similar sites

F093BY011MI	**Dry Uplands** Dry Uplands are found in the sandiest, most permeable soils on the driest landscape positions. While their landscape positions and textures are quite similar, the moderately well to somewhat excessively drained Sandy Uplands sometimes support mesic (ie. slightly wetter) vegetative communities than Dry Uplands.
F093BY006MI	**Alfic Sandy Uplands** Alfic Sandy Uplands occur on upland sites in deep sandy drift deposits where and argillic horizon is either present or forming. These soils are well to somewhat excessively drained. Unlike Sandy Uplands, Alfic Sandy Uplands have a horizon of significant clay accumulation and can hold slightly more water than their Sandy counterparts. The vegetative community reflects this, with more mesic and slightly more nutrient-demanding species present on Alfic Sandy Uplands.
F093BY010MI	**Loamy Uplands** Loamy Uplands occur on upland sites in loamy till, sometimes with a mantle of loess. Like Sandy Uplands, these soils lack significant clay accumulation and are moderately well to well drained. The soil textures of Loamy Uplands are finer than those of Sandy Uplands. Species present on Loamy Uplands are slightly more nutrient-demanding than those present on Sandy Uplands.

Table 1. Dominant plant species

Tree	(1) *Acer saccharum* (2) *Betula alleghaniensis*
Shrub	(1) *Acer saccharum*

Herbaceous	(1) *Pteridium aquilinum* (2) *Eurybia macrophylla*

Physiographic features

These sites formed on moraines, till plains, lake plains, outwash fan and plains, and stream terraces in backslope, shoulder, and summit positions, Slope ranges from 0 to 45 percent.

These sites are subject to neither flooding nor ponding. These sites rarely have evidence of a seasonally high water table within 80 inches. Surface runoff is negligible to medium.

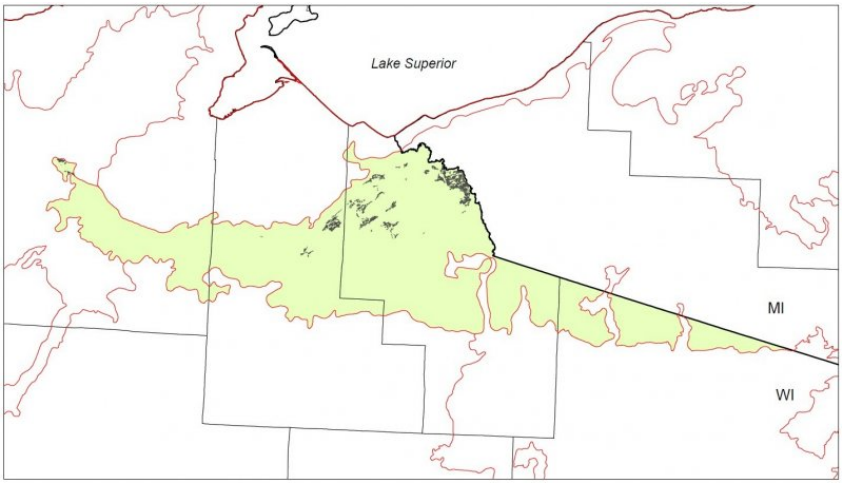


Figure 1. Distribution of Sandy Uplands in the Superior Stoney and Rocky Loamy Plains and Hills, Eastern Part (93B).

Table 2. Representative physiographic features

Landforms	(1) Till plain (2) Hillslope (3) Moraine (4) Lake plain (5) Outwash fan (6) Outwash plain (7) Stream terrace (8) Disintegration moraine
Runoff class	Negligible to medium
Flooding frequency	None
Ponding frequency	None
Elevation	656–985 ft
Slope	0–45%
Water table depth	24–78 in
Aspect	W, NW, N, NE, E, SE, S, SW

Climatic features

The continental climate of the Superior Stoney and Rocky Loamy Plains and Hills, Eastern Part MLRA is characterized by long, cold winters and short, warm summers where precipitation exceeds evapotranspiration. Neither average annual precipitation nor average annual minimum and maximum temperatures vary greatly within this MLRA, though the climate of the northern tip is somewhat affected by Lake Superior and receives higher annual precipitation in the form of lake effect snow.

Table 3. Representative climatic features

Frost-free period (characteristic range)	87-111 days
Freeze-free period (characteristic range)	121-145 days
Precipitation total (characteristic range)	32-36 in
Frost-free period (actual range)	83-119 days
Freeze-free period (actual range)	120-156 days
Precipitation total (actual range)	30-36 in
Frost-free period (average)	99 days
Freeze-free period (average)	134 days
Precipitation total (average)	34 in

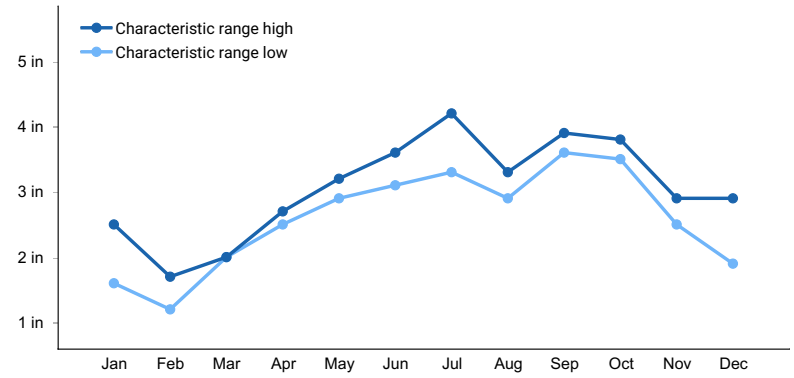


Figure 2. Monthly precipitation range

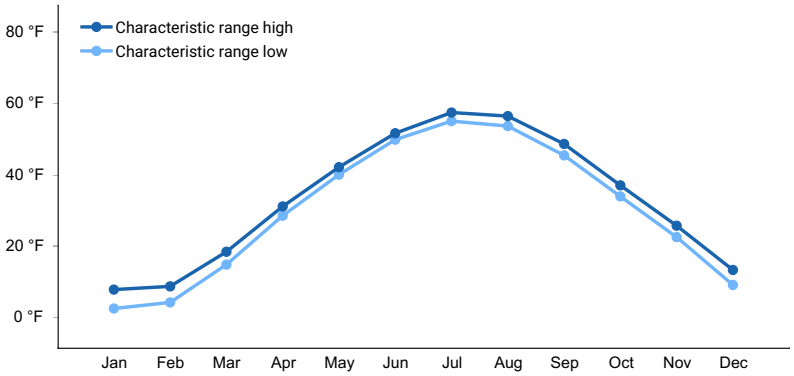


Figure 3. Monthly minimum temperature range

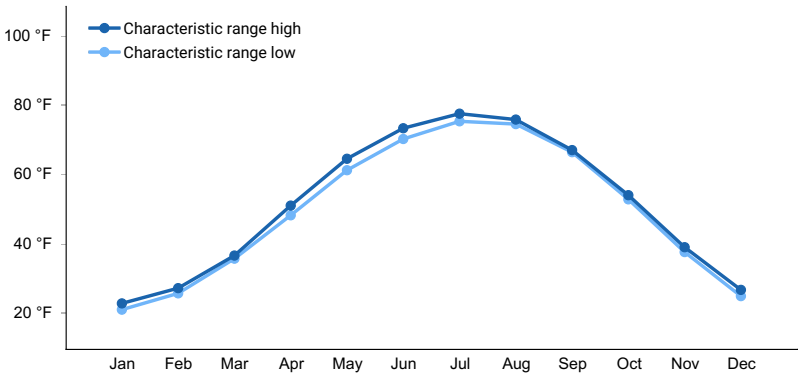


Figure 4. Monthly maximum temperature range

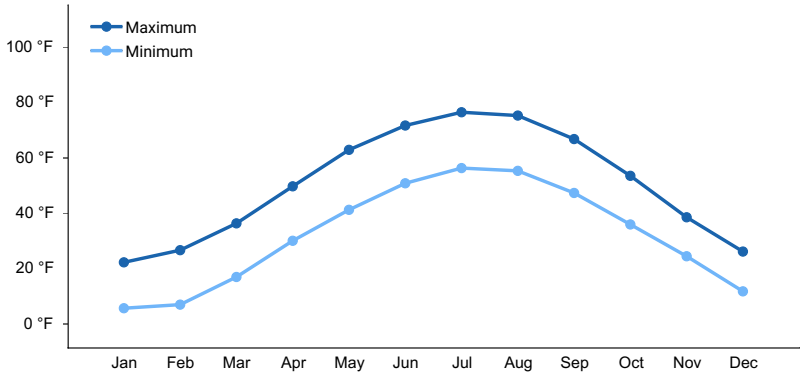


Figure 5. Monthly average minimum and maximum temperature

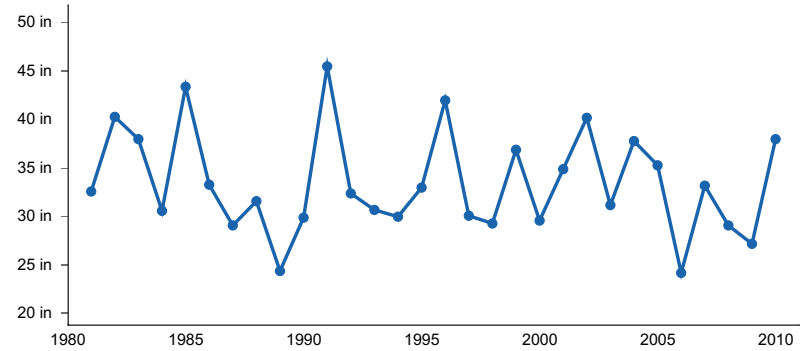


Figure 6. Annual precipitation pattern

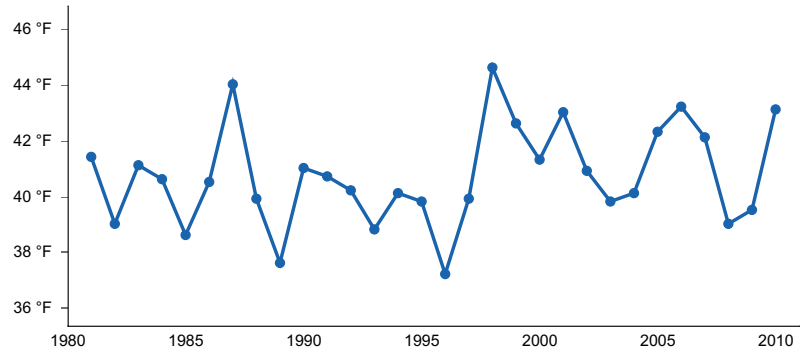


Figure 7. Annual average temperature pattern

Climate stations used

- (1) MELLEN 4 NE [USC00475286], Mellen, WI
- (2) HURLEY [USC00473800], Ironwood, WI
- (3) TWIN LAKES [USC00208345], Toivola, MI
- (4) MARQUETTE [USW00014838], Marquette, MI

Influencing water features

Water is received through precipitation and runoff from adjacent uplands. Water is lost from the site primarily through runoff, evapotranspiration, and groundwater recharge.
Permeability of the soils is slow to rapid. The hydrologic soil group of these sites is A.

Wetland description

Hydrologic Group: A
Hydrogeomorphic Wetland Classification: None
Cowardin Wetland Classification: None

Soil features

These sites are represented by the Pence, Karlin, Neconish, and Manitowish series. Pence is classified as a Typic Haplorthod. Karlin is classified as an Entic Haplorthod. Neconish and Manitowish are both classified as Oxyaquic Haplorthods.

These soils primarily form in sandy outwash, sometimes with a thin mantle of loamy alluvium or loamy eolian deposits. Soils are very deep and moderately well to somewhat excessively drained. They do not meet hydric soil requirements.

Surface textures are sandy loam to loamy fine sand. Subsurface textures range from coarse sand to fine sandy loam. Subsurface fragments are found on nearly all sites. Soil pH ranges from very strongly acid to moderately acid with values of 4.5 to 6.0. Carbonates are generally absent in these sites.

Table 4. Representative soil features

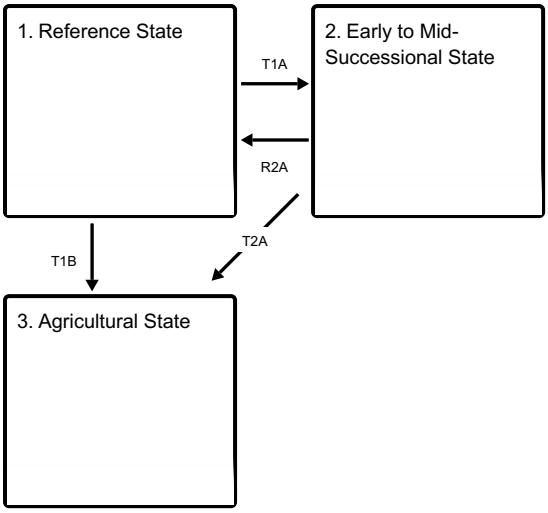
Parent material	(1) Glaciofluvial deposits (2) Outwash (3) Alluvium
Surface texture	(1) Loamy fine sand (2) Fine sandy loam (3) Sandy loam
Drainage class	Moderately well drained to somewhat excessively drained
Permeability class	Slow to rapid
Soil depth	80 in
Surface fragment cover <=3"	0–8%
Surface fragment cover >3"	0–5%
Available water capacity (Depth not specified)	3.98–4.84 in
Calcium carbonate equivalent (Depth not specified)	0%
Soil reaction (1:1 water) (Depth not specified)	4.5–6
Subsurface fragment volume <=3" (Depth not specified)	1–24%
Subsurface fragment volume >3" (Depth not specified)	0–5%

Ecological dynamics

Historically, mature forests on this ecological site were dominated by shade tolerant sugar maple and hemlock, often with an admixture of yellow birch (Wilde, 1933, Finley, 1976). This association was self-maintained with new cohorts of advance regeneration gaining canopy status through gaps formed by small-scale disturbances and natural mortality in the dominant canopy. Scattered large individuals of less shade tolerant white pine also were common component of mesic hardwood forests. These presumably became established following relatively rare disturbances that included fire (Schulte and Mladenoff, 2005).
Current stands on this ecological site represent the entire array of potential successional stages from pure aspen, or aspen-white birch, stands to sugar maple dominated mixed northern hardwoods stands. Succession to sugar maple dominance is evident everywhere that seed sources are present. However, hemlock regeneration is scarce. In old forests, hemlock finds optimal conditions for germination and seedling establishment on rotten logs, stumps and mounds that normally have warmer surfaces and better moisture retention than the forest floor (USDA, 1990). Most present forest communities lack these conditions.

State and transition model

Ecosystem states



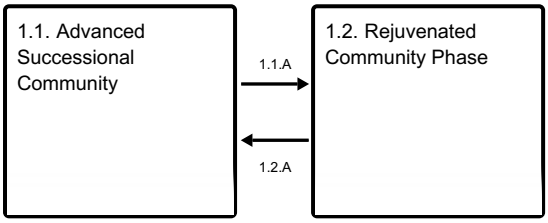
T1A - Large scale disturbance

T1B - Clearing of site; agricultural production

R2A - Abandon agricultural practices

T2A - Clearing; agricultural production

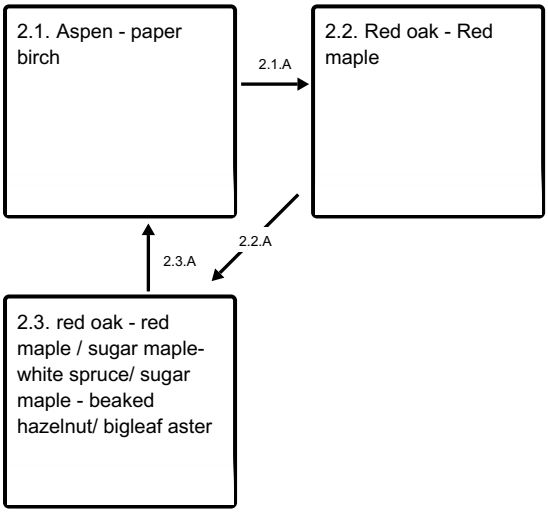
State 1 submodel, plant communities



1.1.A - Natural mortality in the oldest age classes, sporadic small-scale blow-downs and ice storms, create openings for entry of mid-tolerant species, such as red oak and red maple.

1.2.A - Time and natural succession

State 2 submodel, plant communities



2.1.A - Red oak and red maple regenerate under aspen-paper birch canopy

2.2.A - Time and natural succession

State 3 submodel, plant communities

3.1. Agricultural Community

State 1
Reference State

The reference plant community is categorized as mesic forest community dominated by mixed deciduous species, primarily sugar maple (*Acer saccharum*), and sporadic occurrence of several conifer species. Although forest communities can vary greatly in terms of species composition and stand structure, depending on type, degree, and frequency of disturbance, two common phases predominate: advanced succession community and rejuvenated community.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- yellow birch (*Betula alleghaniensis*), tree
- eastern hemlock (*Tsuga canadensis*), tree
- sugar maple (*Acer saccharum*), shrub
- western brackenfern (*Pteridium aquilinum*), other herbaceous
- bigleaf aster (*Eurybia macrophylla*), other herbaceous

Community 1.1
Advanced Successional Community

In the absence of major, stand-replacing disturbance this community is dominated by sugar maple, yellow birch (*Betula alleghaniensis*) and eastern hemlock (Tsuga Canadensis), often with scattered occurrence of old white pines. This was the most common condition in pre-European settlement forests. The tree sapling and shrub layer in this community is not well developed due to dense shade created by multi-story tree canopy. Most common, but low coverage shrub species are American hophornbeam (*Ostrya virginiana*), hornbeam (*Carpinus caroliniana*), and hazelnuts (Corylus, spp.). The herb layer is relatively species rich, but moderate in abundance. The dominant herbs typically include bracken fern (*Pteridium aquilinum*) and big leaf aster (*Eurybia macrophylla*). Other common herb species include Canada mayflower (*Maianthemum canadense*), partridge berry (*Mitchella repens*), Hairy Solomon's seal (*Polygonatum pubescens*), and false Solomon's seal (*Maianthemum racemosum*). It is important to note that in most current mature stands, hemlock is significantly under-represented compared to historic conditions. Apparently, this lack of hemlocks is due to seed source elimination during the early logging era and herbivory by currently high white tail deer populations.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- yellow birch (*Betula alleghaniensis*), tree
- eastern hemlock (*Tsuga canadensis*), tree
- sugar maple (*Acer saccharum*), shrub
- hophornbeam (*Ostrya virginiana*), shrub
- American hornbeam (*Carpinus caroliniana*), shrub
- hazelnut (*Corylus*), shrub
- spinulose woodfern (*Dryopteris carthusiana*), other herbaceous
- starflower (*Trientalis borealis*), other herbaceous

Community 1.2
Rejuvenated Community Phase

Disturbances described in Pathway 1.1A lead to increased species and structural diversity of the forest community.

Depending on seed source, red oak, red maple and—in many cases—white pine regenerate in the canopy openings and in time join sugar maple and hemlock in the dominant canopy. White pine easily exceeds the height of the deciduous canopy and often remains on the site, as scattered individuals, for up to four centuries. This exceptional longevity virtually assures perpetual white pine seed source on the site. The relative density of the shrub and herb layers also increases during this stage. Species composition remains relatively unchanged, but abundance changes can be significant. Particularly beaked hazelnut can form dense thickets and big leaf aster often forms continuous carpets. Many other herb species that were present with very low abundance in the advanced-succession community typically form much larger population clusters.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- red maple (*Acer rubrum*), tree
- northern red oak (*Quercus rubra*), tree
- hophornbeam (*Ostrya virginiana*), shrub
- American hornbeam (*Carpinus caroliniana*), shrub
- western brackenfern (*Pteridium aquilinum*), other herbaceous
- bigleaf aster (*Eurybia macrophylla*), other herbaceous

Pathway 1.1.A
Community 1.1 to 1.2

Natural mortality in the oldest age classes—sporadic small-scale blow-downs and ice storms—create openings for entry of mid-tolerant species such as red oak and red maple.

Pathway 1.2.A
Community 1.2 to 1.1

In the absence of canopy reducing disturbances natural succession leads to community dominance by the most shade-tolerant species resulting in return to community phase 1.1.

State 2
Early to Mid-Successional State

Following disturbances described in Transition T1A a wide range of forest community phases may come into temporary existence, the three most common ones are red oak -red maple -sugar maple, red oak - red maple, and aspen-paper birch.

Dominant plant species

- northern red oak (*Quercus rubra*), tree
- red maple (*Acer rubrum*), tree
- sugar maple (*Acer saccharum*), tree
- sugar maple (*Acer saccharum*), shrub
- beaked hazelnut (*Corylus cornuta*), shrub
- western brackenfern (*Pteridium aquilinum*), other herbaceous
- bigleaf aster (*Eurybia macrophylla*), other herbaceous

Community 2.1
Aspen - paper birch

These two species have a very narrow window of environmental and ecological conditions for successful establishment. Main requirements are exposed mineral soil and elimination, most effectively by fire, of on-site seed sources of potential competing vegetation. In addition, adequate soil moisture must be available for initial seedling development. Once seedlings are firmly established height growth of both species is relatively rapid and able to outgrow most competitive species. Paper birch seedlings and saplings tolerate partial shade and often become members of mixed species communities. This is not true for aspen which requires continuous full-sun exposure for survival. Aspen stands are initially very dense due to sprouting from extensive lateral roots, but rapid natural

thinning ensues as stems compete for available light.

Dominant plant species

- quaking aspen (*Populus tremuloides*), tree
- paper birch (*Betula papyrifera*), tree

Community 2.2
Red oak - Red maple

This community phase may occur via two different origins: 1. By sprouting from stumps or by local seed source, following stand-leveling disturbance, or 2. By invading and succeeding a pioneer aspen-birch community. For this reason, tree species composition and community structure in early stages of development vary considerably, from pure canopy dominance by red oak and red maple, singly, or in combination, to modest, or strong presence of mature, or decaying, aspen and/or paper birch. The shrub layer, dominated by beaked hazelnut (*Corylus cornuta*), typically reaches its best development in this community phase.

Dominant plant species

- northern red oak (*Quercus rubra*), tree
- red maple (*Acer rubrum*), tree

Community 2.3
red oak - red maple / sugar maple-white spruce/ sugar maple - beaked hazelnut/ bigleaf aster

This community phase represents distinct transition into mid-successional state, by strong presence in second canopy, or in reproductive layers, of shade-tolerant species, sugar maple, basswood, eastern hemlock, or balsam fir and white spruce. Sporadic occurrence of individual white pine trees also is common. Eastern hemlock, although historically a prominent member of mature communities on this site, is today under-represented presumably due to lack of seed source and selective browsing by the white-tailed deer.

Dominant plant species

- northern red oak (*Quercus rubra*), tree
- red maple (*Acer rubrum*), tree
- sugar maple (*Acer saccharum*), tree
- white spruce (*Picea glauca*), tree
- beaked hazelnut (*Corylus cornuta*), shrub
- sugar maple (*Acer saccharum*), shrub
- bigleaf aster (*Eurybia macrophylla*), other herbaceous

Pathway 2.1.A
Community 2.1 to 2.2

Natural succession leads to community dominance by the most shade-tolerant species.

Pathway 2.2.A
Community 2.2 to 2.3

Succession by shade-tolerant species, sugar maple, basswood and in some cases also balsam fir and white spruce.

Pathway 2.3.A
Community 2.3 to 2.1

State 3
Agricultural State

This State is composed of crops, hay, or pasture.

Community 3.1
Agricultural Community

This community phase is composed of crops, hay, or pasture.

Transition T1A
State 1 to 2

Major stand-replacing disturbance. In pre-European settlement time, the event was most often a severe blow down, sometimes followed by fires. Such blow downs have been estimated to occur in this part of Wisconsin every 300 to 400 years (Schulte and Mladenoff, 2005). In post settlement virtually every acre has been logged either by clear cutting or successive cuts targeting species marketable at that time. Post logging slash fires also have been a significant factor in most areas. These disturbances created the environment suitable for natural regeneration of many shade-intolerant species and for commercial planting.

Transition T1B
State 1 to 3

Elimination of forest cover, application of agricultural practices.

Restoration pathway R2A
State 2 to 1

Abandonment of agricultural practices and allowing natural vegetation to colonize the site or apply artificial afforestation. The time required for forest community to reach the reference state conditions may exceed 100 years.

Transition T2A
State 2 to 3

Removal of forest cover, tilling and application of other agricultural techniques to grow agricultural crops.

Additional community tables

Inventory data references

Sites key out primarily to ATM, but species are not very well represented by this site. Sites are drier than ATM, and are likely best represented by a dry-mesic type like AVVb. STM designed on ATM and AVVb habitat types. (Wisconsin Forest Habitat Type Classification System)

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Approval

Suzanne Mayne-Kinney, 9/27/2023

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.

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Contact for lead author	
Date	09/27/2023
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):**

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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:**
