Ecological site F093BY006MI
Alfic Sandy Uplands

Last updated: 9/27/2023
Accessed: 05/12/2025

General information

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

MLRA notes

Major Land Resource Area (MLRA): 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): Four of the five sites in teis ES key to the *Acer saccharum* – Tsuga canadensis/ *Maianthemum canadense* (ATM) habitat type, and one outlier site keys to Pinus strobus – Acer rubrum / Vaccinium angustifolium – Aralia nudicaulis (PArVAa).

Biophysical Setting (Landfire, 2014): This ES is mapped as Boreal White Spruce-Fir-Hardwood Forest – Inland, Laurentian-Acadian Pine-Hemlock-Hardwood Forest, and Laurentian-Acadian Northern Hardwoods Forest – Hemlock; though, it is likely best represented by the latter.

WDNR Natural Communities (WDNR (2015): This ES is most similar to the Northern Mesic Forest.

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 Alfic Sandy Uplands ecological site is an uncommon site in MLRA 93B, located on moraines, lake plains, and outwash plains. These sites are characterized by very deep, well to somewhat excessively drained soils that formed in sandy till and sandy outwash. These soils have a layer of significant clay accumulation (i.e. an argillic horizon, sometimes composed of lamellae) that helps perch and retain water in the soil profile. Precipitation and runoff from adjacent uplands are the primary sources of water. Soils range from very strongly acid to slightly acid.

The characteristic clay accumulation found in Alfic Sandy Uplands differentiates it from Sandy Uplands. This boost in available water capacity provided by the clay layer allows Alfic Sandy Uplands to support a wide range of vegetative species. 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 Alfic 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 Alfic 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 Alfic Sandy Uplands.

Similar sites

F093BY009MI	**Alfic Loamy Uplands** Alfic Loamy Uplands occur on upland sites in loamy glaciofluvial deposits. They are moderately well to well drained. They occur on similar landscape positions and drainage sequence positions as Alfic Sandy Uplands. In both sites, an argillic horizon is either present or forming. Alfic Loamy Uplands have finer textures.
F093BY007MI	**Sandy Uplands** Like Alfic Sandy Uplands, Sandy Uplands occur on upland sites in deep sandy outwash deposits, sometimes with a thin loamy mantle of alluvium or loess. Unlike Alfic Sandy Uplands, argillic horizons are neither present nor forming in these soils. These soils are moderately well to somewhat excessively drained.
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 soils lack a horizon of significant clay accumulation. The amount of water stored by these soils is lower than that of Alfic Sandy Uplands. The vegetative community reflects these differences with slightly drier and less nutrient-demanding species present.

Table 1. Dominant plant species

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

Herbaceous	(1) *Dryopteris carthusiana* (2) *Trientalis borealis*

Physiographic features

These sites occur on moraines, lake plains, and outwash plains in backslope, shoulder, and summit positions. Slope ranges from 0 to 45 percent. These sites are subject to neither flooding not ponding. These sites lack evidence of a seasonally high water table within 80 inches. Surface runoff ranges from very low to high and is largely affected by slope and landscape position.

Hillslope Positions: Summit, backslope, shoulder
Slope Shapes: Convex, linear

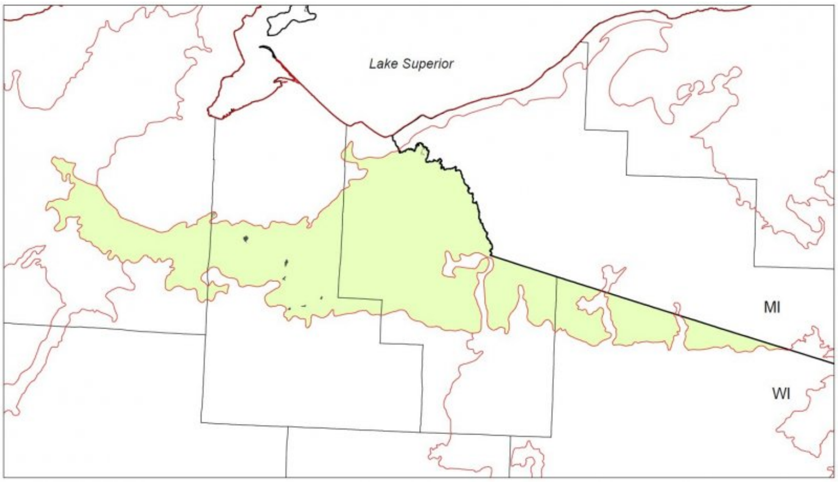


Figure 1. Distribution of Alfic Sandy Uplands in the Superior Stoney and Rocky Loamy Plains and Hills, Eastern Part (93B).

Table 2. Representative physiographic features

Landforms	(1) Disintegration moraine (2) End moraine (3) Ground moraine (4) Lava plain (5) Outwash plain
Runoff class	Very low to high
Flooding frequency	None
Ponding frequency	None
Elevation	656–820 ft
Slope	0–45%
Water table depth	80 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)	100-116 days
Freeze-free period (characteristic range)	127-151 days
Precipitation total (characteristic range)	30-35 in
Frost-free period (actual range)	95-121 days
Freeze-free period (actual range)	121-157 days
Precipitation total (actual range)	29-36 in
Frost-free period (average)	108 days
Freeze-free period (average)	139 days
Precipitation total (average)	33 in

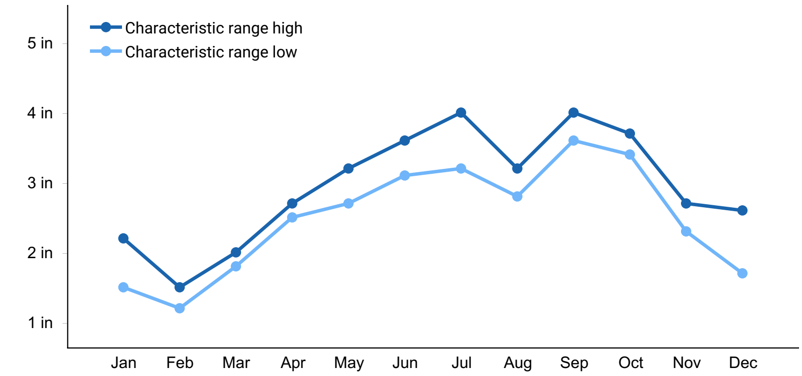


Figure 2. Monthly precipitation range

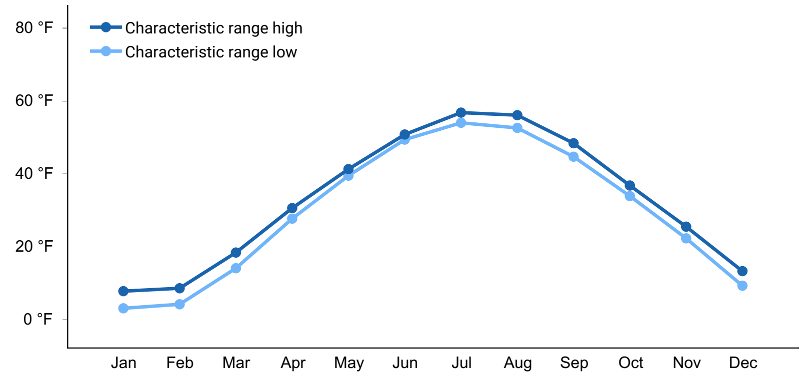


Figure 3. Monthly minimum temperature range

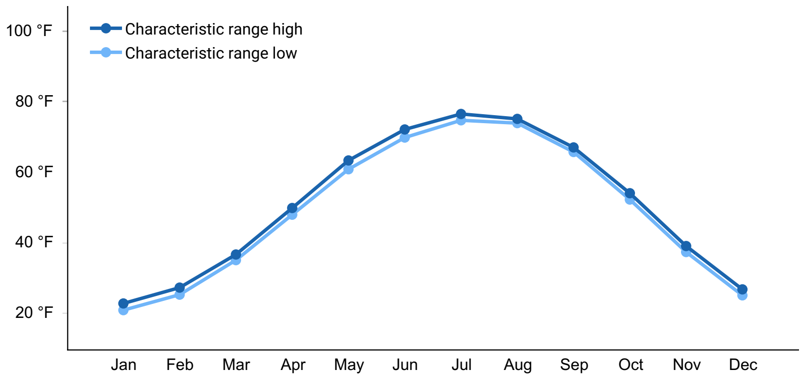


Figure 4. Monthly maximum temperature range

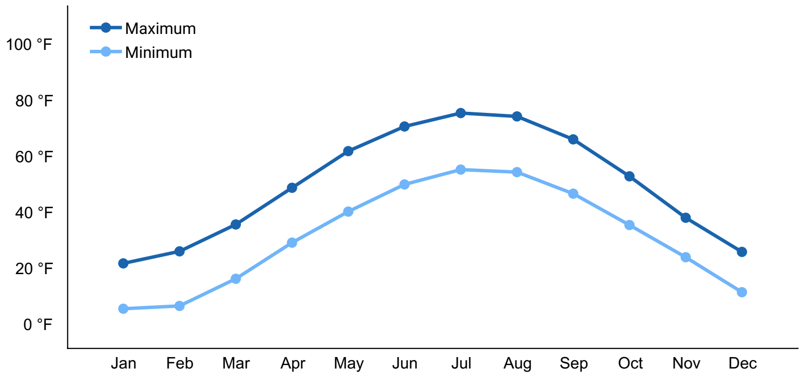


Figure 5. Monthly average minimum and maximum temperature

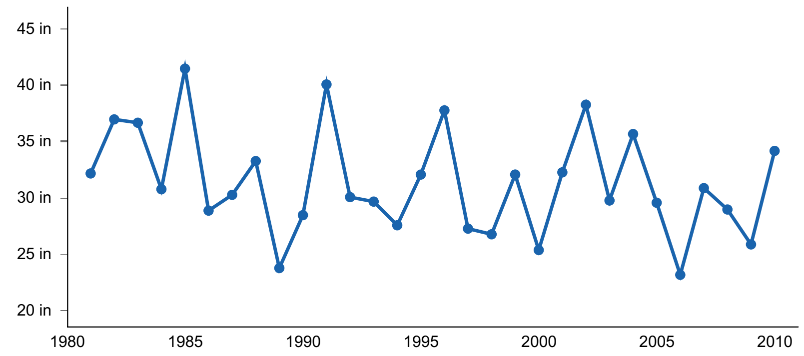


Figure 6. Annual precipitation pattern

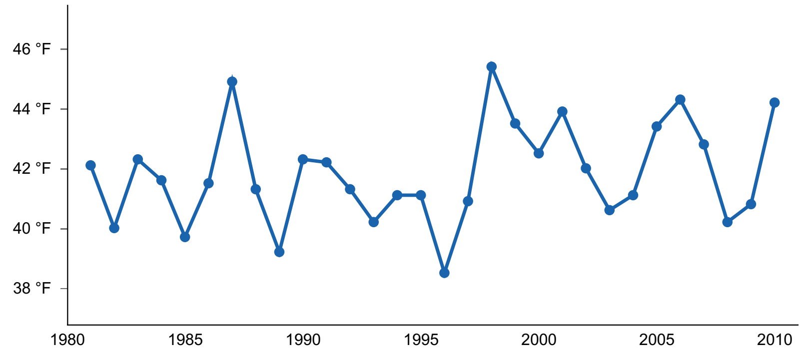


Figure 7. Annual average temperature pattern

Climate stations used

- (1) MELLEN 4 NE [USC00475286], Mellen, WI
- (2) WATTON [USC00208706], Watton, MI
- (3) MARQUETTE [USW00014838], Marquette, MI
- (4) TWIN LAKES [USC00208345], Toivola, 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 or C.

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

Soil features

These sites are represented by the Keweenaw, Menominee, and Lindquist series. Keweenaw and Menominee are classified as Alfic Haplorthods. Lindquist is classified as Lameillc Haplorthods.

In these soils, an argillic horizon is either present or developing, and may be in the form of lamellae with a combined thickness of 6 inches or greater. These soils form in deep sandy drift deposits. They are well to somewhat excessively drained. They do not meet hydric soil requirements.

Surface is either loamy sand or sandy loam. Surface textures are generally sand to sandy loam or the fine or very fine analogues of these textures. Soils formed in relatively finer materials may see clay loam textures in their argillic horizons. Gravels and cobbles may constitute up to 7 percent of surface volume. Subsurface gravel is usually present and may constitute 7 to 13 percent of volume. Soil pH ranges from very strongly acid to slightly acid with values of 4.6 to 6.5. Calcium carbonate equivalency is generally zero, but may be up to 15 percent beginning at 23 inches.

Table 4. Representative soil features

Parent material	(1) Till (2) Outwash
Surface texture	(1) Gravelly sand (2) Fine sand (3) Loamy sand (4) Very fine sand (5) Fine sandy loam (6) Loam (7) Very fine sandy loam (8) Clay loam
Drainage class	Well drained to excessively drained
Permeability class	Slow to rapid
Soil depth	80 in
Surface fragment cover <=3"	0–7%
Surface fragment cover >3"	0–7%
Available water capacity (Depth not specified)	5.7–7.4 in
Calcium carbonate equivalent (Depth not specified)	0–15%
Soil reaction (1:1 water) (Depth not specified)	4.6–6.5
Subsurface fragment volume <=3" (Depth not specified)	7–13%
Subsurface fragment volume >3" (Depth not specified)	0–3%

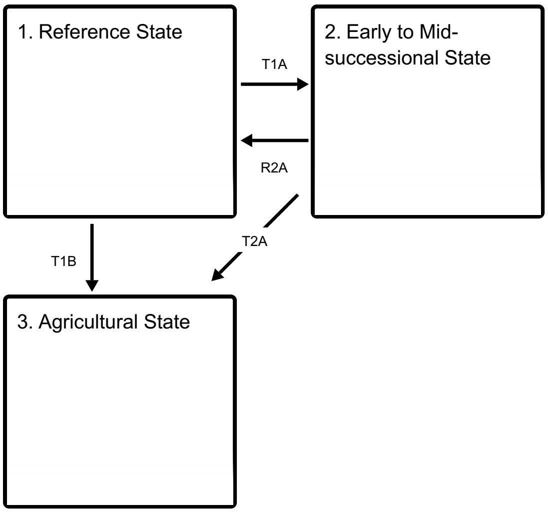
Ecological dynamics

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



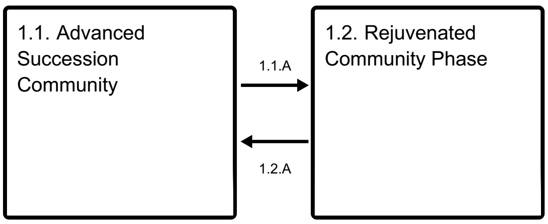
T1A - Major stand replacing disturbance

T1B - Clearing of site; agricultural production

R2A - Time and natural succession

T2A - Clearing; agricultural production

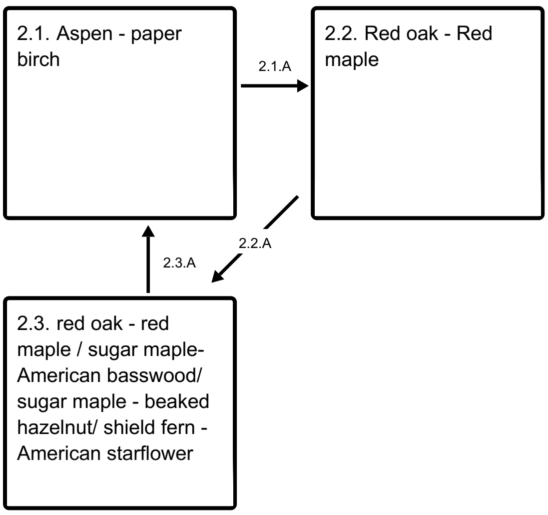
State 1 submodel, plant communities



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 regenerating 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.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- yellow birch (*Betula alleghaniensis*), tree
- eastern hemlock (*Tsuga canadensis*), tree
- sugar maple (*Acer saccharum*), shrub
- beaked hazelnut (*Corylus cornuta*), shrub
- American fly honeysuckle (*Lonicera canadensis*), shrub
- spinulose woodfern (*Dryopteris carthusiana*), other herbaceous
- starflower (*Trientalis borealis*), other herbaceous

Community 1.1
Advanced Succession 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 beaked hazelnut (*Corylus cornuta*), and American fly honeysuckle (*Lonicera canadensis*). The herb layer is relatively species rich, but moderate in abundance. The dominant herbs typically include spinulose wood fern (*Dryopteris carthusiana*) and American starflower (*Trientalis borealis*). Other common herb species include Canada mayflower (*Maianthemum canadense*), partridge berry (*Mitchella repens*), bracken fern (*Pteridium aquilinum*), big leaf aster (*Eurybia macrophylla*), and lady fern (Athyrium felix-femina). 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
- 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

- northern red oak (*Quercus rubra*), tree
- red maple (*Acer rubrum*), tree
- sugar maple (*Acer saccharum*), tree
- eastern white pine (*Pinus strobus*), tree
- beaked hazelnut (*Corylus cornuta*), shrub
- American fly honeysuckle (*Lonicera canadensis*), shrub
- starflower (*Trientalis borealis*), other herbaceous
- spinulose woodfern (*Dryopteris carthusiana*), 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 aspen -paper birch, red oak -red maple, and red oak -red maple -sugar maple.

Dominant plant species

- northern red oak (*Quercus rubra*), tree
- sugar maple (*Acer saccharum*), tree
- red maple (*Acer rubrum*), tree
- beaked hazelnut (*Corylus cornuta*), shrub
- sugar maple (*Acer saccharum*), shrub
- shieldfern (*Lastreopsis*), other herbaceous
- starflower (*Trientalis borealis*), 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-American basswood/ sugar maple - beaked hazelnut/ shield fern - American starflower

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

Aspen and paper birch do not reproduce under their own canopies and, depending on seed source, are succeeded by either mid-shade-tolerant species such as red oak, red maple and white pine, (Pathway 2.1B) - or directly by very tolerant species such as sugar maple, basswood, balsam fir and white spruce (Pathway 2.1A).

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

The community transitions from a red oak-red maple site to one dominated by aspen - paper birch.

State 3
Agricultural State

This community phase 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

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

All sites collected that key to the ATM Kotar Habitat Type are well represented by this type. All these sites were represented by Keweenaw soil series.
One site collected keys to PArVAa, but does not represent this ESD well.

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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.

Author(s)/participant(s)	
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:**
