Ecological site F089XY015WI
Moist Clayey Uplands

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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): 089X–Wisconsin Central Sands

The Wisconsin Central Sands (MLRA 89) corresponds closely to Central Sand Plains Ecological Landscape published by the Wisconsin Department of Natural Resources (WDNR, 2015). Much of the following brief overview of this MLRA is borrowed from that publication.

The Wisconsin Central Sands MLRA is entirely in Wisconsin. The total land area is 2,187,100 acres (3,420 square miles, 8858 square kilometers). It is bordered to the east by Johnstown-Hancock end moraines, which were pushed to their extent by the west side of the Green Bay Lobe (Clayton & Attig, 1999). It is bordered to the southwest by highly eroded, unglaciated valleys and ridges. The dominant feature of this MLRA is the remarkably flat, sandy plain, composed of lacustrine deposits and outwash sand, that was once the main basin of Glacial Lake Wisconsin. It also features extensive pine and oak barrens and wetland complexes.

Glacial Lake Wisconsin was fed primarily by glacial meltwater from the north and east. The lake deposited silt overlain by tens of meters of sand (Clayton & Attig, 1989). The silty layers are closer to the surface in some areas, where they impede drainage and contribute to the formation of extensive wetland complexes. It is believed that Glacial Lake Wisconsin drained within several days after a breach in the ice dam that supported it. The catastrophic flood that followed flowed to the south and carved the scattered buttes and mesas protruding from the sandy plain in the southern portion of this MLRA. Before vegetation established after glacial recession, strong winds formed aeolian sand dunes that now support xeric pine and oak stands within the Wisconsin Central Sands.

The surface of the northwestern portion is mostly undulating. The sandy surface sediment was mostly deposited by meltwater during the Wisconsin glaciation. Gentle hills are a result of underlying bedrock topography. Valleys and floodplains are formed by stream action. The underlying bedrock controls the water table elevation and contributes to the formation of numerous wetlands.

Historically, the Wisconsin Central Sands were dominated by large wetland complexes, sand prairies, and oak forests, savannas, and barrens. Some pine and hemlock forests were found in the northwest portion. The Wisconsin Central Sands was subject to frequent fires, leading to today's need for prescribed burns to maintain the area.

Classification relationships

Major Land Resource Area (MLRA): Wisconsin Central Sands (89)
USFS Subregions: Central Wisconsin Sand Plain (222Ra)
Relationship to Established Framework and Classification Systems:

Habitat Types of S. Wisconsin (Kotar, 1996): The sites of this ES keyed out to two habitat types: Pinus/Vaccinium-Gaultheria (PVG); *Acer rubrum*/Desmodium (ArDe)

Biophysical Settings (Landfire, 2014): This ES is largely mapped as Eastern Cool Temperate Row Crop, Eastern Cool Temperate Developed Ruderal Grassland, and Eastern Cool Temperate Close Grown Crop.

WDNR Natural Communities (WDNR, 2015): This ES is most similar to the Central Sands Pine-Oak Forest, Hardwood Forest, and Northern Mesic Forest communities.

Ecological site concept

The Moist Clayey Uplands ecological site is an uncommon site but exists in the southern portion of MLRA 89 in depressions and drainageways on the glacial lake basin and lake terraces, often (but not exclusively) within five miles of the Lemonweir River. These sites are characterized by very deep, somewhat poorly drained soils formed in silty or sandy alluvium over clayey lacustrine deposits. Precipitation, runoff from adjacent uplands, and groundwater discharge are the primary sources of water. Soils can range from neutral to moderately alkaline.

Although these soils are classified as Somewhat Poorly Drained the vegetation does not reflect this condition. It appears that poorly drained condition occurs more as micro-sites rather than the general character of the site. The dominant tree species on four representative sites were red oak (Quercus rubra), red maple (*Acer rubrum*) and white pine (*Pinus strobus*). Other species were white oak (*Q. alba*), northern pin oak (Q elipsoidalis) and trembling aspen (Populus tremuloides). Common understory flora included sedges (Carex spp.), blueberries (Vaccinium spp.), starflower (Trientalis boreralis), wild lily of-the-valley (*Maianthemum canadense*). Wetter micro sites were characterized by some of the following: Winterberry (Ilex verticillata), tag alder (Alnus crispa), swamp dewberry (Rubus hispidus) or cinnamon fern (Osmunda cinnamomea).

Moist Clayey Uplands differs from other sites by its drainage and clayey textures. Other poorly drained sites are sandy or loamy. Clayey soils often have higher pH and available water capacity than sandy and loamy textures. The somewhat poor drainage differentiates this site from other clayey sites.

Associated sites

F089XY009WI	**Wet Clayey Lowlands** Wet Clayey Lowlands form in deep clayey lacustrine deposits overlain by a silty mantle. These soils are poorly drained, remain saturated for much of the growing season, and are sometimes subject to ponding. These sites are found in the southwestern portion of the Wisconsin Central Sands MLRA. They occur lower on the drainage sequence and are wetter than Moist Clayey Uplands.

Similar sites

F089XY009WI	**Wet Clayey Lowlands** Wet Clayey Lowlands form in deep clayey lacustrine deposits overlain by a silty mantle. These soils are poorly drained, remain saturated for much of the growing season, and are sometimes subject to ponding. These sites are found in the southwestern portion of the Wisconsin Central Sands MLRA. Their vegetative communities may sometimes look similar to those of Moist Clayey Uplands, though Wet Clayey Lowlands support additional communities with a higher tolerance for wetness.
F089XY011WI	**Moist Sandy Outwash Uplands** Moist Sandy Outwash Uplands consist of deep sandy deposits derived from a mixture of outwash, alluvium, and lacustrine sources. They are somewhat poorly drained and are subject to neither flooding nor ponding. Perhaps due to the sandy mantle that occasionally covers the clayey lacustrine deposits in Moist Clayey Uplands, their vegetative communities may sometimes be similar to those supported by sandier soils with similar drainage capabilities.
F089XY008WI	**Wet Loamy Lowlands** Wet Loamy Lowlands form in a loamy or silty mantle 10 to 40 inches (25 to 100 cm) thick overlying sandy residuum weathered from sandstone and shale. Bedrock contact may occur as high at 26 inches (66 cm). These soils are poorly drained, remain saturated for much the growing season, and are sometimes subject to ponding. They are exclusive to the northern third of the Wisconsin Central Sands MLRA, which was covered in loamy glacial deposits prior to the most recent glacial advance. Their vegetative communities may sometimes look similar to those of Moist Clayey Uplands, though Wet Loamy Lowlands are able to support additional communities with a higher tolerance for wetness.

Table 1. Dominant plant species

Tree	(1) *Pinus strobus* (2) *Quercus alba*
Shrub	(1) *Corylus* (2) *Prunus serotina*
Herbaceous	(1) *Pteridium aquilinum* (2) *Maianthemum canadense*

Physiographic features

These sites formed in depressions and drainageways on outwash plains, lake terraces, and glacial lake basins. Slopes range from 0 to 3 percent. Elevation ranges from 705 to 1,394 feet (215 to 425) meters above sea level. These sites are not subject to ponding or flooding. Sites have a seasonally high water table at a depth of 6 to 24 inches (15 to 61 cm). The water table can drop to 60 inches (150 cm) during dry conditions. Surface runoff ranges from low to high.

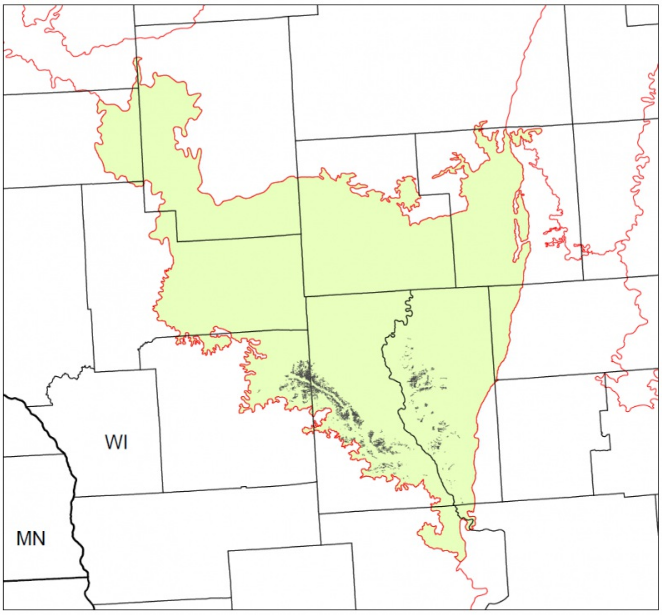


Figure 1. Distribution of Moist Clayey Uplands in the Wisconsin Central Sands MLRA (89).

Table 2. Representative physiographic features

Hillslope profile	(1) Footslope
Slope shape across	(1) Linear
Slope shape up-down	(1) Concave
Landforms	(1) Outwash plain (2) Lake plain
Runoff class	Low to high

Flooding frequency	None
Ponding frequency	None
Elevation	705–1,394 ft
Slope	0–3%
Water table depth	6–24 in
Aspect	Aspect is not a significant factor

Climatic features

The continental climate of the Wisconsin Central Sands is typical of the southern half of the state – cold winters and warm summers. Precipitation is well-distributed throughout the year with a slight peak in the summer months. Snowfall covers the ground from late fall to early spring. The soil moisture regime of MLRA 89 is udic (humid climate). The soil temperature regime is mostly frigid, with a small portion of mesic in the southern tip. Neither precipitation nor temperature vary greatly across this MLRA. More so than latitude, local topography seems to be an important predictor of growing season length, with fewer growing degree days in lower-lying areas.

The average annual precipitation for this ecological site is 34 inches. The average annual snowfall is 41 inches. The annual average maximum and minimum temperatures are 56°F and 34°F, respectively.

Table 3. Representative climatic features

Frost-free period (characteristic range)	101-119 days
Freeze-free period (characteristic range)	136-146 days
Precipitation total (characteristic range)	33-34 in
Frost-free period (actual range)	97-124 days
Freeze-free period (actual range)	133-149 days
Precipitation total (actual range)	33-34 in
Frost-free period (average)	110 days
Freeze-free period (average)	141 days
Precipitation total (average)	34 in

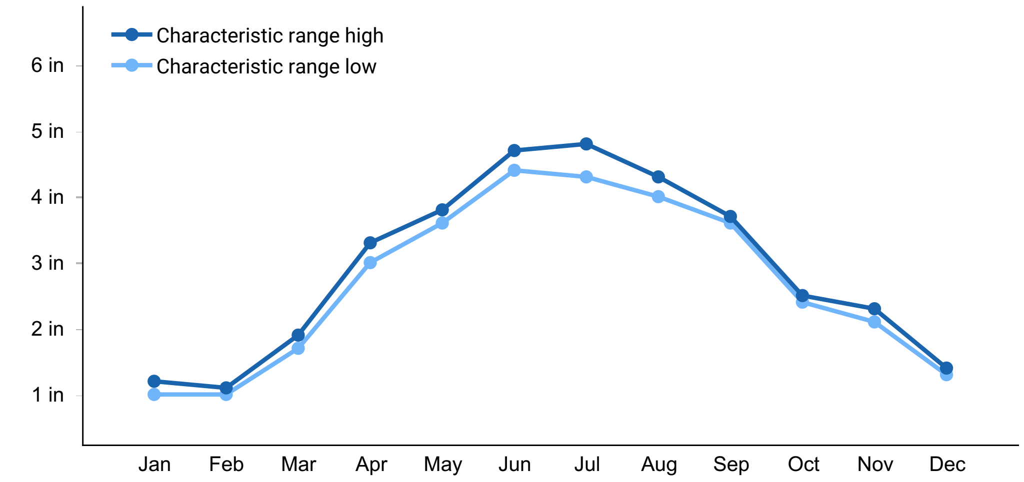


Figure 2. Monthly precipitation range

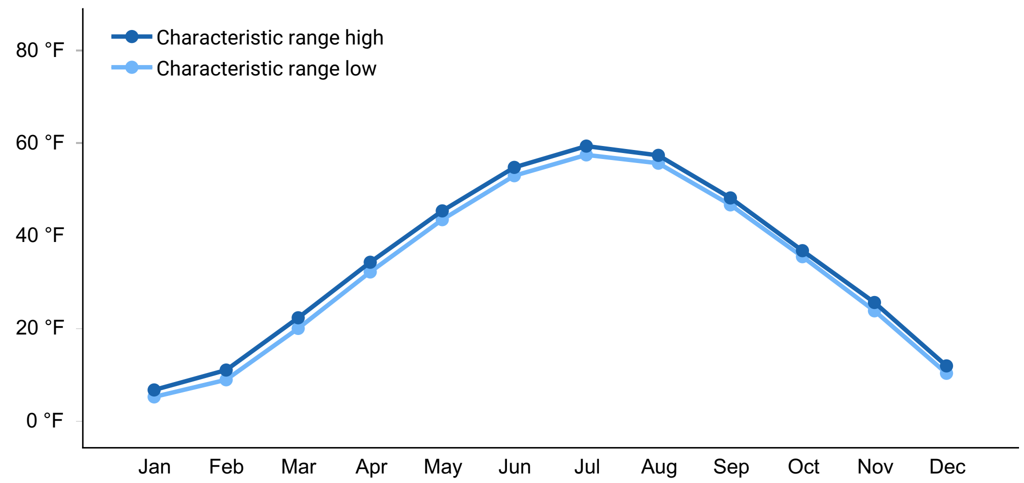


Figure 3. Monthly minimum temperature range

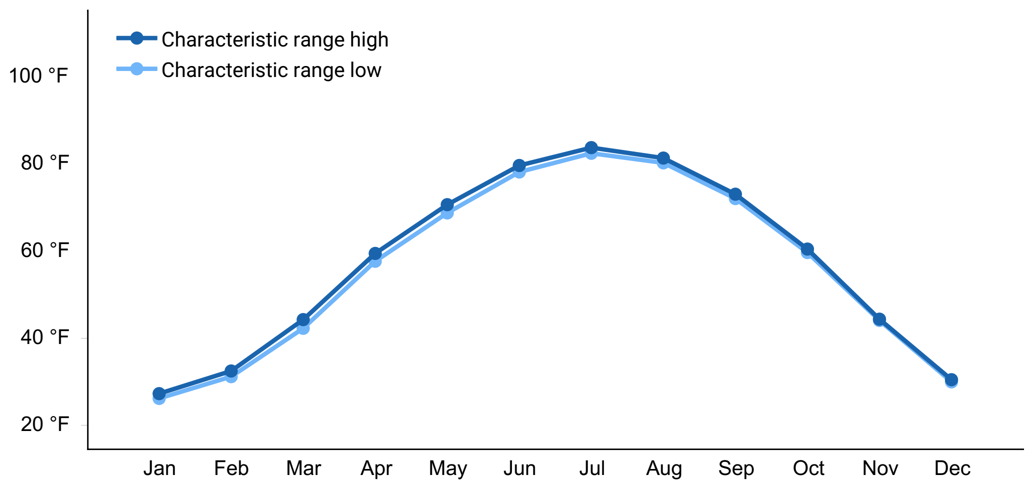


Figure 4. Monthly maximum temperature range

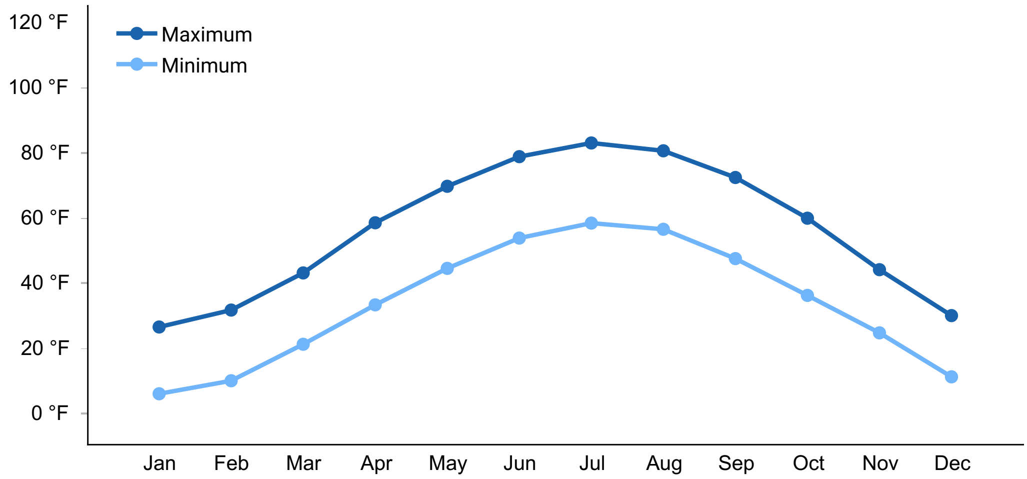


Figure 5. Monthly average minimum and maximum temperature

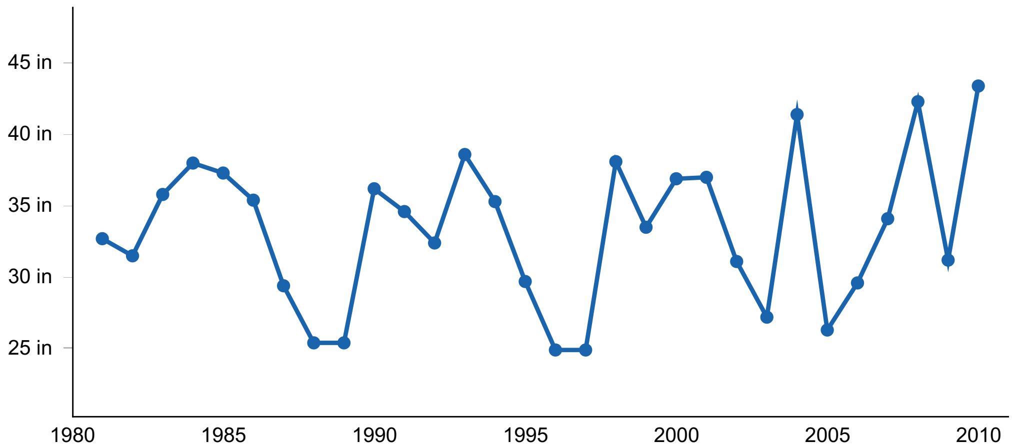


Figure 6. Annual precipitation pattern

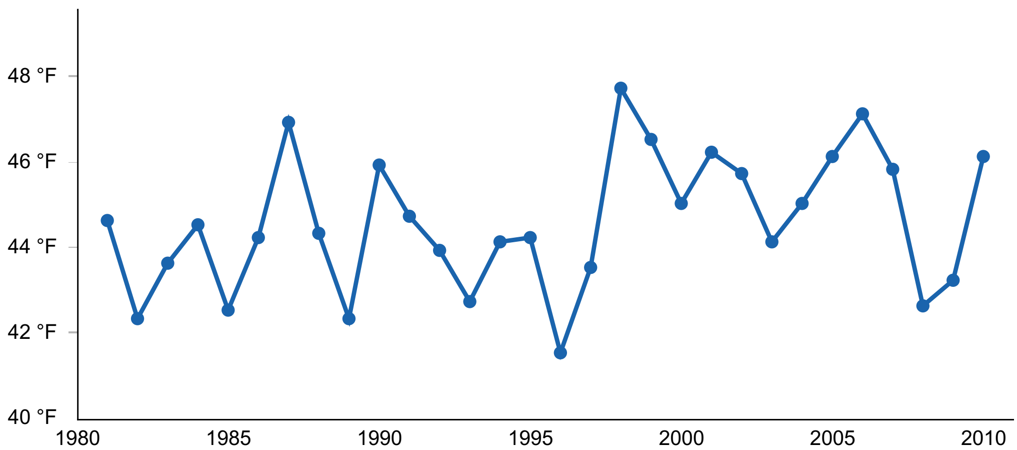


Figure 7. Annual average temperature pattern

Climate stations used

- (1) FRIENDSHIP [USC00472973], Adams, WI
- (2) MAUSTON 1 SE [USC00475178], Mauston, WI
- (3) NECEDAH [USC00475786], Necedah, WI

Influencing water features

Water is received through precipitation, runoff from adjacent uplands, groundwater discharge, and, rarely, stream inflow. Water levels are greatly influenced by precipitation rates and runoff from upland sites. Water leaves the site primarily through runoff, evapotranspiration, and groundwater recharge. Permeability of these sites is impermeable. Hydrologic group is B or D.

Soil features

These sites are represented by the Neenah and Wyeville soil series, classified as Aquollic Hapludalfs and Aquic Arenic Hapludalfs, respectively. These soils formed in sandy and loamy alluvium over clayey lacustrine deposits. Sites are poorly drained. They do not meet hydric soil requirements. The surface of these sites is loamy sand or silt loam. Subsurface textures are sand, silt loam, and silty clay. Soil pH ranges from slightly acid to moderately alkaline with values of 6.2 to 8.1. Surface and subsurface fragments are absent. Carbonates can be present up to 18 percent beginning at 27 inches (69 cm).

Table 4. Representative soil features

Parent material	(1) Alluvium (2) Lacustrine deposits
Surface texture	(1) Loamy sand (2) Silt loam
Drainage class	Somewhat poorly drained
Permeability class	Very slow
Soil depth	78 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-60in)	6.39–8.2 in
Calcium carbonate equivalent (0-40in)	0–18%
Soil reaction (1:1 water) (0-40in)	6.2–8.1
Subsurface fragment volume <=3" (0-80in)	0%
Subsurface fragment volume >3" (0-80in)	0%

Ecological dynamics

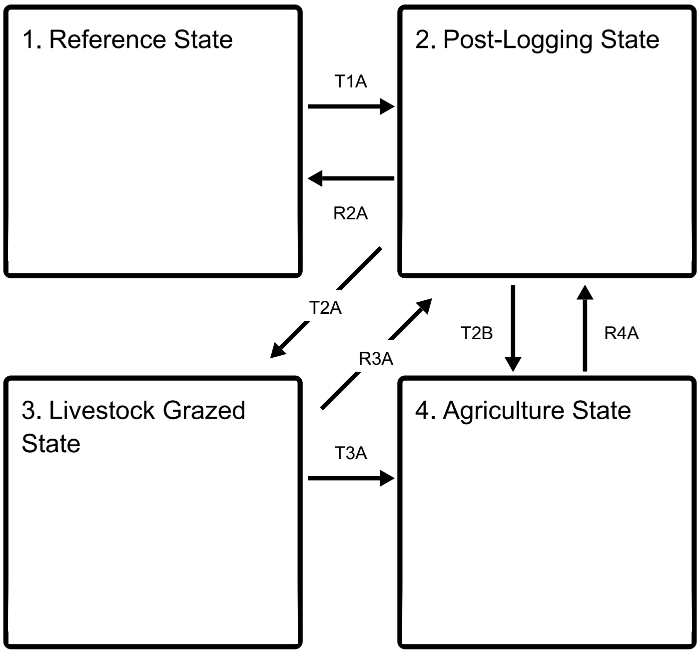
Perhaps the most important ecological characteristic of this Ecological Site, in terms of its influence on forest community dynamics, is its lack of capacity to support the high to moderate soil moisture and nutrient requiring species such as sugar maple, basswood and white ash. These are the shade-tolerant species that typically dominate the more productive sites throughout Wisconsin.

In pre-European settlement time, wildfire was the main controlling factor of forest community dynamics. Following a severe, stand-replacing fire, any of the species present on the landscape could become established, depending on seed source availability and specific conditions of post-fire seedbed. The newly established young stands of any species were easily eliminated by recurring fires, but differences in fire-resisting properties among the species began to play a role in any species' survival success. White pine (*Pinus strobus*) is best adapted for long-term success on this Ecological Site. Although vulnerable to damage or elimination by fire in early life it eventually develops thick fire-resistant bark which helps to extend its longevity, in some cases for up to four centuries or more. These survival properties assure the species' relatively continuous seed source in the region as a whole. White pine is also moderately shade-tolerant in early life which means that it can become established in some pioneer communities, such as aspen – white birch stands, or in poorly stocked oak and red maple dominated communities. Red pine had in the past been a common associate of white pine stands. It shares some of the fire-resisting properties of white pine, but it lacks shade-tolerance and does not become established in the understory. For this reason, it has not maintained its presence in current stands and its seed source has been greatly reduced throughout its natural range following the unset of fire suppression. Several species of oak are common members of forest communities on this ecological site. Northern pin oak (*Q. ellipsoidalis*) and, to a lesser degree, black oak (*Q. velutina*), are intolerant of shade and do not reproduce from seed under existing canopies. However, following fire or clear cutting they respond by sprouting from stumps. In the absence of disturbance they are replaced, through succession, by more shade-tolerant white pine, red maple (*Acer rubrum*), or white oak (*Q. alba*).

Red maple has not been identified by Finley (1976) as an important component of pre-settlement pine or oak forests, but it is a prominent member in current stands. Absence of fire since the original logging era is probably the main reason. Red maple is extremely sensitive to fire damage, but is a prolific and early seed producer. Stems of 2-4 inches in diameter can produce large amounts of seed (USDA For. Serv. 1990). It is sufficiently shade-tolerant to become established in the understories of most communities on sandy soils. On this Ecological Site it behaves similarly to white pine, but because of its much smaller size at maturity, it does not compete with white pine in the upper canopy.

State and transition model

Ecosystem states



T1A - Clear cut; fire

R2A - Disturbance-free period 70+ years.

T2A - Livestock grazing

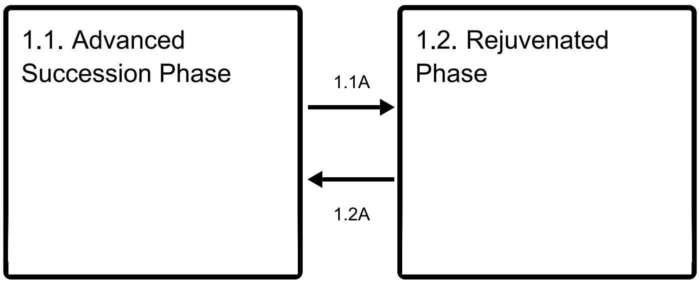
T2B - Cleating; agricultural production

R3A - Restoration to forested site

T3A - Removal of forest vegetation and tilling.

R4A - Cessation of agricultural practices, natural or artificial afforestation.

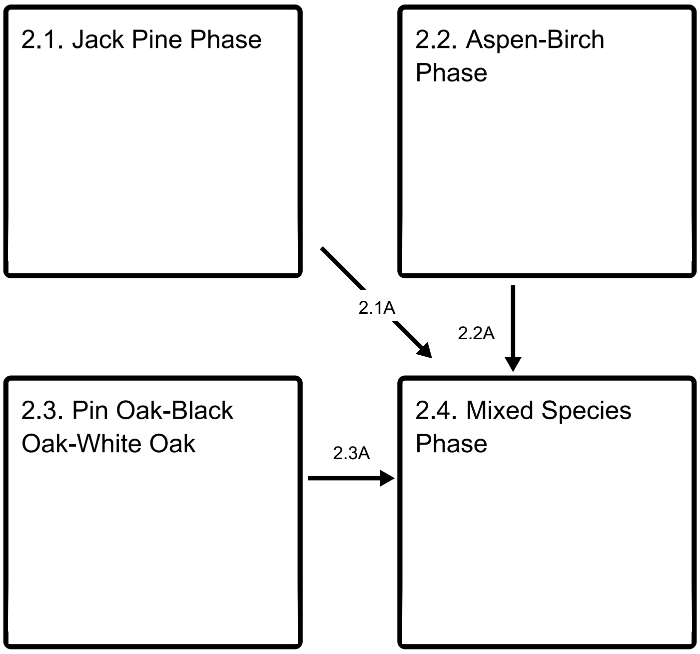
State 1 submodel, plant communities



1.1A - Light to moderate intensity fires, blow-downs, ice storms.

1.2A - Disturbance-free period 30+ years

State 2 submodel, plant communities

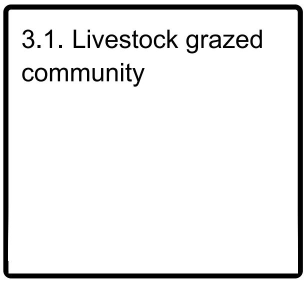


2.1A - Immigration and establishment of white pine and red maple.

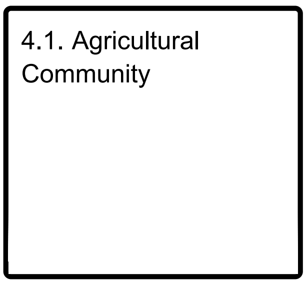
2.2A - Immigration and establishment of white pine and red maple.

2.3A - Immigration and establishment of white pine and red maple.

State 3 submodel, plant communities



State 4 submodel, plant communities



State 1
Reference State

The reference state plant community is categorized as dry, nutrient poor forest, composed of any mixture of pines including Jack pine (*Pinus banksiana*), Red pine (*P. resinosa*), and white pine, (*P. strobus*). Several species of oak may be on site including northern pin oak (*Quercus ellipsoidalis*), black oak (*Q. velutina*), and white oak (*Q. alba*). Red maple (*Acer* *rubrum*) is a common subcanopy tree. All of these species, except for white pine and red maple, depend on disturbance, especially fire, to maintain their presence in the community. In the absence of stand-replacing fires two common community phases can be recognized: mature, or advanced succession community phase, and rejuvenated community phase.

Dominant plant species

- pine (*Pinus*), tree
- oak (*Quercus*), tree

Community 1.1
Advanced Succession Phase

Scattered super-canopy White pines with white oak and red maple as second canopy. Scattered mature red oak and/or red pine are often present. Understory is dominated by hazelnut (Corylus spp.), black cherry (*Prunus serotina*), bracken fern (*Pteridium aquilinum*) and wild lily of the valley (*Maianthemum canadense*). Seedlings and saplings of canopy species, other than red maple, are scarce or absent.

Dominant plant species

- eastern white pine (*Pinus strobus*), tree
- white oak (*Quercus alba*), tree
- red maple (*Acer rubrum*), tree
- hazelnut (*Corylus*), shrub
- black cherry (*Prunus serotina*), shrub
- brackenfern (*Pteridium*), other herbaceous
- European lily of the valley (*Convallaria majalis*), other herbaceous

Community 1.2
Rejuvenated Phase

Openings in the canopy resulting from disturbances in pathway 1.1A create opportunities for potential regeneration of all canopy species. The species composition and age structure is modified by the loss of some mature individuals and addition of young cohorts of some species currently making up the tree community. Because of differences in reproduction biology and environmental requirements for progeny establishment among the species, the new composition is not entirely predictable, but rather, it depends on specific conditions prevailing during and after each disturbance event. Understory species composition is similar to that in Phase 1.1, but relative abundance of represented species varies.

Dominant plant species

- eastern white pine (*Pinus strobus*), tree
- white oak (*Quercus alba*), tree

- red maple (*Acer rubrum*), tree
- hazelnut (*Corylus*), shrub
- black cherry (*Prunus serotina*), shrub
- brackenfern (*Pteridium*), other herbaceous
- European lily of the valley (*Convallaria majalis*), other herbaceous

Pathway 1.1A
Community 1.1 to 1.2

Periodic light to moderate intensity disturbances e.g., ice storms and blow downs create openings in the canopy, and low intensity fires reduce potential competing vegetation in the understory.

Pathway 1.2A
Community 1.2 to 1.1

Time, addition of regeneration of at least some species comprising the advanced succession community phase. This process maintains the reference community phase in the absence of stand replacing fires.

State 2
Post-Logging State

Following original logging around the turn of the 20th century, most logged over areas were followed by fire, often repeatedly, for decades. There was almost no replanting until the 1930’s and 1940’s and new forests, where land was not converted to farming, regenerated naturally, with varying degree of stocking and with varying species mixtures. Eventually planting became the principal method of reforestation with red pine as the most common species of choice. The most common naturally regenerated forest cove types were Jack pine, some times in mixtures with red pine, aspen-paper birch and mixed oak.

Dominant plant species

- pine (*Pinus*), tree
- oak (*Quercus*), tree
- quaking aspen (*Populus tremuloides*), tree
- red maple (*Acer rubrum*), tree
- hazelnut (*Corylus*), shrub
- western brackenfern (*Pteridium aquilinum*), other herbaceous

Community 2.1
Jack Pine Phase

Where seed sources were not destroyed by fire Jack pine readily colonized newly opened lands, some times accompanied by admixture of red pine. White pine was not often a member of these communities because the seed source was absent and any remaining seedlings and saplings were eliminated by post-logging fires.

Dominant plant species

- jack pine (*Pinus banksiana*), tree

Community 2.2
Aspen-Birch Phase

In some logged over stands there were scattered old specimens of aspen, either quaking or trembling, and these became sources for sprouting new clones. Under favorable conditions white birch of seed origin became a successful associate.

Dominant plant species

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

Community 2.3
Pin Oak-Black Oak-White Oak

These three oak species are commonly members of mid-successional forest communities on this site type. Following logging they readily sprout from stumps or from root crowns of saplings that were destroyed in logging operations. Because of rapid growth of sprouts these species easily outcompete pioneer species that propagate through seed, such as paper birch, or any of the pines. In absence of disturbance pin and black oaks slowly drop out of the community due to lack of shade tolerance, but white oak increases its presence frequency and dominance because of its considerably greater shade tolerance.

Dominant plant species

- pin oak (*Quercus palustris*), tree
- black oak (*Quercus velutina*), tree
- white oak (*Quercus alba*), tree

Community 2.4
Mixed Species Phase

Pure, or mixed stands of jack pine, red pine, oaks, white pine and red maple. Species composition and age structure of any given community depends on which early successional stage it is representing. The common denominator is the presence of shade tolerant white pine and red maple, which with time reach community dominance.

Dominant plant species

- jack pine (*Pinus banksiana*), tree

- quaking aspen (*Populus tremuloides*), tree
- white oak (*Quercus alba*), tree
- eastern white pine (*Pinus strobus*), tree
- red maple (*Acer rubrum*), tree
- hazelnut (*Corylus*), shrub
- brackenfern (*Pteridium*), other herbaceous

Pathway 2.1A
Community 2.1 to 2.4

Immigration of white pine and Red maple into stands through natural succession.

Pathway 2.2A
Community 2.2 to 2.4

Immigration of white pine and Red maple into stands through natural succession.

Pathway 2.3A
Community 2.3 to 2.4

Immigration of white pine and Red maple into stands through natural succession.

State 3
Livestock Grazed State

Site phase consists of various grasses and forbs impacted by livestock grazing.

Dominant plant species

- reed canarygrass (*Phalaris arundinacea*), grass
- brome (*Bromus*), grass
- tall fescue (*Schedonorus arundinaceus*), grass

Community 3.1
Livestock grazed community

This plant community consists of various grass and forb species utilized by livestock.

Dominant plant species

- reed canarygrass (*Phalaris arundinacea*), grass
- brome (*Bromus*), grass
- tall fescue (*Schedonorus arundinaceus*), grass

State 4

Agriculture State

This State reflects a site that has been transitioned to agricultural production. Many different crops can be grown depending on the landowner's objectives.

Dominant plant species

- corn (*Zea mays*), grass
- soybean (*Glycine max*), other herbaceous
- Irish potato (*Solanum tuberosum*), other herbaceous

Community 4.1
Agricultural Community

This community is characterized by crop production. A variety of species may be grown.

Dominant plant species

- corn (*Zea mays*), grass
- soybean (*Glycine max*), other herbaceous
- Irish potato (*Solanum tuberosum*), other herbaceous

Transition T1A
State 1 to 2

Stand replacing fire, or clear-cutting.

Restoration pathway R2A
State 2 to 1

Time, natural succession with an increase in white pine and red maple.

Transition T2A
State 2 to 3

The community is transitioned from an early successional forest to a grazed, pasture state. Management inputs include woody plant removal, site preparation, weed management, and seeding of desired forage species.

Transition T2B
State 2 to 4

The site is transitioned from forest to cropland. Inputs include woody species removal, site preparation, tillage, seeding, and in many cases, hydrological modifications.

Restoration pathway R3A
State 3 to 2

Livestock grazing is stopped and the site is allowed to slowly transition to a shrubby woodland. Eventually a mixed forest community will develop. Actual restoration of the site will require management inputs including brush control, weed control, and timber stand improvement projects.

Transition T3A
State 3 to 4

Site cleared and utilized for agricultural crops.

Restoration pathway R4A
State 4 to 2

Agricultural practices abandoned, land planted to trees or forest naturally regenerated.

Additional community tables

Inventory data references

Plot and other supporting inventory data for site identification and community phases is located on a NRCS North Central Region shared and one drive folder. University Wisconsin-Stevens Point described soils, took photographs, and inventoried vegetation data at community phases within the reference state. The data sources include WI ESD Plot Data Collection Form - Tier 2, Releve Method, NASIS pedon description, NRCS SOI 036, photographs, and Kotar Habitat Types.

Other references

Clayton, L., & Attig, J. W. (1989). Glacial Lake Wisconsin (Vol. 173). Geological Society of America.

Clayton, L., Attig, J. W., & Mickelson, D. M. (1999). Tunnel channels formed in Wisconsin during the last glaciation. Special Papers-Geological Society of America, 69-82.

Cleland, D.T.; Avers, P.E.; McNab, W.H.; Jensen, M.E.; Bailey, R.G., King, T.; Russell, W.E. 1997. National Hierarchical Framework of Ecological Units. Published in, Boyce, M. S.; Haney, A., ed. 1997. Ecosystem Management Applications for Sustainable Forest and Wildlife Resources. Yale University Press, New Haven, CT. pp. 181-200.

Curtis, J.T. 1959. Vegetation of Wisconsin: an ordination of plant communities. University of Wisconsin Press, Madison. 657 pp.

Finley, R. 1976. Original vegetation of Wisconsin. Map compiled from U.S. General Land Office notes. U.S. Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota.

NatureServe. 2018. International Ecological Classification Satandard: Terrestrial Ecological Classifications. NautreServe Centreal Databases. Arlington, VA. U.S.A. Data current as of 28 August 2018.

Kotar, J., J. A. Kovach, and T. L. Burger. 2002. A Guide to Forest Communities and Habitat Types of Northern Wisconsin. Second edition. University of Wisconsin-Madison, Department of Forest Ecology and Management, Madison.

Kotar, J., and T. L. Burger. 2017. Wetland Forest Habitat Type Classification System for Northern Wisconsin: A Guide for Land Managers and landowners. Wisconsin Department of Natural Resources, PUB-FR-627 2017, Madison.

Schulte, L.A., and D.J. Mladenoff. 2001. The original U.S. public land sur¬vey records: their use and limitations in reconstructing pre-European settlement vegetation. Journal of Forestry 99:5–10.

Schulte, L.A., and D.J. Mladenoff. 2005. Severe wind and fire regimes in northern forests: historical variability at the regional scale. Ecology 86(2):431–445.

Schulte, L.A., and D.J. Mladenoff. 2005. Severe wind and fire regimes in northern forests: historical variability at the regional scale. Ecology 86(2):431–445.

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land Resource and Major Land Resource Areas of the United Sates, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296.

Wisconsin Department of Natural Resources. 2015. The ecological landscapes of Wisconsin: An assessment of ecological resources and a guide to planning sustainable management. Wisconsin Department of Natural Resources, PUB-SS-1131 2015, Madison.

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Approval

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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):**

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):**

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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:**
