

Ecological site F089XY010WI

Moist Sandy Bedrock Upland Forest

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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 to maintain a representation of fire-dependent communities.

Classification relationships

Major Land Resource Area (MLRA): Wisconsin Central Sands (89) USFS Subregions: Central Wisconsin Sand Plain (222Ra), Neillsville Sandstone Plateau (222Rb), and Lincoln Formation Till Plain - Mixed Hardwoods (212Qb) Relationship to Established Framework and Classification Systems: Habitat Types of N. & S. Wisconsin (Kotar, 2002 & 1996): The sites of this ES keyed out to four habitat types: *Pinus/Vaccinium-Rubus hispidus* (PVRh); *Pinus strobus-Acer rubrum/Vaccinium-Hamamelis* (PARVHa); *Pinus strobus-Acer rubrum/Vaccinium-Rubus hispidus* (PARVRh); *Pinus/Vaccinium-Gaultheria* (PVG) Biophysical Settings (Landfire, 2014): This ES is largely mapped as North-Central Interior Maple-Basswood Forest, North-Central Oak Barrens Woodland, and Laurentian-Acadian Northern Pine-Oak Forest. WDNR Natural Communities (WDNR, 2015): This ES is most similar to the Central Sands Pine-Oak Forest and Northern Dry-mesic Forest communities.

Ecological site concept

The Moist Sandy Bedrock Uplands ecological site is found in the northwest and southwest portion of MLRA 89 in depressions, drainageways, and flats on hills and pediments in areas where sandy sediments and shallow bedrock dominates. These sites are characterized by moderately deep, somewhat poorly drained soils that formed in sandy materials over loamy residuum weathered from the underlying interbedded sandstone and shale. Sites are subject to occasional, brief ponding. Precipitation, runoff from adjacent uplands, and groundwater discharge are the primary sources of water. Soils range from extremely acid to strongly acid. This Ecological Site is characterized by sandy soil where bedrock impedes drainage, causing periodic, or even long-term saturation of the rooting zone. However, in spite of this apparent abundance of water, the dominant vegetation does not differ significantly from that on similar—but excessively drained—sands. Apparently, the limiting factor is the low available nutrient status of the soils as well as impeded water uptake by poorly oxygenated root system. The shallow depth to bedrock also restricts root growth that makes these sites more vulnerable to tree tip. Current woodlots typically consist of mixed oak, primarily northern pin oak (*Quercus ellipsoidalis*), black oak (*Q. velutina*), white

oak (*Q. alba*), red maple (*Acer rubrum*), jack pine (*P. banksiana*) and white pine (*Pinus strobus*). There are also areas of planted red pine (*P. resinosa*).

Associated sites

F089XY001WI	Organic Poor Fen Acidic Poor Fens sites consist of shallow to very deep, highly decomposed herbaceous organic material, sometimes with bedrock contact within 60 inches (150 cm). These sites are very poorly drained and remain saturated throughout the year. They are very strongly to extremely acidic. These sites are wetlands. They occur in lower positions on the drainage sequence than Moist Sandy Bedrock Uplands.
F089XY005WI	Wet Sandy Bedrock Lowlands Wet Sandy Bedrock Lowlands sites consist of sandy alluvium underlain by loamy residuum. Bedrock occurs within 40 inches (100 cm) and perches the water table. Soils are poorly drained and subject to ponding. These sites are found in the northwestern portion of the Wisconsin Central Sands MLRA where the depth to bedrock is shallow. They occur in lower positions on the drainage sequence than Moist Sandy Bedrock Uplands.
F089XY016WI	Sandy Nutrient Limited Bedrock Upland Forest Sandy Bedrock Uplands form in sandy deposits derived from a mixture of outwash, alluvium, and residuum. Contact with interbedded sandstone and shale bedrock occurs within 40 inches (100 cm) of the surface. These soils are moderately well to excessively drained. They occur in higher positions on the drainage sequence than Moist Sandy Bedrock Uplands.

Similar sites

F089XY012WI	Moist Sandy Nutrient Limited Lowland Forest Moist Siliceous Sand Uplands consist of deep sandy deposits sourced primarily from the weathering of sandstone high in silica. The weathered sand was deposited by rivers or glacial lakes. They are somewhat poorly drained and are subject to neither flooding nor ponding. These sites are found west of the Wisconsin River. They support vegetative communities that are similar to those supported by Moist Sandy Bedrock Uplands.
F089XY011WI	Moist Sandy Lowland Forest 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. They support vegetative communities that are similar to those supported by Moist Sandy Bedrock Uplands.

Table 1. Dominant plant species

Tree	(1) <i>Pinus strobus</i> (2) <i>Quercus alba</i>
Shrub	(1) <i>Amelanchier</i>
Herbaceous	(1) <i>Pteridium aquilinum</i>

Physiographic features

This site occurs on depressions, drainageways, and flats hills and pediments. Slopes range from 0 to 6 percent. Elevation ranges from 705 to 1,394 feet (215 to 425 meters) above sea level. Most of these sites are not subject to ponding or flooding. Some sites may experience occasional ponding during the growing season. The ponding duration is brief (2 to 7 days), with depths up to 12 inches (30 cm). The soils have an apparent seasonally high water table (endosaturation) at a depth of 18to 24 inches (46 to 61 cm), but the water table may drop to 40 inches (100 cm) during dry conditions. Runoff is negligible to very low.

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

Table 2. Representative physiographic features

Slope shape across	(1) Linear
Slope shape up-down	(1) Concave
Hillslope profile	(1) Footslope
Landforms	(1) Depression (2) Hill (3) Pediment (4) Drainageway
Runoff class	Negligible to very low
Flooding frequency	None
Ponding duration	Brief (2 to 7 days)
Ponding frequency	None to occasional
Elevation	220 – 430 m
Slope	0 – 10 %
Ponding depth	0 – 30 cm
Water table depth	50 – 60 cm
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 48 inches. The annual average maximum and minimum temperatures are 55°F and 33°F, respectively.

Table 3 Representative climatic features

Frost-free period (characteristic range)	80-120 days
Freeze-free period (characteristic range)	110-140 days
Precipitation total (characteristic range)	860 mm
Frost-free period (actual range)	80-120 days
Freeze-free period (actual range)	100-150 days
Precipitation total (actual range)	860 mm
Frost-free period (average)	100 days
Freeze-free period (average)	120 days
Precipitation total (average)	860 mm

- (1) MAUSTON 1 SE [USC00475178], Mauston, WI
- (2) HATFIELD [USC00473471], Merrilan, 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. Subsurface outflow may occur because of the water perched on the bedrock.

Permeability of these sites is primarily moderate to moderately rapid in the mineral soil, and very slow to impermeable in the lithic portion of the soil. Hydrologic group is B, A/D, B/D, or C/D depending on the site.

Soil features

These sites are represented by Fairchild and Partridge soil series, classified as Ultic Epiaquods and Aquic Udipsamments, respectively. 93% of the acreage of this site is classified as an Ultic Epiaquod.

Fairchild was formed in sandy alluvium over loamy residuum underlaid by interbedded sandstone and shale. Partridge formed in sandy outwash or eolian deposits over sandy alluvium underlaid by sandstone; other sites with Partridge formed in loamy alluvium over sandy residuum weathered from the underlying sandstone. Soil depth to bedrock ranges from 28 to 40 inches (70 to 102 cm). Soils are

somewhat poorly drained. They do not meet hydric soil requirements.

The surface texture of these sites is primarily loamy sand or sandy loam but may be moderately decomposed organic materials (hemic materials) on sites with duff. Subsurface textures range from sand to silty clay loam in the residuum weathered from interbedded sandstone and shale. Soil pH ranges from extremely acid to strongly acid with values of 3.6 to 5.5. Fragments are absent at the surface, but subsurface fragments less than 3 inches can be present up to 7 percent volume and fragments greater than 3 inches up to 13 percent volume. Carbonates are absent.

Table 4. Representative soil features

Parent material	(1) Alluvium (2) Residuum (3) Outwash (4) Eolian sands
Surface texture	(1) Sand (2) Loamy sand (3) Loam
Drainage class	Somewhat poorly drained
Permeability class	Very slow to moderately rapid
Soil depth	70 – 100 cm
Surface fragment cover ≤3"	Not specified
Surface fragment cover >3"	Not specified
Available water capacity (Depth not specified)	4.8 – 10.26 cm
Calcium carbonate equivalent (Depth not specified)	Not specified
Soil reaction (1:1 water) (Depth not specified)	3.6 – 5.5
Subsurface fragment volume ≤3" (Depth not specified)	0 – 10 %

Subsurface fragment volume >3" (Depth not specified)	0 – 10 %
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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 high nutrient requiring species such as sugar maple, basswood and white ash, 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 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 onset 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

Additional community tables

Table 5. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 6. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 7. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 8. Community 2.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 9. Community 2.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 10. Community 2.4 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 11. Community 3.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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Table 12. Community 4.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)
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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, Relevé 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 Standard: Terrestrial Ecological Classifications. NatureServe Central 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 survey 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 States, 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	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. Number and extent of rills:

2. Presence of water flow patterns:

3. Number and height of erosional pedestals or terracettes:

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

5. Number of gullies and erosion associated with gullies:

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

7. Amount of litter movement (describe size and distance expected to travel):

8. Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):

9. Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):

10. Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:

11. Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):

12. Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):

Dominant:

Sub-dominant:

Other:

Additional:

13. Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):

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

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

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

17. Perennial plant reproductive capability:
