

Ecological site F091XY010WI

Acidic Sandy Upland

Last updated: 9/27/2023
Accessed: 08/31/2026

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): 091X–Wisconsin and Minnesota Sandy Outwash

The Wisconsin and Minnesota Sandy Outwash MLRA is the most extensive glacial outwash system in the northern half of Wisconsin. The total land area of the Wisconsin portion is just under 1.4 million acres (2,170 sq miles). The northern half is a former spillway for Glacial Lake Duluth. The flowing meltwater from the draining lake has left behind thick deposits of drift and carved a terraced river valley now occupied by the St. Croix and Bois Brule Rivers. The northeastern section – the Bayfield hills – is a collapsed outwash plain where drift deposits are thick. Lacustrine materials from Glacial Lake Duluth line the northeastern tip. Moving southwest, the landscape transitions into a large pitted outwash plain. This is an area of extensive kettle holes, and, where the underlying till is less permeable, kettle lakes with some interspersed morainic hills and ridges. The glacial drift deposits are thinner in the southwestern section, although there is still no documented surface bedrock within this MLRA. The St. Croix and Bois Brule rivers share a channel that lines much of the northwestern border of this MLRA. In some places, the underlying reddish-brown sandy loam till of the Copper Falls Formation is exposed along cut riverbanks, though most of it is covered by a mantle of outwash. Glacial lakes deposited pockets of fine-textured lacustrine materials, most of which were washed away or buried by glacial outwash and meltwater flowing through the channel. East of the channel, some of the silty and clayey lakebed deposits are found near the surface, where they impede drainage and contribute to the formation of extensive wetlands. Historically, the area supported extensive jack pine (*Pinus banksiana*), scrub, and oak forests and barrens. The northern portion also supported stands of red pine (*Pinus resinosa*) and eastern white pine (*Pinus strobus*) as well. Marsh and sedge meadow, wet prairies, and lowland shrubs dominated the extensive wetland complexes in the southern tip of this MLRA (Finley, R., 1976).

Classification relationships

Relationship to Established Framework and Classification Systems: Biophysical Settings (Landfire, 2014): This ES is largely mapped as Laurentian-Acadian Northern Hardwoods Forest, Boreal White Spruce-Fir Forest, Boreal White Spruce-Fir-Hardwood Forest, Boreal Hardwood Forest, Laurentian Pine Barrens, and Laurentian Oak Barrens Habitat Types of N. Wisconsin (Kotar, 2002): The sites of this ES keyed out to three habitat types: *Pinus strobus*-*Acer rubrum*/Vaccinium. Uvularia variant (PARV-U); *Pinus strobus*-*Acer rubrum*/Vaccinium-Aralia, Polygonatum variant (PARVAa-Po); and a combo of *Acer saccharum*/Vaccinium-Clintonia (AVCI) and *Acer saccharum*/Clintonia (ACI). The two *Acer* habitat types observed (AVCI and ACI) are unlikely to represent this ES. WDNR Natural Communities (WDNR, 2015): This ES is most similar to the Northern Mesic Forest and the Northern Dry-Mesic Forest communities. Hierarchical Framework Relationships: Major Land Resource Area (MLRA): Wisconsin and Minnesota Sandy Outwash (91X) USFS Subregions: Bayfield Sand Plains (212Ka) Small sections occur in the Mille Lacs Uplands (212Kb) subregion Wisconsin DNR Ecological Landscapes: Northwest Sands, North Central Forest

Ecological site concept

The Acidic Sandy Uplands ecological site is located primarily in the northern portion of MLRA 91X on outwash and lake plains, stream and lake terraces, dunes, and ground moraines. These sites are characterized by very deep, moderately well to well drained soils formed primarily in sandy outwash. Some sites have a thin loamy mantle. Precipitation and runoff from adjacent uplands are the primary sources of water. Soils range from extremely acid to neutral. Historically this Ecological Site was occupied by forest communities dominated by various mixtures of pine and oak species. Specific mixtures were largely dependent on frequency and severity of disturbances, particularly fire and subsequent seed-bed conditions and availability of seed sources. White pine (*Pinus strobus*) was the most persistent species in forest communities due to its biological and ecological characteristics of great longevity, resistance of old trees to fire damage and moderate tolerance to shade by seedlings and saplings. Red oak was often present as an associate species. Virtually all stands on this Ecological Site were harvested during the late 19th and early 20th centuries and post-logging fires were almost universal. Today's forests are dominated by any mixture of, aspen, red maple (*Acer rubrum*), red oak (*Quercus rubra*), white oak (*Q. alba*), white pine (*Pinus strobus*) and red pine (*Pinus resinosa*). White birch (*Betula papyrifera*) and balsam fir (*Abies balsamea*) are common associates. Acidic

Sandy Uplands is distinguished from its sandy upland counterparts with its extremely low pH. The low pH indicates low nutrient availability and limits vegetative growth. The sandy materials also have a lower available water capacity than loamy or clayey materials found in other upland sites. The moderately well to well drainage differs this site from other sandy sites.

Associated sites

F091XY005WI	Wet Sandy and Loamy Lowland These sites occur on depressions and drainageways on outwash plains and lake plains. They primarily form in sandy outwash are subject to some flooding. Soils are very deep and poorly or very poorly drained. They are saturated for much of the year. They are much wetter and occur lower on the drainage sequence than Acidic Sandy Uplands.
F091XY007WI	Moist Sandy and Loamy Lowland These soils formed in sandy outwash, sandy lacustrine deposits, sandy eolian deposits, or loess that is sometimes underlain by sandy or loamy till. Soils are very deep and somewhat poorly drained. They are wetter and occur lower on the drainage sequence than Acidic Sandy Uplands.
F091XY014WI	Acidic Dry Upland These soils formed in sandy and gravelly outwash. Soils are very deep and are excessively drained. They are characterized by the presence of a spodic horizon. They may occur higher on the drainage sequence than Acidic Sandy Uplands.

Similar sites

F091XY014WI	Acidic Dry Upland Like Acidic Sandy Upland soils, these soils formed in sandy outwash and are characterized by the presence of a spodic horizon. Unlike the moderately well to somewhat excessively drained Acidic Sandy Uplands, these soils are exclusively excessively drained. The vegetative communities they support are very similar to those found on Acidic Sandy Uplands.
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Table 1. Dominant plant species

Tree	(1) <i>Pinus strobus</i> (2) <i>Acer rubrum</i>
Shrub	(1) <i>Corylus cornuta</i>
Herbaceous	(1) <i>Eurybia macrophylla</i>

Physiographic features

These sites formed on outwash and lake plains, stream and lake terraces, dunes, and ground moraines. Slopes range from 0 to 45 percent. Sites are on summit, shoulder, backslope, and footslope positions.

Sites are not subject to ponding or flooding. Sites have an apparent seasonally high water table (endosaturation) at depths of 24 to 36 inches below the soil surface. The water table can drop to greater than 60 inches during dry conditions. Runoff is primarily negligible to low, but some sites on steep slopes have high runoff potential.

Table 2. Representative physiographic features

Landforms	(1) Lake plain (2) Outwash plain (3) Lagoon (4) Lake terrace (5) Stream terrace (6) Dune (7) Ground moraine
Runoff class	Negligible to high
Flooding frequency	None
Ponding frequency	None
Elevation	180 – 610 m
Slope	0 – 50 %
Water table depth	60 – 90 cm
Aspect	Aspect is not a significant factor

Climatic features

The continental climate of the Wisconsin and Minnesota Sandy Outwash MLRA is typical of northern Wisconsin – colder winters and warmer summers. In general, the northern latitudes have cooler summers, colder winters, lower precipitation, and shorter growing seasons than the south; however, neither average annual precipitation nor average annual minimum and maximum temperatures vary greatly within this MLRA. The climate of the northernmost tip is somewhat affected by Lake Superior and receives higher annual precipitation in the form of lake effect snow.

The average annual precipitation for this site is 32 inches. The average annual snowfall is 65 inches. The average annual maximum and minimum temperatures are 52°F and 30°F, respectively. The average length of the freeze-free period within this site ranges from 121 to 143 days. The average length of the frost-free period ranges from 97 to 121 days.

Table 3 Representative climatic features

Frost-free period (characteristic range)	80-90 days
Freeze-free period (characteristic range)	110-120 days
Precipitation total (characteristic range)	790-810 mm

Frost-free period (actual range)	80-90 days
Freeze-free period (actual range)	110-120 days
Precipitation total (actual range)	790-810 mm
Frost-free period (average)	80 days
Freeze-free period (average)	110 days
Precipitation total (average)	810 mm

- (1) GORDON [USC00473186], Gordon, WI
- (2) SOLON SPRINGS [USC00477892], Solon Springs, WI
- (3) BRULE RS [USC00471131], Brule, WI

Influencing water features

Water is received primarily through precipitation, runoff from adjacent uplands, and groundwater discharge. Water is discharged from the site primarily through runoff, evapotranspiration, and groundwater recharge.

Permeability of these sites is very slow to rapid. Hydrologic group is A.

Wetland description

Hydrogeomorphic Wetland Classification: None
Cowardin Wetland Classification: None

Soil features

These sites are represented by the Croswell, Cublake, Karlin, Lindquist, Neconish, Omega, Pence, Rousseau, Springstead, and Sultz soil series. The Croswell, Cublake, Neconish, and Springstead soils are classified as Oxyaquic Haplorthods; Karlin, Rousseau, and Sultz are Entic Haplorthods; Omega and Pence are Typic Haplorthods; Lindquist is a Lamellic Haplorthod.

These soils formed primarily sandy outwash. Some sites formed in loamy alluvium over sandy outwash, and other sites are sandy outwash underlain by lacustrine deposits. Few sites formed in sandy glaciofluvial or sandy eolian deposits. Soils are very deep and are moderately well to somewhat excessively drained. Soils do not meet hydric soil requirements.

Surface textures include sand, loamy sand, and sandy loam, and some sites have organic material with varying degrees of decomposition. Subsurface textures are similar to surface textures but can have gravelly and coarse modifiers. The soil pH ranges from extremely acid to slightly acid with values of 4.2 to 6.7. Carbonates are absent.

Figure 7. Croswell Soil Series sampled on 06/18/2019 in Douglas County, WI. Image courtesy of UWSP.

Table 4. Representative soil features

Parent material	(1) Till (2) Outwash (3) Lacustrine deposits (4) Eolian deposits (5) Alluvium
Surface texture	(1) Sand (2) Loamy sand (3) Sandy loam (4) Moderately decomposed plant material
Drainage class	Moderately well drained to somewhat excessively drained
Permeability class	Very slow to rapid
Soil depth	200 cm
Surface fragment cover <=3"	0 – 10 %
Surface fragment cover >3"	0 – 10 %
Available water capacity (0-152.4cm)	10.16 – 16.41 cm
Soil reaction (1:1 water) (0-101.6cm)	4.2 – 6.7
Subsurface fragment volume <=3" (0-101.6cm)	10 – 20 %
Subsurface fragment volume >3" (0-101.6cm)	0 – 10 %

Ecological dynamics

Perhaps the most important ecological characteristic of this Ecological Site, in terms of influence on forest community dynamics, is its limited capacity to support the high to moderate soil moisture and nutrient requiring species such as sugar maple (*Acer saccharum*),

basswood (*Tilia americana*) and white ash (*Fraxinus Americana*). These are the shade-tolerant species, commonly known as the northern hardwoods, that typically dominate the more productive sites throughout northern Wisconsin. Although some of these species do occur sporadically on this Ecological Site, their regeneration capacity and growth rates are sub-optimal, thus precluding their canopy dominance.

In pre-European settlement time wild fire was the main controlling factor of forest community dynamics. Following a severe, stand-replacing fire, any of the naturally occurring species could become established, depending on the seed source 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.

In his reconstruction of pre-European settlement vegetation of Wisconsin, Finley (1976), did not identify red maple (*Acer rubrum*) as a prominent component of pine forests, but the species is a prominent member of current stands. Absence of fire since the end of the original logging era is probably the main reason. Red maple is extremely sensitive to fire, but is a prolific and early seed producer. Stems of 2-4 inches in diameter can produce large amounts of seed (USDA Forest Service, 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 stature 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 2.5 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, Relieve Method, NASIS pedon description, NRCS SOI 036, photographs, and Kotar Habitat Types.

Other references

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Approval

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Acknowledgments

NRCS contracted UWSP to write ecological sites for MLRA 91. Completed in 2021.

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:
