Ecological site F091XY014WI
Acidic Dry Upland

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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): 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 Pine Barrens, Laurentian Oak Barrens, Laurentian-Acadian Northern Hardwoods Forest, Laurentian-Acadian Northern Pine Forest, Laurentian-Acadian Northern Oak Forest, and Boreal White Spruce-Fir Forest 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); Pinus strobus-Quercus/Gaultheria (PQG) WDNR Natural Communities (WDNR, 2015): This ES is most similar to the Northern Dry Forest and 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) and Hayward Stagnation Moraines (212Xf) subregions Wisconsin DNR Ecological Landscapes: Northwest Sands, North Central Forest

Ecological site concept

The Acidic Dry Uplands ecological site dominates the northern portion of MLRA 91X. Sites are found on outwash plains, eskers, and moraines. These sites are characterized by very deep, excessively drained soils formed primarily in acidic sandy outwash. Some sites have thin loamy mantles over the outwash or formed in sandy eolian deposits. Precipitation and runoff are the primary sources of water. Soils range from very strongly acid to slightly acid. 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 (Quercus rubra) 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 trembling or big-tooth aspen (Populus tremuloides and P. grandidentata), red oak, red maple Acer rubrum), white pine and red pine (Pinus resinosa). White birch (Betula papyrifera), balsam fir (Abies balsamea) and white spruce (Picea glauca) are common associates. The excessive drainage of Acidic Dry Uplands differs it from other sandy sites. The

low pH differs this site from Dry Uplands, which are also sandy and excessively drained.

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 wetter and occur lower on the drainage sequence than Acidic Dry 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 Dry Uplands.
F091XY010WI	**Acidic Sandy Upland** These soils formed primarily sandy outwash, but some sites formed in loamy alluvium over sandy outwash, and other sites are sandy outwash underlain by lacustrine deposits. Soils are very deep and are moderately well to somewhat excessively drained. These soils are characterized by the presence of a spodic horizon. They are slightly wetter and occur lower on the drainage sequence than Acidic Dry Uplands.

Similar sites

F091XY010WI	**Acidic Sandy Upland** These soils formed primarily sandy outwash, but some sites formed in loamy alluvium over sandy outwash, and other sites are sandy outwash underlain by lacustrine deposits. Like Acidic Dry Uplands, these soils are very deep and are characterized by the presence of a spodic horizon, but they are somewhat wetter.
F091XY015WI	**Dry Upland** These sites formed in sandy outwash or eolian deposits. Soils are very deep and excessively drained. They occupy the same positions on the landscape and have the same particle sizes and drainage class as Acidic Sandy Uplands but lack a spodic horizon.

Table 1. Dominant plant species

Tree	(1) *Pinus strobus* (2) *Quercus rubra*
Shrub	(1) *Acer rubrum* (2) *Pinus strobus*
Herbaceous	(1) *Vaccinium* (2) *Pteridium aquilinum*

Physiographic features

These sites formed on outwash plains, eskers, and moraines. Slopes range from 0 to 45 percent. Sites are on summit, shoulder, and backslope positions.

Sites are not subject to ponding or flooding. The depth to water table exceeds 80 inches below the soil surface. Runoff is negligible to medium.

Table 2. Representative physiographic features

Hillslope profile	(1) Summit (2) Shoulder (3) Backslope
Slope shape across	(1) Convex
Slope shape up-down	(1) Linear
Landforms	(1) Outwash plain (2) Esker (3) Moraine
Runoff class	Negligible to medium
Flooding frequency	None
Ponding frequency	None
Elevation	180 – 600 m
Slope	0 – 50 %
Water table depth	200 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 northern portion of the Acidic Dry Uplands PES is climatically-affected by its proximity to Lake Superior. The average annual snowfall is 69 inches, more than any other site and 11 inches more than the average for this MLRA. It also has a longer growing season than other ecological sites in the northern section of this MLRA. The average annual precipitation for this site is 32 inches. 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)	90-100 days
Freeze-free period (characteristic range)	120-130 days
Precipitation total (characteristic range)	790-840 mm
Frost-free period (actual range)	90-100 days
Freeze-free period (actual range)	120-130 days
Precipitation total (actual range)	790-860 mm
Frost-free period (average)	90 days
Freeze-free period (average)	120 days
Precipitation total (average)	810 mm

- (1) BRULE RS [USC00471131], Brule, WI
- (2) SOLON SPRINGS [USC00477892], Solon Springs, WI
- (3) ASHLAND EXP FARM [USC00470349], Ashland, WI
- (4) DRUMMOND [USC00472240], Drummond, 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 moderate to rapid. Hydrologic group is A.

Wetland description

Hydrogeomorphic Wetland Classification: None
Cowardin Wetland Classification: None

Soil features

These sites are represented by the Rubicon, Sayner, and Vilas soil series, all classified as Entic Haplorthods.

These soils formed in sandy and gravelly outwash. Soils are very deep and are excessively drained. Soils do not meet hydric soil requirements.

Surface textures of these sites is primarily loamy sand and sand, but few sites may have moderately decomposed organic material at the surface. Subsurface textures include sand, loamy sand, gravelly sand, and gravelly coarse sand. Soil pH ranges from very strongly acid to slightly acid with values of 4.8 to 6.3.

Figure 7. Rubicon Soil Series sampled on 06/19/2019 in Douglas County, WI.

Table 4. Representative soil features

Parent material	(1) Outwash
Surface texture	(1) Moderately decomposed plant material (2) Loamy sand (3) Sand
Drainage class	Excessively drained
Permeability class	Moderate to rapid
Soil depth	200 cm
Surface fragment cover <=3"	0 – 10 %
Surface fragment cover >3"	0 – 10 %
Available water capacity (0-150.1cm)	2.21 – 4.29 cm
Soil reaction (1:1 water) (0-100.1cm)	4.8 – 6.3
Subsurface fragment volume <=3" (0-100.1cm)	0 – 30 %
Subsurface fragment volume >3" (0-100.1cm)	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 unset 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 natural, 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 (%)

Table 6. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 7. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 8. Community 2.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 9. Community 2.3 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 10. Community 2.4 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 11. Community 2.5 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

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

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Contributors

Jacob Prater, Associate Professor at University of Wisconsin Stevens Point
John Kotar, Ecological Specialist- independent contract
Bryant Scharenbroch, Assistant Professor at University of Wisconsin Stevens Point

Approval

Suzanne Mayne-Kinney, 9/27/2023

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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):**

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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:**
