USDA Natural Resources Conservation Service

Ecological site F090AY007WI
Wet Clayey Lowlands

Last updated: 10/02/2023
Accessed: 06/02/2024

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): 090A–Wisconsin and Minnesota Thin Loess and Till

MLRA 90A is part of the recently glaciated till and outwash plains of central Minnesota and northern Wisconsin. The area was covered with loamy alluvium or loess after glaciation. It is in Wisconsin (56 percent), Minnesota (40 percent), and Michigan (4 percent). It makes up about 21,967 square miles (56,901 square kilometers).

This MLRA has distinct boundaries to the north where it borders tills of a dissimilar origin on the less morainic landscapes of MLRAs 88, 92, and 93A. The boundary to the west is where the MLRA transitions to the calcareous tills of the Des Moines Lobe, in MLRA 57. To the south, MLRA 90A borders MLRA 90B, which has older soils and better-defined drainage patterns, and MLRA 91, which has the distinct lower landscape relief of an outwash channel.

The part of this area in Minnesota is mostly in the Western Lake section of the Central Lowland province of the Interior Plains. Nearly all the parts in Wisconsin and Michigan are in the Superior Upland province of the Laurentian Upland. Four distinct lobes of the Laurentide Ice Sheet (Rainy, Superior, Chippewa, and Green Bay) played major roles in shaping the landscape in this area. The landscape is characterized by gently undulating to rolling, loess-mantled till plains, drumlin fields, and end moraines mixed with outwash plains associated with major glacial drainageways, swamps, bogs, and fens. In some areas lake plains and ice-walled lakes are significant. Steeper areas occur mostly as valley side slopes along flood plains and as escarpments along the margins of lakes.

Lakes, ponds, and marshes are common throughout the area, and streams generally have a dendritic pattern. The major rivers in this area are the Chippewa, St. Croix, Mississippi, and Wisconsin Rivers. Elevation ranges from 1,100 to 1,950 feet (335 to 595 meters). Local relief is mainly less than 10 feet to 20 feet (3 to 6 meters), but some major valleys and hills are 200 feet (60 meters) above the adjacent lowland.

Precambrian-age bedrock underlies most of the glacial deposits in this MLRA. The bedrock is a complex of folded and faulted igneous and metamorphic rocks. The bedrock terrain has been modified by glaciation and is covered in most areas by Pleistocene deposits and windblown silts. The glacial deposits form an almost continuous cover in most areas. The drift is several hundred feet thick in many areas. Loess covered the area shortly after the glacial ice melted.

Ground water is abundant in deep glacial deposits in most of this area. It also occurs in sedimentary and volcanic rock in the western part of the area. It is scarce where the layer of drift is thin. The water meets the domestic, agricultural, municipal, industrial, rural, and irrigation needs of the area. The content of dissolved solids in the ground water from all the various aquifers in this area is low, and the water generally is moderately hard or hard. The level of total dissolved solids in some of the water can be much higher because of a high content of limestone in some of the glacial deposits. Most of this area obtains ground water from unconsolidated glacial sand and gravel deposits on or very near the surface. Some wells tap the Cambrian sandstone in the southwestern part of the area, in Wisconsin.

In northwest Wisconsin (Ashland and Bayfield Counties) where there are no glacial deposits and in much of the part of this area in Minnesota, ground water from sedimentary and volcanic rock aquifers is used. This water is of very good quality; however, many soils have very porous layers that are poor filters of domestic waste and agricultural chemicals, so there is a risk of contamination from development and agriculture. Minor water concerns are hardness and, in some areas, high concentrations of iron. Yields of water from the glacial deposits vary.

The dominant soil orders are Alfisols, Entisols, Histosols, and Spodosols. The soils in the area have a frigid temperature regime, a udic or aquic moisture regime, and mixed mineralogy.

This area has a significant acreage of public and private forestland used to support the paper and lumber industry Sap collection from sugar maple and syrup production are important forestry enterprises. Agricultural enterprises include row crops, dairy farms, and beef operations. Crops include corn, soybeans, oats, wheat, and alfalfa. Tourism, recreation, and wildlife management are important. Hunting, fishing, snowmobiling, hiking, and skiing are popular activities because of the area's abundance of water, the many acres of national and county forests, and public hunting grounds. (United States Department of Agriculture, Natural Resources Conservation Service, 2022)

Classification relationships

Major Land Resource Area (MLRA 90A): Wisconsin and Minnesota Thin Loess and Till

USFS Subregions: Bayfield Sand Plains (212Ka), Rib Mountain Rolling Ridges (212Qd)

Small sections occur in St. Croix Moraine (212Qa) and Mille Lacs Uplands (212Kb)

Wisconsin DNR Ecological Landscapes: Northwest Sands, Forest Transition, Northwest Lowlands, North Central Forest

Ecological site concept

The Wet Clayey Lowlands ecological site is uncommon in MLRA 90A, located in depressions and drainageways on lake plains and moraines. These sites are characterized by very deep, very poorly or poorly drained soils that formed primarily in clayey lacustrine, till, and residuum. Sites are subject to frequent ponding during the spring and fall. Soils remain saturated for long periods during the growing season and meet hydric soil requirements. Precipitation, runoff from adjacent uplands, and groundwater discharge are the primary sources of water. Soils range from very strongly acid to moderately alkaline.

Wet Clayey Lowlands is differentiated from other ecological sites by its deep clayey deposits and very poorly or poorly drained soils. Other very poorly or poorly drained sites have sandy or loamy deposits. Clays often have higher pH and available water capacity than sandy and loamy sites, which can promote vegetative growth.

Associated sites

F090AY012WI	**Moist Clayey Lowland** Moist Clayey Lowland consist of deep clayey lacustrine deposits. The finer textures perch the water table. These soils remain moist - but not saturated - throughout much of the growing season. They are drier and occur higher on the drainage sequence than Wet Clayey Lowland.
F090AY017WI	**Clayey Upland** Loamy Upland consist of loamy to clayey residuum or lacustrine deposits overlain by loess or sandy outwash. Bedrock contact may occur within two meters of the surface. These sites have a seasonally high water table within one meter of the surface, though they are not saturated for sustained periods. They are drier and occur higher on the drainage sequence than Wet Clayey Lowland.

Similar sites

F090AY006WI	**Wet Loamy Lowland** Wet Loamy Lowland consist primarily of deep loamy deposits derived from a mixture of outwash, alluvium, loess, and lacustrine sources. Some sites may have bedrock contact within two meters of the surface. These sites are seasonally ponded depressions that remain saturated for sustained periods, allowing hydric conditions to occur. They occur in similar landscape positions and have similar drainage as Wet Clayey Lowland, though with coarser particle sizes. The vegetative communities they support are similar to those found on Wet Clayey Lowland.

Table 1. Dominant plant species

Tree	(1) *Fraxinus nigra* (2) *Quercus bicolor*
Shrub	(1) *Fraxinus pennsylvanica*
Herbaceous	(1) *Oligoneuron* (2) *Carex*

Physiographic features

This site occurs in depressions and drainageways on lake plains and moraines. Slopes range from 0 to 2 percent.

Some sites are subject to occasional ponding throughout the year. The ponding duration ranges from brief (2 to 7 days) to long (7 to 30 days), with depths up to 6 inches above the soil surface. These sites do not flood. The soils have an apparent seasonally high water table (endosaturation) at the surface, but the water table may drop to 35 inches during dry conditions. Some sites have a perched seasonally high water table (episaturation). Runoff is negligible to very high.

Table 2. Representative physiographic features

Hillslope profile	(1) Toeslope (2) Footslope
Slope shape across	(1) Concave
Slope shape up-down	(1) Linear
Landforms	(1) Depression (2) Drainageway (3) Lake plain (4) Moraine
Runoff class	Negligible to very high
Flooding frequency	None
Ponding duration	Brief (2 to 7 days) to long (7 to 30 days)
Ponding frequency	None to occasional
Elevation	180–335 m
Slope	0–2%
Ponding depth	0–15 cm
Water table depth	0 cm
Aspect	Aspect is not a significant factor

Climatic features

The climate of the expansive Wisconsin and Minnesota Thin Loess and Till Plain is highly variable. The eco-climatic zone (the “Tension Zone”) that runs southeast-northwest across the state splits the MLRA. In general, the MLRA has cold winters and warm summers with an adequate amount of precipitation. Near Lake Superior, precipitation and temperature tend to increase. The far western section of the MLRA, known as the western prairie ecological landscape by the Wisconsin DNR, has warmer temperatures compared to the rest of the MLRA because it falls

below the eco-climatic zone. The soil moisture regime of MLRA is udic (humid climate). The soil temperature regime is frigid and cryic.

The average annual precipitation for this ecological site is 29 inches. The annual average maximum and minimum temperatures are 53°F and 34°F, respectively.

Table 3. Representative climatic features

Frost-free period (characteristic range)	66-116 days
Freeze-free period (characteristic range)	103-142 days
Precipitation total (characteristic range)	813-889 mm
Frost-free period (actual range)	41-116 days
Freeze-free period (actual range)	86-143 days
Precipitation total (actual range)	813-940 mm
Frost-free period (average)	88 days
Freeze-free period (average)	121 days
Precipitation total (average)	864 mm

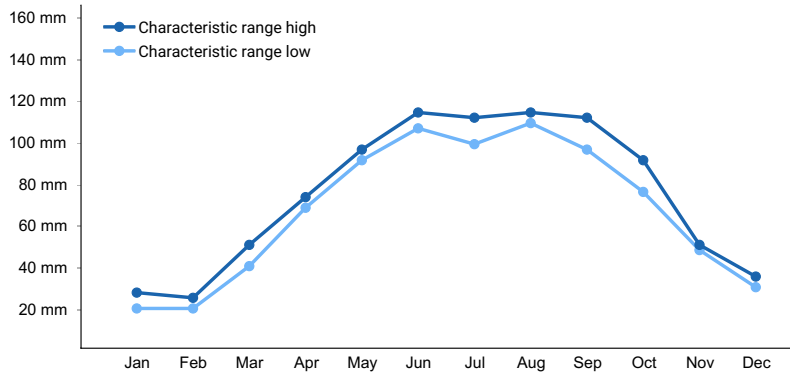


Figure 1. Monthly precipitation range

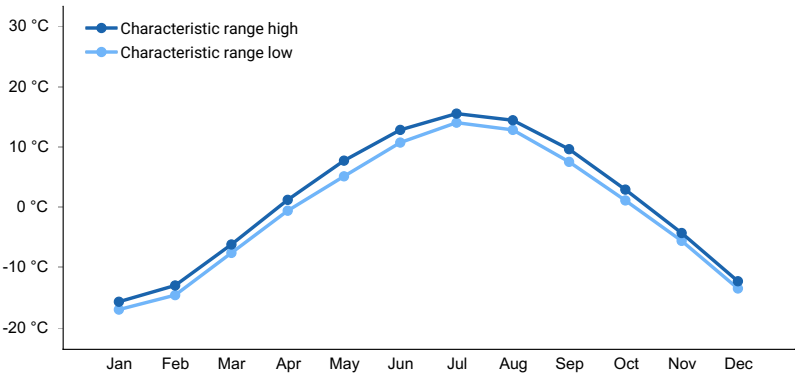


Figure 2. Monthly minimum temperature range

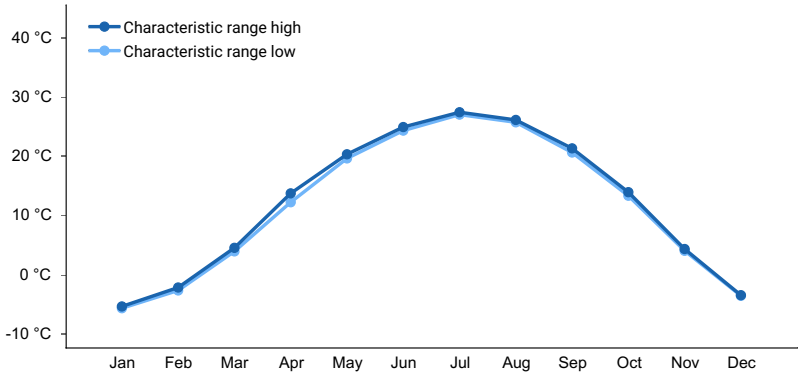


Figure 3. Monthly maximum temperature range

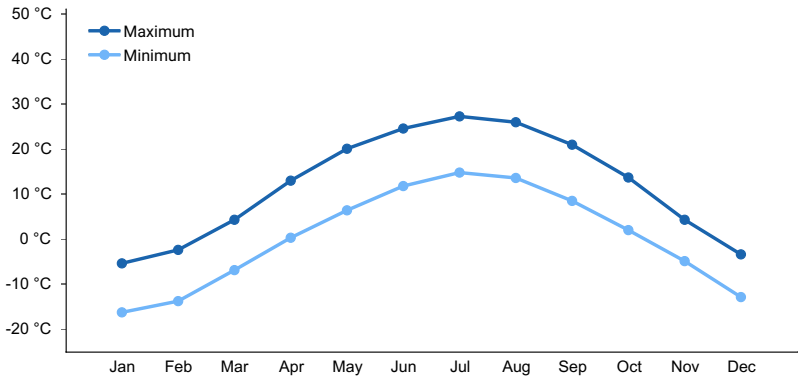


Figure 4. Monthly average minimum and maximum temperature

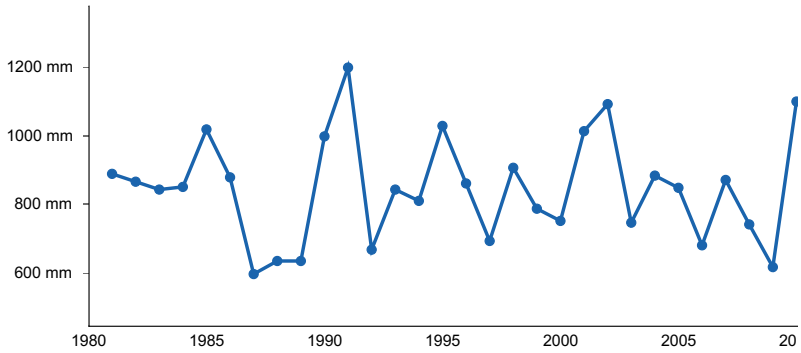


Figure 5. Annual precipitation pattern

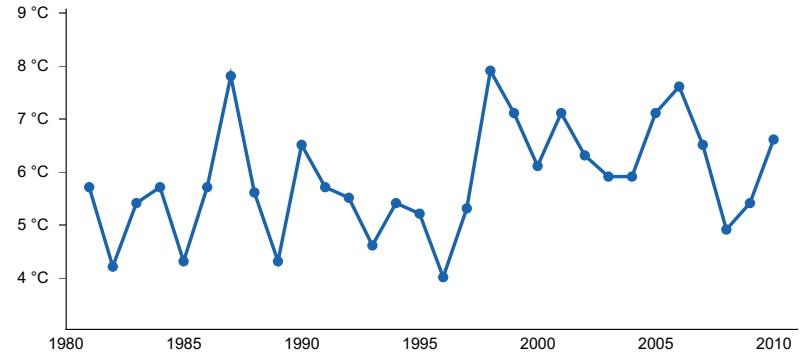


Figure 6. Annual average temperature pattern

Climate stations used

- (1) LUCK [USC00474894], Luck, WI
- (2) AMERY [USC00470175], Amery, WI
- (3) COUDERAY 7 W [USC00471847], Stone Lake, WI

Influencing water features

Water is received through precipitation, runoff from adjacent uplands, and groundwater discharge. Water levels are greatly influenced by precipitation rates and runoff from upland sites. Water leaves the site primarily through evapotranspiration and groundwater recharge. These sites are wetlands.

Wetland description

Under the Cowardin System of Wetland Classification, or National Wetlands Inventory (NWI), the wetlands can be classified as:
1) Palustrine, forested, broad-leaved deciduous, saturated, or
2) Palustrine, scrub-shrub, broad-leaved deciduous, saturated, or
3) Palustrine emergent, persistent, saturated

Under the Hydrogeomorphic Classification System (HGM), the wetlands can be classified as:
1) Depressional, forested/sandy, or
2) Depressional, scrub-shrub/sandy

Permeability of the soils are impermeable to very slow.
Hydrologic Group: D, C/D
Hydrogeomorphic Wetland Classification: Depressional, forested/organic; Depressional, scrub-shrub/organic
Cowardin Wetland Classification: PFO1B, PSS1B, PEM1B

Soil features

These sites are represented by Altdorf, Indus, and Wildwood soil series. Altdorf is classified as an Aeric Glossaqualf, Indus is a Vertic Epiaqualf, and Wildwood is a Histic Humaquept.

These soils formed in various parent materials including silty alluvium, loamy or clayey residuum, loess, loamy or clayey till, and clayey lacustrine. Soils are very deep. Sites are very poorly or poorly drained and remain saturated for much of the growing season. They meet hydric soil requirements.

The surface of these sites is often muck, mucky silt loam, silt loam, or clay loam. Subsurface horizons include clay loam, silt loam, silty clay, and clay textures. Soil pH ranges from very strongly acid to moderately alkaline with values of 4.6 to 7.9. This range occurs because some sites have carbonates present beginning at 25 inches and can have up to 18 percent calcium carbonates. Fragments are typically absent, but subsurface fragments less than 3 inches can be present up to 3 percent in the profile.

Figure 7. Wildwood soil series photograph courtesy of UWSP taken on 7/17/2019 in Burnett County, WI.

Table 4. Representative soil features

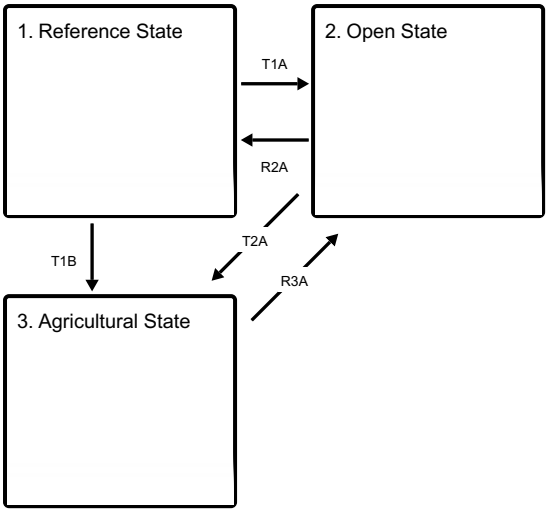
Parent material	(1) Lacustrine deposits (2) Till (3) Organic material (4) Eolian deposits (5) Metamorphic rock
Surface texture	(1) Mucky silt loam (2) Mucky clay
Drainage class	Very poorly drained to poorly drained
Permeability class	Very slow
Soil depth	201–249 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-154.9cm)	5.92–9.98 cm
Calcium carbonate equivalent (0-100.1cm)	0–18%
Soil reaction (1:1 water) (0-100.1cm)	4.6–7.9
Subsurface fragment volume <=3" (Depth not specified)	0–3%
Subsurface fragment volume >3" (Depth not specified)	0%

Ecological dynamics

Because of the poorly drained soils, the historic fire disturbance has likely been less frequent and less severe than on the better drained sites. These forested wetlands are dominated by black ash (*Fraxinus nigra*) with other hardwood associates such as swamp white oak (*Quercus bicolor*) and slippery elm (*Ulmus rubra*). Trembling aspen (Populus trembuloides) is common on many sites, but cannot compete with other hardwoods that are more tolerant of shade and moisture. This community relies heavily on soil moisture and nutrient regimes. These sites can support more nutrient demanding species, and the plants must tolerate seasonal ponding. During the driest months, standing water drains, but soils remain saturated throughout the growing season. Tree species often rely on the pit-and-mound microtopography to remain above the oversaturated rooting zones to avoid prolonged anaerobic conditions. Pit-and-mound topography is caused by tree species that have shallow roots and tip from windthrow. Seasonal ponding prevents other shade-tolerant species such as sugar maple from becoming competitive on these sites.

State and transition model

Ecosystem states



T1A - Major stand replacing disturbance e.g. blow-down or clear-cutting.

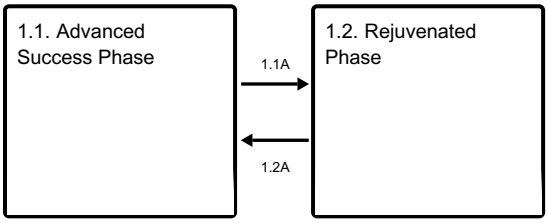
T1B - Elimination of forest cover, application of agricultural practices.

R2A - Conifers slowly increase in abundance in the deciduous forest community.

T2A - Elimination of forest cover, application of agricultural practices.

R3A - Cessation of agricultural practices.

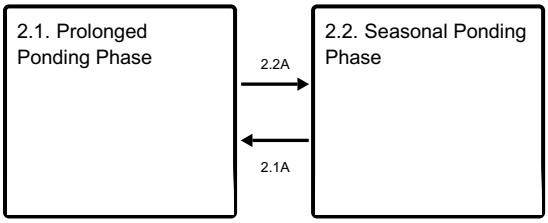
State 1 submodel, plant communities



1.1A - Natural mortality in the oldest age classes, sporadic small-scale blow-downs and ice storms, and prolonged ponding events create openings for entry of mid-tolerant species, such as green ash.

1.2A - Time and natural succession.

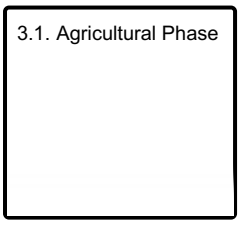
State 2 submodel, plant communities



2.2A - Decreased frequency and duration ponding events, encroachment of tree species such as aspen and black ash.

2.1A - Increased frequency and duration of ponding events.

State 3 submodel, plant communities



State 1

Reference State

Reference state is a forest community dominated by black ash with swamp white as a primary associate. Depending on disturbance history, two community phases can be distinguished largely by differences in dominance of tree species and community age structure.

Community 1.1
Advanced Success Phase

In absence of stand replacing disturbance (major blow-downs, clearcutting, or prolonged ponding event), this community is dominated by black ash in all layers of the forest from canopy to shrub layer. Black ash has a shallow and fibrous root system that to tolerate seasonal ponding of stagnant water. Long duration of ponding will cause black ash to diminish. Swamp white oak and slippery elm are common associates, both tolerant of high soil moisture, but not as tolerant as black ash. The forest floor cover is dominated by goldenrod (Solidago, spp.) and sedges (Carex, spp.), but includes many other wet species like sensitive fern (*Onoclea sensibilis*), hog-peanut (Amphicarpa bracteate), and Virginia creeper (*Parthenocissus quinquefolia*).

Dominant plant species

- black ash (*Fraxinus nigra*), tree
- swamp white oak (*Quercus bicolor*), tree
- beaked hazelnut (*Corylus cornuta*), shrub
- sedge (*Carex*), grass
- goldenrod (*Oligoneuron*), other herbaceous

Community 1.2
Rejuvenated Phase

Figure 8. Photo courtesy of UWSP taken on 7/17/2019 in Burnett County, WI.

The canopy of the rejuvenated community is still dominate by black ash, but swamp white oak and slippery elm have entered canopy and sub-canopy to fill in canopy gaps created by small-scale disturbances. Advanced

regeneration black ash saplings may also gain considerable size. Some additional less shade tolerant species may be able to enter the community, such as Green ash (*Fraxinus pennsylvanica*).

Dominant plant species

- black ash (*Fraxinus nigra*), tree
- swamp white oak (*Quercus bicolor*), tree
- slippery elm (*Ulmus rubra*), tree
- green ash (*Fraxinus pennsylvanica*), shrub
- sedge (*Carex*), grass
- goldenrod (*Oligoneuron*), other herbaceous

Pathway 1.1A
Community 1.1 to 1.2

Natural mortality in the oldest age classes, sporadic small-scale blow-downs and ice storms, and prolonged ponding create canopy openings, releasing advance regeneration and stimulating new seedling establishment. Swamp white oak and slippery elm may enter openings.

Pathway 1.2A
Community 1.2 to 1.1

Time and natural succession. Black ash tolerance to seasonal ponding and soil saturation continues its dominance as most competitive canopy species.

State 2
Open State

Open State consists of two main community phases. Phases are primarily driven by frequency and duration of ponding events that allow or deter establishment of woody, less tolerant species.

Community 2.1
Prolonged Ponding Phase

Figure 9. Photo courtesy of UWSP taken on 6/13/2019 in Lincoln County, WI.

The Prolonged Ponding Phase is defined by the increased frequency and duration of ponding events. Communities are dominated by sedges and grasses that can tolerate constant saturation and long periods of standing, stagnant surface water.

Dominant plant species

- sedge (*Carex*), grass
- Grass, native (*Grass, native*), grass

Community 2.2
Seasonal Ponding Phase

The Seasonal Ponding Phase is defined by the presence of woody species, primarily trembling aspen and black ash with higher transpiration rates.

Dominant plant species

- quaking aspen (*Populus tremuloides*), tree
- black ash (*Fraxinus nigra*), tree
- sedge (*Carex*), grass
- goldenrod (*Oligoneuron*), other herbaceous

Pathway 2.2A
Community 2.1 to 2.2

Decreased frequency and duration of ponding events. Seasonal ponding where surface water usually drains by midsummer. Allows for establishment of less tolerant species.

Pathway 2.1A

Community 2.2 to 2.1

Increased frequency and duration of ponding events.

State 3
Agricultural State

The agricultural state in this ecological site is characterized as likely having artificial drainage and is composed of crops such as corn, soybeans, potatoes, and hay.

Community 3.1
Agricultural Phase

The agricultural state in this ecological site is characterized as likely having artificial drainage and is composed of crops such as corn, soybeans, potatoes, and hay. Agricultural production in these settings is likely to include practices such as tilling and fertilizing.

Transition T1A
State 1 to 2

Major stand-replacing disturbance, such as a blow-down or clear cutting. Removal of canopy causes water table to rise. Sites have more frequent and longer duration of ponding events.

Transition T1B
State 1 to 3

Elimination of forest cover and the application of agricultural practices, such as artificial drainage, tilling, and planting crops.

Restoration pathway R2A
State 2 to 1

Conifers slowly increase in abundance in the deciduous forest community.

Transition T2A
State 2 to 3

Elimination of forest cover and the application of agricultural practices, such as artificial drainage, tilling, and planting crops.

Restoration pathway R3A
State 3 to 2

Cessation of agricultural practices and either planting or allowing natural seeding is required for this restoration pathway. Restoration might be accelerated with removal of artificial drainage and restoring hydrology, if applicable.

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.

Wetland Forest Habitat Type Classification System for Northern Wisconsin (Kotar and Burger, 2017): The sites of this ES keyed out to two main habitat type (due to MLRA spanning several habitat type regions others are included

here as likely in the PESD): *Fraxinus nigra*-Acer rubrum/Impatiens (FnArI); *Fraxinus nigra*-Acer rubrum/Impatiens-Ilex variant (FnArI-Ix); *Fraxinus nigra*/Onoclea (FnOn); *Fraxinus nigra*-Abies balsamea-Acer rubrum/Onoclea (FnAbArOn); Abies balsamea-*Fraxinus nigra*-Thuja/Ilex (AbFnThIx); Acer rubrum-*Fraxinus nigra*/Rubus hispidus (ArFnRh)

Biophysical Settings (Landfire, 2014): This ES is largely mapped as Laurentian-Acadian Northern Hardwoods Forest, Eastern Cool Temperate Close Grown Crop, and Eastern Cool Temperate Pasture and Hayland

WDNR Natural Communities (WDNR, 2015):

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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	06/02/2024
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):**

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:**