USDA Natural Resources Conservation Service

Ecological site F091XY006WI
Wet Clayey Lowland

Last updated: 9/27/2023
Accessed: 04/23/2024

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): 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 and Laurentian-Acadian Herbaceous Wetlands

Wetland Forest Habitat Type Classification System for N. Wisconsin (Kotar and Burger, 2017): The sites of this ES keyed out to one habitat type: *Fraxinus nigra*/Onoclea (FnOn)

WDNR Natural Communities (WDNR, 2015): This ES is most similar to Northern Hardwood Swamp described by the WDNR, but may coincide with and overlap some of the WDNR wetland communities in different states depending on past hydrology.

Hierarchical Framework Relationships:
Major Land Resource Area (MLRA): Wisconsin and Minnesota Sandy Outwash (91X)

USFS Subregions: Bayfield Sand Plains (212Ka)

Wisconsin DNR Ecological Landscapes: Northwest Sands

Ecological site concept

Wet Clayey Lowland sites are an uncommon site located in the southern portion of MLRA 91X in depressions and drainageways on lake plains and outwash plains. These sites are characterized by very deep, very poorly or poorly drained soils that formed primarily in clayey lacustrine. Some sites have stratified sandy and clayey lacustrine, and others have a sandy outwash mantle over the clayey lacustrine deposits. Sites are subject to occasional ponding. Soils remain saturated for long periods during the growing season and meet hydric soil requirements. Soils range from strongly acid to neutral.

The parent materials of Wet Clayey Lowlands were deposited by old glacial lakes, including Glacial Lake Grantsburg. Rushing meltwater from large, proglacial streams during and after Wisconsin's more recent glaciation – including one that occupied today's St. Croix River valley – eroded or capped most of the silty and clayey lacustrine materials from the glacial lakes. Wet Clayey Lowlands are found in locations far enough from the river valleys of these old proglacial streams to have not been washed away or capped.

Wet Clayey Lowland sites have finer textures than Wet Sandy and Loamy Lowland sites. These finer textures often provide higher pH and available water capacity than sandy and loamy materials.

Associated sites

F091XY002WI	**Mucky Swamp** Mucky Swamp sites consist of deep, highly decomposed organic matter, primarily of herbaceous origin. Some sites have mineral soil contact. They occur on drainageways, depressions, and floodplains that receive stream or groundwater discharge. They are very poorly drained and are neutral to strongly acid. They may be adjacent to Wet Clayey Lowland sites, occurring in wetter areas lower on the drainage sequence.
F091XY008WI	**Moist Clayey Lowland** The soils within this site formed in a sandy outwash mantle over clayey lacustrine deposits over sandy lacustrine deposits, or loamy glaciofluvial deposits over clayey lacustrine deposits. Soils are very deep and are somewhat poorly drained. They occur in slightly drier areas higher on the drainage sequence than Wet Clayey Lowland sites.
F091XY013WI	**Clayey Upland** These sites form in clayey lacustrine deposits, often with a sandy or loamy mantle. Soils are very deep and moderately well to well drained. They occur in drier areas higher on the drainage sequence than Wet Clayey Lowland sites.

Similar sites

F091XY002WI	**Mucky Swamp** Mucky Swamp sites consist of deep, highly decomposed organic matter, primarily of herbaceous origin. Some sites have mineral soil contact. They occur on drainageways, depressions, and floodplains that receive stream or groundwater discharge. They are very poorly drained and are neutral to strongly acid. The vegetative communities found on Wet Clayey Lowland sites are sometimes also found on Mucky Swamp sites.
F091XY003WI	**Floodplain** These sites occur in depressions and flats on floodplains. They form in sandy to silty alluvium and are somewhat poorly to very poorly drained. They are subject to flooding. The vegetative communities found on Wet Clayey Lowland sites are sometimes also found on frequently flooded Floodplain 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. The vegetative communities found on Wet Clayey Lowland sites are sometimes also found on Wet Sandy and Loamy Lowland sites.

Table 1. Dominant plant species

Tree	(1) *Fraxinus nigra*
Shrub	(1) *Alnus incana*
Herbaceous	(1) *Carex* (2) *Impatiens capensis*

Physiographic features

Wet Clayey Lowland sites formed in depressions and drainageways on outwash and lake plains. Slopes are 0 to 2 percent. Sites are positioned on foot slopes and toeslopes.

These sites are subject to occasional ponding. Ponding duration is brief (2 to 7 days) to long (7 to 30 days), with depths up to 6 inches above the soil surface. Sites do not flood. These sites have a perched seasonally high water table (episaturation) at the soil surface. The water table may drop to greater than 60 inches during dry conditions. Runoff is negligible to low.

Table 2. Representative physiographic features

Hillslope profile	(1) Footslope (2) Toeslope
Slope shape across	(1) Linear
Slope shape up-down	(1) Concave
Landforms	(1) Depression (2) Drainageway
Runoff class	Negligible to low
Flooding frequency	None
Ponding duration	Brief (2 to 7 days) to long (7 to 30 days)
Ponding frequency	Occasional
Elevation	950–1,115 ft
Slope	0–2%
Ponding depth	0–15 in
Water table depth	0 in
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.

This site sometimes occurs on landscape depressions and its local topography is expected to influence its growing season length. The freeze-free and frost-free periods may be shorter than what is represented here.

Table 3. Representative climatic features

Frost-free period (characteristic range)	89-105 days
Freeze-free period (characteristic range)	124-136 days
Precipitation total (characteristic range)	30-33 in

Frost-free period (actual range)	85-116 days
Freeze-free period (actual range)	114-140 days
Precipitation total (actual range)	30-33 in
Frost-free period (average)	99 days
Freeze-free period (average)	128 days
Precipitation total (average)	31 in

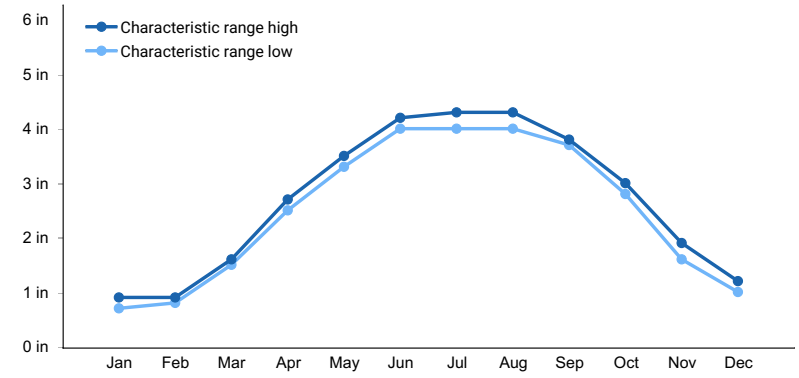


Figure 1. Monthly precipitation range

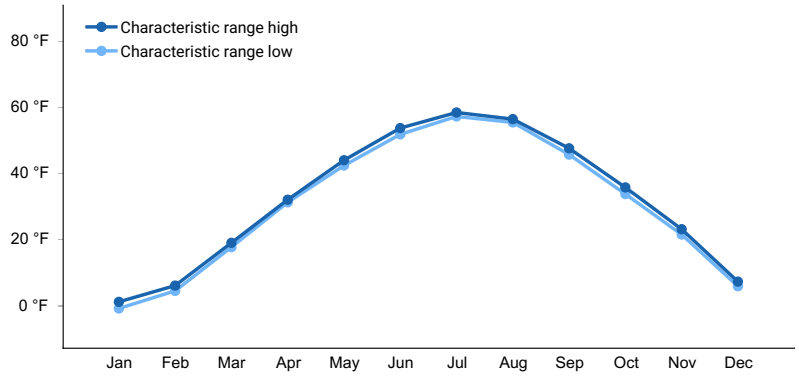


Figure 2. Monthly minimum temperature range

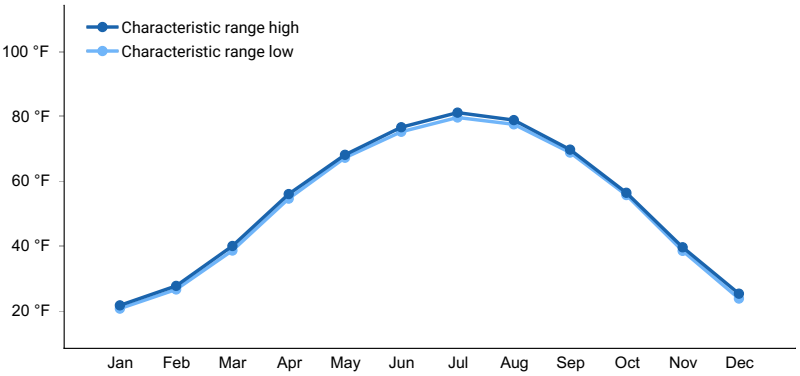


Figure 3. Monthly maximum temperature range

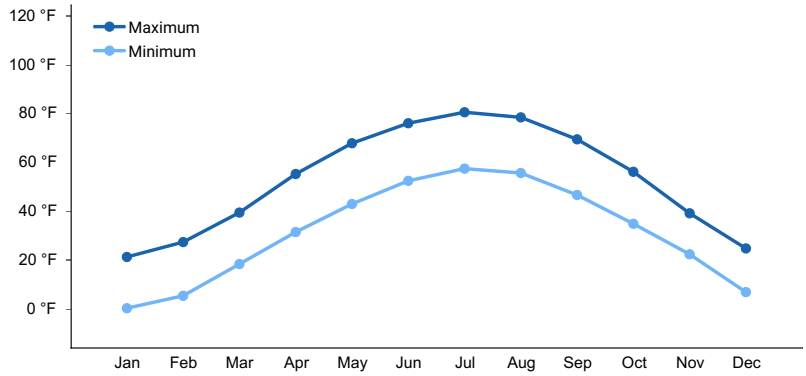


Figure 4. Monthly average minimum and maximum temperature

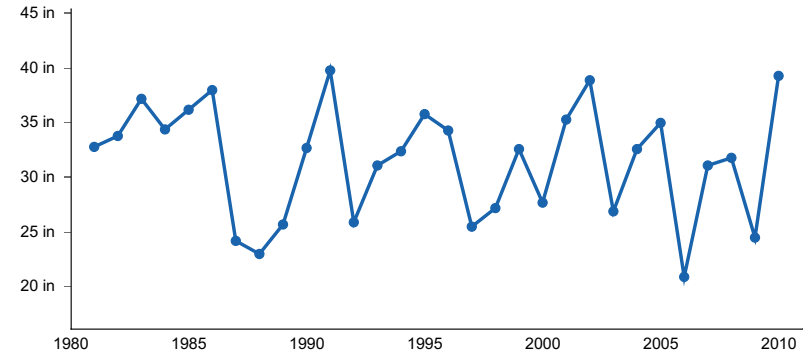


Figure 5. Annual precipitation pattern

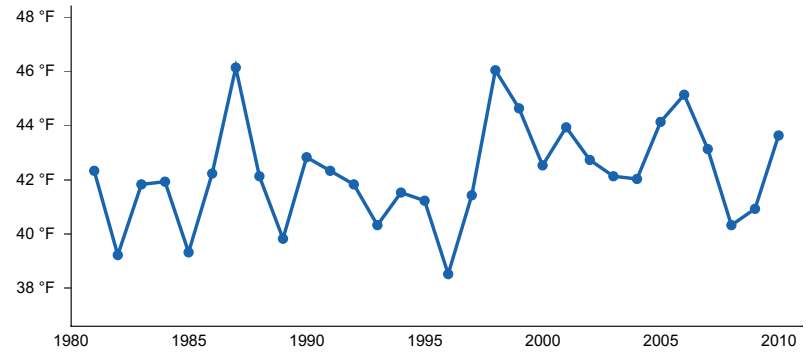


Figure 6. Annual average temperature pattern

Climate stations used

- (1) GRANTSBURG [USW00014995], Grantsburg, WI
- (2) DANBURY [USC00471978], Danbury, WI
- (3) SPOONER AG RES STN [USC00478027], Spooner, WI
- (4) BRUNO 7ENE [USC00211074], Bruno, MN
- (5) MORA [USC00215615], Mora, MN

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 is lost from the site primarily through subsurface outflow, evapotranspiration, and groundwater recharge.

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

Soil features

Wet Clayey Lowland sites are represented by the Chelmo and Dody soil series, classified as Umbric Epiaqualfs and Arenic Albaqualf, respectively.

These soils formed in layers of sandy lacustrine deposits, sandy outwash, and clayey lacustrine deposits. Soils are very deep and are poorly to very poorly drained. These soils meet the hydric soil requirements. These are wetland soils.

The surface of these soils is muck—highly decomposed organic material. Subsurface textures include sand, loamy sand, and clay. Soil pH ranges from strongly acid to neutral with values of 5.5 to 7.0. Carbonates are absent.

Figure 7. Dody Soil Series sampled on 07/24/2019 in Burnett County, WI. Courtesy of UWSP

Table 4. Representative soil features

Parent material	(1) Outwash (2) Lacustrine deposits
Surface texture	(1) Muck (2) Sandy loam
Drainage class	Very poorly drained to poorly drained
Permeability class	Very slow
Soil depth	80 in
Surface fragment cover <=3"	0–2%
Surface fragment cover >3"	0%
Available water capacity (0-60in)	5.4–6 in
Soil reaction (1:1 water) (0-40in)	5.5–7
Subsurface fragment volume <=3" (Depth not specified)	0%
Subsurface fragment volume >3" (Depth not specified)	0–2%

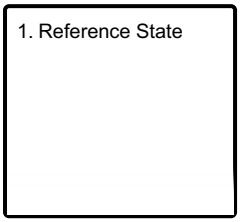
Ecological dynamics

Plant community dynamics are driven by two primary processes: A cyclical and relatively short term effect of

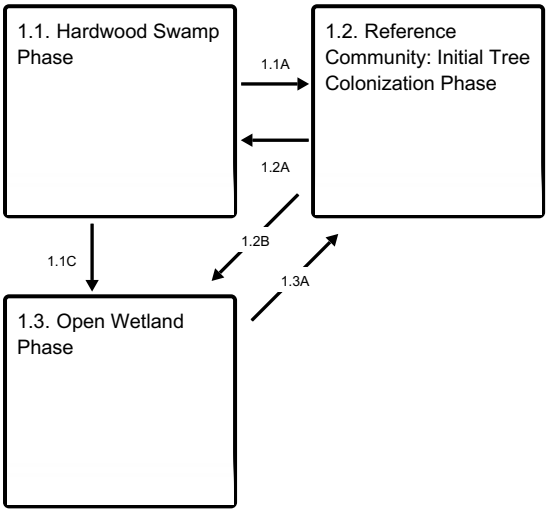
ponding and a slow, long-term progression of tree growth on the site. Since the Ecological Site itself is very wet, the earliest emergent communities are dominated by sedges, grasses and some facultative-wetland herbaceous species. ('Facultative-wetland' species are those that occur primarily in wetlands, but also on some non-wetland sites, as opposed to 'obligate wetland' species, which occur only in wetlands). With enough time between flooding/ponding events (or a lowered water table) some woody species such as black ash (*Fraxinus nigra*), willow (Salix spp.), and tag alder (*Alnus incana*) may begin to get established. These early woody communities tend to be unstable. Prolonged ponding, due to rising water table, may cause partial, or complete mortality of the tree layer and the entire colonization cycle begins anew.

State and transition model

Ecosystem states



State 1 submodel, plant communities



1.1A - Large-scale canopy disturbance, mortality in canopy layer.

1.1C - Large-scale natural disturbance or tree harvesting, causing swamping of the site.

1.2A - Slow accumulation of living and dead sphagnum moss layer.

1.2B - Large-scale natural disturbance or tree harvesting, causing swamping of the site.

1.3A - Colonization by trees with tolerance for prolonged ponding.

State 1
Reference State

The Reference State of this Ecological Site may be represented by any of three distinct community Phases, each reflecting the process of wetland formation, the history of natural disturbances and associated vegetation dynamics.

Community 1.1
Hardwood Swamp Phase

Figure 8. Photo courtesy of UWSP taken on 07/24/2019 in Burnett County, WI.

This Phase develops over long periods of time, as trees are able to establish they effectively dry the site through increased transpiration. This increased transpiration together with a water table that is lowered or decreased flooding/ponding frequency lead to the establishment of a mixture of Balsam fir and White Cedar. Other species such as Yellow birch, Elms, and Tamarack may be present in small amounts as well. There may not be much in the way of a shrub layer, but if present it may include Alders and Ilex species. The herb layer likely consists of Sedges, Jewelweed, and Sensitive fern (other ferns may periodically be present as well, Cinnamon fern and Royal fern).

Dominant plant species

- black ash (*Fraxinus nigra*), tree
- gray alder (*Alnus incana*), shrub
- black ash (*Fraxinus nigra*), shrub
- sedge (*Abildgaardia*), grass
- jewelweed (*Impatiens capensis*), grass
- sensitive fern (*Onoclea sensibilis*), grass

Community 1.2
Reference Community: Initial Tree Colonization Phase

Figure 9. Photo courtesy of UWSP taken on 07/23/2019 in Burnett County, WI.

This Community Phase was chosen as the Reference Community Phase because it appears to be the most common phase under current conditions. When, in the process of wetland formation, the herbaceous plant peat accumulation eventually reaches critical density and seasonal water table recedes enough to permit development of aerated rooting zone, a number of tree and shrub species find conditions suitable for growth. Early colonizing shrubs typically include tag alder (*Alnus incana*), willows (Salix spp.) and chokecherry (*Prunus virginiana*). The most common colonizing trees are red maple (A. rubrum) Oaks and Aspen. This condition is also achieved through community pathway 1.1B, described above.

Dominant plant species

- black ash (*Fraxinus nigra*), tree
- green ash (*Fraxinus pennsylvanica*), tree
- gray alder (*Alnus incana*), shrub
- chokecherry (*Prunus virginiana*), shrub
- sedge (*Carex*), grass
- jewelweed (*Impatiens capensis*), other herbaceous
- sensitive fern (*Onoclea sensibilis*), other herbaceous

Community 1.3
Open Wetland Phase

This community phase represents a transition in wetland formation where obligatory wetland species are being replaced, or outnumbered by the combined facultative wetland and facultative upland species. Sedges and grasses predominate, but characteristic species also include currants (Ribes spp.), jewelweed (*Impatiens capensis*), and sensitive fern (*Onoclea sensibilis*). Trees and tall shrubs are absent, or showing up only as sporadic seedlings or saplings. This condition also occurs through community phase pathways 1.1C and 1.2B described above.

Dominant plant species

- sedge (*Carex*), grass
- Grass, native (*Grass, native*), grass
- steeplebush (*Spiraea tomentosa*), other herbaceous
- bedstraw (*Galium*), other herbaceous
- jewelweed (*Impatiens capensis*), other herbaceous

Pathway 1.1A
Community 1.1 to 1.2

Hardwood Swamp Phase

Reference Community: Initial Tree Colonization Phase

Large scale disturbance, such as major blow-down, tree harvesting or fire, cause major changes in the substrate. Increased light and soil-surface temperature promote faster decomposition of sphagnum peat, increasing nutrient availability, thus making conditions suitable again for colonization by deciduous species.

Pathway 1.1C
Community 1.1 to 1.3

Major disturbances, such as blow-downs, tree harvesting, or fire, promote decomposition of surface layers of peat, while swamping, resulting from reduced transpiration due to removed woody vegetation, cause the return of community to Open Wetland Phase (Community Phase 1.3).

Pathway 1.2A
Community 1.2 to 1.1

Reference Community: Initial Tree Colonization Phase

Hardwood Swamp Phase

Very long periods without major disturbances and reduced flooding/ponding facilitate continuous growth of trees leading community development toward the Hardwood Swamp (Community Phase1.1).

Pathway 1.2B
Community 1.2 to 1.3

Major disturbances, such as blow-downs, tree harvesting, or fire, promote decomposition of surface layers of peat, while swamping, resulting from reduced transpiration due to removed woody vegetation, cause the return of community to Open Wetland Phase (Community Phase 1.3).

Pathway 1.3A
Community 1.3 to 1.2

Colonization by trees with tolerance for prolonged ponding.

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

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.

County Soil Surveys from Douglas, Bayfield, Washburn, Burnett, Polk, and Sawyer.

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.

Hvizdak, David. Personal knowledge and field experience.

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. 1986. Soil – Habitat Type relationships in Michigan and Wisconsin. J. For. and Water Cons. 41(5): 348-350.

Kotar, J., J.A. Kovach and G. Brand. 1999. Analysis of the 1996 Wisconsin Forest Statistics by Habitat Type. U.S.D.A. For. Serv. N.C. Res. Stn. Gen. Tech. Rept. NC-207.

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.

Soil Survey Staff. Input based on personal experience. Tim Miland, Scott Eversoll, Ryan Bevernitz, and Jason Nemecek.

United States Department of Agriculture, Natural Resources Conservation Service. 2022. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture, 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

Suzanne Mayne-Kinney, 9/27/2023

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NRCS contracted UWSP to write ecological sites in 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	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):

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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:**
