Ecological site F090AY010WI
Moist Loamy Lowland with Carbonates

Last updated: 10/02/2023
Accessed: 05/12/2025

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: Rosemont Baldwin Plains and Moraines (222Md), Mille Lacs Uplands (212Kb)

Wisconsin DNR Ecological Landscapes: Northwest Lowlands, Western Prairie

Ecological site concept

The Moist Loamy Lowland with Carbonates ecological site is found on the western border of MLRA 90A, located on till plains, ground and disintegration moraines, and sometimes lake plains and outwash plains. These sites are characterized by very deep, somewhat poorly drained soils that formed in loess and loamy till. The till deposits are enriched with carbonates. Precipitation, runoff from adjacent uplands, and groundwater discharge are the primary sources of water. Sites range from strongly acid to slightly alkaline.

Moist Loamy Lowland with Carbonates is differentiated from other ecological sites by its deep loamy deposits with a strong presence of carbonates and somewhat poorly drained soils. The presence of carbonates raises or buffers pH, which can promote vegetative growth. Other somewhat poorly drained sites have sandy or clayey deposits. Loams often have higher pH and available water capacity than sands, but lower than clays. The somewhat poor drainage of this site differs it from other loamy sites.

Associated sites

F090AY002WI	**Mucky Swamp** Mucky Swamps sites consist of deep, highly decomposed herbaceous organic materials. Some sites have mineral soil contact. They are very poorly drained and are neutral to slightly acid. These sites are permanently saturated wetlands. They are much wetter and occur lower on the drainage sequence thanMoist Loamy Lowland with Carbonates.
F090AY015WI	**Loamy Upland with Carbonates** Loamy Upland with Carbonates consist of deep sandy and loamy deposits of outwash, alluvium, till, and residuum. Soils are primarily sand and loamy sand and have a seasonally high water table within two meters, though they don't remain saturated for extended periods. They are drier and occur higher on the drainage sequence than Moist Loamy Lowlands with Carbonates.

Similar sites

F090AY011WI	**Moist Loamy Lowland** Moist Loamy Lowland consist of deep sandy and loamy deposits derived from a mixture of alluvium, residuum, till, or lacustrine sources. The finer textures allow the soil to stay moist - but not saturated - for sustained periods during the growing season. Carbonates may be present a meter down. These sites share their particle size and drainage class with Moist Loamy Lowland with Carbonates.

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 found in similar landscape positions with the same drainage class as Moist Loamy Lowland with Carbonates, but with finer textures.
F090AY008WI	**Moist Sandy Bedrock Upland** Moist Sandy Bedrock Upland sites consist of sandy to clayey alluvium, till, or eolian deposits over residuum weathered from bedrock. Bedrock contact occurs within two meters of the surface. Sites have seasonally high water table within a meter of the surface. Perching of the water table may occur as a result of bedrock contact. These sites share their particle size and drainage class with Moist Loamy Lowland with Carbonates.

Table 1. Dominant plant species

Tree	(1) *Acer saccharum* (2) *Tilia*
Shrub	(1) *Ostrya*
Herbaceous	(1) *Arisaema* (2) *Geranium maculatum*

Physiographic features

These sites form on outwash plains, lake plains, till plains, and moraines. Slopes range from 0 to 6 percent.

Sites are not subject to ponding or flooding. These soils have a seasonally high water table at a depth of 6 to 18 inches, but the water table may drop below 80 inches during dry conditions. Runoff is negligible to low.

Table 2. Representative physiographic features

Hillslope profile	(1) Summit (2) Backslope (3) Footslope
Slope shape across	(1) Concave
Slope shape up-down	(1) Linear
Landforms	(1) Outwash plain (2) Lake plain (3) Till plain (4) Disintegration moraine (5) Ground moraine
Runoff class	Low to high
Flooding frequency	None
Ponding frequency	None
Elevation	591–853 ft
Slope	0–6%
Water table depth	6–18 in
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 32 inches. The average annual snowfall is 45 inches. The annual average maximum and minimum temperatures are 54°F and 34°F, respectively.

Table 3. Representative climatic features

Frost-free period (characteristic range)	94-108 days
Freeze-free period (characteristic range)	125-136 days
Precipitation total (characteristic range)	32 in
Frost-free period (actual range)	93-114 days
Freeze-free period (actual range)	121-137 days
Precipitation total (actual range)	32 in
Frost-free period (average)	102 days
Freeze-free period (average)	130 days
Precipitation total (average)	32 in

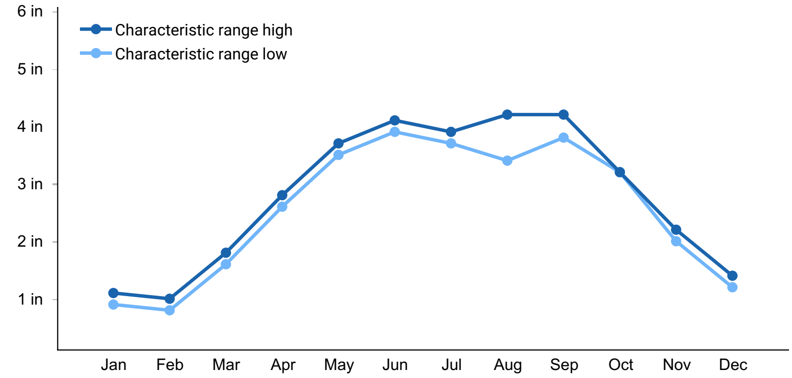


Figure 1. Monthly precipitation range

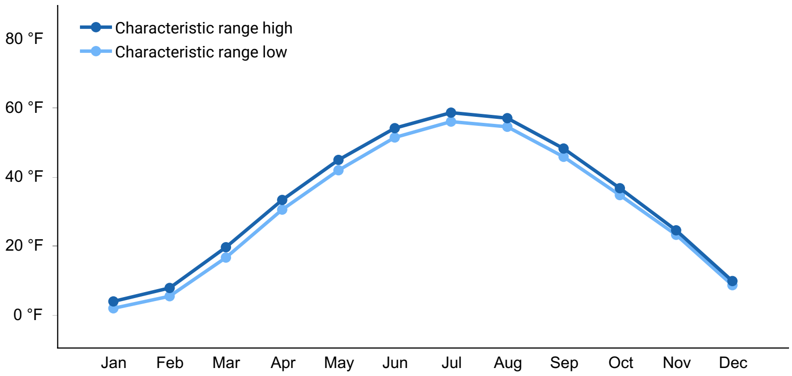


Figure 2. Monthly minimum temperature range

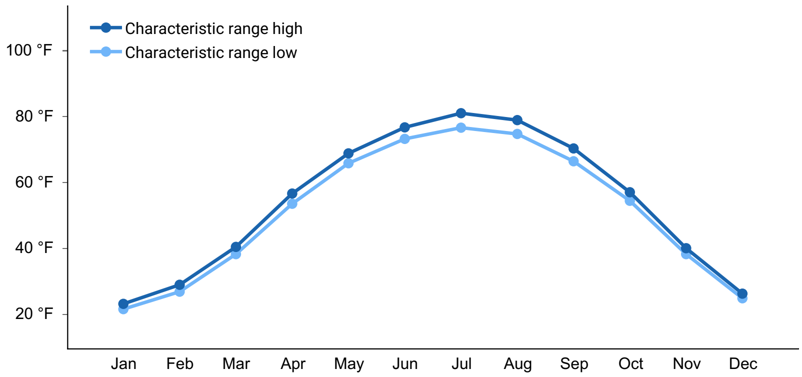


Figure 3. Monthly maximum temperature range

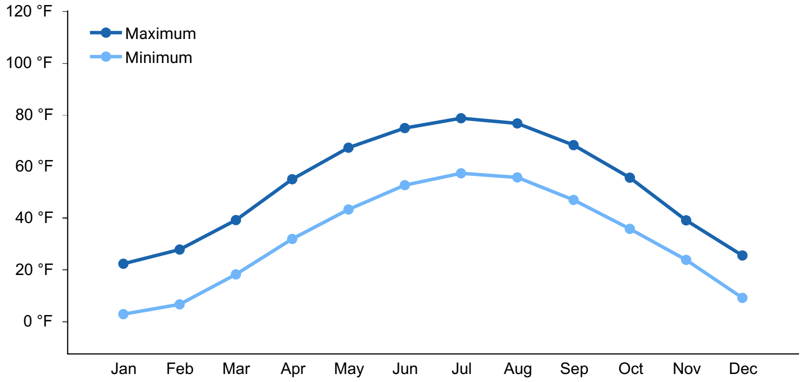


Figure 4. Monthly average minimum and maximum temperature

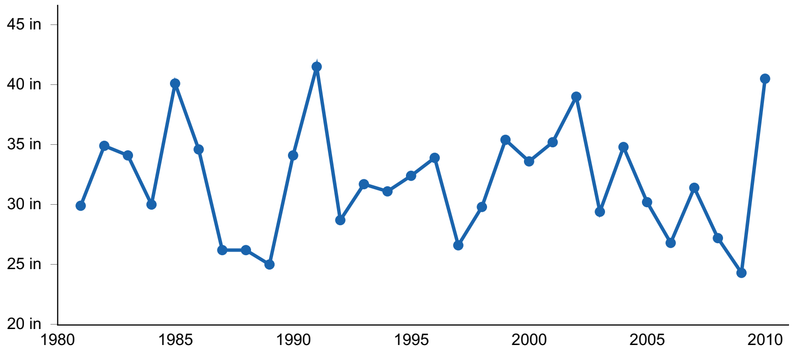


Figure 5. Annual precipitation pattern

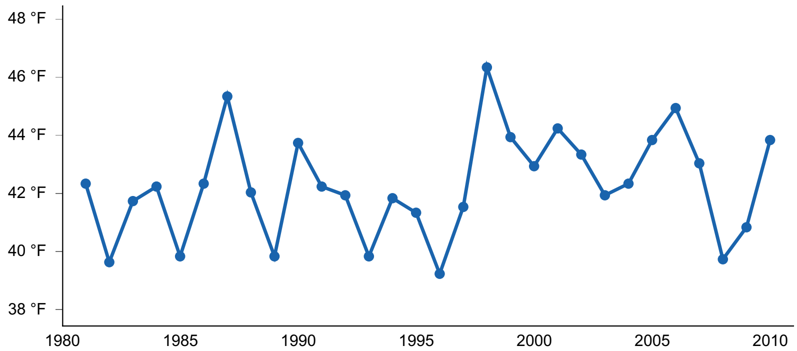


Figure 6. Annual average temperature pattern

Climate stations used

- (1) LUCK [USC00474894], Luck, WI
- (2) BIG FALLS HYDRO [USC00470773], Glen Flora, WI
- (3) LAONA 6 SW [USC00474582], Laona, 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 runoff, evapotranspiration, and groundwater recharge.

Wetland description

Permeability of the soils is very slow to slow.
Hydrologic Group: B/D, C/D
Hydrogeomorphic Wetland Classification: None
Cowardin Wetland Classification: None

Soil features

These sites are represented by the Alstad, Brennyville, Floyd, and Sargeant soil series. Alstad and Brennyville soil series are classified as Aquic Glossudalfs; Floyd is an Aquic Pachic Hapludoll; Sargeant is an Aquollic Hapludalf.

These soils formed in loess and loamy till. Soils are very deep. These sites are somewhat poorly drained. They do not meet hydric soil requirements.

The surface of these sites is loam or silt loam. Subsurface horizons are sandy loam, fine sandy loam, clay loam, sandy clay loam, and loam. Soil pH is strongly acid to slightly alkaline in the profile with a range of 5.3 to 7.5. Soil fragments are absent from the profile. Carbonates can be present up to 5 percent by volume in the upper 40 inches beginning at 35 inches. These sites likely have higher amounts of carbonates, but the data available only reaches 40 inches. Many of these sites have carbonates present beginning just below 40 inches.

Figure 7. Sargeant soil series photograph courtesy of UWSP taken on 7/25/2019 in Pierce County, WI.

Table 4. Representative soil features

Parent material	(1) Till (2) Eolian deposits
Surface texture	(1) Silt loam (2) Loam
Drainage class	Somewhat poorly drained
Permeability class	Very slow to slow
Soil depth	79–98 in
Surface fragment cover <=3"	0–8%
Surface fragment cover >3"	0–2%

Available water capacity (0-61in)	1.35–3.19 in
Calcium carbonate equivalent (0-39.4in)	0%
Soil reaction (1:1 water) (0-39.4in)	4.7–7.3
Subsurface fragment volume <=3" (Depth not specified)	3–7%
Subsurface fragment volume >3" (Depth not specified)	1–3%

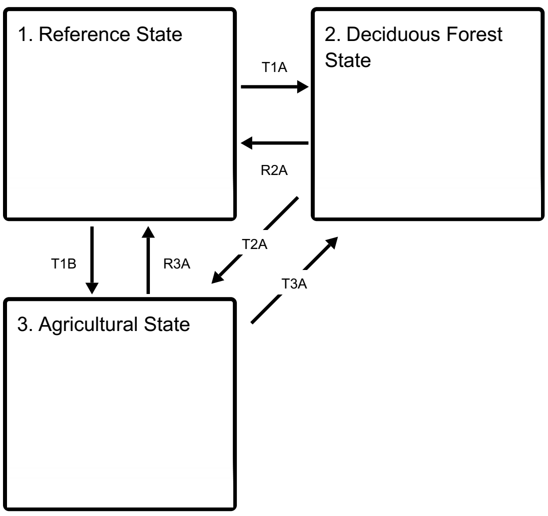
Ecological dynamics

In pre-European settlement time, wildfire was the main controlling factor of forest community dynamics. Following a severe, stand-replacing fire, any of the species present on the landscape could become established, depending on seed source availability and specific conditions of post-fire seedbed. The newly established young stands of any species were easily eliminated by recurring fires, but differences in fire-resisting properties among the species began to play a role in any species' survival success. Many pine and oak species were dominant in the region because of their fire-resistant properties and successful regeneration post-fire. With clear cutting and continued fire suppression, many of the species that are fire-tolerant and intolerant of shade, are replaced by other species. Species such as white pine and red oak are still common on the landscape based on their tolerance to some shade; these species may establish under a canopy, and in time, may become a component of the canopy. Red and white oak species would likely dominate this site if there was recurring fire disturbance.

These sites represent soils that can support the growth of tolerant mesic hardwoods such as sugar and red maple. These species dominate with a lack of fire disturbance. Sugar and red maple are sensitive to fire, but in its absence, they have the ability to dominate sites based on shade tolerance and prolific seed production. The longer a site continues without a fire disturbance, the dominance of maples will continue if seed source is present.

State and transition model

Ecosystem states



T1A - Stand replacing disturbance that includes fire.

T1B - Removal of forest cover and tilling for agricultural crop production.

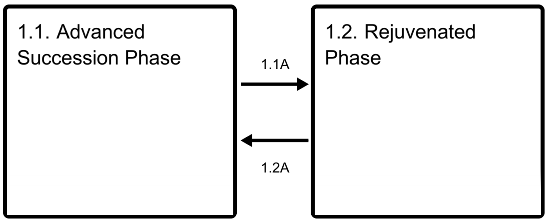
R2A - Conifers slowly increase in abundance in the deciduous forest community.

T2A - Removal of forest cover and tilling for agricultural crop production.

R3A - Cessation of agricultural practices leads to natural reforestation, or site is replanted.

T3A - Cessation of agricultural practices leads to natural reforestation, or site is replanted.

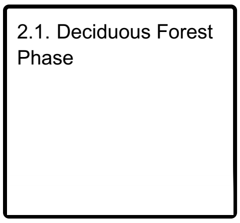
State 1 submodel, plant communities



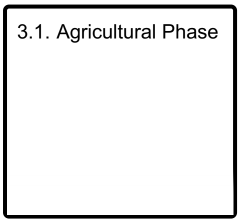
1.1A - Light to moderate intensity fires, blow-downs, ice storms.

1.2A - Disturbance-free period for 30+ years.

State 2 submodel, plant communities



State 3 submodel, plant communities



State 1
Reference State

Reference State is a forest community dominated by sugar maple (*Acer saccharum*), American basswood (Tilia Americana), and red maple (*Acer rubrum*). Other hardwood species including white ash (*Fraxinus americana*) and red oak (*Quercus rubra*) occur sporadically, but often only regenerate in canopy gaps and cannot compete with the shade tolerance of the maples and basswood. Depending on history of disturbance, two community phases can be distinguished largely by differences in dominance of tree species and community age structure.

Community 1.1
Advanced Succession Phase

In the absence of major, stand-replacing disturbance this community is dominated by sugar maple, American basswood, and red maple. The tree sapling and shrub layer in this community is not well developed due to dense shade created by multi-story tree canopy. Sugar and red maple saplings dominate the shrub layer, but American hophornbeam (*Ostrya virginiana*) are common with low coverage. The herb low in coverage based on the heavy shade cast from the dense canopy. The dominant herbs typically include Jack-in-the-pulpit (*Arisaema triphyllum*) and wild geranium (*Geranium maculatum*). Other species include enchanter's nightshade (*Circaea lutetiana*), Virginia creeper (*Parthenocissus quinquefolia*) and lady fern (Athyrium felix-femina).

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- basswood (*Tilia*), tree
- red maple (*Acer rubrum*), tree
- hophornbeam (*Ostrya*), shrub
- Jack in the pulpit (*Arisaema*), other herbaceous
- Bicknell's cranesbill (*Geranium bicknellii*), other herbaceous

Community 1.2
Rejuvenated Phase

Figure 8. Photo courtesy of UWSP taken on 7/25/2019 in Pierce County, WI.

The canopy of the rejuvenated community is still dominated by original species, but the understory now also includes a well-established younger cohort and perhaps a few additional seedlings and saplings of less shade tolerant species. Red oak and green ash (*Fraxinus pennsylvanica*) are common on sites, but have moderate shade tolerance and require canopy breaks to regenerate. They are unable to compete with red maple and balsam fir to maintain a co-dominant position in the canopy in advanced succession, but individuals may be maintained.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- red maple (*Acer rubrum*), tree
- northern red oak (*Quercus rubra*), tree
- common pricklyash (*Zanthoxylum americanum*), shrub
- Jack in the pulpit (*Arisaema*), other herbaceous
- geranium (*Geranium*), 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—create openings for entry of mid-tolerant species such as red oak and red maple.

Pathway 1.2A
Community 1.2 to 1.1

In the absence of canopy reducing disturbances natural succession leads to community dominance by the most shade-tolerant species resulting in return to community phase 1.1.

State 2
Deciduous Forest State

Pure, or mixed, aspen – paper birch community replaces the reference state community. If seed source is present, red maple and red oak readily becomes member of this community. In time, and with a seed source, sugar maple will establish a young cohort in the subcanopy.

Community 2.1
Deciduous Forest Phase

Most commonly this phase will be dominated by aspen or a mixture of aspen and paper birch. Red maple and red oak are likely to be present as long as there is a seed source. As the dominant canopy is aging sugar maple may become present as a young cohort in the subcanopy provided that there is a seed source.

Dominant plant species

- quaking aspen (*Populus tremuloides*), tree
- northern red oak (*Quercus rubra*), tree
- red maple (*Acer rubrum*), tree
- sugar maple (*Acer saccharum*), tree
- pricklyash (*Zanthoxylum*), shrub
- sedge (*Carex*), grass
- Virginia creeper (*Parthenocissus quinquefolia*), other herbaceous

State 3
Agricultural State

Indefinite period of applying agricultural practices.

Community 3.1
Agricultural Phase

Indefinite period of applying agricultural practices. Crops likely include alfalfa, corn, soybeans, and hay or pasture. It is possible that some areas are or have been in ginseng production as well.

Transition T1A
State 1 to 2

Major stand-replacing disturbance. In pre-European settlement time, the event was most often a severe blow down, sometimes followed by fires. Such blow downs have been estimated to occur in this part of Wisconsin every 300 to 400 years (Schulte and Mladenoff, 2005). In post-settlement, virtually every acre has been logged either by clear cutting or successive cuts targeting species marketable at that time. Post-logging slash fires also have been a significant factor in most areas. These disturbances created the environment suitable for natural regeneration of many shade-intolerant species and for commercial planting.

Transition T1B
State 1 to 3

Removal of forest cover, tilling and application of other agricultural techniques to grow agricultural crops.

Restoration pathway R2A
State 2 to 1

Aspen or aspen-paper birch canopy ages out and sugar maple becomes dominant along with mixtures of red oak and red maple. Even from the deciduous forest state this transition may require over 100 years to reach the reference state. Conifers slowly increase in abundance in the deciduous forest community.

Transition T2A
State 2 to 3

Removal of forest cover, tilling and application of other agricultural techniques to grow agricultural crops.

Restoration pathway R3A
State 3 to 1

Abandonment of agricultural practices and allowing natural vegetation to colonize the site or apply artificial afforestation. The time required for forest community to reach the reference state conditions may exceed 100 years.

Transition T3A

State 3 to 2

Abandonment of agricultural practices and allowing natural vegetation to colonize the site or apply artificial afforestation.

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.

Habitat Types of S. Wisconsin (Kotar, 1996): The sites of this ES keyed out to two habitat types: *Acer rubrum*/Circaea (ArCi); *Acer saccharum-Acer rubrum*/Viburnum (AArVb)

Biophysical Settings (Landfire, 2014): This ES is largely mapped as North-Central Interior Maple-Basswood Forest, Eastern Cool Temperate Row Crop, and Eastern Cool Temperate Pasture and Hayland

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Contributors

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

Approval

Suzanne Mayne-Kinney, 10/02/2023

Acknowledgments

NRCS contracted UWSP to write ecological sites in MLRA 90A, 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	05/12/2025
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):**

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

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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:**
