Ecological site F105XY016WI
Clayey Upland

Last updated: 2/23/2024
Accessed: 04/25/2024

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): 105X–Upper Mississippi River Bedrock Controlled Uplands and Valleys

The Northern Mississippi Valley Loess Hills area corresponds closely to the Western Coulees and Ridges and Southwest Savanna Ecological Landscapes. Some of the following brief overview is borrowed from the Wisconsin Department of Natural Resources Ecological Landscape publication (2015).

Fifty-two percent of the Upper Mississippi River Bedrock Controlled Uplands and Valleys MLRA is in Wisconsin; Iowa, Minnesota, and Illinois contain the rest. This region is the only area in Wisconsin that has not been covered by glaciers within the past 2.4 million years. The Wisconsin portion of this MLRA is approximately 7.4 million acres (11,600 square miles). The landscape is characterized by dissected topography with deeply-incised, steep-walled valleys between bedrock controlled ridges.

Though it’s called the “Driftless Region”, some glacial drift is found in the major river valleys of this region in the form of outwash, deposited by proglacial streams of glacial meltwater. Wisconsin’s most recent glaciations also impacted the sediment of the area through the deposition of loess. After the glacier receded and before vegetation established, the bare surfaces of the glaciated areas were highly susceptible to wind erosion. As a result, a veneer of loess (wind-blown silt) was deposited over the entire region. The thickest deposits—nearly five meters—are on ridges near the Mississippi River and gradually thin moving eastward. The loess caps in Dane and Green counties are generally 0.5-1.5 meters deep. Much of the loess has eroded downslope and collected in floodplains.

Bedrock is shallow throughout this MLRA and is a major influence on topography and hydrology. Most of the MLRA has bedrock within two meters, except in the deep river valleys that are filled with outwash and alluvium materials. Sandstone is the dominant bedrock type in MLRA 105, but the southernmost portion is dominated by dolomite. Military Ridge is an escarpment that straddles the boundary between sandstone and dolomite bedrock. The sandstone north of the ridge is weaker than the erosion-resistant dolomite south of the ridge. The sandstone is deeply cut and dissected into steep slopes and valleys. The dolomite-controlled ridges tend to be less dissected and broader with more gentle, south sloping topography. Geomorphic and fluvial processes formed these landscapes by way of sheet wash, soil creep, and flowage. These processes eroded the hillslopes, cut into bedrock, and transported the debris to streams, forming floodplains and terraces.

Underfit streams are common in MLRA 105, especially in the southern portion. These streams currently occupy large river valleys—especially those of the Black, Chippewa, Mississippi, and Wisconsin Rivers—that were carved by proglacial meltwater streams carrying much larger quantities of water than what’s present today. As the climate dried, waterflow decreased and the valleys filled with alluvial sediment. Narrow meanders were formed by the shrinking streams and are often dissimilar to the meanders of the larger valleys they occupy. Fluvial landforms – including terraces, oxbow lakes, sandbars, eroding bluffs, and large floodplain complexes – are found within these large valleys and are subject to varying flooding frequencies, intensities, and durations.
Karst topography formed in this region from dissolution of carbonate bedrock by surface and groundwater. Dolomite and limestone are more easily affected by dissolution, but karst topography also formed in sandstone. Erosion by water (stream meanders, rain/runoff, and groundwater), wind, and frost weaken joints and bedding planes that can

cause collapse. In addition, sandstone materials collapse into cavities in underlying dolomite or limestone.

Historically, MLRA 105 was dominated by oak forests and oak openings making up more than 50% of the area. Prairies were significant and covered 32% of the area south of Military Ridge. Maple-basswood forests covered 19% of the area north of Military Ridge. Dominant tree species were white oak (Quercus alba), bur oak (Quercus macrocarpa), black oak (Quercus velutina), and sugar maple (*Acer saccharum*).

Classification relationships

Relationship to Established Framework and Classification Systems:

Habitat Types of S. Wisconsin (Kotar, 1996): *Acer saccharum*-Tilia/Desmodium [ATiDe] and *Acer saccharum*-Tilia/Desmodium(Prunus serotina) [ATiDe(Pr)].

Biophysical Settings (Landfire, 2014): This ES is largely mapped as North-Central Interior Maple-Basswood Forest, North-Central Interior Dry-Mesic Oak Forest and Woodland, Eastern Cool Temperate Developed Ruderal Deciduous Forest, Eastern Cool Temperate Pasture and Hayland, Eastern Cool Temperate Close Grown Crop, and Eastern Cool Temperate Row Crop

WDNR Natural Communities (WDNR, 2015): This ES is most similar to Southern Mesic Forest as described by the Wisconsin DNR.

Hierarchical Framework Relationships:

Major Land Resource Area (MLRA): Upper Mississippi River Bedrock Controlled Uplands and Valleys (105)

USFS Subregions: Melrose Oak Forest and Savannah (222Lb), Mississippi-Wisconsin River Ravines (222Lc), Kickapoo-Wisconsin River Ravines (222Ld)

Wisconsin DNR Ecological Landscapes: Western Coulee and Ridges

Ecological site concept

The Clayey Uplands ecological site occupies approximately 41,000 acres across MLRA 105, or about 0.6% of total land area. It is found on ridges and hills in upland positions throughout the MLRA. It is especially common to the Viroqua Ridge and Military Ridge in central MLRA 105.

This site is characterized by very deep, moderately well to well drained, clayey soils.

Associated sites

F105XY003WI	**Wet Loamy-Clayey Floodplain** These sites form in deep, loamy alluvium deposits along floodplains, especially those along smaller tributaries to the Chippewa, Black, and Wisconsin rivers. They support vegetation tolerant of seasonal flooding. They are sometimes saturated enough for hydric conditions to occur. They are found in floodplains adjacent to Clayey Upland.
F105XY008WI	**Moist Loamy-Clayey Lowland** These sites form in loamy and clayey materials, often alluvium. They have deep, dark surfaces. They are somewhat poorly drained. They are sometimes found adjacent to Clayey Upland in lower landscape positions.
F105XY013WI	**Loamy-Silty Upland** These sites form in loamy to silty materials, often silty loess and residuum. They are moderately well to well drained. They are often found adjacent to Clayey Upland.
F105XY015WI	**Shallow Clayey Upland** These sites form in clayey materials, often clayey pedisediment and residuum. They have bedrock contact within one meter of the soil surface. They are moderately well to well drained. They are sometimes found adjacent to Clayey Upland.

Similar sites

R105XY014WI	**Mollic Clayey Upland** These sites form in clayey materials, often clayey pedisediment and residuum. They are well drained. They are similar to Clayey Upland but have deeper surfaces (mollic rather than ochric epipedons).
F105XY015WI	**Shallow Clayey Upland** These sites form in clayey materials, often clayey pedisediment and residuum. They are moderately well to well drained. They are similar to Clayey Upland but have bedrock contact within one meter of the soil surface.
F105XY013WI	**Loamy-Silty Upland** These sites form in loamy to silty materials, often silty loess and residuum. They are moderately well to well drained. They are similar to Clayey Upland but have slightly coarser soil textures.
F105XY019WI	**Dry Upland** These sites form in sandy materials deposited by wind, water, gravity, or weathered from sandstone bedrock. They are well drained to excessively drained. They are similar to Clayey Upland but have coarser soil textures.

Table 1. Dominant plant species

Tree	(1) *Acer saccharum* (2) *Fraxinus americana*
Shrub	Not specified
Herbaceous	(1) *Parthenocissus quinquefolia* (2) *Amphicarpaea bracteata*

Physiographic features

These sites are found on ridges, hills, lake plains, and terraces in the summit, shoulder, or backslope position. Slope shape Is convex or linear. Slopes range from 0 to 45 percent. Elevation of the landform ranges from 705 to 1001 feet (215 to 305 meters) above sea level.

These sites are not subject to inundation by water. Evidence of a seasonally high water table is generally found below 80 inches (200 cm) of the soil surface, though it may be found higher when the water table is perched (episaturated). Runoff potential is medium to high.

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) Ridge (2) Hill (3) Terrace (4) Lake plain
Runoff class	Medium to high
Flooding frequency	None
Ponding frequency	None
Elevation	705–1,001 ft
Slope	0–45%
Water table depth	36–80 in
Aspect	Aspect is not a significant factor

Climatic features

The climate of the Upper Mississippi River Bedrock Controlled Uplands and Valleys MLRA is typical of southern Wisconsin, with warmer winters, warmer summers, and higher precipitation rates than MLRA in northern Wisconsin. The MLRA stretches over about 2.9 degrees of latitude, or nearly 200 miles, from its northern tip in Barron county to its southern Wisconsin extent on the border of Illinois. This results in considerable variation in climate throughout the MLRA. The growing season ranges from 117 to 181 growing degree days, with longer growing seasons in the southern portion.

Table 3. Representative climatic features

Frost-free period (characteristic range)	117-127 days
Freeze-free period (characteristic range)	148-171 days
Precipitation total (characteristic range)	34-37 in
Frost-free period (actual range)	117-144 days
Freeze-free period (actual range)	146-173 days
Precipitation total (actual range)	34-37 in
Frost-free period (average)	126 days
Freeze-free period (average)	156 days
Precipitation total (average)	35 in

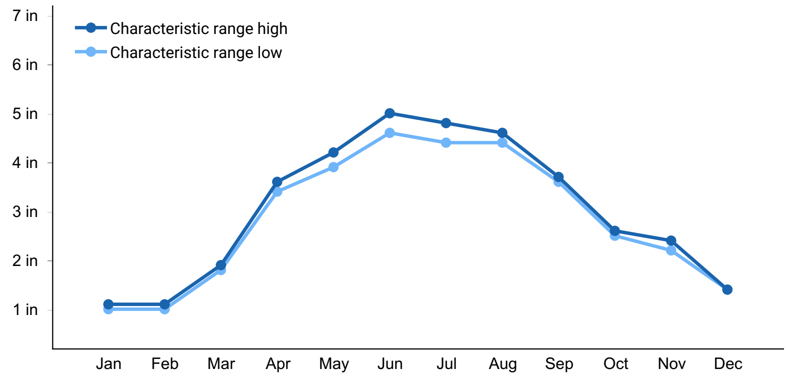


Figure 1. Monthly precipitation range

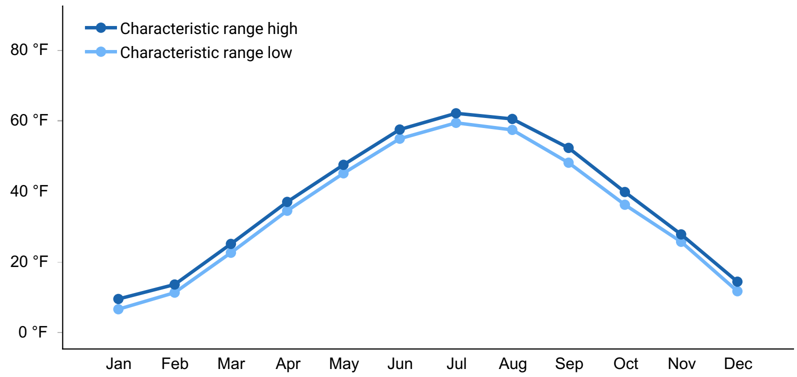


Figure 2. Monthly minimum temperature range

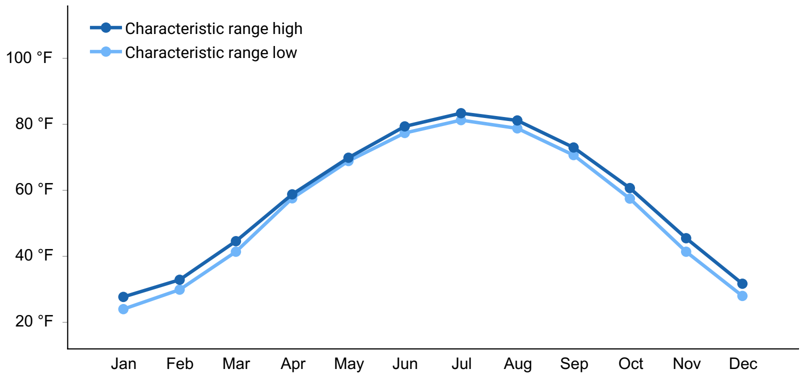


Figure 3. Monthly maximum temperature range

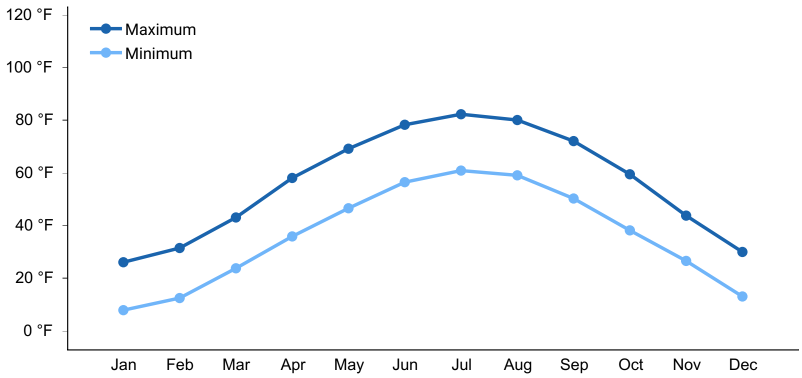


Figure 4. Monthly average minimum and maximum temperature

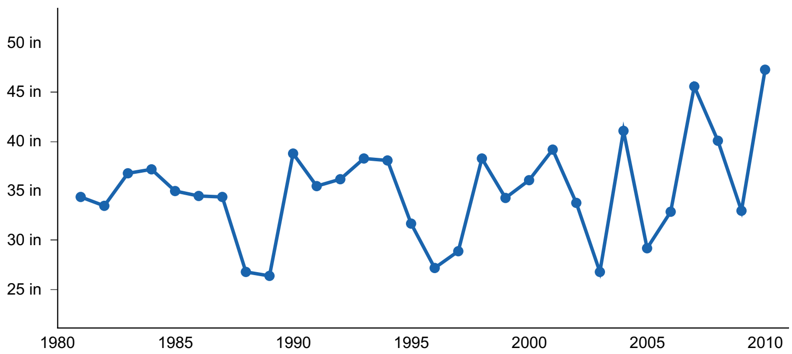


Figure 5. Annual precipitation pattern

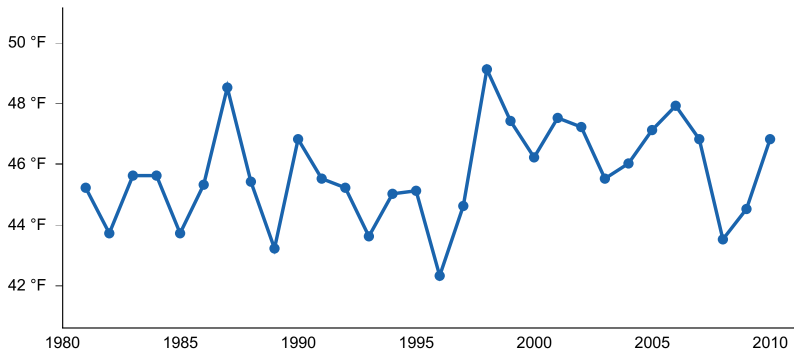


Figure 6. Annual average temperature pattern

Climate stations used

- (1) LA CROSSE WFO [USC00474373], La Crosse, WI
- (2) CASHTON [USC00471280], Cashton, WI
- (3) SPARTA [USC00477997], Sparta, WI

- (4) RICHLAND CTR [USC00477158], Richland Center, WI
- (5) REEDSBURG [USC00477052], Reedsburg, WI
- (6) HILLSBORO [USC00473654], Elroy, WI

Influencing water features

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

Permeability of the soils is impermeable to very slow. The hydrologic soil group is C.

Wetland description

Hydrogeomorphic Wetland Classification: None
Cowardin Wetland Classification: None

Soil features

This site is represented by the Lamoille, Medary, and Wildale soil series. Mollic Paleudalfs and Typic Hapludalfs each make up a little less than half of the acreage of this site. Hapludalfs make up a small amount (about 9%) of sites and are generally found in the lacustrine deposits adjacent to the outwash plains along the Mississippi and Wisconsin rivers.

These soils form in loamy and clayey deposits of alluvium, colluvium, pedisediment, and lacustrine materials. They are often capped with a loess mantle. They lack bedrock contact within two meters of the soil surface and lack a thick, dark surface layer rich in base-forming cations (mollic epipedon). They generally have subsurface accumulations of illuviated clay (argillic horizons). Subsurface fragments smaller than 3 inches in diameter (gravel) may occupy up to 22% soil volume. Larger fragments may occupy up to 30% soil volume. These fragments will often be unconsolidated, angular rocks deposited along slopes with colluviated sediment.

Soils are very strongly acid to moderately alkaline. Secondary carbonate accumulations may occupy up to 5% volume of soils that formed in clayey pedisediment derived from carbonate shale. Soils are moderately well to well drained. They do not meet hydric soil requirements.

Figure 7. Lamoille soil series sampled on 07/10/2020 in LaCrosse County, WI.

Table 4. Representative soil features

Parent material	(1) Loess (2) Pedisediment (3) Colluvium (4) Alluvium (5) Glaciolacustrine deposits (6) Dolomite
Surface texture	(1) Silt loam (2) Silty clay loam
Drainage class	Moderately well drained to well drained
Permeability class	Very slow
Soil depth	80–100 in
Surface fragment cover <=3"	0–10%
Surface fragment cover >3"	0–25%
Available water capacity (0-59.1in)	2.21–3.78 in
Calcium carbonate equivalent (0-39.4in)	0–5%
Soil reaction (1:1 water) (0-39.4in)	4.8–7.9
Subsurface fragment volume <=3" (0-39.4in)	0–22%
Subsurface fragment volume >3" (0-39.4in)	0–30%

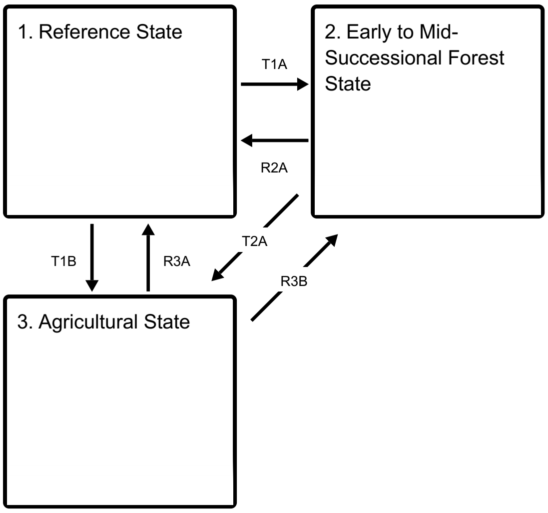
Ecological dynamics

Historically, this site was dominated by mesic hardwoods in a landscape adapted to fire disturbance that allowed for a strong presence of oaks. 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 these species adapted to fire 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 to establish under a canopy, and in time, may become a component of the canopy. Mesic hardwoods are sensitive to fire, but in its absence, the have the ability to dominate sites based on their shade tolerance and prolific seed production.

Today, these forests most commonly include stands of red oak and white oak, and other mesic hardwoods may be present as well. Some sites may have a sugar maple basswood forest, but most lack the seed source. These sites have the conditions to support shade tolerant mesic hardwoods, but historically had significant wind throw and fire disturbance that allowed for a strong presence of oak species. As long as fire is continually suppressed, maples and other mesic hardwoods will dominate the canopy.

State and transition model

Ecosystem states



T1A - Stand replacing disturbance that includes fire.

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

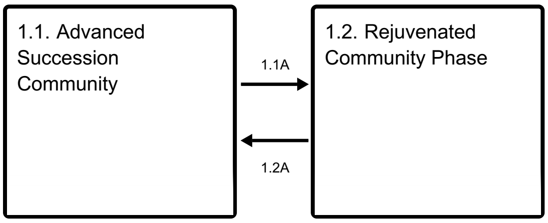
R2A - Deciduous forest community is slowly taken over by shade tolerant maples and other species.

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

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

R3B - Cessation of agricultural practices leads to natural reforestation, or site is replanted.

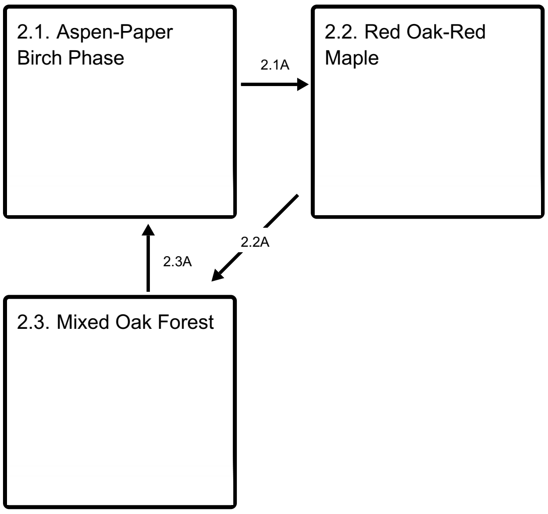
State 1 submodel, plant communities



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

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

State 2 submodel, plant communities



2.1A - Immigration and establishment of red oak and red maple.

2.2A - Immigration and establishment of red oak and red maple.

2.3A - Clear cutting or stand-replacing fire.

State 1
Reference State

Reference state is a forest community dominated by sugar maple (*Acer saccharum*) with a mixture of American basswood (*Tilia americana*), Ashes (Fraxinus spp.), and Oaks (Quercus spp.). Depending on history of disturbance, two community phases can be distinguished largely by differences in dominance of tree species and community age structure. In some places sugar maple seed source may be missing leading to other dominant canopy species.

Community 1.1
Advanced Succession Community

In the absence of any major disturbance, specifically fire, this community is dominated by Sugar maple. Common associates include American basswood, Ashes, and Oaks. Other species may be present in the canopy as well, including: Black Cherry, Red and Shagbark hickory. The shrub layer is typically not well developed in this phase, but is likely to contain regenerating overstory species. The ground layer is often sparse but includes rich site species such as Virginia creeper, Hogpeanut, and Pointedleaf Ticktrefoil.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- white ash (*Fraxinus americana*), tree
- American basswood (*Tilia americana*), tree
- Virginia creeper (*Parthenocissus quinquefolia*), other herbaceous
- American hogpeanut (*Amphicarpaea bracteata*), other herbaceous
- pointedleaf ticktrefoil (*Desmodium glutinosum*), other herbaceous

Community 1.2
Rejuvenated Community Phase

This community is dominated by a mixture of hardwoods including sugar maple, red oak, white oak, and ashes. Associates may include basswood, shagbark hickory, and black cherry. The shrub (often more developed in this phase) and ground layers are similar to the advanced succession phase, but may include the establishment of new seedlings to include more shade intolerant species. This community phase will quickly return to the mature or advanced succession phase with limited disturbance.

Dominant plant species

- sugar maple (*Acer saccharum*), tree
- northern red oak (*Quercus rubra*), tree
- white oak (*Quercus alba*), tree
- ash (*Fraxinus*), tree
- Virginia creeper (*Parthenocissus quinquefolia*), other herbaceous
- American hogpeanut (*Amphicarpaea bracteata*), other herbaceous
- pointedleaf ticktrefoil (*Desmodium glutinosum*), other herbaceous

Pathway 1.1A
Community 1.1 to 1.2

Light intensity fires, crown breakage from ice and snow and small scale blow-downs create canopy openings, allowing gap regeneration of less shade tolerant species such as white ash, red oak, and white oak. These species may join the canopy composition.

Pathway 1.2A
Community 1.2 to 1.1

A long period without major canopy disturbance allows gradual replacement of oldest canopy trees by younger cohorts. Lacking a major disturbance, the canopy will likely be replaced primarily with sugar maple. Small scale disturbances may still occur periodically, but once second or third canopies are established there is minimal new regeneration taking place and the forest gradually returns to mature state.

State 2
Early to Mid-Successional Forest State

Following disturbances described in Transition T1A a wide range of forest community phases may come into temporary existence, the three most common ones are described here. The mixed oak forest phase represents an alternative stable state in the absence of seed source of the dominant mesic hardwoods.

Dominant plant species

- quaking aspen (*Populus tremuloides*), tree
- paper birch (*Betula papyrifera*), tree
- red maple (*Acer rubrum*), tree

Community 2.1
Aspen-Paper Birch Phase

These two species have a very narrow window of environmental and ecological conditions for successful establishment. Main requirements are exposed mineral soil and elimination, most effectively by fire, of on-site seed sources of potential competing vegetation. In addition, adequate soil moisture must be available for initial seedling development. Once seedlings are firmly established, height growth of both species is relatively rapid and able to outgrow most competitive species. Paper birch seedlings and saplings tolerate partial shade and often become members of mixed species communities. This is not true for aspen which requires continuous full-sun exposure for survival. Aspen stands are initially very dense due to sprouting from extensive lateral roots, but rapid natural thinning ensues as stems compete for available light.

Dominant plant species

- quaking aspen (*Populus tremuloides*), tree
- paper birch (*Betula papyrifera*), tree

Community 2.2
Red Oak-Red Maple

This community phase occurs by invading and succeeding a pioneer aspen-birch community.

Dominant plant species

- northern red oak (*Quercus rubra*), tree
- red maple (*Acer rubrum*), tree

Community 2.3
Mixed Oak Forest

Stand structure consists of dominant white oak, red oak and red maple in combination with a modest, or strong presence of mature, or decaying, aspen and/or paper birch. A wide variety of tree species may be present with white oak, red oak and red maple in the canopy (Black cherry, Hickory, Ashes, and Elms). The shrub layer typically reaches its best development in this community phase. Depending on seed source, sugar maple has become established and a young cohort exists in the subcanopy. If sugar maple seeds are not present the site may persist in this state/phase for a long time.

Dominant plant species

- northern red oak (*Quercus rubra*), tree
- white oak (*Quercus alba*), tree
- red maple (*Acer rubrum*), tree
- quaking aspen (*Populus tremuloides*), tree
- paper birch (*Betula papyrifera*), tree
- sugar maple (*Acer saccharum*), tree
- bigleaf aster (*Eurybia macrophylla*), other herbaceous
- Canada mayflower (*Maianthemum canadense*), other herbaceous

Pathway 2.1A
Community 2.1 to 2.2

Time and the immigration, establishment, and growth of red oak and white oak seedlings. These moderately shade tolerant species seed in beneath the aspen and birch and eventually outcompete these intolerant species.

Pathway 2.2A
Community 2.2 to 2.3

Time and natural succession. Red oak and White oak have succeeded the aspen-birch community. Depending on seed source, sugar maple begins growth and establishment in the understory.

Pathway 2.3A
Community 2.3 to 2.1

Clear cutting or major fire disturbance allows for the reinvasion of the shade intolerant aspen-birch community.

State 3
Agricultural State

Indefinite period of applying agricultural practices.

Transition T1A
State 1 to 2

Transition T1A – 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

A period of some 70-100 years without major stand disturbance, especially fire, leads to decreased presence, through natural mortality, of early successional species and the dominance of shade tolerant sugar maple with less tolerant associates of red oak and white ash, returning the community to Reference State.

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.

Restoration pathway R3B
State 3 to 2

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

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 of 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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Approval

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NRCS contracted UWSP to write ecological sites in MLRA 105. 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	04/25/2024
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:**