USDA Natural Resources Conservation Service

Ecological site F090AY018WI
Dry Sandy Bedrock Uplands

Last updated: 10/02/2023
Accessed: 04/27/2024

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: Rosemont Baldwin Plains and Moraines (222Md)

Wisconsin DNR Ecological Landscapes: Western Prairie

Ecological site concept

The Dry Sandy Bedrock Uplands ecological site is an uncommon site in MLRA 90A but may be found in southwest portion, located on hills, till plains, and stream terraces. It's found primarily in St. Croix and Pierce counties where bedrock is relatively shallow. These sites are characterized by moderately deep, somewhat excessively to excessively drained soils that formed in sandy alluvium, sandy till, and sandy residuum. Precipitation and runoff from adjacent uplands are the primary water sources. Soils range from extremely acid to moderately acid.

Dry Sandy Bedrock Uplands is distinguished from other ecological sites based on somewhat excessive to excessive drainage and a moderately deep profile. Other somewhat excessively and excessively drained sands have soils that are greater than 80 inches in depth. The underlying bedrock perches the water table and can cause limitations to growth, acting as a root restricting layer. These sites are more vulnerable to tree tips. Other somewhat excessively and excessively drained sites have loamy deposits. Sands have lower pH and available water capacity than loamy sites, which can limit vegetative growth.

Associated sites

F090AY013WI	**Sandy Upland** Sandy Upland 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 somewhat wetter and occur lower on the drainage sequence than Dry Sandy Bedrock Uplands.
F090AY019WI	**Dry Sandy Upland** Dry Sandy Uplands consist of primarily sandy deposits of various origin. Loamy deposits are also present in many soils. They may have a seasonally high water table within two meters of the surface, though they do not remain saturated for sustained periods. They may be found adjacent to Dry Sandy Bedrock Uplands.

Similar sites

F090AY020WI	**Dry Loamy Bedrock Upland** Dry Loamy Bedrock Upland consist of silty loess, sometimes underlain by loamy till. Basalt or quartzite bedrock typically occurs within one meter of the surface. These soils show no evidence of a seasonally high water table. They occur in similar landscape positions and share both drainage class and bedrock contact with Dry Sandy Bedrock Uplands but have finer particle sizes.
F090AY019WI	**Dry Sandy Upland** Dry Sandy Uplands consist of primarily sandy deposits of various origin. Loamy deposits are also present in many soils. They may have a seasonally high water table within two meters of the surface, though they do not remain saturated for sustained periods. They occur in similar landscape positions and share both drainage class and particle size with Dry Sandy Bedrock Uplands but lack bedrock contact within two meters of the surface.

Table 1. Dominant plant species

Tree	(1) *Pinus strobus* (2) *Quercus rubra*
Shrub	(1) *Rubus*
Herbaceous	(1) *Circaea ×intermedia* (2) *Parthenocissus quinquefolia*

Physiographic features

These sites formed on hills, till plains, and stream terraces. Slopes range from 0 to 50 percent. Sites are on summit, shoulder, and backslope positions.

These sites are not subject to ponding or flooding. They show no evidence of a seasonally high water table within 80 inches. Surface runoff is very low 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) Till plain (2) Stream terrace (3) Hill
Runoff class	Very low to high
Flooding frequency	None
Ponding frequency	None
Elevation	755–902 ft
Slope	0–50%
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 53°F and 34°F, respectively.

Table 3. Representative climatic features

Frost-free period (characteristic range)	91-114 days
Freeze-free period (characteristic range)	120-139 days
Precipitation total (characteristic range)	29-33 in
Frost-free period (actual range)	44-117 days
Freeze-free period (actual range)	88-147 days
Precipitation total (actual range)	28-35 in
Frost-free period (average)	93 days
Freeze-free period (average)	126 days
Precipitation total (average)	31 in

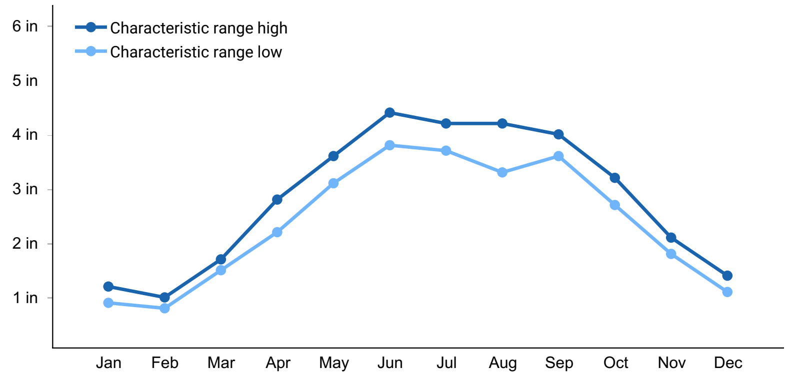


Figure 1. Monthly precipitation range

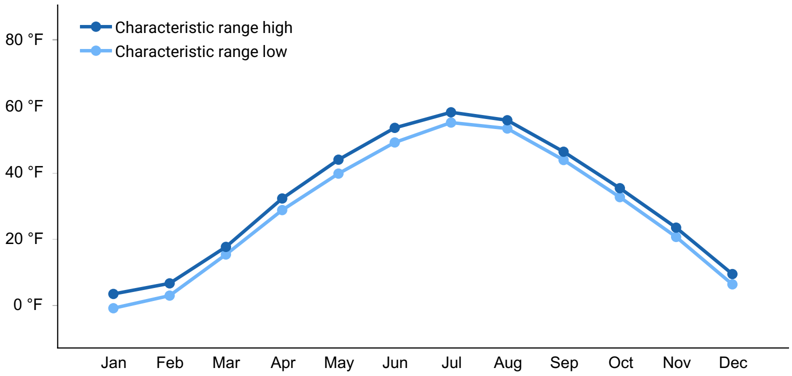


Figure 2. Monthly minimum temperature range

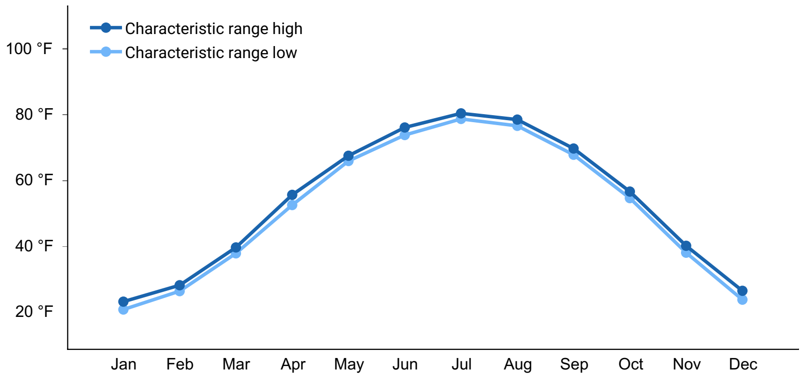


Figure 3. Monthly maximum temperature range

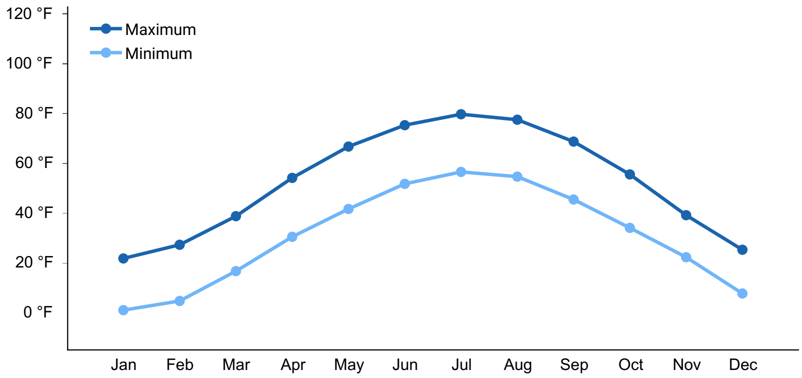


Figure 4. Monthly average minimum and maximum temperature

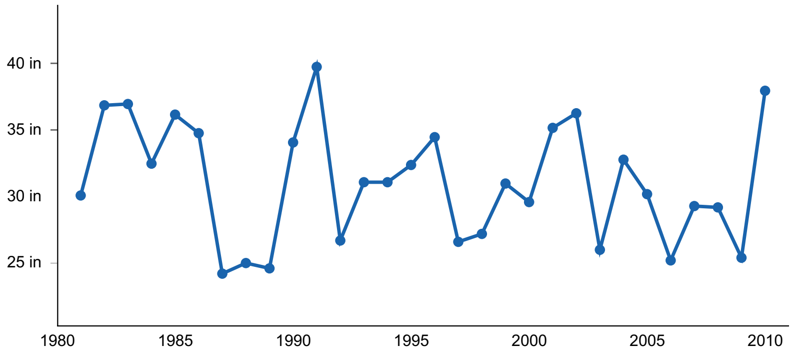


Figure 5. Annual precipitation pattern

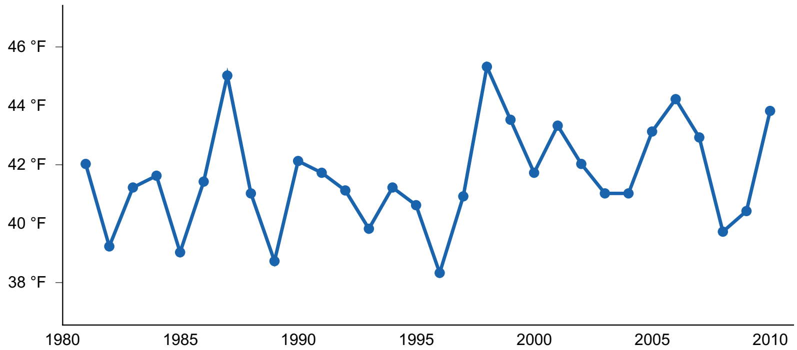


Figure 6. Annual average temperature pattern

Climate stations used

- (1) HOLCOMBE [USC00473698], Holcombe, WI
- (2) ROSHOLT 9 NNE [USC00477349], Wittenberg, WI
- (3) STAMBAUGH 2SSE [USC00207812], Iron River, MI

- (4) BIG FALLS HYDRO [USC00470773], Glen Flora, WI
- (5) COUDERAY 7 W [USC00471847], Stone Lake, WI
- (6) ISLE 12N [USC00214103], Isle, MN
- (7) MILACA [USC00215392], Milaca, MN
- (8) LAKEWOOD 3 NE [USC00474523], Lakewood, WI
- (9) MINONG 5 WSW [USC00475525], Minong, WI
- (10) AMERY [USC00470175], Amery, WI
- (11) BRUNO 7ENE [USC00211074], Bruno, 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 leaves the site primarily through runoff, evapotranspiration, and groundwater recharge. Subsurface flow may occur where water perches on bedrock.

Wetland description

Permeability of these sites is slow to rapid.
Hydrologic Group: A, B
Hydrogeomorphic Wetland Classification: None
Cowardin Wetland Classification: None

Soil features

These sites are represented by the Boone and Ishpeming soil series, classified as Typic Quartzipsamments and Entic Haplorthods, respectively.

These soils formed in sandy residuum and sandy alluvium. Soils are moderately deep with bedrock occurring between 23 and 35 inches. Soils are somewhat excessively or excessively drained. They do not meet hydric soil requirements.

Surface textures are primarily loamy fine sand moderately decomposed plant material. Subsurface textures include sandy loam, loamy sand, and sand. Some horizons have fine sands. Soil pH ranges from very strongly acid to strongly acid with values of 4.6 to 5.5. . Carbonates are absent within 80 inches.

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

Table 4. Representative soil features

Parent material	(1) Alluvium (2) Eolian deposits (3) Lacustrine deposits (4) Till (5) Outwash (6) Drift (7) Sandstone (8) Igneous and metamorphic rock
Surface texture	(1) Loamy sand (2) Sandy loam (3) Loam (4) Silt loam
Drainage class	Moderately well drained to well drained
Permeability class	Very slow to moderately rapid
Depth to restrictive layer	23–35 in
Soil depth	79–98 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0–5%
Available water capacity (0-61in)	1.11–4.98 in
Calcium carbonate equivalent (0-39.4in)	0%
Soil reaction (1:1 water) (0-39.4in)	4.6–5.5
Subsurface fragment volume <=3" (Depth not specified)	7–10%
Subsurface fragment volume >3" (Depth not specified)	0–3%

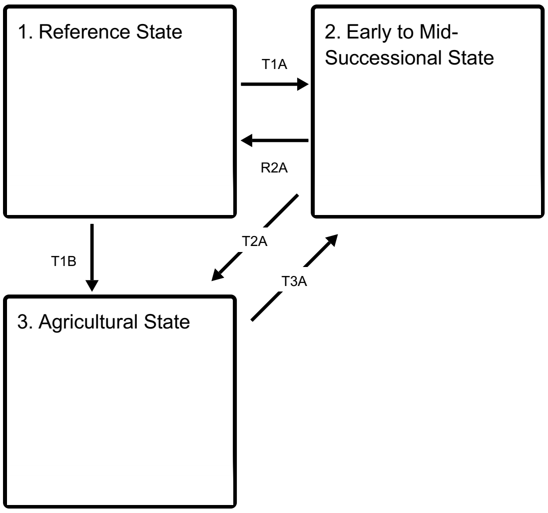
Ecological dynamics

A unique feature of dry, nutrient poor sites such as this ES is that they do not support the highly shade tolerant species Sugar maple, American beech, Basswood, American hophornbeam, and hemlock.

Though similar to Dry Sandy Uplands this site is likely to have lower net primary production and a more open canopy due to bedrock restricting roots and a reduction in available water and nutrients due to the shallower soil profile. Additionally it may be less likely to contain successful Red maple in the Reference State. This ES is also less likely to be in the Advanced Succession Phase of the Reference State, as compared to Dry Sandy Uplands, due to being prone to blow downs.

State and transition model

Ecosystem states



T1A - Major stand replacing disturbance such as blow-down or clear-cutting in conjunction with fire.

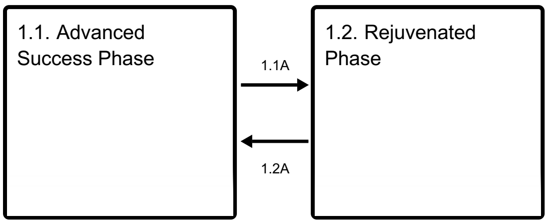
T1B - Removal of forest vegetation and tilling.

R2A - Disturbance-free period 70+ years.

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

T3A - Cessation of agricultural practices, natural, or artificial afforestation.

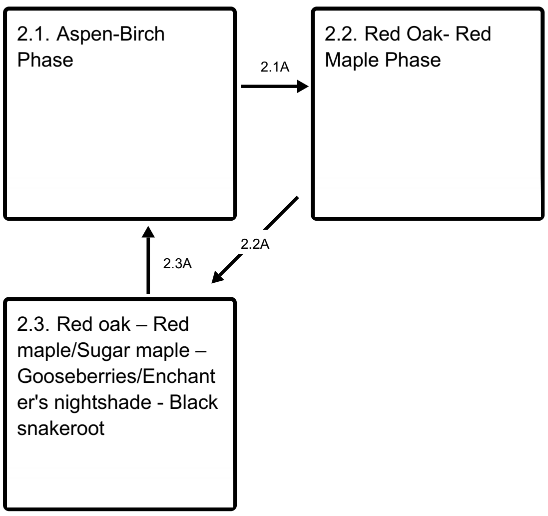
State 1 submodel, plant communities



1.1A - Natural mortality in the oldest age classes, sporadic small-scale blow-downs and ice storms, or low intensity fire create openings for entry of younger trees

1.2A - Time and natural succession. No fire or long fire return interval with low intensity fire.

State 2 submodel, plant communities

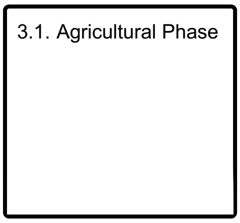


2.1A - Red oak and red maple regenerating under aspen -- paper birch canopy

2.2A - Time and natural succession. No fire or long fire return interval with low intensity fire.

2.3A - Clear cutting or stand-replacing fire.

State 3 submodel, plant communities



State 1
Reference State

Tree species on these sites are mostly fire adapted and it is likely that the intensity and frequency of fires controlled the plant community composition in presettlement time. It is likely though that the same species, perhaps with the exception of Jack pine, could maintain themselves on these sites. White pine would have likely dominated these sites in the advanced reference state. Red maple would be less likely with more frequent or higher intensity fire.

Community 1.1
Advanced Success Phase

Common forest cover types include mixtures of White oak, Black oak, Pin oak, and White pine. Jack pine may be present and is more likely with greater prevalence of fire. Red maple and Black cherry may also be common, but the latter does not usually develop to its full potential. The shrub layer (commonly present) most likely includes gray dogwood, Choke cherry, Service berry, and hazelnuts along with blackberries and raspberries. Ground flora is usually sparse but may include Wild sarsaparilla, Solomon’s seal, and Virginia creeper.

Dominant plant species

- eastern white pine (*Pinus strobus*), tree
- northern red oak (*Quercus rubra*), tree
- black cherry (*Prunus serotina*), shrub
- blackberry (*Rubus*), shrub
- enchanter's nightshade (*Circaea ×intermedia*), other herbaceous
- Virginia creeper (*Parthenocissus quinquefolia*), other herbaceous

Community 1.2
Rejuvenated Phase

This community is often dominated by White pine and red oak. While similar to the Advanced Succession Phase there are likely to be some openings in the canopy. The shrub and ground layers are similar to the advanced succession phase, but may include the establishment of new seedlings and the presence of box elder and red elderberry where there are small canopy openings.

Dominant plant species

- eastern white pine (*Pinus strobus*), tree
- northern red oak (*Quercus rubra*), tree
- blackberry (*Rubus*), shrub
- red elderberry (*Sambucus racemosa*), shrub
- enchanter's nightshade (*Circaea ×intermedia*), other herbaceous
- Virginia creeper (*Parthenocissus quinquefolia*), 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, releasing advance regeneration and stimulating new seedling establishment. Some additional less shade tolerant species such as red oak may be able to enter the community.

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 with White pine, but red oak can compete to maintain its place in the canopy. 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 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.

Community 2.1
Aspen-Birch Phase

These two species have a very narrow window of environmental and ecological conditions for successful establishment. The 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 Phase

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

This community phase occurs by invading and succeeding a pioneer aspen-birch community. Stand structure consists of dominant red oak and red maple in combination with a modest, or strong presence of mature, or decaying, aspen and/or paper birch. The shrub layer, dominated by beaked hazelnut (*Corylus cornuta*), typically reaches its best development in this community phase.

Dominant plant species

- northern red oak (*Quercus rubra*), tree

- red maple (*Acer rubrum*), tree

Community 2.3
Red oak – Red maple/Sugar maple – Gooseberries/Enchanter's nightshade - Black snakeroot

This community phase represents a distinct transition into mid-successional state, by strong presence in second canopy, or in reproductive layers, White pine and possibly of Sugar maple. This phase also includes the development of understory plants in greater abundance.

Dominant plant species

- northern red oak (*Quercus rubra*), tree
- red maple (*Acer rubrum*), tree
- sugar maple (*Acer saccharum*), tree
- Missouri gooseberry (*Ribes missouriense*), shrub
- enchanter's nightshade (*Circaea ×intermedia*), other herbaceous
- Virginia creeper (*Parthenocissus quinquefolia*), other herbaceous

Pathway 2.1A
Community 2.1 to 2.2

Time and the immigration, establishment, and growth of red oak and red maple 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

These two community phase pathways both require the passage of time without disturbance. In this case allowing for full canopy development.

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. Primary crops include row crops, hay, and pasture.

Community 3.1
Agricultural Phase

Sites phase consists of various crops being grown. Agricultural pactices such as tillage are likely in use in this phase. Crops may include row crops, hay, and pasture.

Transition T1A
State 1 to 2

Clear cutting with initial control of competing vegetation, or stand-replacing fire, prepare the site for occupancy by shade intolerant species. This may occur through natural regeneration or by 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

This pathway relies on natural succession with only minor disturbances for 70+ years to allow full canopy development. Particularly this pathway is allowing for the regeneration and growth of a White pine super canopy and greater development of the understory species present.

Transition T2A
State 2 to 3

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

Transition T3A
State 3 to 2

Abandonment of agricultural practices and allowing natural vegetation to colonize the site or apply artificial afforestation. Whether re-vegetation or planting is allowed it is likely to require over 100 years to return to the reference state via the early to mid-successional state.

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 one habitat types: Pinus/Vaccinium-Cornus (PVCr)

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, North-Central Interior Dry Oak Forest and Woodland, and Eastern Cool Temperate Pasture and Hayland

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Approval

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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	04/27/2024
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:**