USDA Natural Resources Conservation Service

Ecological site F090AY019WI
Dry Sandy Upland

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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: Glidden Loamy Drift Plain (212Xa), Hayward Stagnation Moraines (212Xf), St. Croix Moraine (212Qa), Lincoln Formation Till Plain - Mixed Hardwoods (212Qb), Green Bay Lobe Stagnation Moraine (212Ta), Brule and Paint Rivers Drumlinized Ground Moraine (212Xc), Rosemont Baldwin Plains and Moraines (222Md), Rib Mountain Rolling Ridges (212Qd)

Small sections occur in Central-Northwest Wisconsin Loess Plains (212Xd), Perkinstown End Moraine (212Xe), Mille Lacs Uplands (212Kb), Lincoln Formation Till Plain - Hemlock Hardwoods (212Qc), Bayfield Sand Plains (212Ka), Crystal Falls Till and Outwash (212Xq), Athelstane Sandy Outwash and Moraines (212Tc)

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

Ecological site concept

The Dry Sandy Uplands ecological site is scattered throughout the MLRA 90A, located on primarily on outwash plains but may also be found on lake plains, eskers, kames, drumlins, hills, and stream terraces. These sites are characterized by very deep, somewhat excessively to excessively drained soils that formed primarily in sandy deposits including alluvium, outwash, till and eolian. Precipitation and runoff from adjacent uplands are the primary sources of water. Soils range from extremely acid to neutral.

Dry Sandy Uplands is distinguished from other ecological sites based on the deep sandy deposits and drainage. This site lacks the underlying bedrock found Dry Sandy Bedrock Uplands. Sandy materials often have lower pH and available water capacity, and often lack carbonates found in loamy materials. These conditions can limit vegetative growth.

Associated sites

F090AY009WI	**Moist Sandy Upland** Moist Sandy Lowland primarily consist of deep, sandy deposits from outwash, alluvium, lacustrine, and till. They sandy deposits may have a loamy mantle or be underlain by loamy deposits. The finer materials can cause episaturation and allow the site to remain moist for some of the growing season. These sites are wetter and occur lower on the drainage sequence than Dry Sandy Uplands.
F090AY001WI	**Poor Fen** Poor Fens sites consist of deep herbaceous organic materials. Some sites have mineral soil contact. They are very poorly drained and remain saturated throughout the year. They are strongly to extremely acidic. These sites are permanently saturated wetlands. These sites are much wetter and occur lower on the drainage sequence than Dry Sandy Uplands.

F090AY005WI	**Wet Sandy Lowland** Wet Sandy Lowland consist of deep sandy deposits derived from a mixture of outwash, alluvium, and lacustrine sources. They form in seasonally ponded depressions and are saturated long enough for hydric conditions to occur. Some sites are wetlands. These sites are much wetter and occur lower on the drainage sequence than Dry Sandy Uplands.
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. These sites are somewhat wetter and occur lower on the drainage sequence than Dry Sandy Uplands.

Similar sites

F090AY018WI	**Dry Sandy Bedrock Uplands** Dry Sandy Bedrock Upland consist sandy alluvium or outwash, sometimes underlain by sandy residuum. Contact with igneous or sandstone bedrock typically occurs within one meter of the surface. These soils show no evidence of a seasonally high water table. They are found in similar landscape positions and share both drainage class and particle size with Dry Sandy Uplands but have bedrock contact within two meters of the surface.
F090AY021WI	**Dry Loamy Upland** Dry Loamy Upland consist of deep sandy to loamy outwash, alluvium, or till. The water table is deeper than two meters year-round. They are found in similar landscape positions and share their drainage class with Dry Sandy Uplands but have finer particle sizes.

Table 1. Dominant plant species

Tree	(1) *Pinus strobus* (2) *Quercus rubra*
Shrub	(1) *Corylus cornuta* (2) *Prunus serotina*
Herbaceous	(1) *Eurybia macrophylla* (2) *Pteridium*

Physiographic features

These sites formed on outwash plains, lake plains, eskers, kames, drumlins, hills, and stream terraces. Slopes range from 0 to 55 percent. Sites are positioned on summit, shoulder backslope positions.

These sites are not subject to ponding or flooding. Sites have a seasonally high water table at depths of 40 to 80 inches. The water table can drop below 80 inches during dry conditions. Surface runoff ranges from negligible to high. The range in surface runoff is caused by the wide range in slope percent across the sites.

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) Outwash plain (2) Lake plain (3) Esker (4) Kame (5) Drumlin (6) Hill (7) Stream (8) Terrace

Runoff class	Negligible to high
Flooding frequency	None
Ponding frequency	None
Elevation	170–305 m
Slope	0–55%
Water table depth	102–203 cm
Aspect	Aspect is not a significant factor

Climatic features

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

The average annual precipitation for this ecological site is 32 inches. The average annual snowfall is 53 inches. The annual average maximum and minimum temperatures are 53°F and 32°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)	737-838 mm
Frost-free period (actual range)	44-117 days
Freeze-free period (actual range)	88-147 days
Precipitation total (actual range)	711-889 mm
Frost-free period (average)	93 days
Freeze-free period (average)	126 days
Precipitation total (average)	787 mm

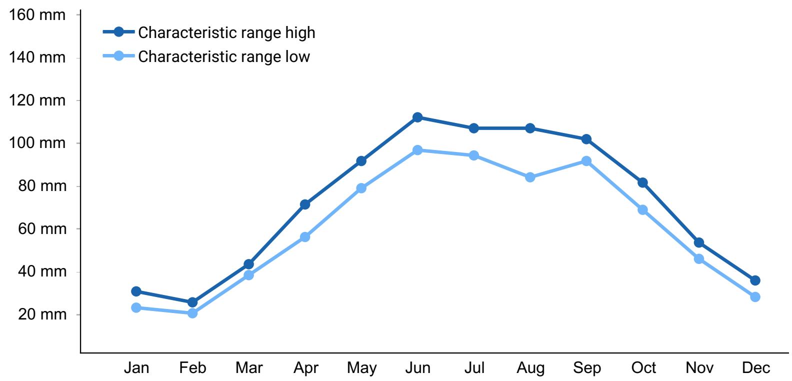


Figure 1. Monthly precipitation range

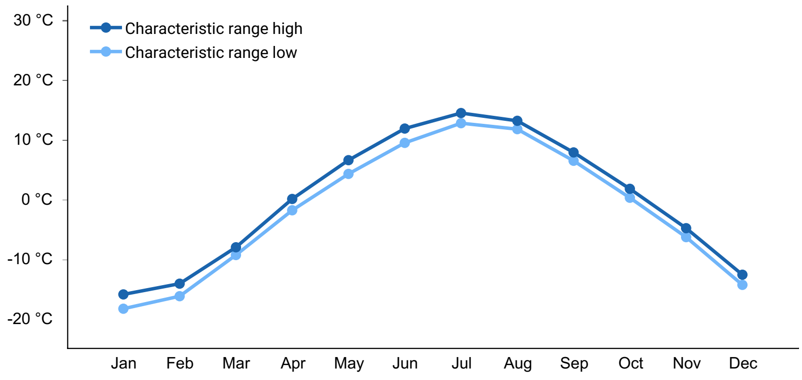


Figure 2. Monthly minimum temperature range

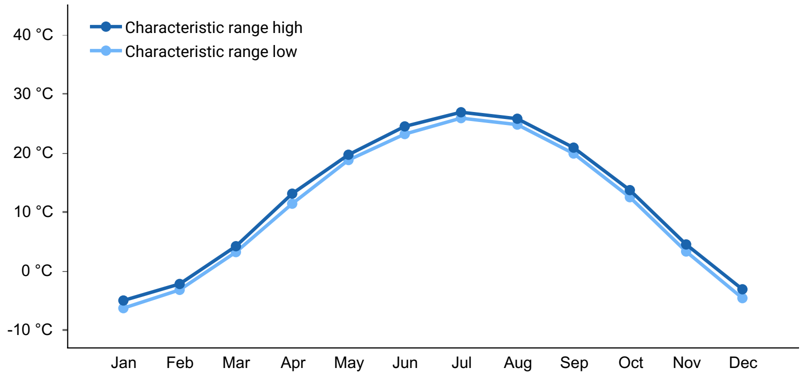


Figure 3. Monthly maximum temperature range

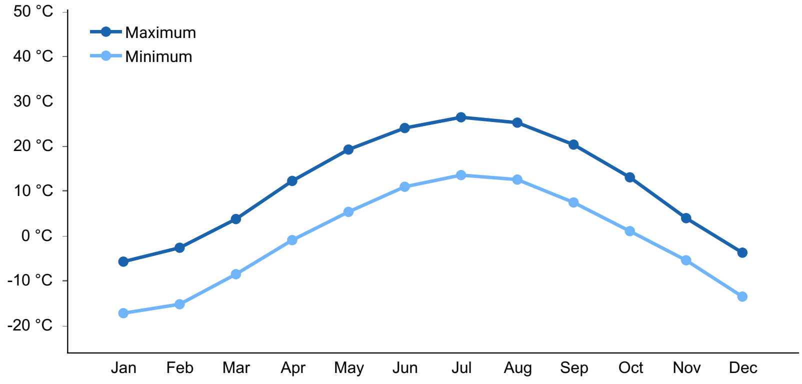


Figure 4. Monthly average minimum and maximum temperature

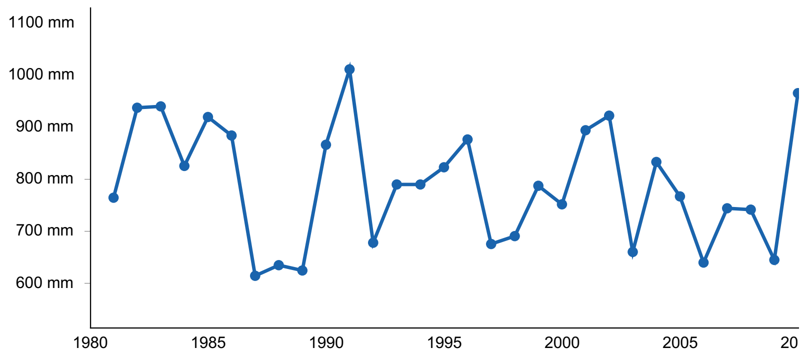


Figure 5. Annual precipitation pattern

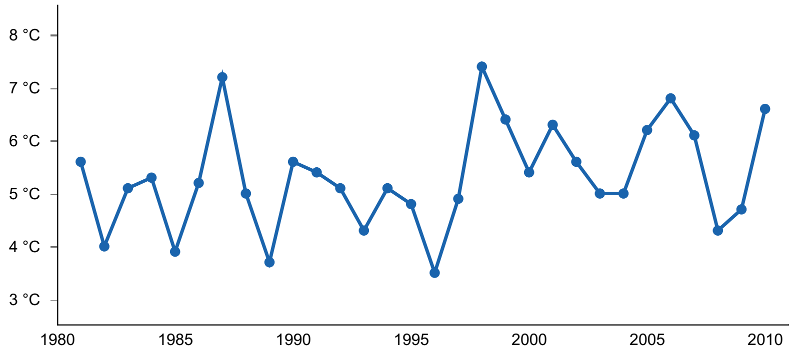


Figure 6. Annual average temperature pattern

Climate stations used

- (1) 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.

Wetland description

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

Soil features

These sites are represented by the Burkhardt, Cress, Cromwell, Drammen, Duelm Variant, Elderon, Emmert, Graycalm, Hubbard, Karlin, Lilah, Lindquist, Mahtomedi, Menahga, Moberg, Nymore, Omega, Pelissier, Pence, Plainfield, Rosholt, Sayner, Udorthents, and Vilas soil series. Burkhardt is classified as a Typic Hapludoll; Duelm variant is an Aquic Hapludoll; Karlin, Plissier, Rubicon, Sayner, and Vilas are classified as Entic Haplorthods; Hubbard is an Entic Hapludoll; Cress is a Humic Dystrudept; Lindquist is Lamellic Haplorthod; Drammen is a Lamellic Hapludalf; Graycalm is a Lamellic Udipsamment; Lilah is a Psammentic Hapludalf; Cromwell, Elderon, and Moberg are Typic Dystrudepts; Omega and Pence are Typic Haplorthods; Mahtomedi, Menahga, Nymore, Plainfield, and Rosholt are Typic Udipsamments; Emmert is a Typic Udorthent.

These soils formed in various parent materials including sandy or loamy alluvium; sandy, loamy, and gravelly outwash; sandy, loamy, gravelly, and cobbly drift; loamy till; and eolian sand. Soils are very deep, and somewhat excessively or excessively drained. They do not meet hydric soil requirements.

Surface texture is sandy loam, silt loam, loamy sand, sand, and slightly to highly decomposed plant material. Some surface horizons have a fine sand or gravelly modifier. Subsurface textures are sandy loam, silt loam, loamy sand,

and sand. Some horizons have fine sand, gravelly, very gravelly, extremely gravelly, very cobbly, or extremely cobbly modifiers. Soil pH ranges from very strongly acid to slightly acid with values of 4.6 to 6.9. Carbonates may be present up to 8 percent beginning at 17 inches.

Figure 7. Mahtomedi soil series photograph courtesy of UWSP taken on 7/22/2019 in Chippewa County, WI.

Table 4. Representative soil features

Parent material	(1) Alluvium (2) Eolian deposits (3) Till (4) Outwash
Surface texture	(1) Loamy sand (2) Sandy loam (3) Loam (4) Silt loam (5) Sand
Drainage class	Somewhat excessively drained to excessively drained
Permeability class	Slow to rapid
Soil depth	203–254 cm
Surface fragment cover <=3"	0–8%
Surface fragment cover >3"	0–5%
Available water capacity (0-152.4cm)	1.19–6.27 cm
Calcium carbonate equivalent (0-101.6cm)	0–8%
Soil reaction (1:1 water) (0-101.6cm)	4.6–6.9
Subsurface fragment volume <=3" (Depth not specified)	0–45%
Subsurface fragment volume >3" (Depth not specified)	0–30%

Ecological dynamics

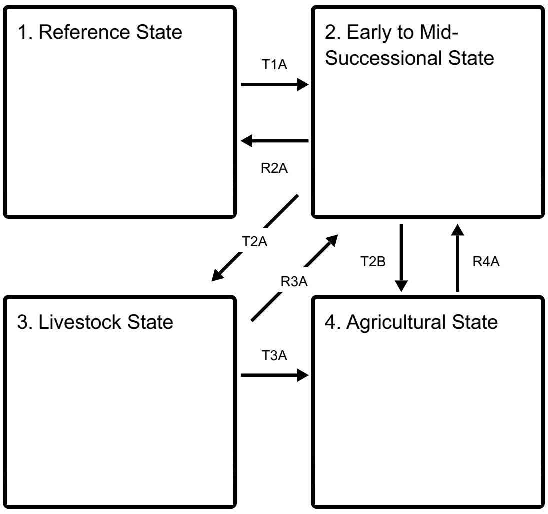
Perhaps the most important ecological characteristic of this Ecological Site, in terms of its influence on forest community dynamics, is its lack of capacity to support the high to moderate soil moisture and nutrient requiring species such as sugar maple, basswood and white ash, the shade-tolerant species, that typically dominate the more productive sites throughout Wisconsin.

In pre-European settlement time wild fire 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. White pine is best adapted for long-term success on this Ecological Site. Although vulnerable to damage or elimination by fire in early life it eventually develops thick fire-resistant bark which helps to extend its longevity, in some cases for up to four centuries or more. These survival properties assure the species' relatively continuous seed source in the region as a whole. White pine is also moderately shade-tolerant in early life which means that it can become established in some pioneer communities, such as aspen – white birch stands, or in poorly stocked oak and red maple dominated communities. Red pine had in the past been a common associate of white pine stands. It shares some of the fire-resisting properties of white pine, but it lacks shade-tolerance and does not become established in the understory. For this reason, it has not maintained its presence in current stands and its seed source has been greatly reduced throughout its natural range following the unset of fire suppression.

Red maple has not been identified by Finley (1976) as an important component of pre-settlement pine or oak forests, but it is a prominent member in current stands. Absence of fire since the original logging era is probably the main reason. Red maple is extremely sensitive to fire, but is a prolific and early seed producer. Stems of 2-4 inches in diameter can produce large amounts of seed (USDA For. Serv. 1990). It is sufficiently shade-tolerant to become established in the understories of most communities on sandy soils. On this Ecological Site it behaves similarly to white pine, but because of its much smaller size at maturity, it does not compete with white pine in the upper canopy.

State and transition model

Ecosystem states



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

R2A - Disturbance-free period 70+ years.

T2A - Grazing by livestock.

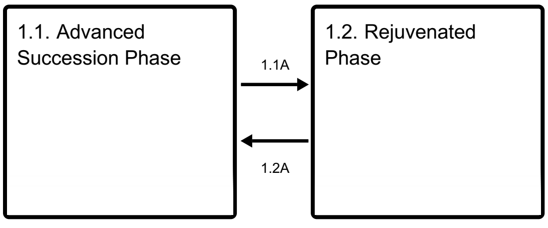
T2B - Removal of forest vegetation and tilling.

R3A - Removal of livestock grazing.

T3A - Removal of vegetation and tilling.

R4A - Cessation of agricultural practices, natural or artificial afforestation.

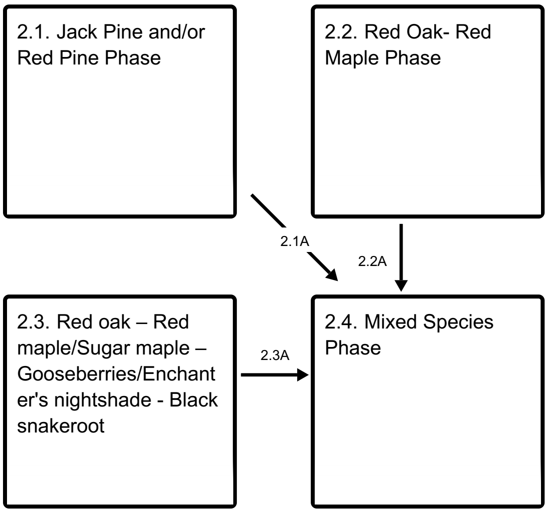
State 1 submodel, plant communities



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

1.2A - Disturbance-free period 30+ years

State 2 submodel, plant communities

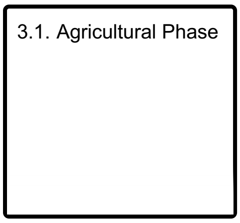


2.1A - Immigration and establishment of white pine and red maple.

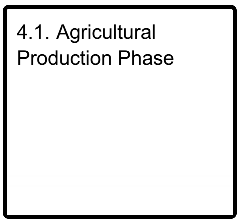
2.2A - Immigration and establishment of white pine and red maple.

2.3A - Immigration and establishment of white pine and red maple.

State 3 submodel, plant communities



State 4 submodel, plant communities



State 1
Reference State

In absence of stand-leveling disturbances the Reference State Community oscillates between two easily definable community phases, a mature, or late successional, community phase and a rejuvenated community phase.

Community 1.1
Advanced Succession Phase


Figure 8. Photo courtesy of UWSP taken on 7/22/2019 in Chippewa County, WI.

A mature forest community contains a super-canopy, or a scattering, of large white pine trees. In pre-European settlement time such trees would have been anywhere from 80 to more than 300 years old (Sterns, 1950). Common associates have been red pine (P. resinosa), red oak (Q. rubra) and white oak (Q. alba). However, only white pine and white oak are moderately shade-tolerant and able to reproduce in small canopy openings and remain as permanent members of mature community in absence of moderate to severe disturbance. Red maple (*Acer rubrum*) had not been an important species in pre-settlement forests, but is today the most successful reproducing tree species in forest communities on this Ecological Site.

Dominant plant species

- eastern white pine (*Pinus strobus*), tree
- northern red oak (*Quercus rubra*), tree
- red maple (*Acer rubrum*), tree
- black cherry (*Prunus serotina*), shrub
- beaked hazelnut (*Corylus cornuta*), shrub
- bigleaf aster (*Eurybia macrophylla*), other herbaceous
- brackenfern (*Pteridium*), other herbaceous

Community 1.2
Rejuvenated Phase

Figure 9. Photo courtesy of UWSP taken on 8/1/2019 in Winnebago County, WI.

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
- red maple (*Acer rubrum*), tree
- black cherry (*Prunus serotina*), shrub
- beaked hazelnut (*Corylus cornuta*), shrub
- bigleaf aster (*Eurybia macrophylla*), other herbaceous
- brackenfern (*Pteridium*), other herbaceous

Pathway 1.1A
Community 1.1 to 1.2

Advanced Succession Phase

Rejuvenated Phase

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

Rejuvenated Phase

Advanced Succession Phase

A long period without major canopy disturbance allows gradual replacement of oldest canopy trees by younger cohorts. 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

Post-logging state may consist of considerable diversity of pioneer and mid-successional community phases. Here we are describing four, most commonly found under current conditions.

Community 2.1
Jack Pine and/or Red Pine Phase

Jack pine and red pine have historically been almost entirely dependent on fire for regeneration. Jack pine is a predominantly a northern species and in southern part of Wisconsin seldom approaches its growth potential. Everywhere it occurs it is a pronounce pioneer, highly light demanding and resistant to drought and frost. It has low requirements for soil organic matter and nutrients. It is a prolific producer of seed and it often colonizes burnt over areas. Forest fires speed natural regeneration by opening the cones. However, today, jack pine is regenerated mostly by planting. Without disturbance jack pine does not regenerate and is readily succeeded by various species, even those of only moderate shade tolerance, such as white pine and red oak. Historically, red pine has often occurred in mixtures with jack pine. In terms of light, soil moisture and nutrient requirements it is intermediate between jack and white pines. In contrast to jack pine, natural red pine regeneration is often found in moderately dense pure or mixed pine stands, although not to the same extent as is white pine. Under current ecological and economic conditions red pine is regenerated almost entirely by planting.

Dominant plant species

- jack pine (*Pinus banksiana*), tree
- red pine (*Pinus resinosa*), tree

Community 2.2
Red Oak- Red Maple Phase

Although a ubiquitous species, quaking aspen (*Populus tremuloides*) is far more characteristic of northern rather than southern forest regions. Its most notable ecological characteristic is the ability to rapidly invade cut-over and burned-over areas. However, its perpetuation depends entirely on recurrence of disturbance. Because of its extreme intolerance to shade, it is readily replaced by many tree species in the absence of disturbance. Once in place, aspen reproduces entirely by sprouting from extensive, superficial root systems (root suckering). Most aspen stands on this Ecological Site resulted from sprouting following clear cutting of mixed stands of pine and/or oak, in which some aspen trees were still present. Paper birch (*Betula papyrifera*) is often a member of aspen stands. It shares aspen's intolerance of shade and also produces small, winged seeds that readily disperse by wind. It does not sucker from root sprouts, but it readily sprouts from stumps upon clear cutting. It also has greater ability than does aspen of reproducing from seed under favorable seedbed conditions and in presence of large canopy openings. However in absence of disturbance it also succeeds to other species.

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

Community 2.4
Mixed Species Phase

Figure 10. Photo courtesy of UWSP taken on 7/26/2019 in Barron County, WI.

This community phase is considered a mid-successional community between the pioneering communities 2.1, 2.2, 2.3 and the Reference State. The community is characterized by canopy dominance of any of the early - succession species (i.e.: oaks, aspen - birch, jack pine) and strong presence in the understory of white pine and/or red maple seedlings and saplings.

Dominant plant species

- eastern white pine (*Pinus strobus*), tree
- quaking aspen (*Populus tremuloides*), tree
- northern red oak (*Quercus rubra*), tree

- red maple (*Acer rubrum*), tree

Pathway 2.1A
Community 2.1 to 2.4

Immigration and establishment of white pine and red maple.

Pathway 2.2A
Community 2.2 to 2.4

Immigration and establishment of white pine and red maple.

Pathway 2.3A
Community 2.3 to 2.4

Immigration and establishment of white pine and red maple.

State 3
Livestock State

Livestock grazed forests are more often referred to as woodlands rather than forests because this long-term land use significantly changes some soil characteristics and nature of vegetative community. Species composition is altered by selective browsing and grazing as well as by distribution of seeds and other propagules by grazing animals. In addition, soil compaction differentially affects germination and establishment of plant species, including trees.

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.

State 4
Agricultural State

Indefinite period of applying agricultural practices, such as tilling and irrigation.

Community 4.1
Agricultural Production Phase

This community phase is characterized by row crop production using tillage and potentially irrigation. In some instances there may be hay production or permanent pasture as well.

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.

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 relatively shade tolerant white pine and sub-canopy of red maple, returning the community to Reference State.

Transition T2A
State 2 to 3

Introduction of grazing by livestock. Livestock remove and trample most of the regenerating trees, shrubs, and understory plants leading to the establishment of grasses and forbs.

Transition T2B
State 2 to 4

Removal of forest vegetation for agricultural crop production. Includes plowing, tilling, and irrigation.

Restoration pathway R3A
State 3 to 2

Removal of livestock grazing. As long as grazing was not present for too great a length of time the understory plants may recover and return to the site. Grasses are likely to persist and out compete the native understory plants until the canopy is closed.

Transition T3A
State 3 to 4

Removal of vegetation for agricultural crop production. Includes plowing, tilling, and irrigation.

Restoration pathway R4A
State 4 to 2

Cessation of agricultural practices, natural or artificial afforestation. Process of afforestation is likely to take over 100 years to reach the reference 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 N. Wisconsin (Kotar, 2002): The sites of this ES keyed out to eight habitat types: Acer saccharum/Athyrium (AAt); Acer saccharum/Vaccinium-Desmodium (AVDe); Acer saccharum-Tsuga/Dryopteris (ATD); Acer saccharum-Tsuga/Maianthemum (ATM); Acer saccharum/Viburnum, Vaccinium variant (AVb-V); Pinus-*Acer rubrum*/Vaccinium-Aralia (PArVHa); Pinus-*Acer rubrum*/Vaccinium-Amphicarpa (PArVAm); Pinus-*Acer rubrum*/Vaccinium-Hamamelis (PArVHa)

Biophysical Settings (Landfire, 2014): This ES is largely mapped as Laurentian-Acadian Northern Hardwoods Forest, Laurentian-Acadian Northern Oak Forest, Boreal White Spruce-Fir Forest, Boreal White Spruce-Fir-Hardwood Forest, Boreal Hardwood Forest, Eastern Cool Temperate Row Crop, Managed Tree Plantation-Northern and Central Hardwood and Conifer Plantation Group, Eastern Cool Temperate Urban Shrubland, Developed-Low Intensity, and Developed-Medium Intensity

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Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	
Contact for lead author	
Date	05/20/2024
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):**

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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:**
