USDA Natural Resources
Conservation Service

Ecological site F089XY017WI
Sandy Outwash Uplands

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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): 089X–Wisconsin Central Sands

The Wisconsin Central Sands (MLRA 89) corresponds closely to Central Sand Plains Ecological Landscape published by the Wisconsin Department of Natural Resources (WDNR, 2015). Much of the following brief overview of this MLRA is borrowed from that publication.

The Wisconsin Central Sands MLRA is entirely in Wisconsin. The total land area is 2,187,100 acres (3,420 square miles, 8858 square kilometers). It is bordered to the east by Johnstown-Hancock end moraines, which were pushed to their extent by the west side of the Green Bay Lobe (Clayton & Attig, 1999). It is bordered to the southwest by highly eroded, unglaciated valleys and ridges. The dominant feature of this MLRA is the remarkably flat, sandy plain, composed of lacustrine deposits and outwash sand, that was once the main basin of Glacial Lake Wisconsin. It also features extensive pine and oak barrens and wetland complexes.

Glacial Lake Wisconsin was fed primarily by glacial meltwater from the north and east. The lake deposited silt overlain by tens of meters of sand (Clayton & Attig, 1989). The silty layers are closer to the surface in some areas, where they impede drainage and contribute to the formation of extensive wetland complexes. It is believed that Glacial Lake Wisconsin drained within several days after a breach in the ice dam that supported it. The catastrophic flood that followed flowed to the south and carved the scattered buttes and mesas protruding from the sandy plain in the southern portion of this MLRA. Before vegetation established after glacial recession, strong winds formed aeolian sand dunes that now support xeric pine and oak stands within the Wisconsin Central Sands.

The surface of the northwestern portion is mostly undulating. The sandy surface sediment was mostly deposited by meltwater during the Wisconsin glaciation. Gentle hills are a result of underlying bedrock topography. Valleys and floodplains are formed by stream action. The underlying bedrock controls the water table elevation and contributes to the formation of numerous wetlands.

Historically, the Wisconsin Central Sands were dominated by large wetland complexes, sand prairies, and oak forests, savannas, and barrens. Some pine and hemlock forests were found in the northwest portion. The Wisconsin Central Sands was subject to frequent fires, leading to today’s need for prescribed burns to maintain a representation of fire-dependent communities.

Classification relationships

Major Land Resource Area (MLRA): Wisconsin Central Sands (89)

USFS Subregions: Central Wisconsin Sand Plain (222Ra) and Neillsville Sandstone Plateau (222Rb)

Small sections occur in the Central Wisconsin Moraines and Outwash (222Kb) and Lincoln Formation Till Plain - Mixed Hardwoods (212Qb) Subregions

Relationship to Established Framework and Classification Systems:
Habitat Types of N. & S. Wisconsin (Kotar, 2002 & 1996): The sites of this ES keyed out to five habitat types: Pinus/Vaccinium-Gaultheria (PVG); Pinus/Vaccinium-Gaylussacia (PVGy); Pinus-*Acer rubrum*/Vaccinium-Hamamelis (PArVHa); Acer-Quercus/Viburnum, Geranium variant (AQVb-Gr); *Acer rubrum*/Desmodium (ArDe)

Biophysical Settings (Landfire, 2014): This ES is largely mapped as North-Central Interior Dry Oak Forest and Woodland, North-Central Interior Dry Oak Forest and Woodland, Laurentian-Acadian Northern Hardwoods Forest, Eastern Cool Temperate Row Crop, and Eastern Cool Temperate Close Grown Crop.

WDNR Natural Communities (WDNR, 2015): This ES is most similar to the Northern Dry-Mesic Forest, Northern Dry Forest, and Central Sands Pine-Oak Forest communities.

Ecological site concept

The Sandy Outwash Uplands heavily populate the eastern portion of MLRA 89 which is dominated by sandy outwash and lake plains. These sites are characterized by very deep, well drained soils formed primarily in sandy outwash materials. Few sites have eolian sand deposits, and others are underlain with till or alluvium. Precipitation, runoff from adjacent uplands, and groundwater discharge are the primary sources of water. Soils range from very strongly acid to neutral.

Historically, this Ecological Site was dominated by a variety of plant communities, apparently reflecting differences in historic fire regime. Prairie, Pine Barrens, Oak Barrens, Oak Savanna and mixed Pine - Oak forests were all represented. Following European settlement most of the area was cleared of forest vegetation and converted to farming, although scattered woodlots remained. Current woodlots typically consist of mixed oak, primarily northern pin oak (Quercus ellipsoidalis), black oak (Q. velutina), white oak (Q. alba), red maple (*Acer rubrum*) and white pine (Pinus strobus). There are also considerable areas of planted red pine (P. resinosa).

Sandy Outwash Uplands differs from other sites by its deep sandy deposits and somewhat poorly drained soils. These sites formed in deep outwash and lacustrine sands that are not siliceous, differing them from Siliceous Sand Uplands. Sites with outwash sand tend to be more productive than the siliceous sands. Difference in vegetation is observed. Depth to bedrock sets apart Dry Sandy Bedrock Uplands. The sandy texture sets this site apart from the loamy well drained sites. Sands tend to have lower pH and available water capacity than loams, which can limit vegetative growth. The well-draining soil of this site differentiates it from other sandy sites.

Associated sites

F089XY002WI	**Mucky Swamps** Mucky Swamps sites consist of herbaceous organic materials sometimes underlain by sandy to loamy mineral soil. They are very poorly drained and remain saturated throughout much of the year. These sites are wetlands and they occur lower on the drainage sequence and are much wetter than Sandy Outwash Uplands.
F089XY006WI	**Wet Sandy Outwash Lowlands** Wet Sandy Outwash Lowlands consist of deep sandy deposits derived from a mixture of outwash, alluvium, and lacustrine sources. They are very poorly to poorly drained, remain saturated for much of the growing season, and are subject to frequent ponding. These sites are primarily found in the eastern half of the Wisconsin Central Sands MLRA. They occur lower on the drainage sequence and are wetter than Sandy Outwash Uplands.
F089XY011WI	**Moist Sandy Outwash Uplands** Moist Sandy Outwash Uplands consist of deep sandy deposits derived from a mixture of outwash, alluvium, and lacustrine sources. They are somewhat poorly drained and are subject to neither flooding nor ponding. They occur lower on the drainage sequence and are wetter than Sandy Outwash Uplands.

Similar sites

F089XY016WI	**Dry Sandy Bedrock Uplands** Dry Sandy Bedrock Uplands form in sandy deposits derived from a mixture of outwash, alluvium, and residuum. Contact with interbedded sandstone and shale bedrock occurs within 40 inches (100 cm) of the surface. These soils are moderately well to excessively drained. Their textures and drainage capabilities are very similar to those of Sandy Outwash Uplands, amounting to very similar vegetative communities between the two sites.
F089XY018WI	**Siliceous Sand Uplands** Siliceous Sand Uplands consist of deep sandy deposits sourced primarily from the weathering of sandstone high in silica. The weathered sand was deposited by rivers or glacial lakes. Soils are moderately well to excessively drained. These sites are found west of the Wisconsin River. Their textures and drainage capabilities are very similar to those of Sandy Outwash Uplands, amounting to very similar vegetative communities between the two sites.

Table 1. Dominant plant species

Tree	(1) *Pinus strobus* (2) *Quercus alba*
Shrub	(1) *Corylus* (2) *Prunus serotina*
Herbaceous	(1) *Pteridium aquilinum* (2) *Maianthemum canadense*

Physiographic features

These sites formed on moraines, stream terraces, dunes, sand sheets, and upland hills on outwash and lake plains, river valleys, and valley trains. Slopes range from 0 to 60 percent. Sites are on summit, shoulder, and toeslope positions. Elevation ranges from 328 10 1,541 feet (100 to 470 meters) above sea level. These sites are not subject to ponding or flooding. Sites have an apparent seasonally high water table (endosaturation) at depths between 48 to 73 inches (122 to 185 cm). The water table can drop to greater than 80 inches (200 cm) during dry conditions. Surface runoff is negligible to medium.

Table 2. Representative physiographic features

Slope shape across	(1) Linear
Slope shape up-down	(1) Concave
Hillslope profile	(1) Summit (2) Shoulder (3) Toeslope
Landforms	(1) Terrace (2) Moraine (3) Hill (4) Dune
Runoff class	Negligible to medium
Flooding frequency	None
Ponding frequency	None
Elevation	328–1,541 ft
Slope	0–60%
Water table depth	48–80 in
Aspect	W, NW, N, NE, E, SE, S, SW

Climatic features

The continental climate of the Wisconsin Central Sands is typical of the southern half of the state – cold winters and warm summers. Precipitation is well-distributed throughout the year with a slight peak in the summer months. Snowfall covers the ground from late fall to early spring. The soil moisture regime of MLRA 89 is udic (humid climate). The soil temperature regime is mostly frigid, with a small portion of mesic in the southern tip.

Neither precipitation nor temperature vary greatly across this MLRA. More so than latitude, local topography seems to be an important predictor of growing season length, with fewer growing degree days in lower-lying areas. The average annual precipitation for this ecological site is 33 inches. The average annual snowfall is 43 inches.

Table 3. Representative climatic features

Frost-free period (characteristic range)	98-123 days
Freeze-free period (characteristic range)	121-142 days
Precipitation total (characteristic range)	32-34 in
Frost-free period (actual range)	79-124 days
Freeze-free period (actual range)	101-144 days
Precipitation total (actual range)	32-34 in
Frost-free period (average)	109 days
Freeze-free period (average)	130 days
Precipitation total (average)	33 in

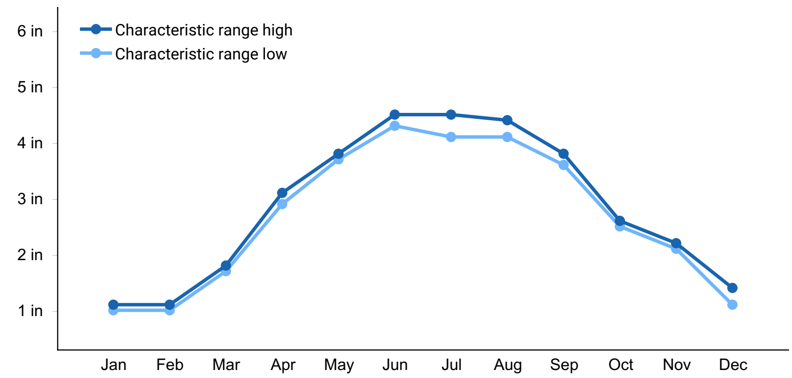


Figure 1. Monthly precipitation range

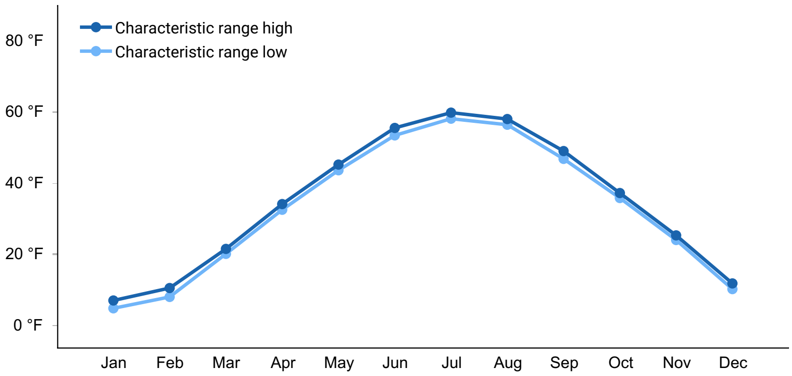


Figure 2. Monthly minimum temperature range

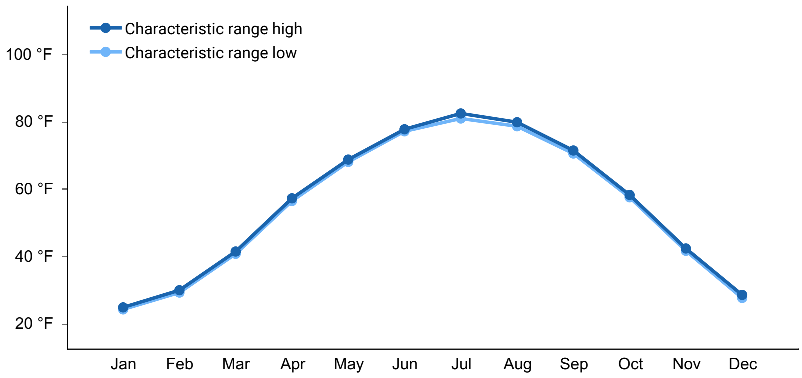


Figure 3. Monthly maximum temperature range

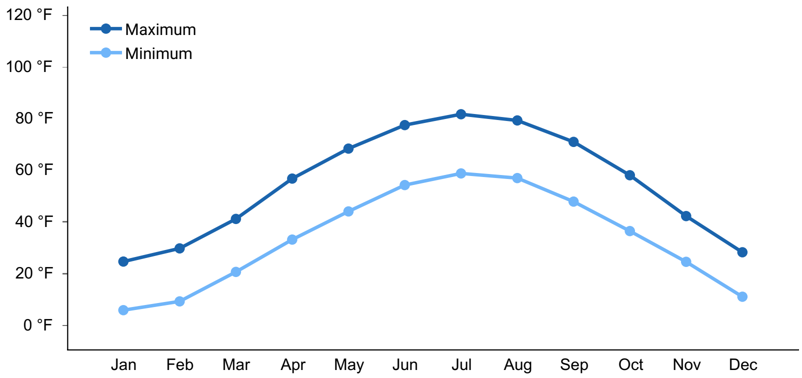


Figure 4. Monthly average minimum and maximum temperature

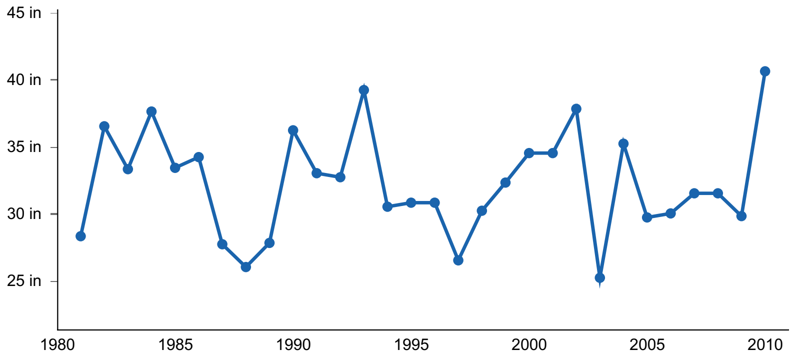


Figure 5. Annual precipitation pattern

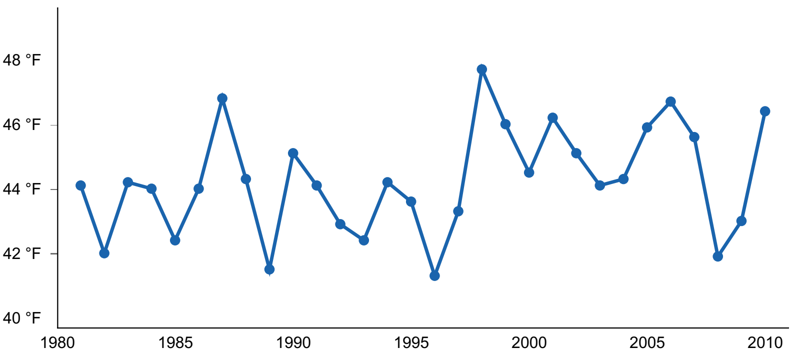


Figure 6. Annual average temperature pattern

Climate stations used

- (1) STEVENS POINT [USC00478171], Stevens Point, WI
- (2) WISCONSIN RAPIDS ALEXANDER FLD [USW00004826], Port Edwards, WI
- (3) FRIENDSHIP [USC00472973], Adams, WI

- (4) HANCOCK EXP FARM [USC00473405], Hancock, WI
- (5) HATFIELD [USC00473471], Merrillan, WI

Influencing water features

Water is received primarily from precipitation, runoff from adjacent uplands, and groundwater discharge. Water leaves the site primarily through runoff, evapotranspiration, and groundwater recharge. Permeability of these sites is moderately to rapid. Hydrologic group is A.

Soil features

These sites are represented by the Windward, Chelsea, Coloma, Friendship, Mahtomedi, Menahga, Nymore, and Plainfield soil series. Friendship, Mahtomedi, Menahga, Nymore, and Plainfield are all classified as Typic Udipsamments. Windward is classified as a Lamellic Quartzipsamment, and Chelsea and Coloma are Lamellic Udipsamments.

These soils primarily formed in deep sandy glacial outwash, but some sites were formed in eolian sands, sandy drift or sandy lacustrine deposits. Soils are very deep and are somewhat excessively to excessively drained. They do not meet hydric soil requirements.

Surface textures are primarily loamy sand and sand, but some sites have somewhat to moderately decomposed plant materials at the surface. Subsurface textures include fine sand, loamy fine sand and sand. Lamellae (sand with thin bands of accumulated clay) are also present in some soils. Soil pH ranges from very strongly acid to neutral with values of 4.7 to 6.7. Surface fragments less than 3 inches can be present up to 5 percent volume. Subsurface fragments less than 3 inches can be present up to 35 percent volume, and subsurface fragments greater than 3 inches can be present up to 8 percent. Carbonates are absent on most sites, but a few sites may have up to 8 percent carbonates beginning at 20 inches (51 cm).

Table 4. Representative soil features

Parent material	(1) Eolian deposits (2) Lacustrine deposits (3) Outwash (4) Drift
Surface texture	(1) Sand (2) Loamy sand
Drainage class	Somewhat excessively drained to excessively drained
Permeability class	Moderate to rapid
Soil depth	78 in
Surface fragment cover <=3"	0–5%
Surface fragment cover >3"	0%
Available water capacity (0-60in)	2.7–5.43 in
Calcium carbonate equivalent (0-40in)	0–8%
Soil reaction (1:1 water) (0-40in)	4.7–6.7
Subsurface fragment volume <=3" (0-78in)	0–35%
Subsurface fragment volume >3" (0-78in)	0%

Ecological dynamics

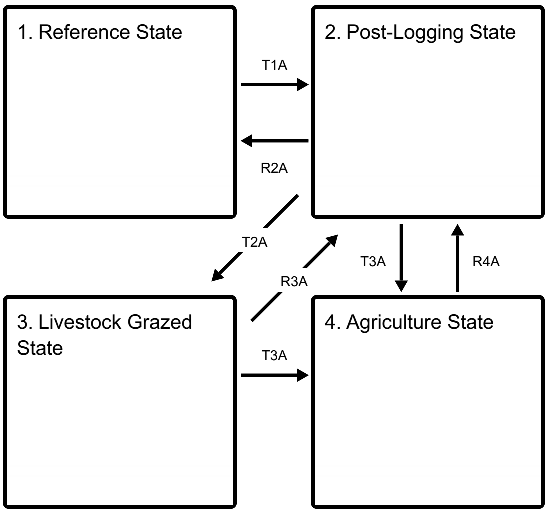
Perhaps the most important ecological characteristic of this Ecological Site, in terms of its influence on forest community dynamics, is its lack of capacity to support the high to moderate soil moisture and nutrient requiring species such as sugar maple, basswood and white ash, the shade-tolerant species, 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. Several species of oak are common members of forest communities on this ecological site. Northern pin oak (Q. ellipsoidalis) and, to a lesser degree, black oak (Q. velutina), are intolerant of shade and do not reproduce from seed under existing canopies. However, following fire or clear cutting they respond by sprouting from stumps. In the absence of disturbance, they are replaced—through succession—by more shade-tolerant white pine, red maple (*Acer rubrum*), or white oak (Q. alba).

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 damage, 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. Some portions of this ES may support grassland or oak savanna and restoration/establishment efforts have had some success.

State and transition model

Ecosystem states



T1A - Clear cutting or stand-replacing fire

R2A - Disturbance-free period 70+ years

T2A - Forage established; grazing

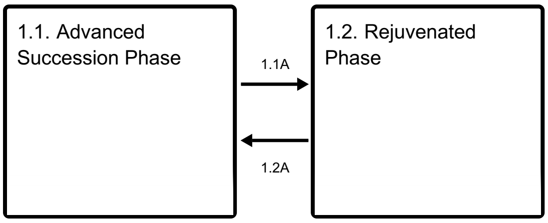
T3A - Site cleared; managed for agricultural crops

R3A - Livestock removed

T3A - Transition to crop production

R4A - Site is forested through planting or natural succession

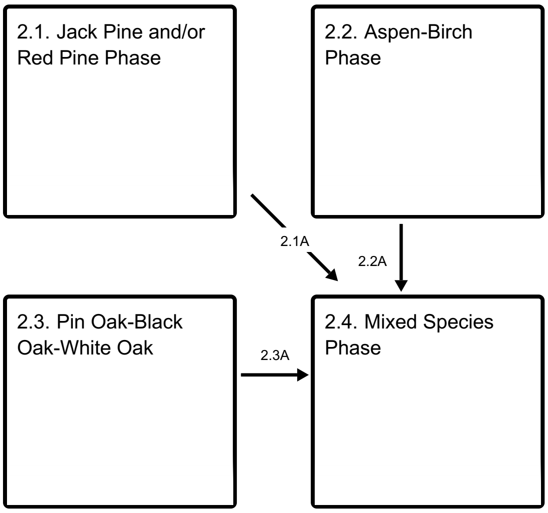
State 1 submodel, plant communities



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

1.2A - Disturbance-free period 30+ years

State 2 submodel, plant communities

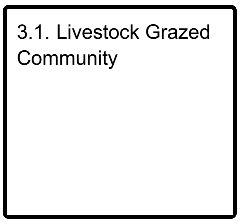


2.1A - Increase in white pine and red maple.

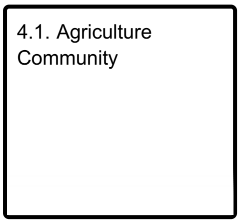
2.2A - Increase in white pine and red maple.

2.3A - Increase in 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.

Dominant plant species

- eastern white pine (*Pinus strobus*), tree

- white oak (*Quercus alba*), tree
- red maple (*Acer rubrum*), tree
- hazelnut (*Corylus*), shrub
- black cherry (*Prunus serotina*), shrub
- western brackenfern (*Pteridium aquilinum*), other herbaceous
- Canada mayflower (*Maianthemum canadense*), other herbaceous

Community 1.1
Advanced Succession Phase

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
- white oak (*Quercus alba*), tree
- red maple (*Acer rubrum*), tree
- hazelnut (*Corylus*), shrub
- black cherry (*Prunus serotina*), shrub
- western brackenfern (*Pteridium aquilinum*), other herbaceous
- Canada mayflower (*Maianthemum canadense*), other herbaceous

Community 1.2
Rejuvenated Phase

The canopy of the rejuvenated community is still dominated by original species, but the understory now also includes a well established younger cohort and perhaps a few additional seedlings and saplings of less shade tolerant species.

Dominant plant species

- eastern white pine (*Pinus strobus*), tree
- white oak (*Quercus alba*), tree
- red maple (*Acer rubrum*), tree
- hazelnut (*Corylus*), shrub
- black cherry (*Prunus serotina*), shrub
- brackenfern (*Pteridium*), other herbaceous
- European lily of the valley (*Convallaria majalis*), 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. 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
Post-Logging 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.

Dominant plant species

- pine (*Pinus*), tree
- oak (*Quercus*), tree
- quaking aspen (*Populus tremuloides*), tree
- paper birch (*Betula papyrifera*), tree

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
Aspen-Birch 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

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

Community 2.3
Pin Oak-Black Oak-White Oak

On this Ecological Site these three oak species occur in mixtures dominated by any of them. In some stands there also occur red oak, bur oak (Q. macrocarpa) or shagbark hickory (Carya ovvata). Community composition and structure is a function of composition of the preceding, cut-over, or burned-over community and time since the disturbance. Time since disturbance is an important factor because of significant differences in sprouting abilities and success of regeneration from seed, among the participating species. Pin and black oak typically exist in current stands as multy-stem clusters resulting from stump sprouting, while white oak often reproduces from seed and gradually gains canopy dominance because of its greater shade tolerance than that of other oak species.

Dominant plant species

- pin oak (*Quercus palustris*), tree
- black oak (*Quercus velutina*), tree
- white oak (*Quercus alba*), tree

Community 2.4
Mixed Species Phase

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

- jack pine (*Pinus banksiana*), tree
- red pine (*Pinus resinosa*), tree
- quaking aspen (*Populus tremuloides*), tree
- white oak (*Quercus alba*), tree
- eastern white pine (*Pinus strobus*), tree
- red maple (*Acer rubrum*), tree

Pathway 2.1A
Community 2.1 to 2.4

Immigration and establishment of relatively shade tolerant white pine and red maple into shade – intolerant communities of aspen – birch, oaks or jack pine.

Pathway 2.2A
Community 2.2 to 2.4

Immigration and establishment of relatively shade tolerant white pine and red maple into shade – intolerant communities of aspen – birch, oaks or jack pine.

Pathway 2.3A
Community 2.3 to 2.4

Immigration and establishment of relatively shade tolerant white pine and red maple into shade – intolerant communities of aspen – birch, oaks or jack pine.

State 3
Livestock Grazed State

Site phase consists of various grasses and forbs utilized for livestock grazing.

Dominant plant species

- brome (*Bromus*), grass
- tall fescue (*Schedonorus arundinaceus*), grass

Community 3.1
Livestock Grazed Community

This community consists of various grass and forb species that support livestock grazing.

Dominant plant species

- brome (*Bromus*), grass
- tall fescue (*Schedonorus arundinaceus*), grass

State 4
Agriculture State

Lower slope areas of this site are sometimes utilized for crop production. Corn, soybeans, small grains are common. Some areas are irrigated and produce specialty crops.

Dominant plant species

- corn (*Zea mays*), grass
- wheat (*Triticum*), grass
- soybean (*Glycine max*), other herbaceous

Community 4.1
Agriculture Community

Areas that have low slopes within this site may be utilized for crop production. A variety of species may be grown depending on the landowners goals and management. Growing of specialty crops often requires irrigation.

Dominant plant species

- corn (*Zea mays*), grass
- wheat (*Triticum*), grass
- soybean (*Glycine max*), other herbaceous

Transition T1A
State 1 to 2

Clear cutting with initial control of competing vegetation, or a stand-replacing fire, will 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 the Reference State.

Transition T2A
State 2 to 3

The site is transition to forage species and grazing by livestock. Management inputs would often include woody species removal, site preparation, seeding with desired forage species, weed control, and grazing management.

Transition T3A
State 2 to 4

This State applies to lower slope areas only. The site is cleared of woody vegetation and transitioned to crop production. Common management inputs include site preparation, planting of desired crop species, and weed control. Some sites may be irrigated.

Restoration pathway R3A

State 3 to 2

Removal of livestock grazing will allow the site to slowly transition toward an early successional woodland. Management inputs may include brush control, weed control, and timber stand improvement projects.

Transition T3A
State 3 to 4

A pasture site is transitioned to agricultural production. This is feasible only on lower slope sites. Various agricultural crops may be planted depending on the landowner goals. Management inputs will include site preparation, weed control, and planting of crop species. Some sites may utilized irrigation.

Restoration pathway R4A
State 4 to 2

Cessation of agricultural practices, natural or artificial afforestation.

Additional community tables

Inventory data references

Plot and other supporting inventory data for site identification and community phases is located on a NRCS North Central Region shared and one drive folder. University Wisconsin-Stevens Point described soils, took photographs, and inventoried vegetation data at community phases within the reference state. The data sources include WI ESD Plot Data Collection Form - Tier 2, Releve Method, NASIS pedon description, NRCS SOI 036, photographs, and Kotar Habitat Types.

Other references

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Approval

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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	09/27/2023
Approved by	Suzanne Mayne-Kinney
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

2. **Presence of water flow patterns:**

3. **Number and height of erosional pedestals or terracettes:**

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):**

5. **Number of gullies and erosion associated with gullies:**

6. **Extent of wind scoured, blowouts and/or depositional areas:**

7. **Amount of litter movement (describe size and distance expected to travel):**

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

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

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

    Dominant:

    Sub-dominant:

    Other:

    Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**

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:**