Ecological site F089XY016WI
Dry Sandy Bedrock 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), Neillsville Sandstone Plateau (222Rb), and Lincoln Formation Till Plain - Mixed Hardwoods (212Qb)

Relationship to Established Framework and Classification Systems:

Habitat Types of N. & S. Wisconsin (Kotar, 2002 & 1996): The sites of this ES keyed out to four habitat types: Pinus-*Acer rubrum*/Vaccinium-Hamamelis (PArVHa); Pinus/Vaccinium-Gaultheria (PVG); Acer/Viburnum, Vaccinium variant (AVb-V); Pinus/Vaccinium-Cornus (PVCr)

Biophysical Settings (Landfire, 2014): This ES is largely mapped as North-Central Interior Dry Oak Forest and Woodland, Laurentian-Acadian Northern Pine-Oak Forest, Laurentian-Acadian Northern Hardwoods Forest, North-Central Interior Maple-Basswood Forest, and Laurentian-Acadian Northern Pine Forest.

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

Ecological site concept

The Dry Sandy Bedrock Uplands ecological site occurs in the northcentral to northwest portion of MLRA 89 on strath terraces, hills, and pediments in areas where the sandstone bedrock is relatively shallow. These sites are characterized by moderately deep, well drained soils formed in sandy alluvium overlying a thin layer of loamy residuum over interbedded sandstone and shale or sandy residuum over sandstone. Water is primarily from precipitation and runoff from adjacent uplands, but groundwater discharge also contributes as a water source. Soils range from extremely acid to slightly acid. These sites support dry to dry-mesic forest communities dominated by varying mixtures of pines (Pinus strobus, P. resinosa, P. banksiana), oaks (Quercus ellipsoidalis, Q. velutina, Q. rubra), and red maple (*Acer rubrum*).

Historically this Ecological Site was occupied by forest communities dominated by various mixtures of pine and oak species. The mixtures were largely dependent on frequency and severity of disturbances, particularly fire and subsequent seed-bed conditions and availability of seed sources. White pine was the most constant species in forest communities due to its ecological characteristics of great longevity, resistance of old trees to fire damage and moderate tolerance to shade by seedlings and saplings. Red oak and white oak were often present as associate species. Virtually all stands on this Ecological Site were harvested during the late 19th century and post-logging fires were almost universal. Today’s forests are dominated by any mixture of white pine, red pine, aspen, red oak and red maple. White birch also occurs sporadically.

Dry Sandy Bedrock Uplands differs from other sites by its drainage, sandy deposits, and moderately deep profile. Other well drained sands have soils that are greater than 80 inches (200 cm) in depth. The bedrock both perches water and restricts root growth, which can cause trees to tip. 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 sets this site apart from other sandy sites.

Associated sites

F089XY005WI	**Wet Sandy Bedrock Lowlands** Wet Sandy Bedrock Lowlands consist of sandy alluvium underlain by loamy residuum. Bedrock occurs within 40 inches (100 cm) and perches the water table. Soils are poorly drained and subject to ponding. These sites are found in the northwestern portion of the Wisconsin Central Sands MLRA where the depth to bedrock is shallow. They occur in lower positions on the drainage sequence and are wetter than Dry Sandy Bedrock Uplands.
F089XY010WI	**Moist Sandy Bedrock Uplands** Moist Sandy Bedrock Uplands consist of sandy deposits derived from a mixture of outwash, alluvium, and lacustrine sources. They have contact with sandstone bedrock within 40 inches (102 cm) of the surface. These soils are somewhat poorly drained. These sites are found to the west of the Wisconsin River, mostly in Clark and Jackson counties where the depth of bedrock is shallow. They occur in lower positions on the drainage sequence and are wetter than Dry Sandy Bedrock Uplands.

Similar sites

F089XY017WI	**Sandy Outwash Uplands** Sandy Outwash Uplands primarily consist of deep sandy outwash deposits. Soils are somewhat excessively to excessively drained and are primarily found east of the Yellow River. Sandy Outwash Uplands have drainage capabilities and textures similar to Dry Sandy Bedrock Uplands, amounting to very similar vegetative communities between the two.
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. Siliceous Sand Uplands have drainage capabilities and textures similar to Dry Sandy Bedrock Uplands, amounting to very similar vegetative communities between the two

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 rock pediments, strath terraces, ridges, and upland hills. Slopes range from 2 to 30 percent. Sites are on summit, shoulder, and toeslope positions. Elevation ranges from 672 to 1,394 feet (200 to 425 meters) above sea level. These sites are not subject to ponding or flooding. Most sites have a seasonally high water table at depths between 24 and 30 inches (61 and 76 cm). The water table can drop to 80+ inches (200+ cm) during dry conditions. Surface runoff potential is primarily very low, but sites on steeper slopes can have high surface runoff potential.

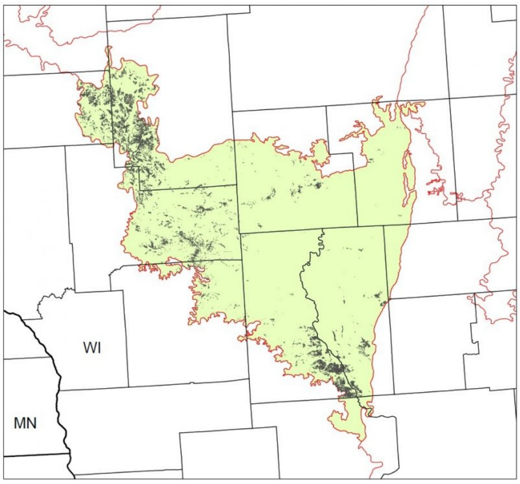


Figure 1. Distribution of Dry Sandy Bedrock Uplands in the Wisconsin Central Sands MLRA (89).

Table 2. Representative physiographic features

Hillslope profile	(1) Summit (2) Shoulder (3) Toeslope
Slope shape across	(1) Linear
Slope shape up-down	(1) Convex
Landforms	(1) Pediment (2) Terrace (3) Hill

Runoff class	Very low to high
Flooding frequency	None
Ponding frequency	None
Elevation	205–425 m
Slope	2–30%
Water table depth	61–203 cm
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 34 inches. The average annual snowfall is 47 inches. The annual average maximum and minimum temperatures are 55°F and 33°F, respectively.

Table 3. Representative climatic features

Frost-free period (characteristic range)	89-121 days
Freeze-free period (characteristic range)	116-150 days
Precipitation total (characteristic range)	864 mm
Frost-free period (actual range)	77-124 days
Freeze-free period (actual range)	100-150 days
Precipitation total (actual range)	864 mm
Frost-free period (average)	104 days
Freeze-free period (average)	131 days
Precipitation total (average)	864 mm

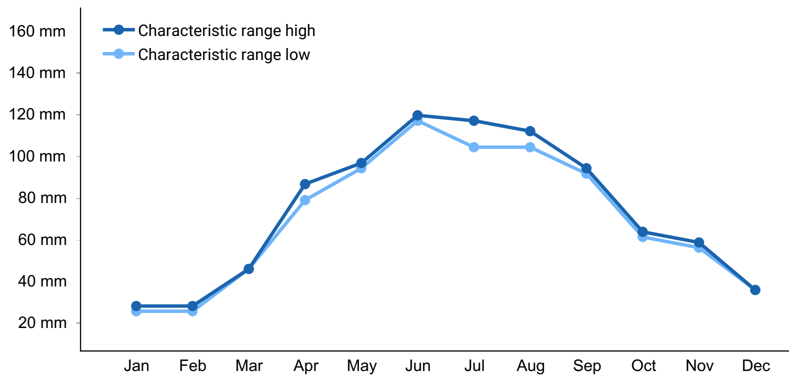


Figure 2. Monthly precipitation range

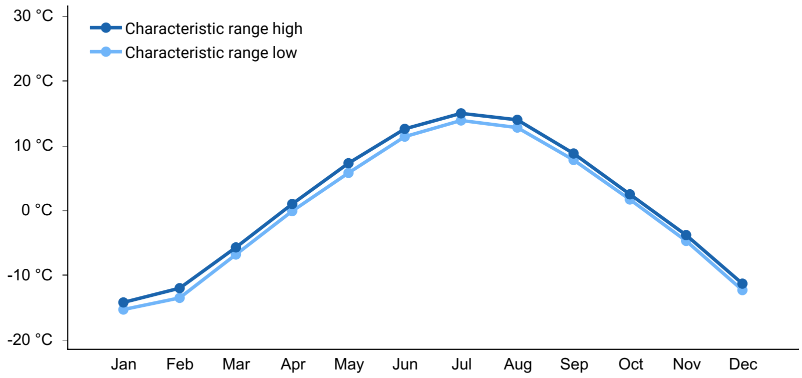


Figure 3. Monthly minimum temperature range

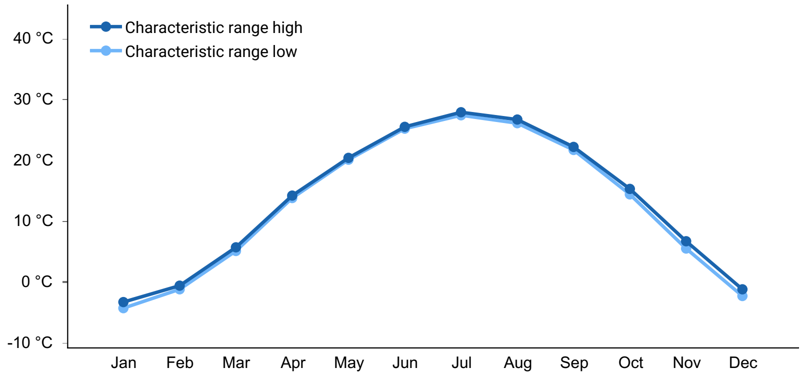


Figure 4. Monthly maximum temperature range

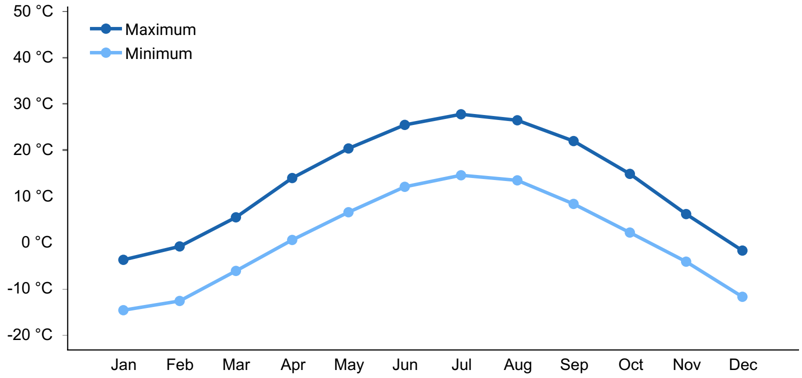


Figure 5. Monthly average minimum and maximum temperature

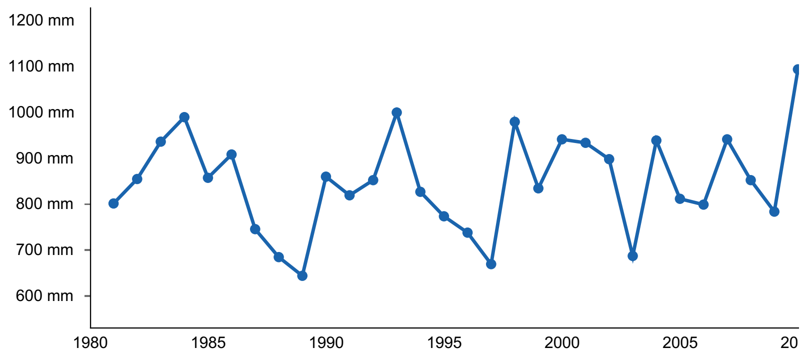


Figure 6. Annual precipitation pattern

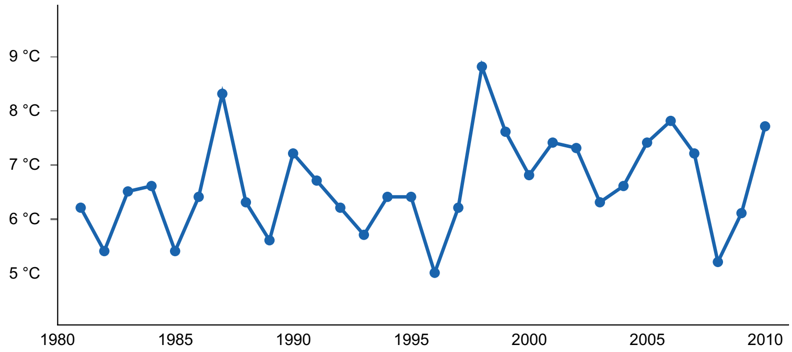


Figure 7. Annual average temperature pattern

Climate stations used

- (1) FRIENDSHIP [USC00472973], Adams, WI
- (2) HATFIELD [USC00473471], Merrillan, WI
- (3) MATHER 3 NW [USC00475164], Warrens, WI
- (4) MAUSTON 1 SE [USC00475178], Mauston, 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. Subsurface outflow may occur where the sandstone bedrock perches the water table. Permeability of these sites is rapid in the sandy mantle, but slow to impermeable in the bedrock. Hydrologic group is A.

Soil features

These sites are represented by the Arbutus, Boone, Ludington, and Plainbo soil series. Arbutus is classified as an Entic Haplorthod; Boone is a Typic Quartzipsamment; Ludington is an Oxyaquic Ultic Haplorthod; and Plainbo is a Typic Udipsamment. These soils formed in sandy alluvium, sandy outwash, or sandy residuum underlain by either sandstone or by loamy residuum with underlying sandstone and shale bedrock. Soil depth to bedrock ranges from 25 to 40 inches (64 to 100 cm). Sites are moderately well or excessively drained. They do not meet hydric soil requirements.

The surface of these soils is loamy sand, sand, or moderately decomposed plant material. Subsurface textures are loamy sand, sand, sandy clay loam, and loam. Soil pH ranges from extremely acid to strongly acid with values of 3.5 to 5.5. Surface fragments are absent. Subsurface fragments less than 3 inches can be present up to 7 percent volume. Subsurface fragments greater than 3 inches can be present up to 5 percent volume. Carbonates are absent.

Table 4. Representative soil features

Parent material	(1) Alluvium (2) Residuum (3) Outwash
Surface texture	(1) Sand (2) Loamy sand
Drainage class	Moderately well drained to excessively drained
Permeability class	Very slow to rapid
Soil depth	64–102 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%

Available water capacity (0-152.4cm)	4.52–8.92 cm
Calcium carbonate equivalent (0-101.6cm)	0%
Soil reaction (1:1 water) (0-101.6cm)	3.5–6.2
Subsurface fragment volume <=3" (0-101.6cm)	0–7%
Subsurface fragment volume >3" (0-101.6cm)	0–5%

Ecological dynamics

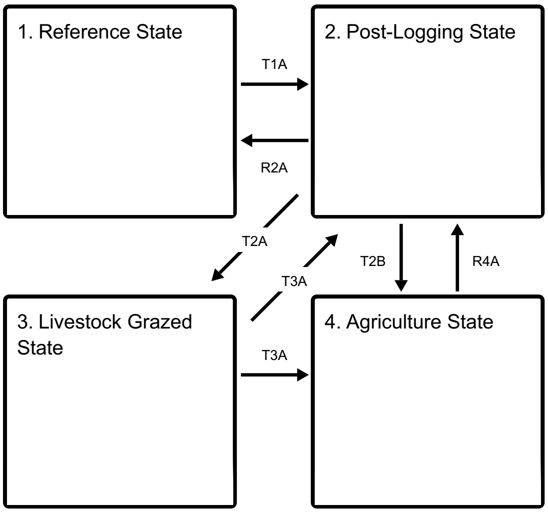
Perhaps the most important ecological characteristic of this Ecological Site, in terms of its influence on forest community dynamics, is its lack of capacity to support the high to moderate soil moisture and nutrient requiring species such as sugar maple, basswood and white ash, the shade-tolerant species,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

In pre-European settlement time wildfire was the main controlling factor of forest community dynamics. Following a severe, stand-replacing fire, any of the species present on the landscape could become established, depending on seed source availability and specific conditions of post-fire seedbed. The newly established young stands of any species were easily eliminated by recurring fires, but differences in fire-resisting properties among the species began to play a role in any species' survival success. 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, 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 - Clear cutting or stand-replacing fire.

R2A - Disturbance-free period 70+ years.

T2A - Grazing by livestock.

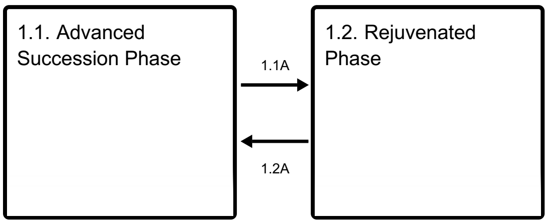
T2B - Clearing of woody vegetation; agricultural uses

T3A - Succession to woody species

T3A - Agricultural production

R4A - Cessation of agriculture and natural or artificial afforestation.

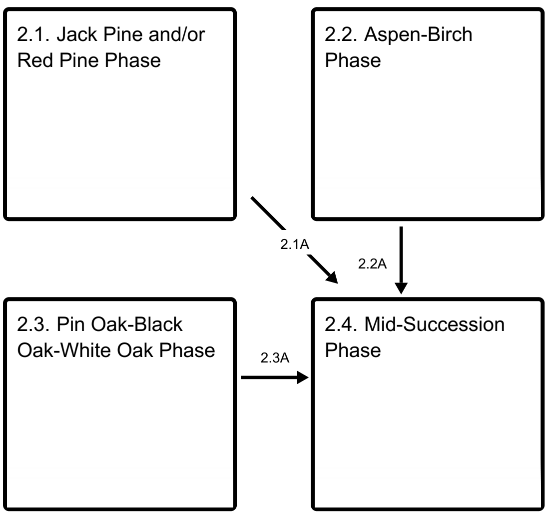
State 1 submodel, plant communities



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 - 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

3.1. Livestock Grazed Community

State 4 submodel, plant communities

4.1. Agricultural Community

State 1
Reference State

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

Dominant plant species

- pine (*Pinus*), tree
- oak (*Quercus*), 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 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
- western brackenfern (*Pteridium aquilinum*), other herbaceous
- Canada mayflower (*Maianthemum canadense*), 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 which release advance regeneration and stimulate new seedling establishment. 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. The four communities in State 2 are 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 Phase

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 multi-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
Mid-Succession 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 impacted by livestock grazing.

Dominant plant species

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

Community 3.1
Livestock Grazed Community

This site is planted in forage plants and utilized by livestock.

Dominant plant species

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

State 4
Agriculture State

Sites phase consists of various crops being grown.

Dominant plant species

- corn (*Zea mays*), grass
- wheat (*Triticum*), grass

Community 4.1
Agricultural Community

This community is characterized by the production of agricultural crops such as corn or small grains. Irrigation may be necessary on some sites.

Dominant plant species

- corn (*Zea mays*), grass
- wheat (*Triticum*), grass

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

The site is transitioned to forage production and livestock grazing.

Transition T2B
State 2 to 4

The site is cleared and utilized for agricultural production.

Restoration pathway T3A
State 3 to 2

Grazing is removed from the site and tree regeneration is allowed.

Transition T3A
State 3 to 4

The site is transitioned from livestock grazing to cropland.

Restoration pathway R4A
State 4 to 2

Cessation of agriculture and 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.

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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.

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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:

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

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14. **Average percent litter cover (%) and depth (in):**

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):**

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16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:**

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17. **Perennial plant reproductive capability:**
