USDA Natural Resources Conservation Service

Ecological site F089XY019WI
Loamy Bedrock Uplands

Last updated: 9/27/2023
Accessed: 11/04/2024

General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

MLRA notes

Major Land Resource Area (MLRA): 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: Neillsville Sandstone Plateau (222Rb) and Lincoln Formation Till Plain - Mixed Hardwoods (212Qb)

Small sections occur in the Central Wisconsin Sand Plain (222Ra) 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 three habitat types: Pinus-*Acer rubrum*/Vaccinium-Hamamelis (PArVHa); Pinus/Vaccinium-Gaultheria (PVG); Pinus/Vaccinium-Rubus hispidus (PVRh)

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

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

Ecological site concept

Loamy Bedrock Uplands formed on pediments, hillslopes, upland hills, and ridges, primarily in the northern portion of MLRA 89 where loamy materials were deposits during the Wisconsin glaciation and the bedrock is relatively shallow. This region has bedrock influence that is absent in most of the MLRA. These sites are characterized by shallow to moderately deep, well drained soils that formed primarily in loamy alluvium over loamy residuum weathered from the underlying interbedded sandstone and shale. Some sites have sandy residuum over sandstone underlying the loamy alluvium, and others may have other loamy materials, such as loess or silty alluvium. Precipitation and runoff from adjacent uplands are the primary sources of water, but groundwater discharge can be a significant contribution. Soils range from very strongly acid to slightly acid.

Current plant community is a dry-mesic forest dominated by varying mixtures of red oak (*Quercus rubra*), white oak (*Q. alba*) and red maple (*Acer rubrum*) with sporadic presence of white pine (*Pinus strobus*). Aspen-Paper birch (*P. tremuloides – B. papyrifera*) stands and red pine plantations also occur.

Loamy Bedrock Uplands differs from other sites based on moderate depth to bedrock, drainage, and loamy textures. Loamy Uplands 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. Other well drained sites have sandy textures. Loamy textures tend to have higher pH and available water capacity than sand. The well-draining soil sets this site apart from other loamy sites.

Associated sites

F089XY004WI	**Loamy Floodplains** Loamy Floodplains are found exclusively on floodplains in loamy alluvium underlain by sandy alluvium. Soils are somewhat poorly to poorly drained and are subject to flooding. These sites occur primarily along tributaries to the Yellow River in central Wood County and along the Lemonweir River. They may be adjacent to Loamy Bedrock Uplands.
F089XY008WI	**Wet Loamy Lowlands** Wet Loamy Lowlands form in a loamy or silty mantle 10 to 40 inches (25 to 100 cm) thick overlying sandy residuum weathered from sandstone and shale. Bedrock contact may occur as high at 26 inches (66 cm). These soils are poorly drained, remain saturated for much the growing season, and are sometimes subject to ponding. They are exclusive to the northern third of the Wisconsin Central Sands MLRA, which was covered in loamy glacial deposits prior to the most recent glacial advance. They occur lower on the drainage sequence and are wetter than Loamy Bedrock Uplands.

Similar sites

F089XY020WI	**Loamy Uplands** Loamy Uplands consist of sandy deposits underlain by clayey lacustrine deposits or of loamy alluvium underlain by sandy outwash. They are moderately well to somewhat excessively drained. Because of they lack bedrock contact within 80 inches (200 cm), these sites sometimes have a much deeper water table and can hold more water. They may support vegetative communities with higher nutrient requirements than those of Loamy Bedrock Uplands.

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. Because Loamy Bedrock Uplands sometimes have a mantle of sandy alluvium, the vegetative communities they support may sometimes be similar to those of Loamy Bedrock Uplands.

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 pediments, hillslopes, and upland hills and ridges. Slopes range from 1 to 33 percent. Sites are positioned on summits, shoulders, backslopes, and toeslopes. Elevation ranges from 689 to 1,411 feet (210 to 430) meters above sea level. These sites are not subject to ponding or flooding. Most sites have a seasonally high water table at depths of 24 to 80+ inches (61 to 200+ cm). The water table may drop to greater than 80 inches (200 cm) during dry conditions. Surface runoff ranges from medium to very high.

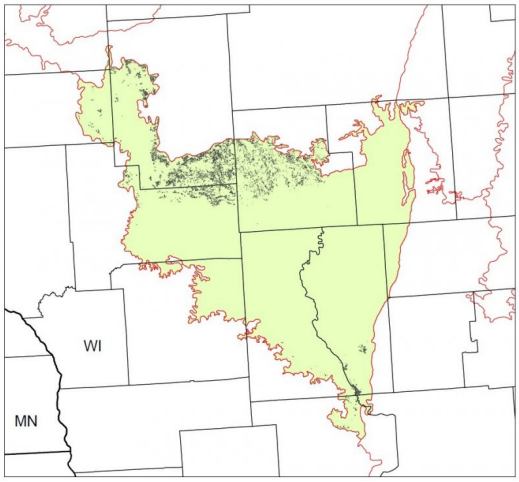

Figure 1. Distribution of Loamy Bedrock Uplands in the Wisconsin Central Sands MLRA (89).

Table 2. Representative physiographic features

Slope shape across	(1) Linear
Slope shape up-down	(1) Convex
Hillslope profile	(1) Summit (2) Shoulder (3) Backslope (4) Toeslope
Landforms	(1) Pediment (2) Hillslope (3) Hill
Runoff class	Medium to very high
Flooding frequency	None
Ponding frequency	None

Elevation	689–1,411 ft
Slope	1–33%
Water table depth	24–80 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.

Table 3. Representative climatic features

Frost-free period (characteristic range)	78-115 days
Freeze-free period (characteristic range)	109-139 days
Precipitation total (characteristic range)	32-34 in
Frost-free period (actual range)	74-117 days
Freeze-free period (actual range)	98-141 days
Precipitation total (actual range)	31-34 in
Frost-free period (average)	97 days
Freeze-free period (average)	123 days
Precipitation total (average)	33 in

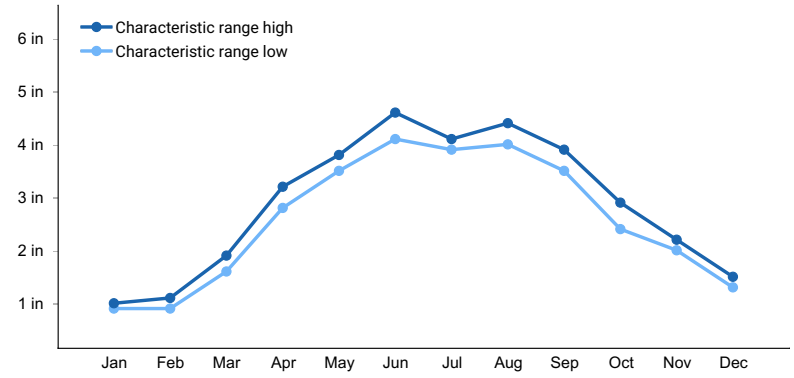

Figure 2. Monthly precipitation range

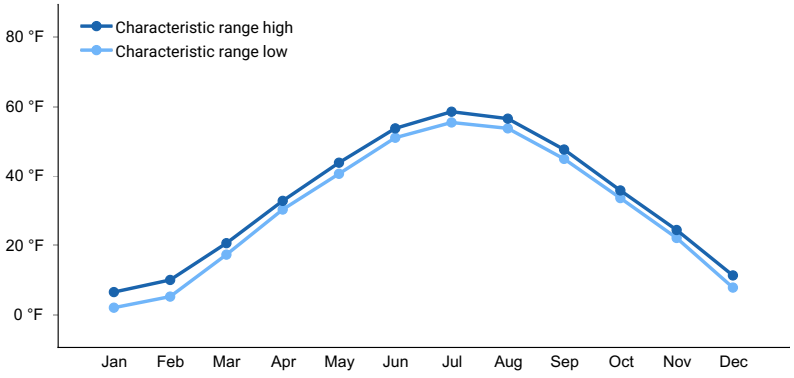

Figure 3. Monthly minimum temperature range

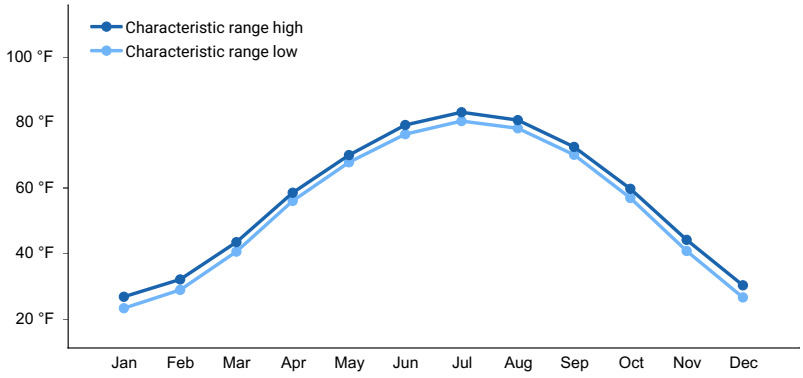

Figure 4. Monthly maximum temperature range

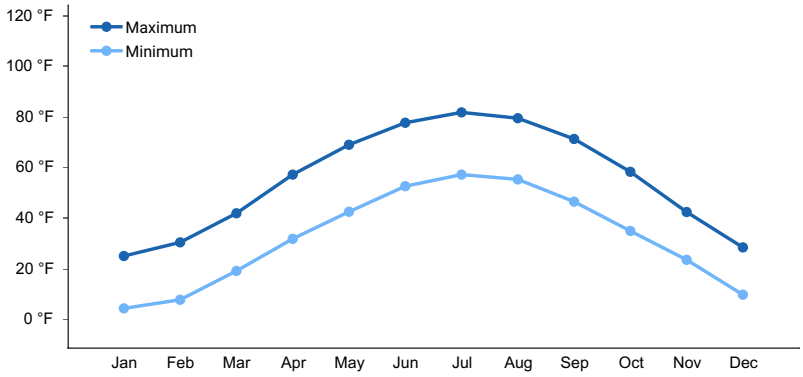

Figure 5. Monthly average minimum and maximum temperature

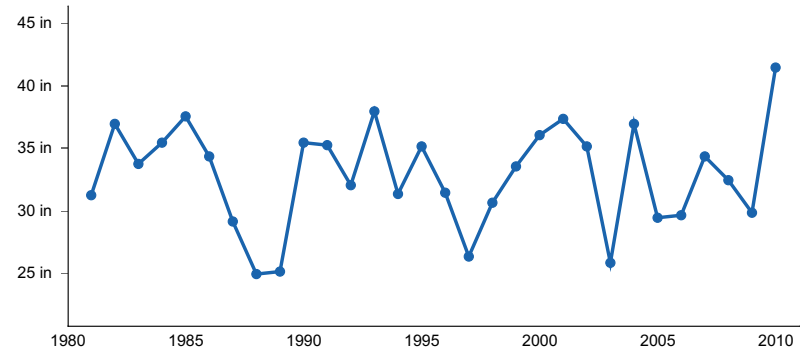

Figure 6. Annual precipitation pattern

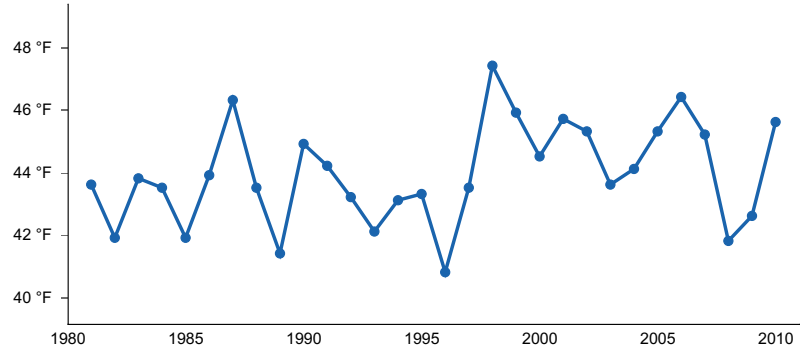

Figure 7. Annual average temperature pattern

Climate stations used

- (1) HATFIELD [USC00473471], Merrillan, WI
- (2) WISCONSIN RAPIDS [USC00479335], Wisconsin Rapids, WI
- (3) PRENTICE #2 [USC00476859], Marshfield, WI

- (4) WISCONSIN DELLS [USC00479319], Wisconsin Dells, 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 moderate in the loamy mantle, but slow to impermeable in the bedrock. Hydrologic group is B, C, or D.

Soil features

These sites are represented by the Elevasil, Hiles, Humbird, and Norgo soil series. Elevasil is classified as an Ultic Hapludalf; Hiles is an Oxyaquic Glossudalf; Humbird is an Oxyaquic Ultic Haplorthod; and Norgo is a Lithic Hapludalf.

These soils formed in loamy materials underlain by sandstone or interbedded sandstone and shale bedrock, sometimes with residuum. Loamy materials are alluvium, pedisediment, or loess, and the residuum is weathered from underlying sandstone or interbedded sandstone and shale. Soil depth ranges from 12 to 40 inches (30 to 99 cm) to bedrock. Soils are moderately well to well drained. Sites do not meet hydric soil requirements.

Surface textures of these sites are sandy loam and silt loam. Subsurface textures include sand, loamy sand, sandy loam, loam, silt loam, and clay loam. Soil pH ranges from very strongly acid to slightly acid with values of 4.50 to 6.10. Surface fragments are absent. Subsurface fragments less than 3 inches can be present up to 14 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) Pedisediment (4) Loess
Surface texture	(1) Sandy loam (2) Silt loam
Drainage class	Moderately well drained to well drained
Permeability class	Very slow to moderately slow
Soil depth	12–40 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-60in)	1.66–5.24 in
Calcium carbonate equivalent (0-40in)	0%
Soil reaction (1:1 water) (0-40in)	4.5–6.1
Subsurface fragment volume <=3" (0-78in)	0–14%
Subsurface fragment volume >3" (0-78in)	0–5%

Ecological dynamics

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Current plant community is a dry-mesic forest dominated by varying mixtures of red oak (*Quercus rubra*), white oak (*Q. alba*) and red maple (*Acer rubrum*) with sporadic presence of white pine (*Pinus strobus*). Aspen-Paper birch (*P. tremuloides – B. papyrifera*) stands and red pine plantations also occur.

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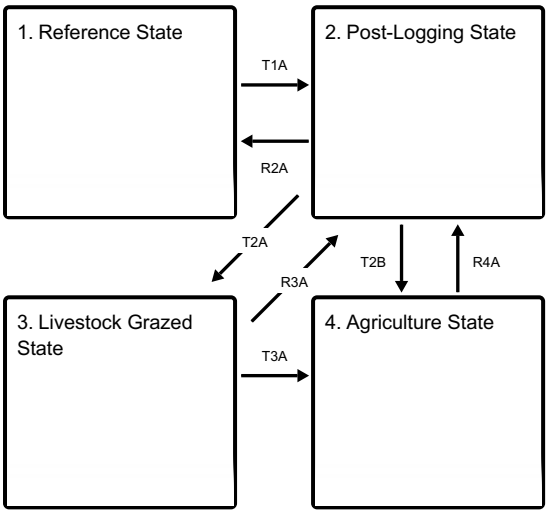
State and transition model

Ecosystem states



T1A - Clear cutting or stand-replacing fire

R2A - Disturbance-free period 70+ years

T2A - Grazing by livestock

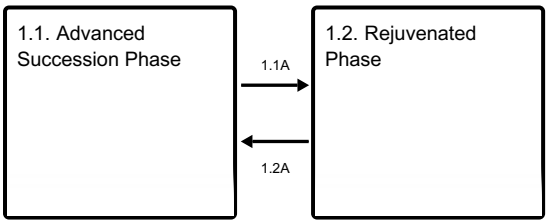
T2B - Site transitioned to agricultural production

R3A - Removal of livestock grazing

T3A - Site transitioned to agricultural production

R4A - Site is restored to forest vegetation

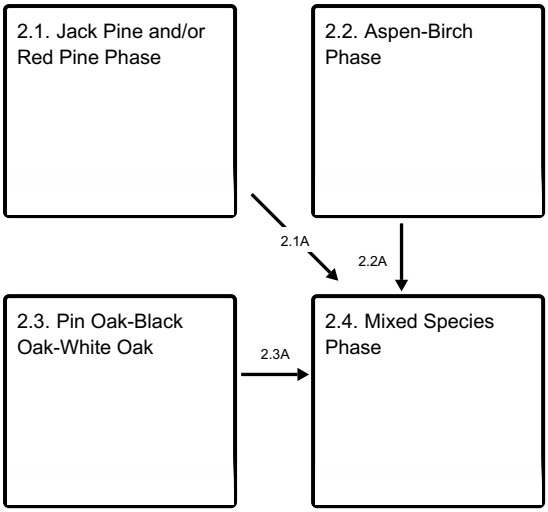
State 1 submodel, plant communities



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

1.2A - Disturbance-free period 30+ years

State 2 submodel, plant communities

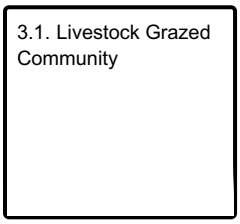


2.1A - Immigration and establishment of white pine and red maple.

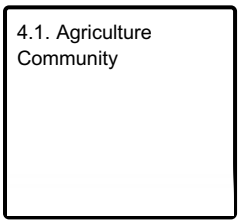
2.2A - Immigration and establishment of white pine and red maple.

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

State 3 submodel, plant communities



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

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

Community 1.1
Advanced Succession Phase

A mature forest community contains a super-canopy, or a scattering, of large eastern white pine (*Pinus strobus*) 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
- 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 stimulating new seedling establishment. Some 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 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
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 community of 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 community of aspen and birch.

Pathway 2.3A
Community 2.3 to 2.4

Immigration and establishment of relatively shade tolerant white pine and red maple into shade intolerant community of mixed oak.

State 3
Livestock Grazed State

This State is characterized by livestock grazing on site. Management inputs are variable but may include woody species removal, brush control, and seeding of forage species.

Community 3.1
Livestock Grazed Community

This community consists of grasses and forbs utilized by livestock.

Dominant plant species

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

State 4
Agriculture State

This community is characterized by crop production. Many species may be planted. Common species include corn, wheat, and other small grains.

Dominant plant species

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

Community 4.1
Agriculture Community

This community consist of various crops being grown.

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 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.

Transition T2A
State 2 to 3

Livestock grazing commenced.

Transition T2B
State 2 to 4

The site is cleared for agricultural production.

Restoration pathway R3A
State 3 to 2

Removal of livestock grazing.

Transition T3A
State 3 to 4

The site is transitioned to crop production.

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.

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:

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

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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:**
