USDA Natural Resources
Conservation Service

Ecological site F091XY013WI
Clayey Upland

Last updated: 9/27/2023
Accessed: 08/17/2024

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): 091X–Wisconsin and Minnesota Sandy Outwash

The Wisconsin and Minnesota Sandy Outwash MLRA is the most extensive glacial outwash system in the northern half of Wisconsin. The total land area of the Wisconsin portion is just under 1.4 million acres (2,170 sq miles). The northern half is a former spillway for Glacial Lake Duluth. The flowing meltwater from the draining lake has left behind thick deposits of drift and carved a terraced river valley now occupied by the St. Croix and Bois Brule Rivers.

The northeastern section – the Bayfield hills – is a collapsed outwash plain where drift deposits are thick. Lacustrine materials from Glacial Lake Duluth line the northeastern tip. Moving southwest, the landscape transitions into a large pitted outwash plain. This is an area of extensive kettle holes, and, where the underlying till is less permeable, kettle lakes with some interspersed morainic hills and ridges. The glacial drift deposits are thinner in the southwestern section, although there is still no documented surface bedrock within this MLRA.

The St. Croix and Bois Brule rivers share a channel that lines much of the northwestern border of this MLRA. In some places, the underlying reddish-brown sandy loam till of the Copper Falls Formation is exposed along cut riverbanks, though most of it is covered by a mantle of outwash. Glacial lakes deposited pockets of fine-textured lacustrine materials, most of which were washed away or buried by glacial outwash and meltwater flowing through the channel. East of the channel, some of the silty and clayey lakebed deposits are found near the surface, where they impede drainage and contribute to the formation of extensive wetlands.

Historically, the area supported extensive jack pine (Pinus banksiana), scrub, and oak forests and barrens. The northern portion also supported stands of red pine (Pinus resinosa) and eastern white pine (*Pinus strobus*) as well. Marsh and sedge meadow, wet prairies, and lowland shrubs dominated the extensive wetland complexes in the southern tip of this MLRA (Finley, R., 1976).

Classification relationships

Relationship to Established Framework and Classification Systems:
Biophysical Settings (Landfire, 2014): This ES is largely mapped as Laurentian-Acadian Northern Hardwoods Forest, Laurentian-Acadian Northern Pine Forest, Eastern Cool Temperate Pasture and Hayland, and Eastern Cool Temperate Row Crop

Habitat Types of N. Wisconsin (Kotar, 2002): The sites of this ES keyed out to three habitat types: *Acer saccharum*/Athyrium-Rubus pubescens (AAtRp); *Acer saccharum*/Clintonia (ACl); *Pinus strobus*-Quercus/Gaultheria-Ceanothus (PQGCe)

WDNR Natural Communities (WDNR, 2015): This ES is most similar to the Northern Mesic Forest community.

Hierarchical Framework Relationships:
Major Land Resource Area (MLRA): Wisconsin and Minnesota Sandy Outwash (91X)

USFS Subregions: Bayfield Sand Plains (212Ka)
Small sections occur in the Mille Lacs Uplands (212Kb) subregion

Wisconsin DNR Ecological Landscapes: Northwest Sands

Ecological site concept

The Clayey Uplands ecological site is found the southern portion of MLRA 91X on lake and outwash plains. These sites are characterized by very deep, moderately well to well drained soils formed in loamy alluvium or sandy outwash overlying deep clayey lacustrine deposits. Precipitation and runoff from adjacent uplands are the primary sources of water. Soils range from very strongly acid to slightly alkaline.

The parent materials of Clayey Uplands were deposited by old glacial lakes, including Glacial Lake Grantsburg. Rushing meltwater from large, proglacial streams during and after Wisconsin's more recent glaciation – including one that occupied today's St. Croix River valley – eroded or capped most of the silty and clayey lacustrine materials from the glacial lakes. Clayey Uplands are found in locations far enough from the river valleys of these old proglacial streams to have not been washed away or thickly-capped.

Based on cumulative ecological indicator values of species present, the site falls into the Dry-Mesic, Nutrient-Medium, category. This condition is reflected by co-occurrence of some species with typically wide range of distribution on the moisture/nutrient gradient, but including the "dry end", and a small number of those that become more common on the "mesic end" of the gradient. Among the former are bracken fern (*Pteridium aquilinum*), big-leaf aster (*Eurybia macrophylla*), serviceberry (Amelanchier spp.) and blueberries (Vaccinium spp.), and among the latter are fly-honeysucke (Lonicera Canadensis), trillium (Trillium spp.) and jack in the pulpit (Arisaema atrorubens). Most tree species have a wide ecological amplitude in regard to soil moisture and nutrient requirements, but they differ more drastically in the degree of shade tolerance. Sugar maple (*Acer saccharum*) is one of the most shade tolerant native tree species and in the absence of major disturbances it dominates forest communities, to the exclusion of less shade tolerant species, on all sites where its soil moisture and nutrient requirements are met. On this ES sugar maple's soil moisture requirements are at their minimum. This is significant in terms of community dynamics because the less shade tolerant species, such as white pine, red oak and white oak, grow much faster than does sugar maple on these sites, and they can take advantage of canopy openings to regenerate, even in the presence of the shade tolerant, but slower growing sugar maple.

Clayey Uplands differ from the sandy loamy uplands due to its finer textures. The clayey textures often have higher pH and available water capacity than sandy and loamy materials. The moderately well to well-drained soil differs Clayey Uplands from other clayey sites.

Associated sites

F091XY006WI	**Wet Clayey Lowland** These sites occur on depressions and drainageways on outwash plains and lake plains. They form in clayey lacustrine deposits overlain by sandy lacustrine or sandy outwash deposits. They are subject to some flooding. These are wetland soils. They are wetter and occur lower on the drainage sequence than Clayey Uplands.
F091XY008WI	**Moist Clayey Lowland** These soils formed in a sandy outwash mantle over clayey lacustrine deposits over sandy lacustrine deposits, or loamy glaciofluvial deposits over clayey lacustrine deposits. Soils are very deep and are somewhat poorly drained. They are wetter and occur lower on the drainage sequence than Clayey Uplands.

Similar sites

F091XY012WI	**Loamy Upland** These soils formed in loamy lacustrine, loamy alluvium, loamy till, sandy outwash, sandy eolian, or loess deposits. Some sites have underlying lacustrine deposits, till, or basalt bedrock. They are moderately well or well drained. The occupy the same position on the landscape as Clayey Uplands but have coarser particle size classes.

Table 1. Dominant plant species

Tree	(1) *Pinus strobus* (2) *Quercus rubra*
Shrub	(1) *Acer saccharum* (2) *Acer rubrum*
Herbaceous	(1) *Pteridium aquilinum* (2) *Eurybia macrophylla*

Physiographic features

These sites formed on lake plains and outwash plains. Most sites have slopes ranging from 0 to 30 percent, though some sites may have slopes as high as 80 percent. Sites are on summit, shoulder, and backslope positions.

Sites are not subject to ponding or flooding. Sites have a perched seasonally high water table (episaturation) at depths of 12 to 66 inches below the soil surface. The water table can drop to greater than 80 inches during dry conditions. Runoff ranges from negligible to very high.

Table 2. Representative physiographic features

Hillslope profile	(1) Summit (2) Shoulder (3) Shoulder
Slope shape across	(1) Convex
Slope shape up-down	(1) Linear
Landforms	(1) Lake plain (2) Outwash plain
Runoff class	Negligible to very high
Flooding frequency	None
Ponding frequency	None
Elevation	240–335 m
Slope	0–80%
Water table depth	30–168 cm
Aspect	Aspect is not a significant factor

Climatic features

The continental climate of the Wisconsin and Minnesota Sandy Outwash MLRA is typical of northern Wisconsin – colder winters and warmer summers. In general, the northern latitudes have cooler summers, colder winters, lower precipitation, and shorter growing seasons than the south; however, neither average annual precipitation nor average annual minimum and maximum temperatures vary greatly within this MLRA. The climate of the northernmost tip is somewhat affected by Lake Superior and receives higher annual precipitation in the form of lake effect snow.

The average annual precipitation for this site is 32 inches. The average annual snowfall is 52 inches. The average annual maximum and minimum temperatures are 53°F and 32°F, respectively.

Table 3. Representative climatic features

Frost-free period (characteristic range)	84-114 days
Freeze-free period (characteristic range)	119-142 days
Precipitation total (characteristic range)	787-813 mm
Frost-free period (actual range)	75-120 days

Freeze-free period (actual range)	112-146 days
Precipitation total (actual range)	787-838 mm
Frost-free period (average)	99 days
Freeze-free period (average)	130 days
Precipitation total (average)	813 mm

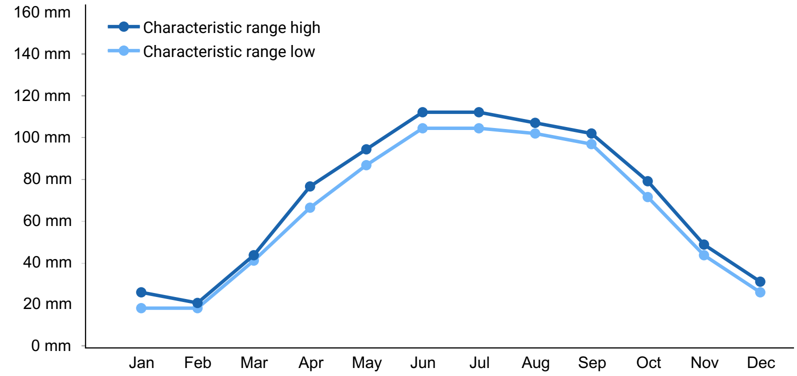


Figure 1. Monthly precipitation range

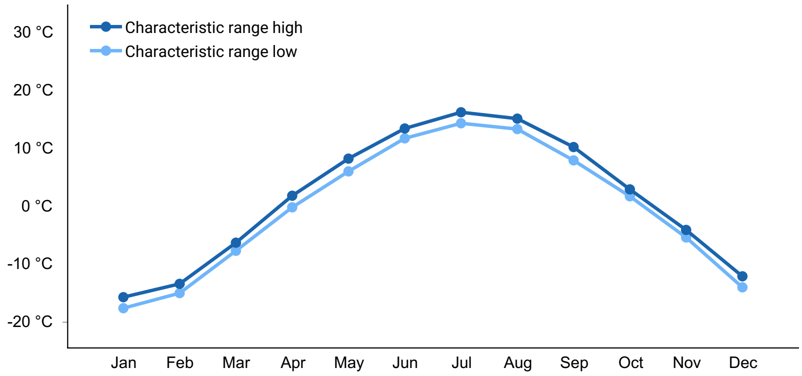


Figure 2. Monthly minimum temperature range

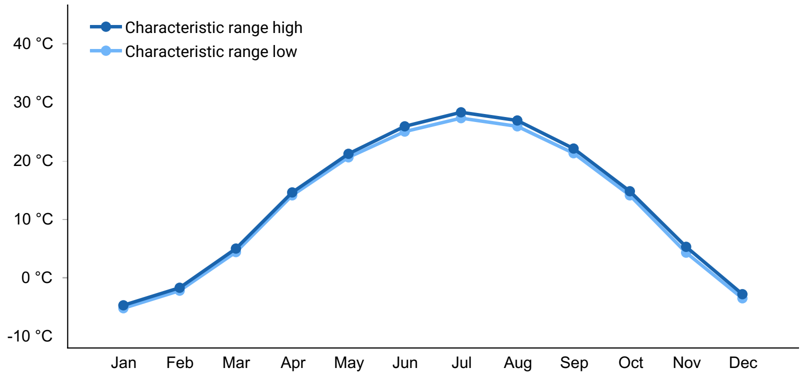


Figure 3. Monthly maximum temperature range

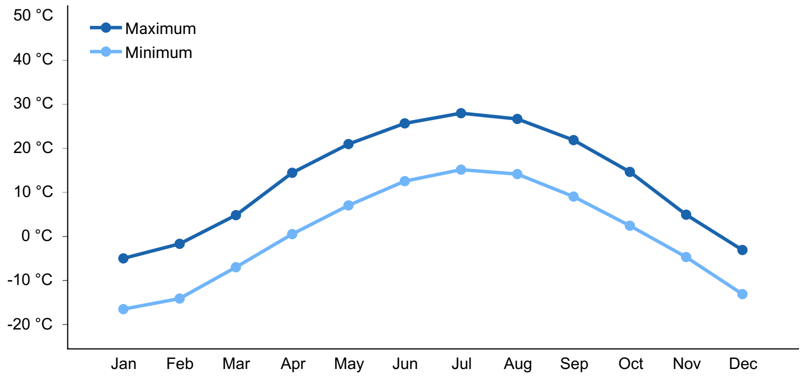


Figure 4. Monthly average minimum and maximum temperature

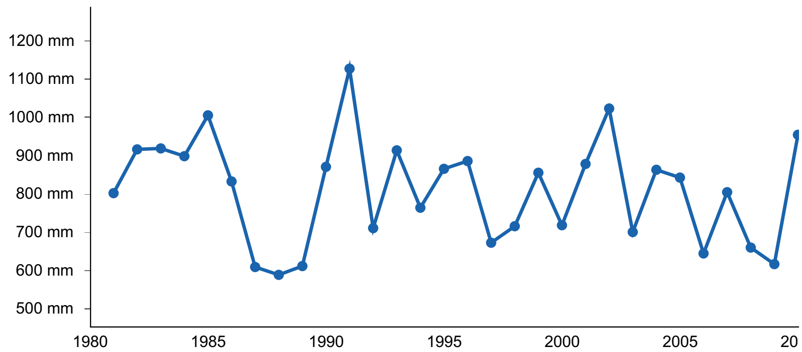


Figure 5. Annual precipitation pattern

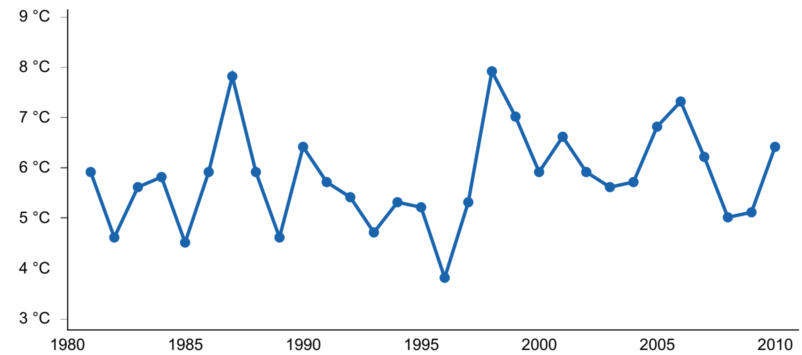


Figure 6. Annual average temperature pattern

Climate stations used

- (1) SPOONER AG RES STN [USC00478027], Spooner, WI
- (2) HAYWARD RS [USC00473511], Hayward, WI
- (3) ANDOVER 1N [USC00210190], Andover, MN
- (4) CEDAR [USC00211390], Cedar, MN
- (5) ELK RIVER [USC00212500], Elk River, MN

Influencing water features

Water is received primarily through precipitation, runoff from adjacent uplands, and groundwater discharge. Water is discharged from the site primarily through runoff, evapotranspiration, and groundwater recharge.

Permeability of these sites is impermeable or very slow.

Hydrologic group is A, C, D, or C/D.

Wetland description

Hydrogeomorphic Wetland Classification: None
Cowardin Wetland Classification: None

Soil features

These sites are represented by the Beede Lake, Karlsborg, Kellogg, Perida, Trade River soil series. The Beede Lake series is classified as a Haplic Glossudalf; Karlsborg is an Arenic Oxyaquic Hapludalf; Kellogg is an Alfic Oxyaquic Haplorthod; Perida is an Arenic Hapludalf; and Trade River is an Oxyaquic GLossudalf.

These soils formed in loamy alluvium over clayey lacustrine or sandy outwash or lacustrine over clayey lacustrine. Soils are very deep and are moderately well to well drained. Soils do not meet hydric soil requirements.

Surface textures of these sites include sandy loam, loamy sand, sand, and moderately decomposed organic material. Subsurface textures include sandy loam, clay, sandy clay loam, silty clay loam, and silty clay. Soil pH ranges from very strongly acid to slightly alkaline with values of 4.6 to 7.6. Carbonates may be present up to 5 percent beginning at 22 inches.

Figure 7. Karlsborg Soil Series sampled on 07/23/2019 in Burnett County, WI.

Table 4. Representative soil features

Parent material	(1) Alluvium (2) Lacustrine deposits (3) Outwash
Surface texture	(1) Moderately decomposed plant material (2) Sand (3) Loamy sand (4) Sandy loam
Drainage class	Moderately well drained to well drained
Permeability class	Very slow
Soil depth	203 cm
Surface fragment cover <=3"	0–7%
Surface fragment cover >3"	0%
Available water capacity (0-152.4cm)	3.68–7.67 cm
Soil reaction (1:1 water) (0-101.6cm)	4.6–7.6
Subsurface fragment volume <=3" (0-101.6cm)	2–9%

Subsurface fragment volume >3" (0-101.6cm)	0–3%

Ecological dynamics

Perhaps the most important ecological characteristic of this Ecological Site, in terms of influence on forest community dynamics, is its limited capacity to support the high to moderate soil moisture and nutrient requiring species such as sugar maple (*Acer saccharum*), basswood (*Tilia americana*) and white ash (Fraxinus Americana). These are the shade-tolerant species, commonly known as the northern hardwoods, that typically dominate the more productive sites throughout northern Wisconsin. Although some of these species do occur sporadically on this Ecological Site, their regeneration capacity and growth rates are sub-optimal, thus limiting their attainment of canopy dominance.

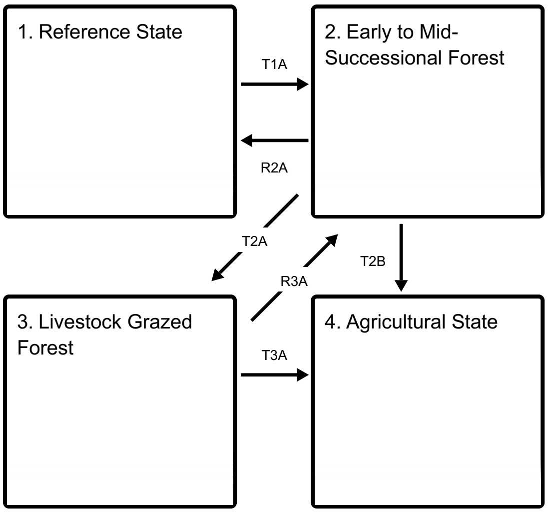
In pre-European settlement time wild fire was the main controlling factor of forest community dynamics. Following a severe, stand-replacing fire, any of the naturally occurring species could become established, depending on the seed source and specific conditions of post-fire seedbed. The newly established 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 a given 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 growth stages, 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 and white oak (*Quercus rubra* and *Q. alba*) have been common members of white pine-dominated stands and upon removal of white pine during early logging era, became the dominant tree component in most stands. Red oak's shade tolerance is only moderate, about equal to that of white pine and both species typically regenerate in large canopy openings. White oak is somewhat more tolerant and regenerates more readily in stands with full stocking. The oaks also have an advantage with the ability to sprout from stumps and damaged seedlings and saplings, while pines do not reproduce vegetatively.

In his reconstruction of pre-European settlement vegetation of Wisconsin, Finley (1976) did not identify red maple (*Acer rubrum*) as a prominent component of pine forests, but the species is a common member of current communities. Absence of fire since the end of 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 Forest Service, 1990). It is sufficiently shade-tolerant to become established in the understories of most communities on sandy soils and on other sites, wherever sugar maple's growing conditions, and therefore its competitive advantage, are sub-optimal.

Sugar maple also was not well represented in pre-settlement communities on this ES, presumably for same reasons as described above for red maple. Sugar maple's re-establishment in present forest communities is slower than that of red maple, largely because it reaches its reproductive stage much more slowly. Light seed production occurs only when trees reach stem diameter of about 8 inches at age 40-60 years (USDA Forest Service, 1990). Because of its very high level of shade tolerance, once established, sugar maple retains its strong presence in stands dominated by white pine, oaks and red maple.

State and transition model

Ecosystem states



T1A - Stand replacing disturbance e.g., blow-down and fire, or clear-cutting followed by fire. Regeneration by natural seeding or planting.

R2A - Time, natural succession by white pine and red maple.

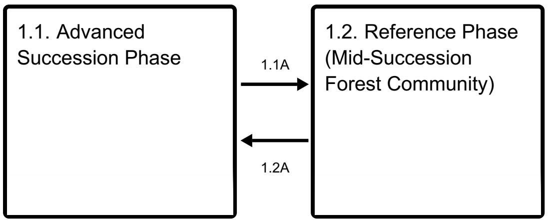
T2A - Grazing by livestock. Disruption of tree regeneration and ground vegetation.

T2B - Removal of natural vegetation, plowing, fertilizing, irrigating, planting agricultural crops.

R3A - Removal of livestock from stands.

T3A - Removal of natural vegetation, plowing, fertilizing, irrigating, planting agricultural crops.

State 1 submodel, plant communities



1.1A - Light to moderate intensity fires, reducing or eliminating advance tree regeneration.

1.2A - White pine and red oak regeneration re-establishes.

State 2 submodel, plant communities

2.1A - Red pine seed into the successional communities of mixed oak

2.1B - Repetitive clearcutting and burning of earlier stands

2.2A - Disturbance e.g., blow-down and fire, or clear-cutting followed by fire. Regeneration by natural seeding or planting.

2.3A - Time without disturbance, natural succession

State 1
Reference State

In the long-term absence of stand replacing disturbance, tree species composition of forest communities on this ecological site fluctuates among white pine (*Pinus strobus*), red pine (P. Resinosa), red oak (*Quercus rubra*) and red maple (*Acer rubrum*). This fluctuation is due to many factors. There is a differential response to a range of common, but not stand-replacing disturbances, such as light fire, snow and ice brakeage and natural mortality in the canopy. There are differences in regeneration requirements among the species and in seedling tolerance of understory conditions. While the resulting community species composition and structure can be viewed as a continuum, two distinct community phases can be described as representing the opposite ends of a continuum.

Dominant plant species

- eastern white pine (*Pinus strobus*), tree
- red pine (*Pinus resinosa*), tree
- northern red oak (*Quercus rubra*), tree

Community 1.1
Advanced Succession Phase

In long-term absence of stand-replacing natural disturbance, or harvesting, forest communities on this ES typically develop into white pine dominated stands with varying admixtures of red oak, white oak and red maple. The shrub layer may be thick or sparse and typically includes hazelnut (*Corylus cornuta* and *C. americana*) as well as saplings of red maple and, more rarely, ironwood (*Ostrya virginiana*). The herb layer is most often dominated by bracken fern (*Pteridium aquilinum*), large leaf aster (*Eurybia macrophylla*) and hog peanut (Amphicarpa bracteata). This Community Phase is rare on today's landscape and for this reason is not designated as the Reference Community Phase.

Community 1.2
Reference Phase (Mid-Succession Forest Community)

Next to the ubiquitous aspen stands, red maple is the most common tree species on this ES. It is commonly associated with red and/or white oaks, which became the dominant components of stands, following the removal of white pine in the early logging era and subsequent selection harvesting practices, often considered as high-grading. White pine reproduction is common if seed sources are present. Understory species composition is similar to that describe in Community Phase 1.1, but individual species' abundance varies greatly depending on the frequency and intensity of disturbance. In general, bracken fern and large-leaf aster comprise dominant cover and hog peanut is well represented. This community phase was chosen as reference state because it is compositionally closest to late successional community and commonly occurs on the landscape today.

Pathway 1.1A
Community 1.1 to 1.2

Low to moderate intensity fire eliminates maple regeneration and in some instances also causes partial or complete mortality of older maple trees. It does not significantly impact fire resistant mature white pines and oaks. This condition promotes oak regeneration, primarily from sprouting of top-killed seedlings and saplings, but also by seedling establishment in the new canopy openings.

Pathway 1.2A
Community 1.2 to 1.1

Canopy species re-establish regeneration layer.

State 2
Early to Mid-Successional Forest

Community 2.1

Red Oak-White Oak Phase

Figure 8. Image courtesy of UWSP taken on 07/23/2019 in Burnett County, WI.

Most oak dominated communities originated following heavy disturbance such as blow-downs, logging and fire. Reproduction from seed is sporadic and dependent on many factors, such as seed dispersal by animals, seed predation by insects and seedbed conditions. Ability to sprout from stumps and damaged, or destroyed, above-ground portions of seedlings and saplings, is a significant factor in the maintenance of oak communities. Red maple is more shade-tolerant than are oaks and white pine and tends to be the primary succeeding species in oak communities, but white pine regeneration also is common in larger canopy gaps wherever seed sources exist. Understory species composition is similar to that describe in Community Phase 1.1, but individual species' abundance varies greatly depending on the frequency and intensity of disturbance. In general, bracken fern and large-leaf aster comprise dominant cover and hog peanut is well represented.

Dominant plant species

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

Community 2.2
Red Pine Plantation

Almost all red pine stands on the landscape today are plantations. Red pine has been by far the most successful species for nursery production and planting, ever since the first attempts of reforestation, following the end of the logging era in the early 20th century. For almost half a century it was promoted as a species of choice on all landscapes with no consideration of ecological appropriateness of the site for the species. This approach naturally led to the existence of a range of excellent to failed plantations. Plantations on this Ecological Site turned out to be successful, if competing vegetation was controlled during the plantation establishment phase. Many plantations continue to be managed as even-aged red pine forests by clearcutting and planting, or by other silvicultural techniques. If left unmanaged, these plantation typically succeed to either red maple or white pine, or a mixture of the two.

Dominant plant species

- red pine (*Pinus resinosa*), tree

Community 2.3
Aspen Phase

Figure 9. Image courtesy of UWSP taken on 06/25/2019 in Bayfield County, WI.

Aspen became established on this Ecological Site almost exclusively following clearcutting and burning of eariler stands of pine and oak. Both, the trembling aspen (*Populus tremuloides*) and big-tooth aspen (*P. grandidentata*) play a role. These stands are being perpetuated through clear cutting. If left unmanaged, they most commonly succeed to red maple and/or white pine. Red or white oak admixtures may occur if scattered individuals of these species existed in the cut-over aspen stand.

Dominant plant species

- quaking aspen (*Populus tremuloides*), tree
- bigtooth aspen (*Populus grandidentata*), tree

Pathway 2.1A
Community 2.1 to 2.2

Red pine seed into the successional communities of mixed oak, leading to the development of Red Pine Plantation.

Pathway 2.1B
Community 2.1 to 2.3

Red Oak-White Oak Phase **Aspen Phase**

Aspen becomes established following repetitive clearcutting and burning of early stages of pine and oak. These stands are being perpetuated through clear cutting.

Pathway 2.2A
Community 2.2 to 2.1

Disturbance e.g., blow-down and fire, or clear-cutting followed by fire. Regeneration by natural seeding or planting.

Pathway 2.3A
Community 2.3 to 2.1

Aspen Phase **Red Oak-White Oak Phase**

Elimination of repetitive clearcutting and burning of stands. Lack of disturbance over time will cause this transition.

State 3
Livestock Grazed Forest

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

State 4
Agricultural State

Production of agricultural crops, most often oats or hay. Routine usage of tillage, fertilizer, and other field practices.

Transition T1A
State 1 to 2

Stand-replacing disturbance, such as blow-down, or ice storm, followed by fire, or clear-cut logging, followed by natural regeneration or site preparation and planting.

Restoration pathway R2A
State 2 to 1

Red maple and white pine seed into the successional communities of mixed oak, red pine or aspen leading to the development of Reference State communities.

Transition T2A
State 2 to 3

Prolonged grazing by livestock

Transition T2B
State 2 to 4

Elimination of forest cover and introduction of tilling, fertilizing an/or irrigation.

Restoration pathway R3A
State 3 to 2

Removal of livestock, natural succession. Results may be sped up by planting and initial outcomes will be heavily influenced by seed source and adjacent plant communities.

Transition T3A
State 3 to 4

Elimination of forest cover and introduction of tilling, fertilizing an/or irrigation.

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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Approval

Suzanne Mayne-Kinney, 9/27/2023

Acknowledgments

NRCS contracted UWSP to write ecological sites for MLRA 91. Completed in 2021.

Rangeland health reference sheet

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

Author(s)/participant(s)	
Contact for lead author	
Date	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):

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

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

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

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

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

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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):**

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:**