Ecological site R110XY021IL
Ponded Organic Alkaline Peatland

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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): 110X–Northern Illinois and Indiana Heavy Till Plain

The Northern Illinois and Indiana Heavy Till Plain (MLRA 110) encompasses the Northeastern Morainal, Grand Prairie, and Southern Lake Michigan Coastal landscapes (Schwegman et al. 1973, WDNR 2015). It spans three states – Illinois (79 percent), Indiana (10 percent), and Wisconsin (11 percent) – comprising about 7,535 square miles (Figure 1). The elevation is about 650 feet above sea level (ASL) and increases gradually from Lake Michigan south. Local relief varies from 10 to 25 feet. Silurian age fractured dolomite and limestone bedrock underlie the region. Glacial drift covers the surface area of the MLRA, and till, outwash, lacustrine deposits, loess or other silty material, and organic deposits are common (USDA-NRCS 2006).

The vegetation in the MLRA has undergone drastic changes over time. At the end of the last glacial episode – the Wisconsinan glaciation – the evolution of vegetation began with the development of tundra habitats, followed by a phase of spruce and fir forests, and eventually spruce-pine forests. Not until approximately 9,000 years ago did the climate undergo a warming trend which prompted the development of deciduous forests dominated by oak and hickory. As the climate continued to warm and dry, prairies began to develop approximately 8,300 years ago. Another shift in climate that resulted in an increase in moisture prompted the emergence of savanna-like habitats from 8,000 to 5,000 years before present (Taft et al. 2009). Forests maintained footholds on steep valley sides, morainal ridges, and wet floodplains. Fire, droughts, and grazing by native mammals helped to maintain the prairies and savannas until the arrival of European settlers, and the forests were maintained by droughts, wind, lightning, and occasional fire (Taft et al. 2009; NatureServe 2018).

Classification relationships

USFS Subregions: Southwestern Great Lakes Morainal (222K) and Central Till Plains and Grand Prairies (251D) Sections; Kenosha-Lake Michigan Plain and Moraines (222Kg), Valparaiso Moraine (Kj), and Eastern Grand Prairie (251Dd) Subsections (Cleland et al. 2007)

U.S. EPA Level IV Ecoregion: Kettle Moraines (53b), Illinois/Indiana Prairies (54a), and Valparaiso-Wheaton Morainal Complex (54f) (USEPA 2013)

National Vegetation Classification – Ecological Systems: North-Central Interior Shrub-Graminoid Alkaline Fen (CES202.702) (NatureServe 2018)

National Vegetation Classification – Plant Associations: *Dasiphora fruticosa*/Carex sterilis – Andropogon gerardii – Arnoglossum plantagineum Fen (CEGL005139) (Nature Serve 2018)

Biophysical Settings: Central Interior and Appalachian Shrub-Herbaceous Wetland System (BpS 4314930) (LANDFIRE 2009)

Illinois Natural Areas Inventory: Fen (White and Madany 1978)

Wisconsin Natural Communities: Calcareous fen (WDNR 2015)

Ecological site concept

Ponded Organic Alkaline Peatland are located within the green areas on the map. They occur on outwash plains. The soils are Histosols that are very poorly drained and very deep, formed in herbaceous organic material.

The historic pre-European settlement vegetation on this ecological site was dominated by hydrophytic herbaceous vegetation adapted to alkaline environments. Dioecious sedge (Carex sterilis Willd.) and Ontario lobelia (Lobelia kalmia L.) are the dominant and characteristic species on the site, respectively. Other important monocots include prairie sedge (Carex prairea Dewey ex Alph. Wood), water sedge (Carex aquatilis Wahlenb.), Buxbaum's sedge (Carex buxbaumii Wahlenb.), marsh muhly (Muhlenbergia glomerata (Willd.) Trin.), big bluestem (Andropogon gerardii Vitman), and tufted hairgrass (Deschampsia caespitosa (L.) P. Beauv.). Species typical of an undisturbed plant community associated with this ecological site may include white lady's slipper (Cypripedium candidum Muhl. ex Willd.), Ohio goldenrod (Oligoneuron ohioense (Frank ex Riddell) G.N. Jones), fen grass of Parnassus (Parnassia glauca Raf.), and fewflower spikerush (Eleocharis quinqueflora (Hartmann) O. Schwarz) (Taft et al. 1997; WDNR 2015). Constant, calcareous groundwater discharge is the primary disturbance factor that maintains the site, while occasional fire and drought are secondary disturbances (LANDFIRE 2009; WDNR 2015).

Associated sites

R110XY008IL	**Wet Glacial Drift Upland Prairie** Loess or other silty or loamy material, loamy outwash, glacial till, lacustrine deposits, and colluvium that are shallow to a high-water table including Ashkum, Bryce, Drummer, Dunham, Elpaso, Matherton, Milford, Monee, Montgomery, Pella, Reddick, Rowe, Selma, Selmass, Westland, and Will soils

Similar sites

R110XY020IL	**Ponded Organic Acidic Peatland** Ponded Organic Acidic Peatlands have a similar vegetation type but the site is an ORGANIC SOIL FLATS wetland

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Carex sterilis* (2) *Lobelia kalmii*

Physiographic features

Ponded Organic Alkaline Peatland occur on outwash plains. They are situated on elevations ranging from approximately 499 to 1020 feet ASL. The site does not experience flooding, but rather is continuously saturated due to groundwater discharge moving laterally throughout the soil and discharging along hillside.

Figure 1.

Table 2. Representative physiographic features

Slope shape up-down	(1) Concave (2) Concave
Landforms	(1) Outwash plain
Runoff class	Negligible
Ponding duration	Brief (2 to 7 days) to long (7 to 30 days)
Ponding frequency	Frequent
Elevation	152–311 m
Slope	0–2%
Ponding depth	0–30 cm
Water table depth	8–15 cm
Aspect	Aspect is not a significant factor

Climatic features

The Northern Illinois and Indiana Heavy Till Plain falls into the hot-summer humid continental climate (Dfa) and warm-summer humid continental climate (Dfb) Köppen-Geiger climate classifications (Peel et al. 2007). The two main factors that drive the climate of the MLRA are latitude and weather systems. Latitude, and the subsequent reflection of solar input, determines air temperatures and seasonal variations. Solar energy varies across the seasons, with summer receiving three to four times as much energy as opposed to winter. Weather systems (air masses and cyclonic storms) are responsible for daily fluctuations of weather conditions. High-pressure systems are responsible for settled weather patterns where sun and clear skies dominate. In fall, winter, and spring, the polar jet stream is responsible for the creation and movement of low-pressure systems. The clouds, winds, and precipitation associated with a low-pressure system regularly follow high-pressure systems every few days (Angel n.d.).

The soil temperature regime of MLRA 110 is classified as mesic, where the mean annual soil temperature is between 46 and 59°F (USDA-NRCS 2006). Temperature and precipitation occur along a north-south gradient, where temperature and precipitation increase the further south one travels. The average freeze-free period of this ecological site is about 149 days, while the frost-free period is about 132 days (Table 2). The majority of the precipitation occurs as rainfall in the form of convective thunderstorms during the growing season. Average annual precipitation is 38 inches, which includes rainfall plus the water equivalent from snowfall (Table 3). The average annual low and high temperatures are 39.6 and 58.1°F, respectively.

Table 3. Representative climatic features

Frost-free period (characteristic range)	121-146 days

Freeze-free period (characteristic range)	133-168 days
Precipitation total (characteristic range)	914-991 mm
Frost-free period (actual range)	105-151 days
Freeze-free period (actual range)	108-177 days
Precipitation total (actual range)	914-1,016 mm
Frost-free period (average)	132 days
Freeze-free period (average)	149 days
Precipitation total (average)	965 mm

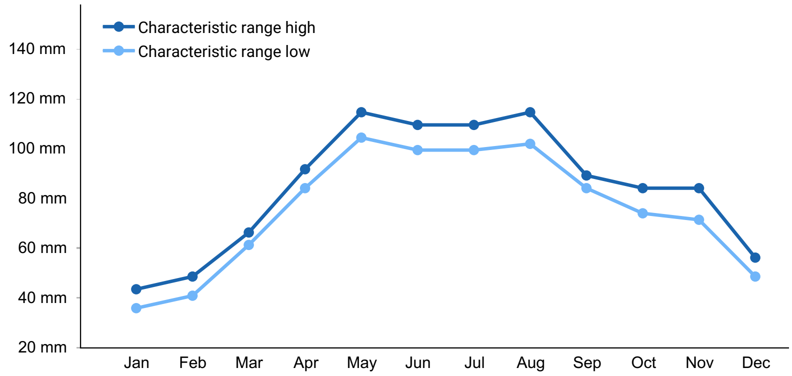


Figure 2. Monthly precipitation range

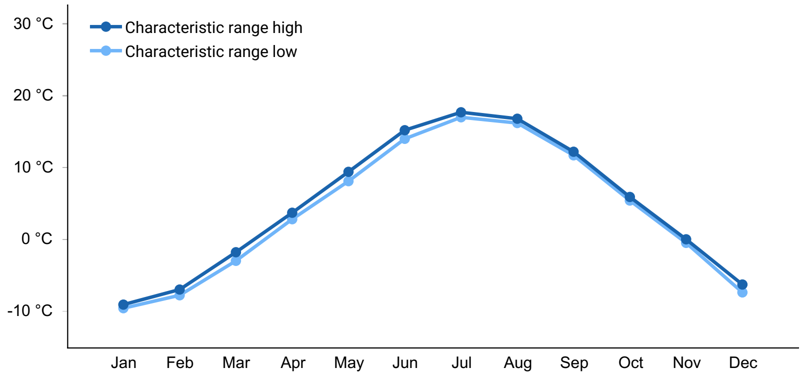


Figure 3. Monthly minimum temperature range

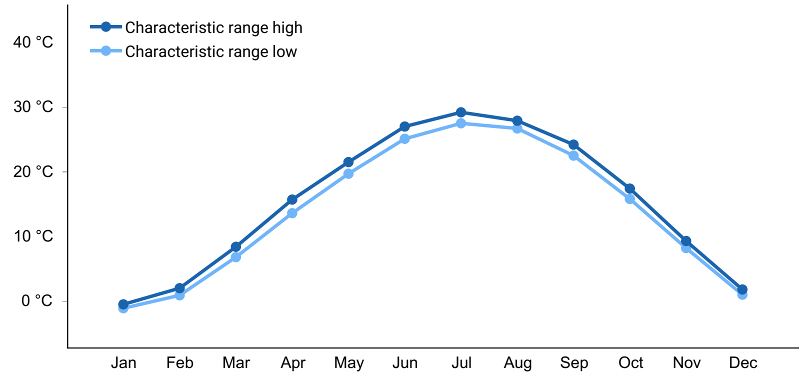


Figure 4. Monthly maximum temperature range

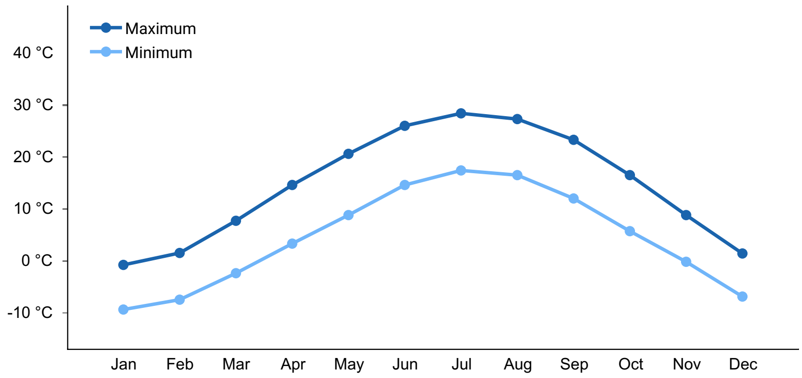


Figure 5. Monthly average minimum and maximum temperature

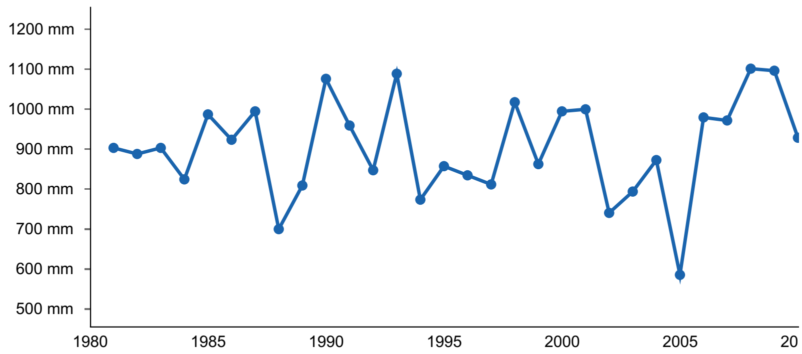


Figure 6. Annual precipitation pattern

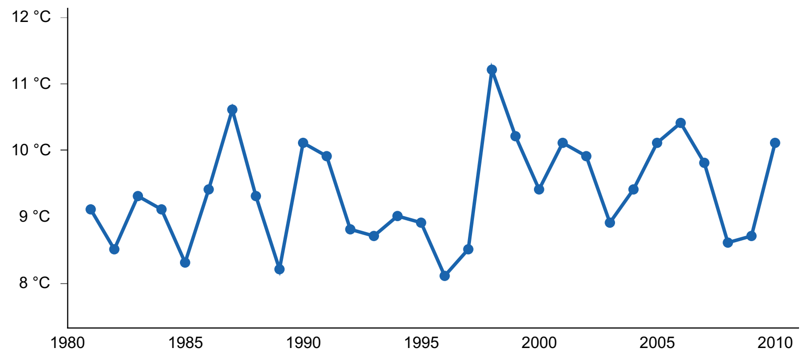


Figure 7. Annual average temperature pattern

Climate stations used

- (1) PARK FOREST [USC00116616], Chicago Heights, IL
- (2) WEST CHICAGO DUPAGE AP [USW00094892], Saint Charles, IL
- (3) MUNDELEIN 4WSW [USC00115961], Lake Zurich, IL
- (4) CHICAGO WAUKEGAN RGNL AP [USW00014880], Waukegan, IL

Influencing water features

Ponded Organic Alkaline Peatlands are classified as a SLOPE: groundwater influenced, discharge, herbaceous wetland under the Hydrogeomorphic (HGM) classification system (Smith et al. 1995; USDA-NRCS 2008) and as a Palustrine, Persistent, Emergent, Continuously Saturated wetland under the National Wetlands Inventory (FGDC 2013). Groundwater discharge from a perched water table is the main source of water for this ecological site (Smith et al. 1995). Infiltration is very slow (Hydrologic Group D) for undrained soils, and surface runoff is negligible.

Wetland description

Primary wetland hydrology indicators for an intact Ponded Organic Alkaline Peatland may include: A2 High water table and A3 Saturation. Secondary wetland hydrology indicators may include: C2 Dry-season water table and D5

FAC-neutral test (USACE 2010).

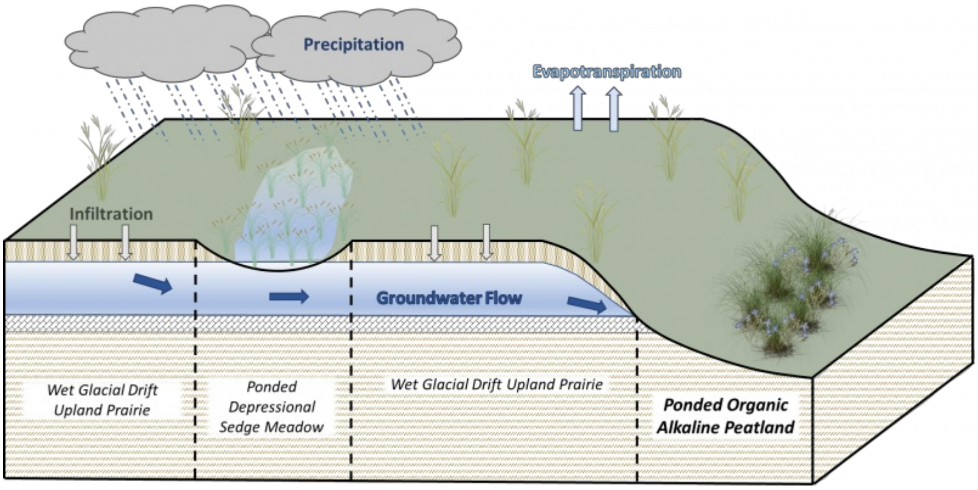


Figure 8. Hydrologic cycling in Ponded Organic Alkaline Peatland ecological site.

Soil features

Soils of Ponded Organic Alkaline Peatlands are in the Histosols order, further classified as Limnic Haplosaprists and Typic Haplosaprists with very slow infiltration and negligible runoff potential. The soil series associated with this site includes Houghton, Lena, and Muskego. The parent material is herbaceous organic matter, and the soils are very poorly drained and very deep with seasonal high-water tables. Soil pH classes are neutral to moderately alkaline (WDNR 2015) . No rooting restrictions are noted for the soils of this ecological site.

Some soil map units in this ecological site, if not drained, may meet the definition of hydric soils and are listed as meeting criteria 1 of the hydric soils list (77 FR 12234).

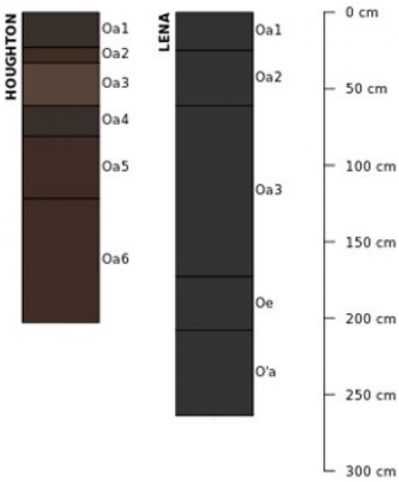


Figure 9. Profile sketches of soil series associated with Ponded Organic Alkaline Peatland.

Table 4. Representative soil features

Parent material	(1) Organic material
Drainage class	Very poorly drained
Permeability class	Very slow to moderate
Depth to restrictive layer	203 cm
Soil depth	203 cm
Surface fragment cover <=3"	0%

Surface fragment cover >3"	0%
Available water capacity (Depth not specified)	33.02–40.64 cm
Calcium carbonate equivalent (Depth not specified)	0–60%
Electrical conductivity (Depth not specified)	0 mmhos/cm
Sodium adsorption ratio (Depth not specified)	0
Soil reaction (1:1 water) (Depth not specified)	6.6–8.4
Subsurface fragment volume <=3" (Depth not specified)	0–1%
Subsurface fragment volume >3" (Depth not specified)	0%

Ecological dynamics

The information in this Ecological Site Description, including the state-and-transition model (STM), was developed based on historical data, current field data, professional experience, and a review of the scientific literature. As a result, all possible scenarios or plant species may not be included. Key indicator plant species, disturbances, and ecological processes are described to inform land management decisions.

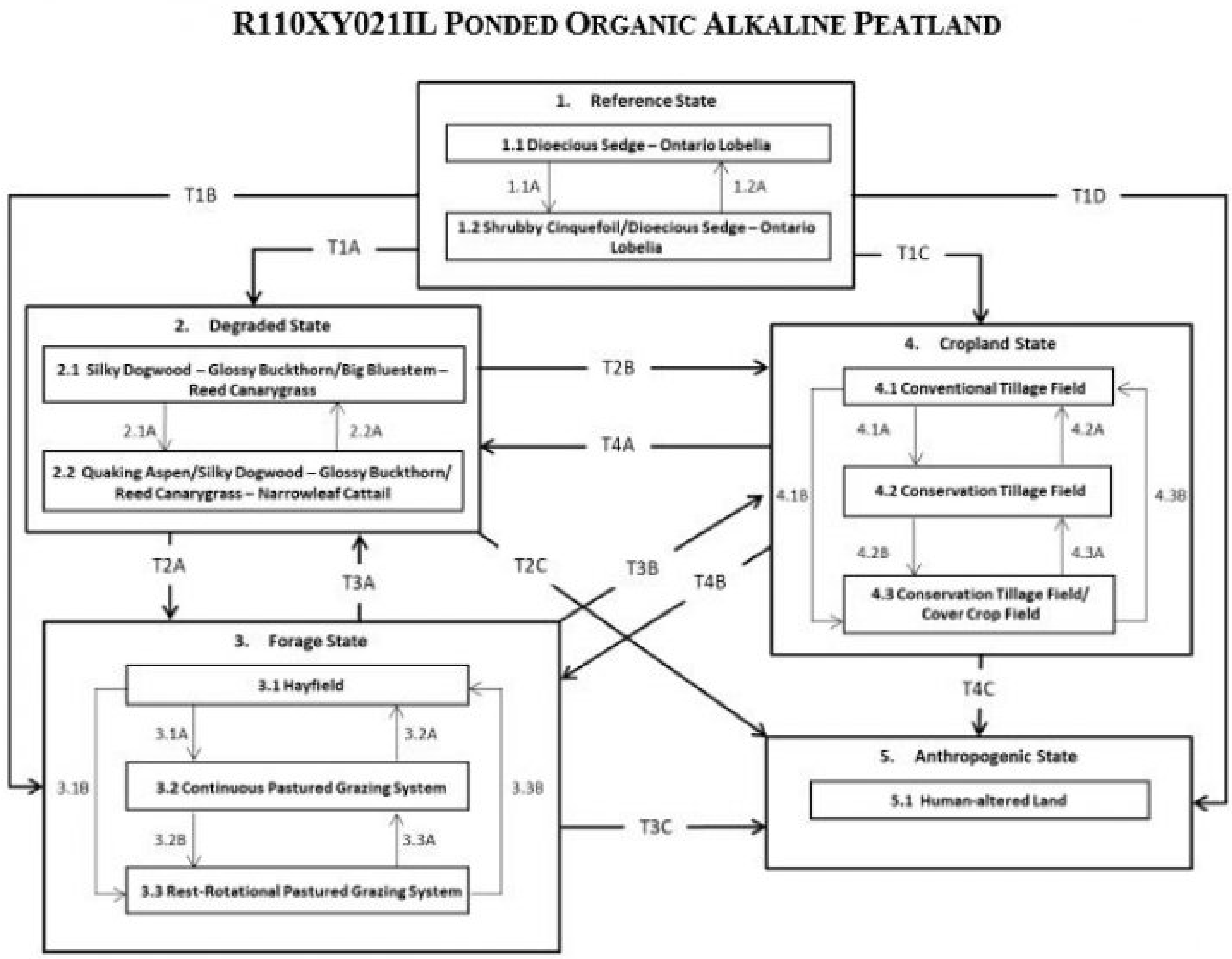
The MLRA lies within the tallgrass prairie ecosystem of the Midwest, but a variety of environmental and edaphic factors resulted in landscape that historically supported prairies, savannas, forests, and various wetlands. Ponded Organic Alkaline Peatlands form an aspect of this vegetative continuum. This ecological site occurs on outwash plains on very poorly drained, alkaline, organic soils. Species characteristic of this ecological site consist of hydrophytic herbaceous vegetation adapted to alkaline environments.

Ponded Organic Alkaline Peatlands are dependent on consistent, calcareous groundwater discharge. These conditions are present where surface slopes intersect a perched water table, allowing the groundwater to slowly seep from the hillside (Richardson and Brinson 2001; Dixon 2014). While water levels may fluctuate throughout the year, they generally remain at or near the soil surface (LANDFIRE 2009). The near-constant anaerobic conditions maintain the herbaceous wetland plant community and prevent woody species from dominating.

Drought and fire have also played a role in shaping this ecological site. The periodic episodes of reduced soil moisture in conjunction with the very poorly-drained soils have favored the proliferation of plant species tolerant of such conditions. Drought can also slow the growth of plants and result in dieback of certain species. Occasional fires reduced plant litter and aided in preventing declines in species richness. Drought coupled with fire would keep woody plants from encroaching (LANDFIRE 2009).

Today, Ponded Organic Alkaline Peatlands have been greatly reduced in abundance and diversity as a result of type-conversion to agricultural or other human-modified landscape. Sites that have not been directly altered show evidence of indirect anthropogenic influences from hydrologic alterations, long-term fire suppression, and non-native invasive species. These land conversions and alterations to the natural groundwater flow can be irreversible, making restoration an improbability. The state-and-transition model that follows provides a detailed description of each state, community phase, pathway, and transition. This model is based on available experimental research, field observations, literature reviews, professional consensus, and interpretations.

State and transition model



Code	Process
1.1A	Natural succession
1.2A	Replacement fire
T1A, T3A, T4A	Changes to hydrology, long-term fire suppression, and/or land abandonment
2.1A	Natural succession following continuing landscape alterations
2.2A	Limited woody species removal
T1B, T2A, T4B	Cultural treatments are implemented to increase forage quality and yield
3.1A	Mechanical harvesting is replaced with domestic livestock and continuous grazing
3.1B	Mechanical harvesting is replaced with domestic livestock and rest-rotational grazing
3.2A, 3.3B	Tillage, forage crop planting, and mechanical harvesting replace grazing
3.2B	Implementation of rest-rotational grazing
3.3A	Implementation of continuous grazing
T1C, T2B, T3B	Agricultural conversion via tillage, seeding, and non-selective herbicide
4.1A	Less tillage, residue management
4.1B	Less tillage, residue management, and implementation of cover cropping
4.2B	Implementation of cover cropping
4.2A, 4.3B	Intensive tillage, remove residue, and reinitiate monoculture row cropping
T1D, T2C, T3C, T4C	Vegetation removal and human alterations/transportation of soils

State 1
Reference State

The reference plant community is categorized as a groundwater-fed slope wetland community, dominated by hydrophytic herbaceous vegetation. The two community phases within the reference state are dependent on consistent groundwater seepage to maintain the plant community. Drought and occasional fires have more localized impacts in the reference state, but do contribute to overall species composition, diversity, cover, and productivity.

Community 1.1
Dioecious Sedge - Ontario Lobelia

Sites in this reference community phase are dominated by hydrophytic herbaceous vegetation. Dioecious sedge, prairie sedge, water sedge, Buxbaum's sedge, marsh muhly, big bluestem, and tufted hairgrass are important graminoids. Characteristic forbs can include Ontario lobelia, Ohio goldenrod, fen grass of Parnassus, swamp lousewort (*Pedicularis lanceolata* Michx.), tobacco root (*Valeriana edulis* Nutt. ex Torr. & A. Gray), and fourflower yellow loosestrife (*Lysimachia quadriflora* Sims) (White and Madany 1978; WDNR 2015).

Dominant plant species

- dioecious sedge (*Carex sterilis*), other herbaceous
- Ontario lobelia (*Lobelia kalmii*), other herbaceous

Community 1.2
Shrubby Cinquefoil/Dioecious Sedge - Ontario Lobelia

This reference community phase represents a successional shift following an extended fire return interval. The lack of fire allows low, woody shrubs (less than 20 inches tall) to establish and become an important component of the plant community. The most common shrubs include shrubby cinquefoil (*Dasiphora fruticosa* (L.) Rydb.), sageleaf willow (*Salix candida* Flueggé ex Willd.), and Kalm's St. Johnswort (*Hypericum kalmianum* L.) (White and Madany 1978; WDNR 2015).

Dominant plant species

- shrubby cinquefoil (*Dasiphora fruticosa*), shrub
- dioecious sedge (*Carex sterilis*), other herbaceous
- Ontario lobelia (*Lobelia kalmii*), other herbaceous

Pathway 1.1A
Community 1.1 to 1.2

Natural succession following an extended fire return interval.

Pathway 1.2A
Community 1.2 to 1.1

Replacement fire.

State 2
Degraded State

The expansion of ruderal woody and herbaceous species into Ponded Organic Alkaline Peatlands can arise due to a complex interaction of fire suppression, hydrological alterations, and edge effects. Subsurface water reduction from agricultural tiling, ditching, or off-site development in conjunction with the removal of periodic fires allows woody species to encroach, casting shade on the native plant community and altering the natural light regime. In addition, edge effects can arise from indirect land management practices (e.g., cropping, herbicide drift) on directly adjacent sites that lead to a transition in the herbaceous species composition to taller, ruderal species (Panno et al. 1999; NatureServe 2018).

Community 2.1
Silky Dogwood - Glossy Buckthorn/Big Bluestem - Reed Canarygrass

This community phase represents the initial changes to the natural community following hydroperiod alterations, fire suppression, and adjacent land management actions. Reduction in the water table allows woody species, such as silky dogwood (*Cornus obliqua* Raf.), to establish a significant shrub cover. The herbaceous layer shifts away from the characteristic, calciphilic plants to more generalized species (e.g., big bluestem). Non-native invasive species, including glossy buckthorn (*Frangula alnus* Mill.) and reed canarygrass (*Phalaris arundinacea* L.) begin to encroach as well (WDNR 2015).

Dominant plant species

- silky dogwood (*Cornus obliqua*), shrub
- glossy buckthorn (*Frangula alnus*), shrub
- big bluestem (*Andropogon gerardii*), grass
- reed canarygrass (*Phalaris arundinacea*), grass

Community 2.2
Quaking Aspen/Silky Dogwood - Glossy Buckthorn/Reed Canarygrass - Narrowleaf Cattail

Sites falling into this community phase represent the natural succession as a result of continuing changes to the hydroperiod and adjacent lands. Quaking aspen (*Populus tremuloides* Michx.) readily develops and occupies the overstory canopy, and silky dogwood and glossy buckthorn continue to form the dominant shrubs. The herbaceous layer continues to be simplified and inhabited by ruderal and non-native species, with species such as narrowleaf cattail (*Typha angustifolia* L.) indicative of perpetuating water quality changes (Panno et al. 1999).

Dominant plant species

- quaking aspen (*Populus tremuloides*), tree
- silky dogwood (*Cornus obliqua*), shrub
- glossy buckthorn (*Frangula alnus*), shrub
- reed canarygrass (*Phalaris arundinacea*), grass
- narrowleaf cattail (*Typha angustifolia*), other herbaceous

Pathway 2.1A
Community 2.1 to 2.2

Natural succession as a result of continuing landscape changes.

Pathway 2.2A
Community 2.2 to 2.1

Limited woody species removal.

State 3
Forage State

The forage state arises when the site is converted to a farming system that emphasizes domestic livestock production, known as grassland agriculture. Fire suppression, periodic cultural treatments (e.g., clipping, drainage, soil amendment applications, planting new species and/or cultivars, mechanical harvesting) and grazing by domesticated livestock transition and maintain this state (USDA-NRCS 2003). Early settlers seeded non-native species, such as smooth brome (*Bromus inermis* Leyss.) and Kentucky bluegrass (*Poa pratensis* L.), to help extend the grazing season (Smith 1998). Over time, as lands were continuously harvested or grazed by herds of cattle, these species were able to spread and expand across the landscape, reducing the native species diversity and ecological function.

Community 3.1
Hayfield

Sites in this community phase consist of forage plants that are planted and mechanically harvested. Mechanical harvesting removes much of the aboveground biomass and nutrients that feed the soil microorganisms (Franzluebbers et al. 2000; USDA-NRCS 2003). As a result, soil biology is reduced leading to decreases in nutrient uptake by plants, soil organic matter, and soil aggregation. Frequent biomass removal can also reduce the site's carbon sequestration capacity (Skinner 2008). This phase may not be prevalent on this ecological site due to the high soil moisture making it difficult to run large equipment across it.

Community 3.2
Continuous Pastured Grazing System

This community phase is characterized by continuous grazing where domestic livestock are allowed to graze a pasture for the entire season. Depending on stocking density, this can result in lower forage quality and productivity, weed invasions, and uneven pasture use. Continuous grazing can also increase the amount of bare ground and erosion and reduce soil organic matter, cation exchange capacity, water-holding capacity, and nutrient availability and retention (Bharati et al. 2002; Leake et al. 2004; Teague et al. 2011). Smooth brome, Kentucky bluegrass, and white clover (*Trifolium repens* L.) are common pasture species used in this phase. Their tolerance to continuous grazing has allowed these species to dominate, greatly reducing the native species diversity to only low palatability species such as woolly sedge and sawtooth sunflower (*Helianthus grosseserratus* M. Martens) (Pearson and Leoschke 1992).

Community 3.3
Rest-Rotation Pastured Grazing System

This community phase is characterized by rotational grazing where the pasture has been subdivided into several smaller paddocks. Through the development of a grazing plan, livestock utilize one or a few paddocks, while the remaining area is rested allowing plants to restore vigor and energy reserves, deepen root systems, develop seeds, as well as allow seedling establishment (Undersander et al. 2002; USDA-NRCS 2003). Rest-rotation pastured grazing systems include deferred rotation, rest rotation, high intensity – low frequency, and short duration methods. Vegetation is generally more diverse and can include orchardgrass (*Dactylis glomerata* L.), timothy (Phleum pretense L.), red clover (*Trifolium pratense* L.), and alfalfa (*Medicago sativa* L.). The addition of native prairie species can further bolster plant diversity and, in turn, soil function. This community phase promotes numerous ecosystem benefits including increasing biodiversity, preventing soil erosion, maintaining and enhancing soil quality, sequestering atmospheric carbon, and improving water yield and quality (USDA-NRCS 2003).

Pathway 3.1A
Community 3.1 to 3.2

Mechanical harvesting is replaced with domestic livestock utilizing continuous grazing.

Pathway 3.1B
Community 3.1 to 3.3

Mechanical harvesting is replaced with domestic livestock utilizing rotational grazing.

Pathway 3.2A
Community 3.2 to 3.1

Domestic livestock are removed, and mechanical harvesting is implemented.

Pathway 3.2B
Community 3.2 to 3.3

Rotational grazing replaces continuous grazing.

Pathway 3.3B
Community 3.3 to 3.1

Domestic livestock are removed, and mechanical harvesting is implemented.

Pathway 3.3A
Community 3.3 to 3.2

Continuous grazing replaces rotational grazing.

State 4
Cropland State

The continuous use of tillage, row-crop planting, chemicals (i.e., herbicides, fertilizers, etc.), and subsurface tile drainage has effectively eliminated the reference community and many of its natural ecological functions in favor of crop production. Corn and soybeans are the dominant crops for the site, and common wheat (*Triticum aestivum* L.) and alfalfa (*Medicago sativa* L.) may be rotated periodically. These areas are likely to remain in crop production for the foreseeable future.

Community 4.1
Conventional Tillage Field

Sites in this community phase typically consist of monoculture row-cropping maintained by conventional tillage practices. They are cropped in either continuous corn or corn-soybean rotations. The frequent use of deep tillage, low crop diversity, and bare soil conditions during the non-growing season negatively impacts soil health. Under these practices, soil aggregation is reduced or destroyed, soil organic matter is reduced, erosion and runoff are increased, and infiltration is decreased, which can ultimately lead to undesirable changes in the hydrology of the watershed (Tomer et al. 2005).

Community 4.2
Conservation Tillage Field

This community phase is characterized by rotational crop production that utilizes various conservation tillage methods to promote soil health and reduce erosion. Conservation tillage methods include strip-till, ridge-till, vertical-till, or no-till planting systems. Strip-till keeps seedbed preparation to narrow bands less than one-third the width of the row where crop residue and soil consolidation are left undisturbed in-between seedbed areas. Strip-till planting may be completed in the fall and nutrient application either occurs simultaneously or at the time of planting. Ridge-till uses specialized equipment to create ridges in the seedbed and vegetative residue is left on the surface in between the ridges. Weeds are controlled with herbicides and/or cultivation, seedbed ridges are rebuilt during cultivation, and soils are left undisturbed from harvest to planting. Vertical-till systems employ machinery that lightly tills the soil and cuts up crop residue, mixing some of the residue into the top few inches of the soil while leaving a large portion on the surface. No-till management is the most conservative, disturbing soils only at the time of planting and fertilizer application. Compared to conventional tillage systems, conservation tillage methods can improve soil ecosystem function by reducing soil erosion, increasing organic matter and water availability, improving water quality, and reducing soil compaction.

Community 4.3
Conservation Tillage Field/Alternative Crop Field

This community phase applies conservation tillage methods as described above as well as adds cover crop practices. Cover crops typically include nitrogen-fixing species (e.g., legumes), small grains (e.g., rye, wheat, oats), or forage covers (e.g., turnips, radishes, rapeseed). The addition of cover crops not only adds plant diversity but also promotes soil health by reducing soil erosion, limiting nitrogen leaching, suppressing weeds, increasing soil organic matter, and improving the overall soil ecosystem. In the case of small grain cover crops, surface cover and water infiltration are increased, while forage covers can be used to graze livestock or support local wildlife. Of the three community phases for this state, this phase promotes the greatest soil sustainability and improves ecological functioning within a cropland system.

Pathway 4.1A
Community 4.1 to 4.2

Tillage operations are greatly reduced, crop rotation occurs on a regular interval, and crop residue remains on the soil surface.

Pathway 4.1B
Community 4.1 to 4.3

Tillage operations are greatly reduced or eliminated, crop rotation occurs on a regular interval, crop residue remains on the soil surface, and cover crops are planted following crop harvest.

Pathway 4.2A
Community 4.2 to 4.1

Intensive tillage is utilized, and monoculture row-cropping is established.

Pathway 4.2B
Community 4.2 to 4.3

Cover crops are implemented to minimize soil erosion.

Pathway 4.3B
Community 4.3 to 4.1

Intensive tillage is utilized, cover crop practices are abandoned, monoculture row-cropping is established, and crop rotation is reduced or eliminated.

Pathway 4.3A
Community 4.3 to 4.2

Cover crop practices are abandoned.

State 5
Anthropogenic State

The anthropogenic state occurs when the reference state is cleared and developed for human use and inhabitation, such as for commercial and housing developments, landfills, parks, golf courses, cemeteries, earthen spoils, etc. The native vegetation has been removed and soils have either been altered in place (e.g. cemeteries) or transported from one location to another (e.g. housing developments). Most of the soils in this state have 50 to 100 cm of overburden on top of the natural soil. This natural material can be determined by observing a buried surface horizon or the unaltered subsoil, till, or lacustrine parent materials. This state is generally considered permanent.

Community 5.1
Human-altered land

Sites in this community phase have had the native plant community removed and soils heavily re-worked in support of human development projects.

Transition T1A
State 1 to 2

Changes to the natural hydrology, long-term fire suppression, and edge effects from adjacent land uses transition this site to the degraded state (2).

Transition T1B
State 1 to 3

Cultural treatments to enhance forage quality and yield transition the site to the forage state (3).

Transition T1C
State 1 to 4

Installation of drain tiles, seeding of agricultural crops, and non-selective herbicide transition the site to the cropland state (4).

Transition T1D
State 1 to 5

Vegetation removal and human alterations/transportation of soils transitions the site to the anthropogenic state (5).

Transition T2A
State 2 to 3

Cultural treatments to enhance forage quality and yield transition the site to the forage state (3).

Transition T2B
State 2 to 4

Installation of drain tiles, seeding of agricultural crops, and non-selective herbicide transition the site to the cropland state (4).

Transition T2C
State 2 to 5

Vegetation removal and human alterations/transportation of soils transitions the site to the anthropogenic state (5).

Transition T3A
State 3 to 2

Land is abandoned and left fallow; natural succession by opportunistic species transition this site the degraded state (2).

Transition T3B
State 3 to 4

Installation of drain tiles, seeding of agricultural crops, and non-selective herbicide transition the site to the cropland state (4).

Transition T3C
State 3 to 5

Vegetation removal and human alterations/transportation of soils transitions the site to the anthropogenic state (5).

Transition T4A
State 4 to 2

Land is abandoned and left fallow; natural succession by opportunistic species transition this site to the degraded state (2).

Transition T4B
State 4 to 3

Cultural treatments to enhance forage quality and yield transitions the site to the forage state (3).

Transition T4C
State 4 to 5

Vegetation removal and human alterations/transportation of soils transitions the site to the anthropogenic state (5).

Additional community tables

Inventory data references

No field plots were available for this site. A review of the scientific literature and professional experience were used to approximate the plant communities for this provisional ecological site. Information for the state-and-transition model was obtained from the same sources. All community phases are considered provisional based on these plots and the sources identified in this ecological site description.

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Rangeland health reference sheet

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

Author(s)/participant(s)	
Contact for lead author	
Date	05/07/2024
Approved by	Chris Tecklenburg
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

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

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

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

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

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

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

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

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

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

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

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

    Dominant:

    Sub-dominant:

    Other:

    Additional:

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

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

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

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

17. **Perennial plant reproductive capability:**