Ecological site R108XA001IL
Organic Sedge Meadow

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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): 108X–Illinois and Iowa Deep Loess and Drift

The Illinois and Iowa Deep Loess and Drift, Eastern Part (MLRA 108A) encompasses the Grand Prairie physiographic division (Schewman et al. 1973). It spans two states – Illinois (97 percent) and Indiana (3 percent) – comprising about 11,145 square miles (Figure 1). The elevation ranges from 985 feet above sea level (ASL) in the northern part to 660 feet above sea level in the southern part. Local relief varies from 3 to 10 feet on most of the area which is on broad flat uplands. The maximum relief is about 160 feet along major streams. The northern part of this area is underlain by Ordovician and Silurian limestone and the southern part is underlain by Pennsylvanian shale, siltstone, and limestone. Except for some areas along streams where bedrock is exposed, glacial drift covers all the MLRA. The glacial drift consists of till and stratified outwash and is of Wisconsinan age. A moderately thin to thick layer of loess covers the entire area (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. Moisture continued to increase in the southernmost region 5,000 years ago, resulting in an increase of forested systems (Taft et al. 2009). 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: Central Till Plains and Grand Prairies (251D) and Central Till Plains-Beech-Maple Sections; Northern Grand Prairie (251Dc), Eastern Grand Prairie (251Dd), Southern Grand Prairie (251De), and Entrenched Valleys (222Hf) Subsections (Cleland et al. 2007)

U.S. EPA Level IV Ecoregion: Illinois/Indiana Prairies (54a) and Glaciated Wabash Lowlands (72b) (USEPA 2013)

National Vegetation Classification – Ecological Systems: Eastern Great Plains Wet Meadow, Prairie, and Marsh (CES205.687) (NatureServe 2018)

National Vegetation Classification – Plant Associations: Carex stricta – Carex spp. Wet Meadow (CEGL002258) (Nature Serve 2018)

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

Illinois Natural Areas Inventory: Sedge Meadow (White and Madany 1978)

Ecological site concept

Organic Sedge Meadows are located within the green areas on the map (Figure 1). They occur depressions, ground moraines, and outwash plains on uplands and on floodplains in river valleys. The soils are Histosols that are very poorly-drained and deep, formed in herbaceous organic material.

The historic pre-European settlement vegetation on this ecological site was dominated by herbaceous vegetation adapted to temporarily ponded conditions. Upright sedge (Carex stricta Lam.) and bluejoint (Calamagrostis canadensis (Michx.) P. Beauv.) are the dominant species on the site. Other monocots can include hairy sedge (Carex lacustris Willd.), water sedge (Carex aquatilis Wahlenb.), rushes (Juncus L.), and spikerushes (Eleocharis R. Br.) (White and Madany 1978; NatureServe 2018). Species typical of an undisturbed plant community associated with this ecological site can include white turtlehead (Chelone glabra L.) and Bebb's sedge (Carex bebbii Olney ex Fernald) (Taft et al. 1997). Few shrubs may be present in very low densities and can include silky dogwood (Cornus amomum Mill.) and white meadowsweet (Spiraea alba Du Roi). Depth and duration of ponding as well as periodic fire are the primary disturbance factors that maintain this site, while drought is a secondary factor (LANDFIRE 2009; NatureServe 2018).

Associated sites

R108XA018IL	**Ponded Floodplain Marsh** Ponded and flooded alluvial soils including Colo, Comfrey, Millington, Moundprairie, Otter, Sawmill, Titus, and Wabash
R108XA006IL	**Loess Upland Prairie** Deep loess soils including Arrowsmith, Catlin, Dana, Danabrook, Flanagan, Graymont, Harco, La Rose, Lisbon, Mona, Normal, Parr, Raub, Rooks, Rutland, Saybrook, Varna, Wenona and Wyanet
R108XA007IL	**Wet Loess Upland Prairie** Deep loess soils that are shallow to the water table including Elpaso and Hartsburg
R108XA013IL	**Wet Outwash Prairie** Shallow loess over outwash soils that are shallow to the water table including Drummer and Thorp

Similar sites

R108XA008IL	**Ponded Loess Sedge Meadow** Ponded Loess Sedge Meadows occur only on uplands and are MINERAL SOIL FLATS wetlands

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Carex stricta* (2) *Calamagrostis canadensis*

Physiographic features

Organic Sedge Meadows occur on depressions, ground moraines, and outwash plains on uplands and on floodplains in river valleys. They are situated on elevations ranging from approximately 341 to 1601 feet ASL. Brief flooding can occur, and ponding can be rare to frequent, lasting up to 30 days (Table 1).

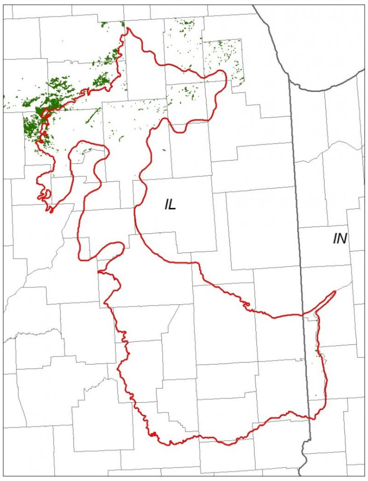


Figure 1. Figure 1. Location of Organic Sedge Meadow ecological site within MLRA 108A.

Table 2. Representative physiographic features

Slope shape across	(1) Concave
Slope shape up-down	(1) Concave
Landforms	(1) Upland > Depression (2) Upland > Ground moraine (3) Outwash plain (4) River valley > Flood plain
Runoff class	Negligible to low
Flooding duration	Brief (2 to 7 days)
Flooding frequency	None to frequent
Ponding duration	Brief (2 to 7 days) to long (7 to 30 days)
Ponding frequency	None to frequent
Elevation	104–488 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 Illinois and Iowa Deep Loess and Drift, Eastern Part falls into the hot-summer humid continental climate (Dfa) and the humid subtropical continental climate (Cfa) 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 108A 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 179 days, while the frost-free period is about 140 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 approximately 36 inches, which includes rainfall plus the water equivalent from snowfall (Table 3). The average annual low and high temperatures are 40 and 60°F, respectively.

Climate data and analyses are derived from 30-year averages gathered from two National Oceanic and Atmospheric Administration (NOAA) weather stations contained within the range of this ecological site (Table 4).

Table 3. Representative climatic features

Frost-free period (characteristic range)	136-144 days
Freeze-free period (characteristic range)	172-185 days
Precipitation total (characteristic range)	914 mm
Frost-free period (actual range)	135-145 days
Freeze-free period (actual range)	169-188 days
Precipitation total (actual range)	914 mm
Frost-free period (average)	140 days
Freeze-free period (average)	179 days
Precipitation total (average)	914 mm

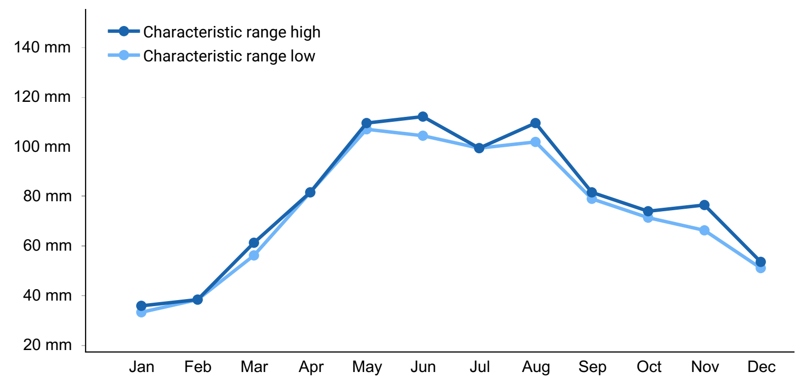


Figure 2. Monthly precipitation range

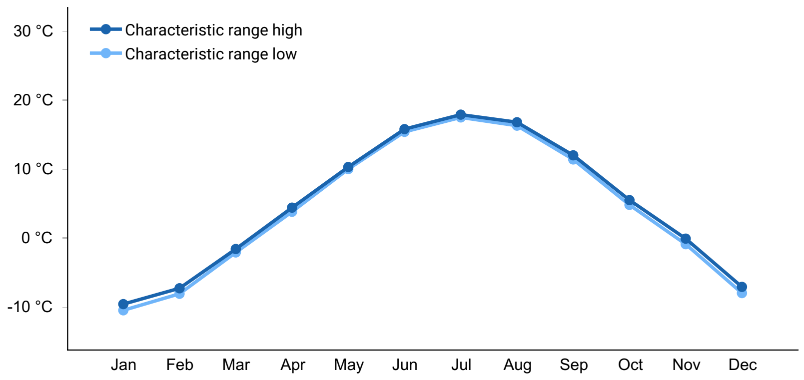


Figure 3. Monthly minimum temperature range

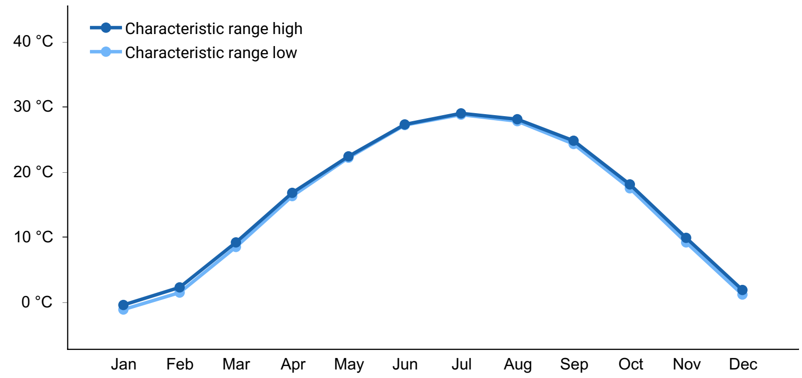


Figure 4. Monthly maximum temperature range

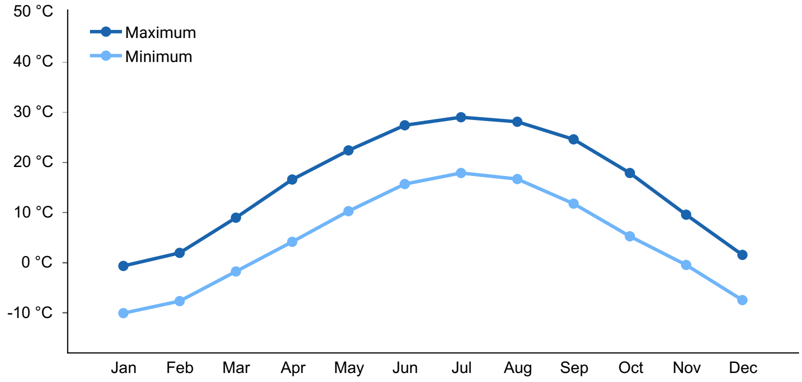


Figure 5. Monthly average minimum and maximum temperature

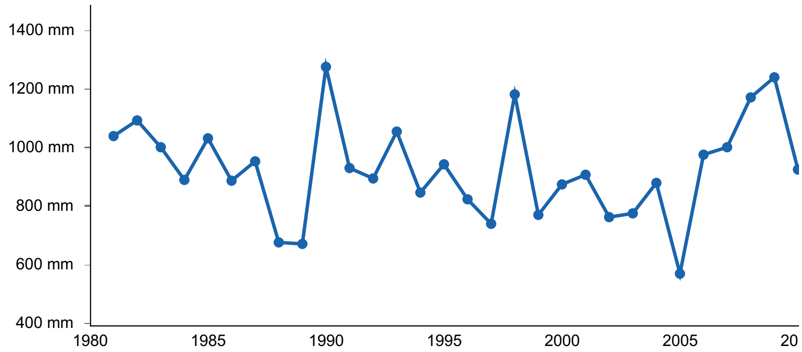


Figure 6. Annual precipitation pattern

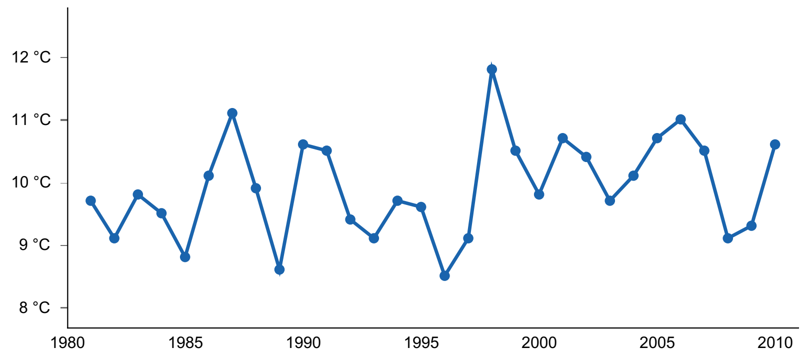


Figure 7. Annual average temperature pattern

Climate stations used

- (1) OTTAWA 5SW [USC00116526], Ottawa, IL
- (2) WALNUT [USC00118916], Walnut, IL

Influencing water features

Organic Sedge Meadows on uplands are classified as an ORGANIC SOIL FLATS: ponded; herbaceous wetland under the Hydrogeomorphic (HGM) classification system. On river valleys they are classified as RIVERINE: flooded, ponded, herbaceous wetlands. (Smith et al. 1995; USDA-NRCS 2008). Under the National Wetlands Inventory, the uplands fall under the Palustrine Persistent Emergent wetland, while the river valleys fall under the Palustrine, Persistent, Emergent, Seasonally Flooded-Saturated wetland (FGDC 2013). Precipitation, overbank flow, and subsurface hydraulic connections are the main sources 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 to low (Figure 5).

Primary wetland hydrology indicators for an intact Ponded Loess Sedge Meadows may include: A1 Surface water, A2 High water table, A3 Saturation, and B7 Inundation visible on aerial photography. Secondary wetland hydrology indicators may include: C2 Dry-season water table, D2 Geomorphic position, and D5 FAC-neutral test (USACE 2010).

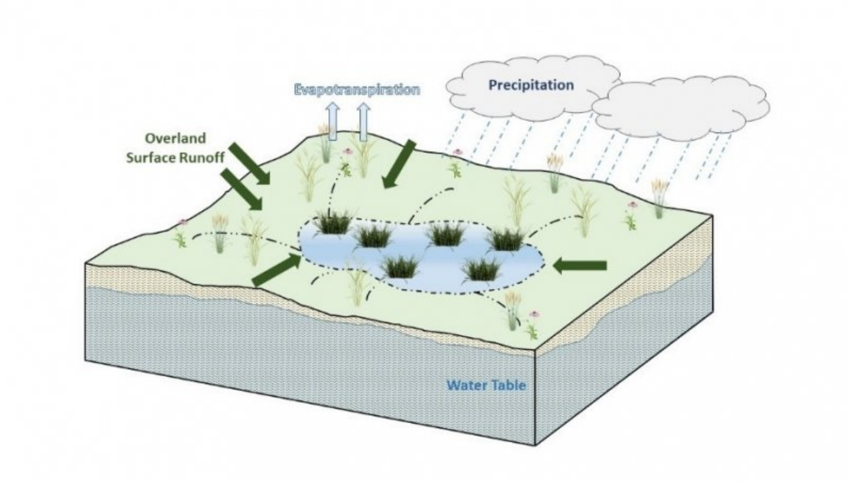


Figure 8.

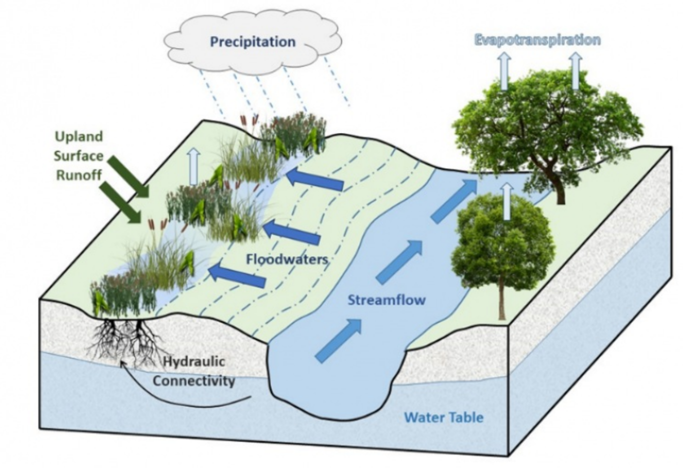


Figure 9. Figure 5. Hydrologic cycling in Organic Sedge Meadow ecological site.

Soil features

Soils of Organic Sedge Meadows are in the Histosols orders with very slow infiltration and negligible to low runoff potential. The soil series associated with this site includes Lena, Muskego, and Palms (Figure 6). The parent material is herbaceous organic material, and the soils are very poorly-drained and deep with seasonal high-water tables. Soil pH classes are strongly acid to moderately alkaline. No rooting restrictions are noted for the soils of this ecological site (Table 5).

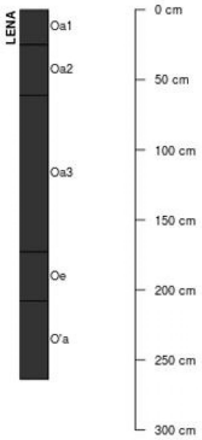


Figure 10. Figure 6. Profile sketches of soil series associated with Organic Sedge Meadow.

Table 4. Representative soil features

Parent material	(1) Herbaceous organic material
Drainage class	Very poorly drained
Permeability class	Very slow to moderately slow
Soil depth	203 cm

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.

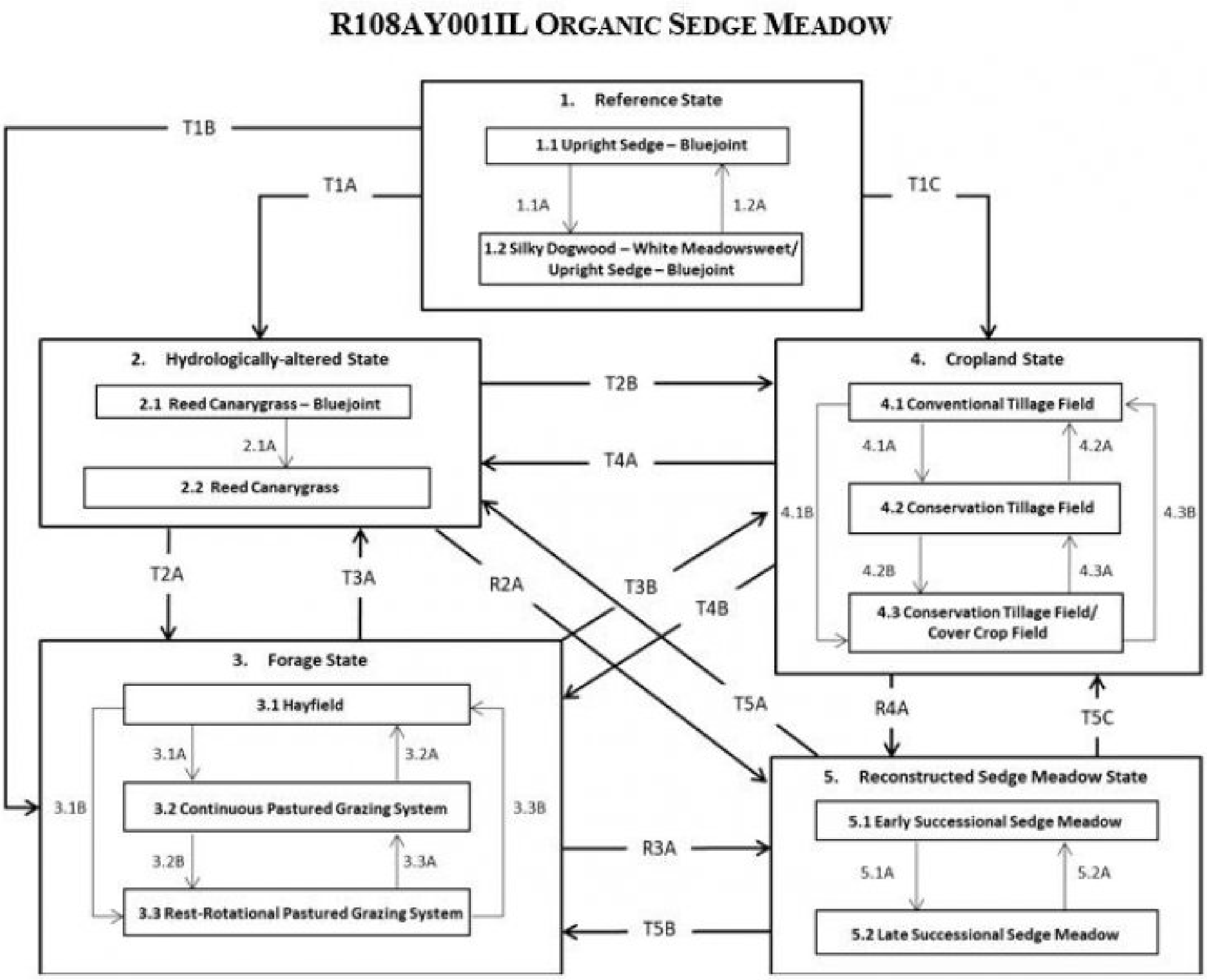
The MLRA lies within the tallgrass prairie ecosystem of the Midwest. The heterogeneous topography of the area results in variable microclimates and fuel matrices that in turn support prairies, savannas, and forests. Organic Sedge Meadows form an aspect of this vegetative continuum. This ecological site occurs on uplands and river valleys on very poorly-drained organic soils. Species characteristic of this ecological site consist of hydrophytic, herbaceous vegetation.

Ponding and fire are the most important ecosystem drivers for maintaining this ecological site. The depth and duration of ponding affect species composition, cover, and vegetative production due to alternating aerobic and anaerobic surface substrate conditions. Replacement fires likely occurred on a ten-year rotation interval and helped to reduce the accumulation of peat. The combination of fire and high-water levels prevented the establishment of shrubs for any significant amount of time (LANDFIRE 2009).

Drought has 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 slow the growth of plants and result in dieback of certain species. When coupled with fire, periods of drought can eliminate or greatly reduce the occurrence of woody vegetation, substantially altering the extent of shrubs and trees (Pyne et al. 1996).

Today, Organic Sedge Meadows have been greatly reduced as the land has mostly been converted to agricultural production. Corn (*Zea mays* L.) and soybeans (*Glycine max* (L.) Merr.) are the dominant crops grown, but small patches of forage land may be present. A return to the historic plant community is likely not possible due to significant hydrologic and water quality changes in the watershed, but long-term conservation agriculture or habitat reconstruction efforts can help to restore some natural diversity and ecological functioning. 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
T1A, T3A, T4A, T5A	Changes to natural hydroperiod and/or land abandonment
T1B, T2A, T4B, T5B	Cultural treatments are implemented to increase forage quality and yield
T1C, T2B, T3B, T5C	Agricultural conversion via tillage, seeding, and non-selective herbicide
1.1A	Increased fire return interval and/or reduction in average soil water levels
1.2A	Reduced fire return interval and/or average soil water levels increase
2.1A	Increasing changes to hydrology and increasing sedimentation
R2A, R3A, R4A	Site preparation, non-native species control, and native seeding
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
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
4.3A	Remove cover cropping
5.1A	Invasive species control and implementation of disturbance regimes
5.2A	Drought or improper timing/use of management actions

State 1
Reference State

The reference plant community is categorized as a sedge meadow community, dominated by hydrophytic herbaceous vegetation. The two community phases within the reference state are dependent on ponding and fire. The depth and duration of ponding alters species composition, cover, and extent, while regular fire intervals keep woody species from encroaching. Drought has more localized impacts in the reference phases, but does contribute to overall species composition, diversity, cover, and productivity.

Community 1.1
Upright Sedge - Bluejoint

Sites in this reference community phase are dominated by sedges with grasses and forbs interspersed. Mature plants typically range between 1.5 and 3 feet tall, and ground cover is continuous (75 to 100 percent) (LANDFIRE 2009). Upright sedge and bluejoint are the dominant species. Hairy sedge, water sedge, rushes, and spikerushes area also present. Common forbs include spotted joe pye weed (*Eutrochium maculatum* (L.) E.E. Lamont), swamp milkweed (*Asclepias incarnata* L.), and white panicle aster (*Symphyotrichum lanceolatum* (Willd.) G.L. Nesom ssp. lanceolatum var. lanceolatum) (White and Madany 1978; NatureServe 2018).

Dominant plant species

- bluejoint (*Calamagrostis canadensis*), grass
- upright sedge (*Carex stricta*), other herbaceous

Community 1.2
Silky Dogwood - White Meadowsweet/Upright Sedge - Bluejoint

This reference community phase can occur when the frequency and depth of ponding are reduced such as from periodic drought. This phase can also occur when fire return intervals increase. The community assumes more of a shrub-carr assemblage, and shrubs, such as silky dogwood and white meadowsweet, become more prominent in the community encompassing at least 25 percent cover (NatureServe 2018). Sedges and forbs are still present but are likely reduced in areas where shrubs create pockets of shade (LANDFIRE 2009).

Dominant plant species

- silky dogwood (*Cornus amomum*), shrub
- white meadowsweet (*Spiraea alba*), shrub
- bluejoint (*Calamagrostis canadensis*), grass
- upright sedge (*Carex stricta*), other herbaceous

Pathway 1.1A
Community 1.1 to 1.2

Reduced fire return intervals and/or periodic drying results in a reduction of the average soil water levels.

Pathway 1.2A
Community 1.2 to 1.1

Increased fire return intervals and/or average soil water levels rise.

State 2
Hydrologically-Altered State

Hydrology is the most important determinant of wetlands and wetland processes. Hydrology modifies and determines the physiochemical environment (i.e., sediments, soil chemistry, water chemistry) which in turn directly affects the vegetation, animals, and microbes (Mitsch and Gosselink 2007). Human activities on landscape hydrology have greatly altered Organic Sedge Meadows. Alterations such as agricultural tile draining and conversion to cropland on adjacent lands have changed the natural hydroperiod, increased the rate of sedimentation, and intensified nutrient pollution (Werner and Zedler 2003; Mitsch and Gosselink 2007).

Community 2.1
Reed Canarygrass - Bluejoint

This community phase represents the early changes to the natural wetland hydroperiod, sedimentation, and nutrient runoff. Sedimentation results in a reduction of soil organic matter and high dry bulk density. It also leads to a homogenization of the local microtopography, reducing the surface area and associated species diversity (Green and Galatowitsch 2002; Werner and Zedler 2002). Bluejoint and some sedges continues to form a component of the herbaceous layer, but the highly-invasive reed canarygrass (*Phalaris arundinacea*L.) co-dominates.

Dominant plant species

- reed canarygrass (*Phalaris arundinacea*), grass
- bluejoint (*Calamagrostis canadensis*), grass

Community 2.2
Reed Canarygrass

Sites falling into this community phase have experienced significant sedimentation and are dominated by a monoculture of reed canarygrass. Reed canarygrass stands can significantly alter the physiochemical environment as well as the biotic communities, making the site only suitable to reed canarygrass. These monotypic stands create a positive feedback loop that perpetuates increasing sedimentation, altered hydrology, and dominance by this non-native species, especially in sites affected by nutrient enrichment from agricultural runoff (Vitousek 1995; Bernard and Lauve 1995; Green and Galatowitsch 2002; Werner and Zedler 2002; Kercher et al. 2007; Waggy 2010).

Dominant plant species

- reed canarygrass (*Phalaris arundinacea*), grass

Pathway 2.1A
Community 2.1 to 2.2

Continuing alterations to the natural hydrology and increasing sedimentation.

State 3
Forage State

The forage state occurs when the reference state 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. Over time, as lands were continuously harvested or grazed by herds of cattle, the non-native 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).

Community 3.2
Continuous Pastured Grazing System

This community phase is characterized by continuous grazing where domestic livestock 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, sometimes completely excluding the native vegetation.

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, and chemicals (i.e., herbicides, fertilizers, etc.) and subsurface tile drainage have 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 oats (Avena 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
Reconstructed Sedge Meadow State

Sedge meadow habitats provide multiple ecosystem services including flood abatement, water quality improvement, and biodiversity support. However, many sedge meadow communities have been stressed from watershed-scale changes in hydrology or eliminated due to type conversions to agricultural production, thereby significantly reducing these services (Zedler 2003). The extensive alterations of lands adjacent to Organic Sedge Meadows may not allow for restoration back to the historic reference condition. However, ecological reconstruction can aim to aid the recovery of degraded, damaged or destroyed functions. A successful reconstruction will have the ability to structurally and functionally sustain itself, demonstrate resilience to the natural ranges of stress and disturbance, and create and maintain positive biotic and abiotic interactions (SER 2002; Mitsch and Jørgensen 2004).

Community 5.1
Early Successional Sedge Meadow

This community phase represents the early community assembly from sedge meadow reconstruction and is highly dependent on seed viability, hydroperiod, soil organic matter content, and site preparation. Successful establishment of sedges can be maximized by using seed collected during the same growing season, utilizing genotypes adapted to the environmental location, ensuring soil moisture is saturated at the time of seeding, and improving the water holding capacity and fertility of the soil (Budelsky and Galatowitsch 1999; van der Valk et al. 1999; Mitsch and Gosselink 2007; Hall and Zedler 2010). In addition, suppression and removal of non-native species is essential for reducing competition (Perry and Galatowitsch 2003).

Community 5.2
Late Successional Sedge Meadow

Appropriately timed disturbance regimes (e.g., hydroperiod, prescribed fire) and nutrient management applied to the early successional community phase can help increase the species richness, pushing the site into a late successional community phase over time (Mitsch and Gosselink 2007).

Pathway 5.1A
Community 5.1 to 5.2

Maintenance of proper hydrology and nutrient balances in line with a developed wetland management plan.

Pathway 5.2A
Community 5.2 to 5.1

Reconstruction experiences a setback from extreme weather event or improper timing of management actions.

Transition T1A
State 1 to 2

Direct and indirect alterations to the landscape hydrology from human-induced land development transition the site to the hydrologically-altered 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 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).

Restoration pathway R2A
State 2 to 5

Hydroperiod restoration, site preparation, non-native species control, and seeding native species transition the site to the reconstructed sedge meadow state (5).

Transition T3A
State 3 to 2

Land is abandoned and left fallow; natural succession by opportunistic species transition this site to the hydrologically-altered 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).

Restoration pathway R3A
State 3 to 5

Hydroperiod restoration, site preparation, non-native species control, and seeding native species transition the site to the reconstructed sedge meadow state (5).

Transition T4A
State 4 to 2

Agricultural production abandoned and left fallow; natural succession by opportunistic species transition this site to the hydrologically-altered state (2).

Transition T4B
State 4 to 3

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

Restoration pathway R4A
State 4 to 5

Hydroperiod restoration, site preparation, non-native species control and seeding native species transition this site to the reconstructed sedge meadow state (5).

Transition T5A
State 5 to 2

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

Transition T5B
State 5 to 3

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

Transition T5C
State 5 to 4

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

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	05/01/2020
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:**