

Ecological site R115XC016IL Ponded Floodplain Marsh

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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): 115X–Central Mississippi Valley Wooded Slopes

This MLRA is characterized by deeply dissected, loess-covered hills bordering well defined valleys of the Illinois, Mississippi, Missouri, Ohio, and Wabash Rivers and their tributaries. It is used to produce cash crops and livestock. About one-third of the area is forested, mostly on the steeper slopes. This area is in Illinois (50 percent), Missouri (36 percent), Indiana (13 percent), and Iowa (1 percent) in two separate areas. It makes up about 25,084 square miles (64,967 square kilometers).

Most of this area is in the Till Plains section and the Dissected Till Plains section of the Central Lowland province of the Interior Plains. The Springfield-Salem plateaus section of the Ozarks Plateaus province of the Interior Highlands occurs along the Missouri River and the Mississippi River south of the confluence with the Missouri River. The nearly level to very steep uplands are dissected by both large and small tributaries of the Illinois, Mississippi, Missouri, Ohio, and Wabash Rivers. The Ohio River flows along the southernmost boundary of this area in Indiana. Well defined valleys with broad flood plains and numerous stream terraces are along the major streams and rivers. The flood plains along the smaller streams are narrow. Broad summits are nearly level to undulating. Karst topography is common in some parts along the Missouri and Mississippi Rivers and their tributaries. Well-developed karst areas have hundreds of sinkholes, caves, springs, and losing streams. In the St. Louis area, many of the karst features have been obliterated by urban development.

Elevation ranges from 90 feet (20 meters) on the southernmost flood plains to 1,030 feet (320 meters) on the highest ridges. Local relief is mainly 10 to 50 feet (3 to 15 meters) but can be 50 to 150 feet (15 to 45 meters) in the steep, deeply dissected hills bordering rivers and streams. The bluffs along the major rivers are generally 200 to 350 feet (60 to 105 meters) above the valley floor.

The uplands in this MLRA are covered almost entirely with Peoria Loess. The loess can be more than 7 feet (2 meters) thick on stable summits. On the steeper slopes, it is thin or does not occur. In Illinois, the loess is underlain mostly by Illinoian-age till that commonly contains a paleosol. Pre-Illinoian-age till is in parts of this MLRA in Iowa and Missouri and to a minor extent in the western part of Illinois. Wisconsin-age outwash, alluvial deposits, and sandy eolian material are on some of the stream terraces and on dunes along the major tributaries. The loess and glacial deposits are underlain by several bedrock systems. Pennsylvanian and Mississippian bedrock are the most extensive. To a lesser extent are Silurian, Devonian, Cretaceous, and Ordovician bedrock. Karst areas have formed where limestone is near the surface, mostly in the southern part of the MLRA along the Mississippi River and some of its major tributaries. Bedrock outcrops are common on the bluffs along the Mississippi, Ohio, and Wabash Rivers and their major tributaries and at the base of some steep slopes along minor streams and drainageways.

The annual precipitation ranges from 35 to 49 inches (880 to 1,250 millimeters) with a mean of 41 inches (1,050 millimeters). The annual temperature ranges from 48 to 58 degrees F (8.6 to 14.3 degrees C) with a mean of 54 degrees F (12.3 degrees C). The freeze-free period ranges from 150 to 220 days with a mean of 195 days.

Soils The dominant soil orders are Alfisols and, to a lesser extent, Entisols and Mollisols. The soils in the area have

a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed or smectitic mineralogy. They are shallow to very deep, excessively drained to poorly drained, and loamy, silty, or clayey.

The soils on uplands in this area support natural hardwoods. Oak, hickory, and sugar maple are the dominant species. Big bluestem, little bluestem, and scattered oak and eastern redcedar grow on some sites. The soils on flood plains support mixed forest vegetation, mainly American elm, eastern cottonwood, river birch, green ash, silver maple, sweetgum, American sycamore, pin oak, pecan, and willow. Sedge and grass meadows and scattered trees are on some low-lying sites. (United States Department of Agriculture, Natural Resources Conservation Service, 2022)

LRU notes

The Central Mississippi Valley Wooded Slopes, Northern part (Land Resource Unit (LRU) 115XC) encompasses the Wyaconda River Dissected Till Plains, Mississippi River Hills, and Mississippi River Alluvial Plain (Schwegman et al. 1973; Nelson 2010). It spans three states – Illinois (73 percent), Iowa (6 percent), and Missouri (21 percent) – comprising about 13,650 square miles (Figure 1). The elevation ranges from 420 feet above sea level (ASL) along the Mississippi River floodplains to 885 feet on the upland ridges. Local relief varies from 10 to 20 feet but can be as high as 50 to 100 feet along drainageways and streams and the bluffs on the major rivers reaching 250 feet above valley floors. Wisconsin-aged loess covers the uplands, while Illinoian glacial drift lies directly below. The loess and drift deposits are underlain by several bedrock systems, including the Cretaceous, Pennsylvania, Mississippian, Silurian, Devonian, and Ordovician Systems. Wisconsin outwash deposits and sandy eolian material occur along stream terraces of major tributaries (USDA-NRCS 2006).

The vegetation across the region has undergone drastic changes over time. At the end of the last glacial episode – the Wisconsin glacial episode – 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). During the most recent climatic shifts, forested ecosystems maintained footholds on steep valley sides and wet floodplains. Due to the physiography of the MLRA, forests were the dominant ecosystems and were affected by such natural disturbances as droughts, wind, lightning, and occasional fire (Taft et al. 2009).

Classification relationships

USFS Subregions: Central Dissected Till Plains (251C)Section; Western Mississippi River Hills (251Ce), Mississippi River and Illinois Alluvial Plains (251Cf), Eastern Mississippi River Hills (251Ci), Galesburg Dissected Till Plain (251Cj), and Wyaconda River Dissected Till Plain (251Cm) Subsections (Cleland et al. 2007)

U.S. EPA Level IV Ecoregion: Upper Mississippi River Alluvial Plain (72d), River Hills (72f), and Western Dissected Illinoian Till Plain (72i) (USEPA 2013)

National Vegetation Classification – Ecological Systems: North-Central Interior Floodplain (CES202.694) , Eastern Great Plains Wet Meadow, Prairie and Marsh (CES205.687) (NatureServe 2018)

National Vegetation Classification – Plant Associations: Schoenoplectus fluviatilis – Schoenoplectus spp. Marsh (CEGL002221), Carex lacustris Wet Meadow (CEGL002256) (Nature Serve 2018)

Biophysical Settings: Central Interior and Appalachian Floodplain Systems (BpS 4214710), Eastern Great Plains Wet Meadow-Marsh-Prairie System (BpS 4214880) (LANDFIRE 2009)

Illinois Natural Areas Inventory: Sedge meadow, Marsh (White and Madany 1978)

Missouri Terrestrial Natural Communities: Marsh (Nelson 2010)

Ecological site concept

Ponded Floodplain Marshes are located within the green areas on the map (Figure 1). They occur on floodplains in river valleys. The soils are Alfisols, Mollisols, Entisols, and Histosols that are very poorly to poorly drained and very deep, formed in alluvium or organic material. The site experiences seasonal flooding and ponding for a significant portion of the growing season.

The historic pre-European settlement vegetation on this ecological site was dominated by emergent herbaceous vegetation adapted to flooded and saturated conditions. Hairy sedge (*Carex lacustris* L.) and broadleaf arrowhead (*Sagittaria latifolia* Willd.) are the dominant and characteristic species for the site, respectively. River bulrush (*Bolboschoenus fluviatilis* (Torr.) Soják), softstem bulrush (*Schoenoplectus tabernaemontani* (C.C. Gmel.) Palla), and broadleaf cattail (*Typha latifolia* L.) are other common emergent associates. An herbaceous species typical of an undisturbed plant community associated with this ecological site is swamp loosestrife (*Decodon verticillatus* (L.) Elliott) (White and Madany 1978; Taft et al. 1997). Depth and duration of flooding are the primary disturbance factors that maintain this ecological site, while native mammal herbivory is a secondary factor (LANDFIRE 2009).

Associated sites

F115XC019IL	Clayey Floodplain Forest Clayey alluvial parent material including Carlow, Chequest, McFain, Moline, and Titus soils
F115XC020IL	Loamy Floodplain Forest Silty and loamy alluvial parent material including Ackmore, Ambraw, Arenzville, Belknap, Blake, Blyton, Ceresco, Coffeen, Dockery, Dorchester, Dozaville, Elrick, Haymond, Huntsville, Jules, Lawson, Medway, Orion, Paxico, Radford, Riley, Ross, Shaffton, Tice, Udorthents, Volney, Wakeland, and Wirt soils
F115XC021IL	Sandy Floodplain Forest Sandy and gravelly alluvial parent material including Caneek variant, Elsah, Fruitfield, Klum, Landes, Psammets, Sarpy, and Zumbro soils

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) <i>Carex lacustris</i> (2) <i>Sagittaria latifolia</i>

Physiographic features

Ponded Floodplain Marshes occur on floodplains. They are situated on elevations ranging from approximately 341 to 2000 feet ASL. The site experiences rare to frequent flooding and occasional to frequent ponding.

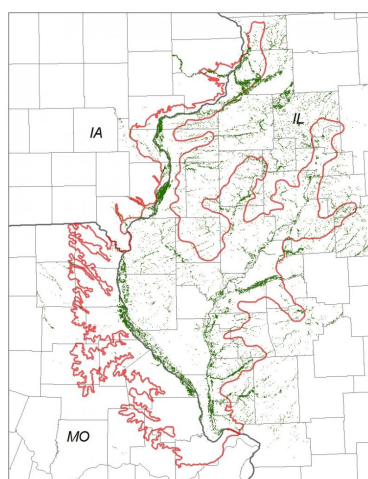


Figure 1. Location of Ponded Floodplain Marsh ecological site within LRU 115XC.

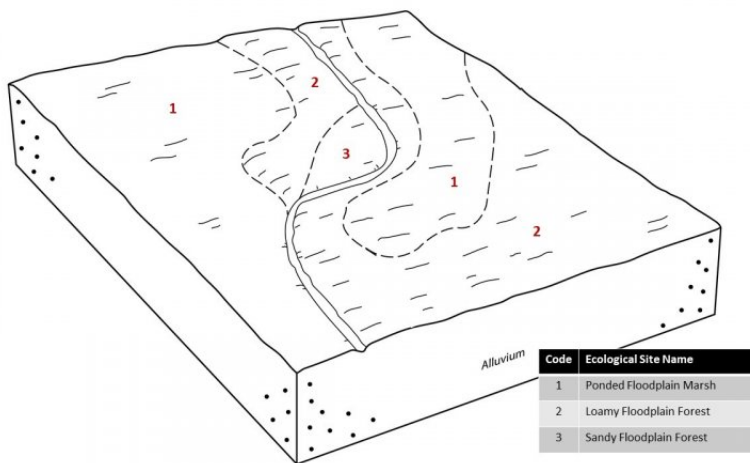


Figure 2. Representative block diagram of Pondered Floodplain Marsh and associated ecological sites.

Table 2. Representative physiographic features

Slope shape across	(1) Concave (2) Linear
Slope shape up-down	(1) Concave
Landforms	(1) River valley > Flood plain
Runoff class	Negligible to low
Flooding duration	Brief (2 to 7 days) to long (7 to 30 days)
Flooding frequency	Rare to frequent
Ponding duration	Brief (2 to 7 days) to long (7 to 30 days)
Ponding frequency	Occasional to frequent
Elevation	341–2,000 ft
Slope	0–2%
Ponding depth	0–12 in
Water table depth	0–6 in
Aspect	Aspect is not a significant factor

Climatic features

The Central Mississippi Valley Wooded Slopes, Northern Part falls into the humid subtropical (Cfa) and hot-summer humid continental climate (Dfa) 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 LRU 115XC 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 184 days, while the frost-free period is about 152 days. 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. The average annual low and high temperatures are 42 and 62°F, respectively.

Table 3. Representative climatic features

Frost-free period (characteristic range)	141-168 days
Freeze-free period (characteristic range)	170-196 days
Precipitation total (characteristic range)	35-40 in
Frost-free period (actual range)	140-170 days
Freeze-free period (actual range)	169-203 days
Precipitation total (actual range)	35-40 in
Frost-free period (average)	152 days
Freeze-free period (average)	184 days
Precipitation total (average)	38 in

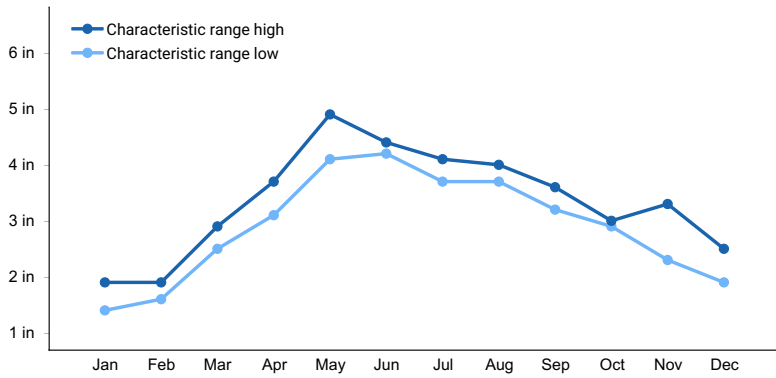


Figure 3. Monthly precipitation range

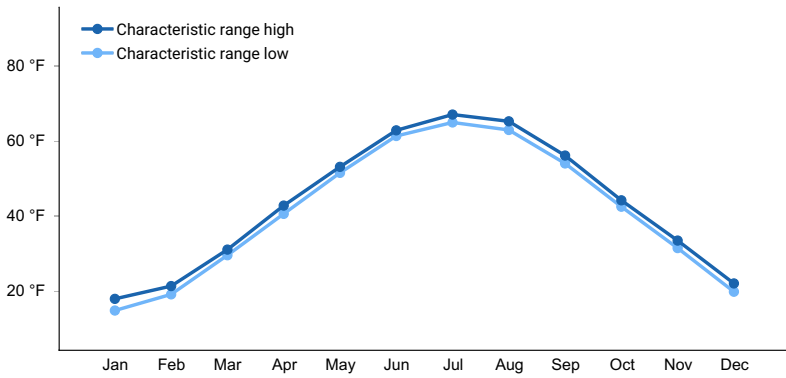


Figure 4. Monthly minimum temperature range

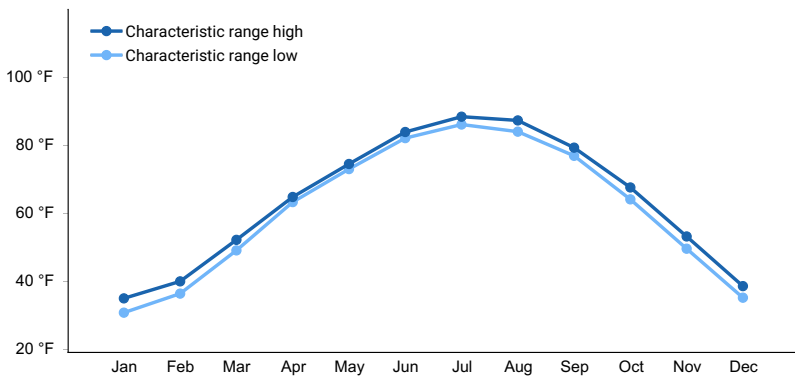


Figure 5. Monthly maximum temperature range

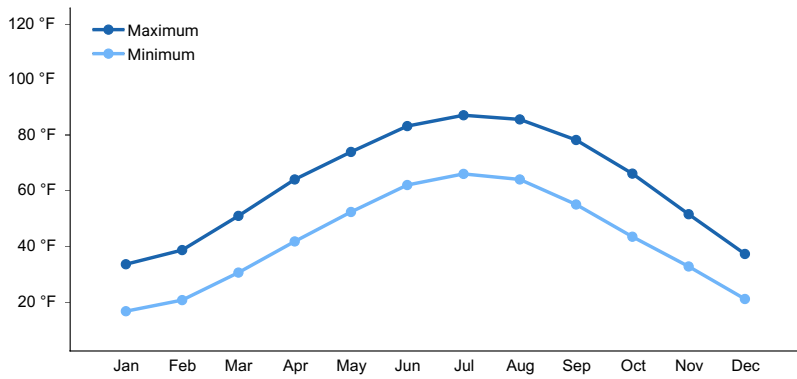


Figure 6. Monthly average minimum and maximum temperature

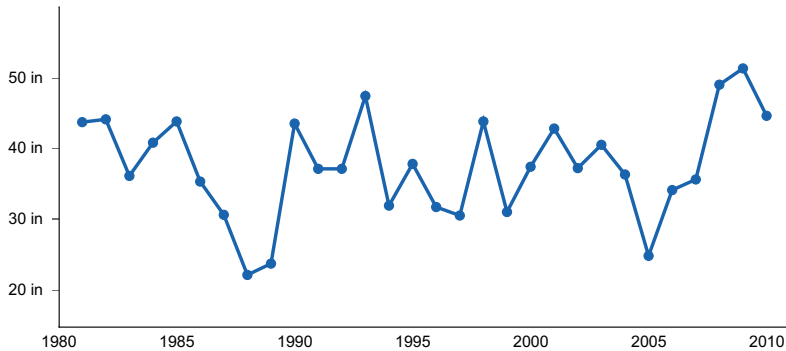


Figure 7. Annual precipitation pattern

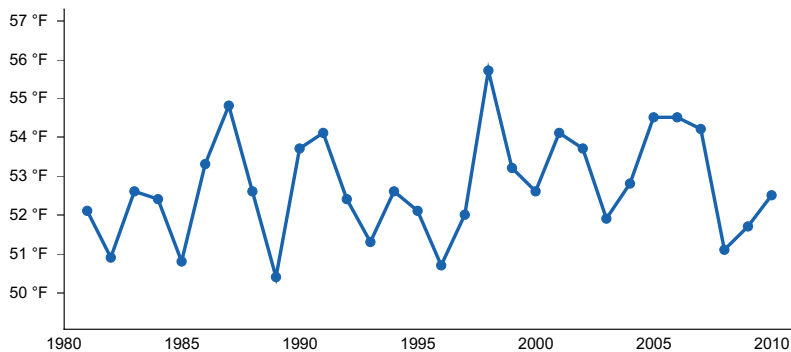


Figure 8. Annual average temperature pattern

Climate stations used

- (1) CLINTON #1 [USC00131635], Camanche, IA
- (2) NEW BOSTON DAM 17 [USC00116080], Wapello, IL
- (3) CANTON L&D 20 [USC00231275], Canton, MO
- (4) CLARKSVILLE L&D 24 [USC00231640], Clarksville, MO
- (5) HAVANA [USC00113940], Lewistown, IL

Influencing water features

Ponded Floodplain Marshes are classified as a RIVERINE: flooded, ponded, herbaceous wetland under the Hydrogeomorphic (HGM) classification system (Smith et al. 1995; USDA-NRCS 2008) and as a Palustrine, Persistent, Emergent, Seasonally Flooded-Saturated wetland under the National Wetlands Inventory (FGDC 2013). Overbank flow and subsurface hydraulic connections are the main sources of water for this ecological site, but other sources may be from surface runoff from adjacent uplands and precipitation (Smith et al. 1995). Infiltration is very slow (Hydrologic Group D) for undrained soils, and surface runoff is negligible to low.

Wetland description

Primary wetland hydrology indicators for an intact Pondered Floodplain Marsh may include: A1 Surface water, A2 High water table, A3 Saturation, and B14 True aquatic plants. Secondary wetland hydrology indicators may include: B10: Drainage patterns, C2 Dry-season water table, D2 Geomorphic position, and D5 FAC-neutral test (USACE 2010).

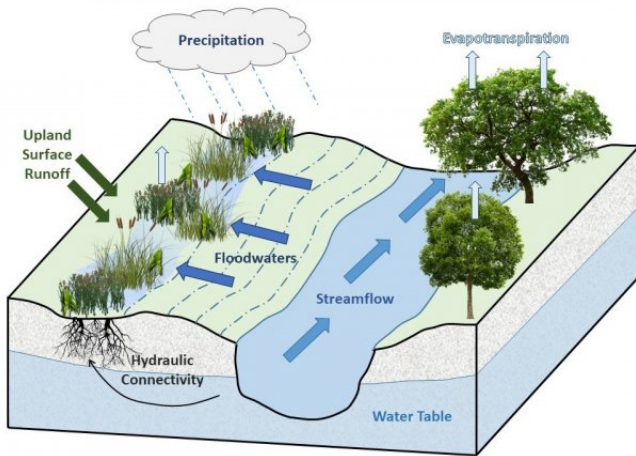


Figure 9. Hydrologic cycling in Pondered Floodplain Marsh ecological site.

Soil features

Soils of Pondered Floodplain Marshes are in the Alfisols, Mollisols, Entisols, and Histosols orders, further classified as Chromic Vertic Albaqualfs, Typic Albaqualfs, Cumulic Endoaquolls, Cumulic Vertic Endoaquolls, Fluvaquentic Endoaquolls, Fluvaquentic Vertic Endoaquolls, Typic Endoaquolls, Vertic Endoaquolls, Mollic Fluvaquents, Thapto-histic Fluvaquents, Typic Fluvaquents, Terric Haplosaprists, Typic Haplosaprists with very slow infiltration and negligible to low runoff potential. The soil series associated with this site includes Adrian, Ambraw, Aquents, Aquolls, Beaucoup, Birds, Calco, Carlow, Cohoctah, Darwin, Elvers, Fluvaquents, Houghton, McFain, Moline, Okaw, Palms, Rushville, Sawmill, Selma, Shiloh, Slacwater, Titus, Wabash, and Zook. The parent material is alluvium or organic material, and the soils are very poorly to poorly drained and very deep with seasonal high-water tables. Soil pH classes are extremely acid to moderately alkaline. 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 1,2,3 or 4 of the hydric soils list (77 FR 12234).

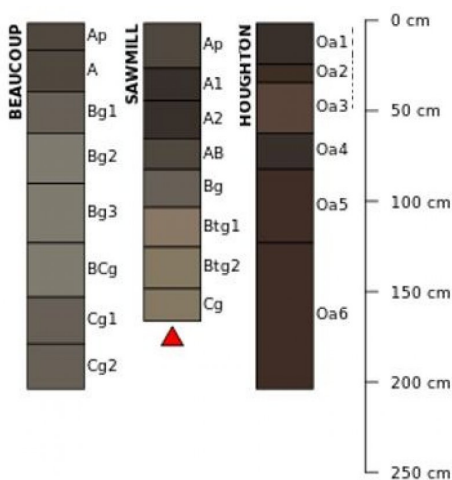


Figure 10. Profile sketches of soil series associated with Pondered Floodplain Marsh.

Table 4. Representative soil features

Parent material	(1) Alluvium (2) Organic material
Surface texture	(1) Silty clay loam (2) Silty clay (3) Silt loam
Family particle size	(1) Fine (2) Fine-silty (3) Fine-loamy (4) Loamy (5) Coarse-loamy
Drainage class	Very poorly drained to poorly drained
Permeability class	Very slow to moderate
Depth to restrictive layer	80 in
Soil depth	80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (Depth not specified)	0–16 in
Calcium carbonate equivalent (Depth not specified)	0–40%
Electrical conductivity (Depth not specified)	0–2 mmhos/cm
Sodium adsorption ratio (Depth not specified)	0
Soil reaction (1:1 water) (Depth not specified)	3.6–8.4
Subsurface fragment volume <=3" (Depth not specified)	0–12%
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 a landscape that historically supported upland hardwood forests, lowland mixed forests, and scattered grass and sedge meadows. Pondered Floodplain Marshes form an aspect of this vegetative continuum. This ecological site occurs on floodplains on very poorly to poorly drained soils. Species characteristic of this ecological site consist of hydrophytic vegetation.

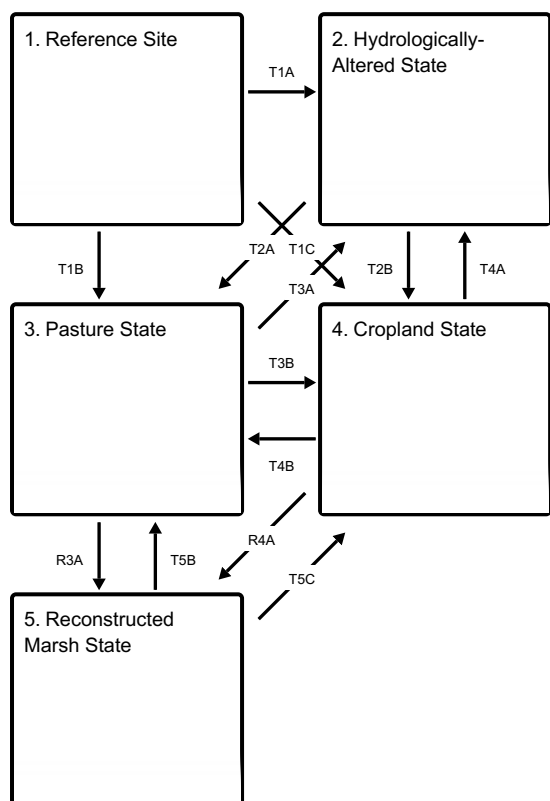
Flooding and ponding are the dominant disturbance factors in Pondered Floodplain Marshes (LANDFIRE 2009). Seasonal flooding likely occurred annually from spring snow melt and heavy rains. The depth and duration of ponded water affects species diversity, composition, and productivity. Little to no ponded water allows more of a sedge meadow community to dominate, while deep water depths create a shallow to deep marsh community populated with emergent and aquatic vegetation.

Animal herbivory also played a role in shaping this ecological site. Foraging muskrats can alter the extent of emergent vegetation, creating larger patches of open water. Left unchecked, muskrats can remove all the emergent vegetation, which won't re-establish until the next drought or drawdown event (White and Madany 1978).

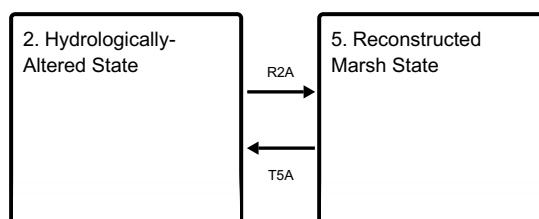
Today, Pondered Floodplain Marshes have been greatly reduced as the land has mostly been converted for agricultural production. Remnants that do exist show evidence of indirect anthropogenic influences from hydrological alterations as non-native species have replaced the natural vegetation. A return to the historic plant community may not be 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 function. 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

Ecosystem states



States 2 and 5 (additional transitions)



T1A - Hydrology altered

T1B - Establish and manage for forage production

T1C - Site transition to row crop production; hydrology altered

T2A - Establish and manage for forage production

T2B - Site transition to row crop production; hydrology altered

R2A - Restoration of hydrology; planting of native species

T3A - Abandonment; hydrology altered

T3B - Site transition to row crop production; hydrology altered

R3A - Restoration of hydrology; planting of native species

T4A - Abandonment; altered hydrology

T4B - Establish and manage for forage production

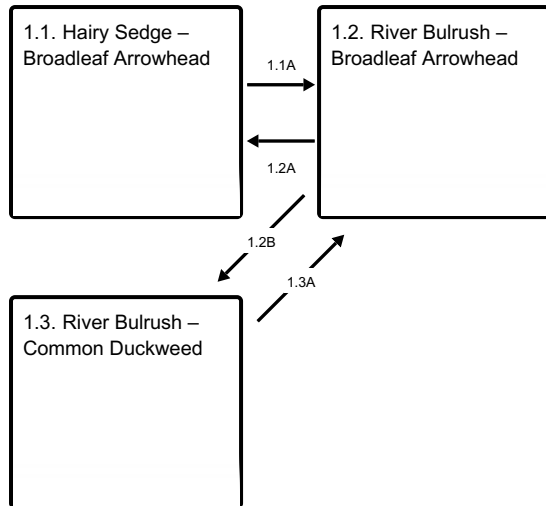
R4A - Restoration of hydrology; planting native species

T5A - Abandonment; altered hydrology

T5B - Establish and manage for forage production

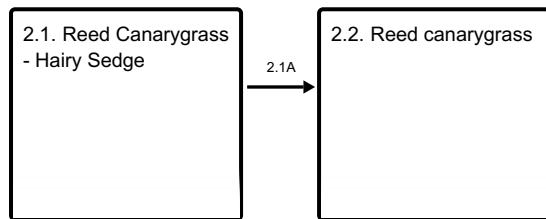
T5C - Site transition to row crop production; hydrology altered

State 1 submodel, plant communities



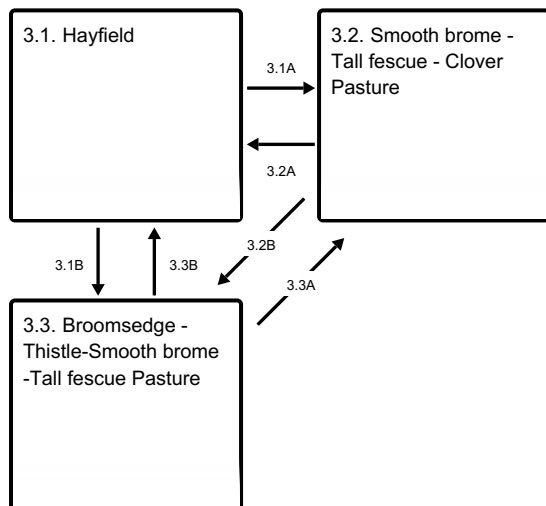
- 1.1A - Water depth 1-2'
- 1.2A - Water depth less than 12 inches
- 1.2B - Water depth above 2'
- 1.3A - Water depth 1-2'

State 2 submodel, plant communities



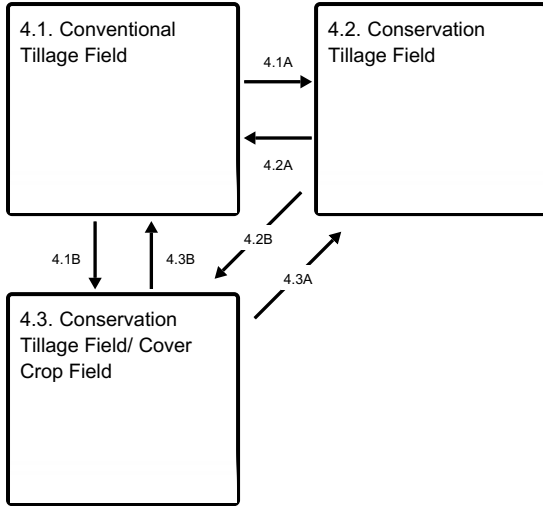
- 2.1A - Altered hydrology; sedimentation

State 3 submodel, plant communities



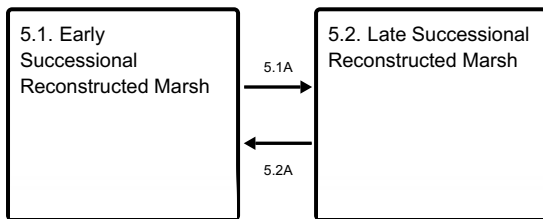
- 3.1A - Grazing; proper animal for forage balance
- 3.1B - Grazing; overutilization
- 3.2A - Mechanical harvesting
- 3.2B - Grazing; overutilization
- 3.3B - Mechanical harvesting
- 3.3A - Grazing; proper forage-to-animal balance

State 4 submodel, plant communities



- 4.1A - Less tillage, residue management
- 4.1B - Less tillage, residue management, cover cropping
- 4.2A - Intensive tillage, remove residue, and reinitiate monoculture row cropping
- 4.2B - Implementation of cover cropping
- 4.3B - Intensive tillage, remove residue, and reinitiate monoculture row cropping
- 4.3A - Remove cover cropping

State 5 submodel, plant communities



- 5.1A - Invasive species control; hydrology management
- 5.2A - Drought or improper timing/use of management actions

State 1 Reference Site

The reference plant community is categorized as a sedge meadow-marsh community, dominated by hydrophytic vegetation. The three community phases within the reference state are dependent on seasonal flooding and subsequent ponding. The depth and duration of ponding alters species composition, cover, and extent. Animal herbivory has more localized impacts in the reference phases, but does contribute to overall species composition, diversity, cover, and productivity.

Dominant plant species

- hairy sedge (*Carex lacustris*), grass
- broadleaf arrowhead (*Sagittaria latifolia*), other herbaceous

Community 1.1 Hairy Sedge – Broadleaf Arrowhead

This reference community phase can occur when the frequency and depth of ponding are reduced to less than 1 foot. Hairy sedge is the dominant monocot, but bulrushes can also be present. Broadleaf arrowhead is still the dominant forb, but forb diversity is greatest in this phase with species such as marsh skullcap (*Scutellaria galericulata* L.), longroot smartweed (*Polygonum amphibium* L. var. *emersum* Michx.), spotted joe pye weed (*Eutrochium maculatum* (L.) E.E. Lamont), and jewelweed (*Impatiens capensis* Meerb.) (White and Madany 1978;

NatureServe 2018). Shallow ponded water depths (less than 1 foot) will maintain this phase, but an increase in water depths can shift the community to phase 1.2.

Community 1.2

River Bulrush – Broadleaf Arrowhead

Sites in this reference community phase are dominated by hydrophytic herbaceous vegetation. River bulrush and broadleaf arrowhead are the dominant species. Some sites may be dominated by other bulrushes, such as softstem bulrush. Characteristic forbs can include broadfruit bur-reed (*Sparganium eurycarpum* Engelm.) and American water plantain (*Alisma subcordatum* Raf.) (NatureServe 2018). Water depths between 1 and 2 feet will maintain this phase, but a reduced water level (below 1 foot) will shift the community to phase 1.1 while an increase in water level (above 2 feet) will shift the community to phase 1.3.

Dominant plant species

- river bulrush (*Bolboschoenus fluviatilis*), grass
- broadleaf arrowhead (*Sagittaria latifolia*), other herbaceous

Community 1.3

River Bulrush – Common Duckweed

This reference community phase can occur when the frequency and depth of ponding are greater than 2 feet. Bulrushes and cattails are the dominant monocots. Aquatic vegetation becomes important characteristic species during this phase and can include species such as common duckweed (*Lemna minor* L.), common duckmeat (*Spirodela polyrrhiza* (L.) Schleid), and American white waterlily (*Nymphaea odorata* Aiton ssp. *tuberosa* (Paine) Wiersma & Hellquist) (NatureServe 2018). Deep ponded water depths (greater than 2 feet) will maintain this phase, but a decrease in water depths can shift the community back to phase 1.2.

Dominant plant species

- river bulrush (*Bolboschoenus fluviatilis*), grass
- common duckweed (*Lemna minor*), other herbaceous

Pathway 1.1A

Community 1.1 to 1.2

Ponded water depths increase to 12 – 24 inches.

Pathway 1.2A

Community 1.2 to 1.1

Ponded water depths decrease to <12 inches.

Pathway 1.2B

Community 1.2 to 1.3

Ponded water depths increase to greater than 24 inches

Pathway 1.3A

Community 1.3 to 1.2

Ponded water depths decrease to 12 – 24 inches.

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 Mucky 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).

Dominant plant species

- reed canarygrass (*Phalaris arundinacea*), grass
- hairy sedge (*Carex lacustris*), grass

Community 2.1

Reed Canarygrass - Hairy Sedge

This community phase represents the early changes to the natural wetland hydroperiod, increasing sedimentation, and unabated nutrient runoff. Native monocots, such as river bulrush, softstem bulrush, and cattails, continue to form a component of the herbaceous layer, but the highly invasive reed canarygrass (*Phalaris arundinacea* L.) co-dominates (Waggy 2010). As reed canarygrass invades, it can not only alter species composition, but vegetation structure as well (Annen et al. 2008). Common reed (*Phragmites australis* (Cav.) Trin. Ex Steud.) may be a non-native invader in conjunction with or in place of reed canarygrass.

Dominant plant species

- reed canarygrass (*Phalaris arundinacea*), grass
- hairy sedge (*Carex lacustris*), grass

Community 2.2

Reed canarygrass

Sites falling into this community phase have experienced significant sedimentation and nutrient enrichment 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; Kercher et al. 2007; Waggy 2010). As in community phase 2.1, common reed may be present, dominant, or monotypic on the site.

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

Pasture State

The Pasture 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.), tall fescue (*Festuca arundinacea*) 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.

Dominant plant species

- brome (*Bromus*), grass

- fescue (*Festuca*), grass
- bluegrass (*Poa*), grass
- clover (*Trifolium*), other herbaceous

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).

Dominant plant species

- brome (*Bromus*), grass
- fescue (*Festuca*), grass
- bluegrass (*Poa*), grass
- alfalfa (*Medicago*), other herbaceous
- clover (*Trifolium*), other herbaceous

Community 3.2

Smooth brome -Tall fescue - Clover Pasture

This community is characterized by seeded cool-season grass and forbs. Species will depend upon landowner goals and objectives and may include many different grasses and forbs. Common species include smooth brome (*Bromus inermis*), tall fescue (*Festuca arundinacea*), Kentucky bluegrass (*Poa pratensis*), timothy (*Phleum pratense*), red clover (*Trifolium pratense*) and white clover (*Trifolium repens* L.). Management inputs include control of weeds and brush. These sites are managed to ensure a proper forage/animal balance. Plants are not overutilized and have adequate rest and recovery.

Dominant plant species

- smooth brome (*Bromus inermis*), grass
- tall fescue (*Schedonorus arundinaceus*), grass
- Kentucky bluegrass (*Poa pratensis*), grass
- red clover (*Trifolium pratense*), other herbaceous
- white clover (*Trifolium repens*), other herbaceous

Community 3.3

Broomsedge -Thistle-Smooth brome -Tall fescue Pasture

Overutilization of the pasture will result in a shift to include more undesirable species such as thistle (*Cirsium* spp.), broomsedge (*Andropogon virginicus* L.), ironweed (*Vernonia gigantea*), buttercup (*Ranunculus* spp.), ragweed (*Ambrosia* spp.) and blackberries (*Rubus* spp.). Many woody and weed species may be present depending on seed sources and level of soil disturbance. This community reflects an improper forage-to-animal balance which will negatively impact forage productivity and reproduction, soil health, and water quality. Ecological resiliency is compromised under these conditions.

Dominant plant species

- broomsedge bluestem (*Andropogon virginicus*), grass
- sedge (*Carex*), grass
- fescue (*Festuca*), grass
- bluegrass (*Poa*), grass
- thistle (*Cirsium*), other herbaceous
- buttercup (*Ranunculus*), other herbaceous
- ragweed (*Ambrosia*), other herbaceous

Pathway 3.1A

Community 3.1 to 3.2

Mechanical harvesting is replaced with domestic livestock grazing.

Pathway 3.1B

Community 3.1 to 3.3

Mechanical harvesting is replaced with domestic livestock grazing. Forage plants are overutilized.

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

Grazing of livestock with overutilization of the forage plants.

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

Forage plants are not overutilized and the site has a proper forage-to-animal balance.

State 4

Cropland State

The continuous use of tillage, row-crop planting, and chemicals (i.e., herbicides, fertilizers, etc.) 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 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.

Dominant plant species

- corn (*Zea mays*), other herbaceous
- soybean (*Glycine max*), other herbaceous

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).

Dominant plant species

- corn (*Zea mays*), other herbaceous
- soybean (*Glycine max*), other herbaceous

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.

Dominant plant species

- corn (*Zea mays*), grass
- soybean (*Glycine max*), grass

Community 4.3

Conservation Tillage Field/ Cover 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.

Dominant plant species

- oat (*Avena*), grass
- wheat (*Triticum*), grass
- rye (*Secale*), grass
- corn (*Zea mays*), other herbaceous
- soybean (*Glycine max*), other herbaceous
- radish (*Raphanus*), other herbaceous

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 reduce erosion and increase soil health.

Pathway 4.3B **Community 4.3 to 4.1**

Intensive tillage is utilized, cover crops 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 Marsh State**

Marsh habitats provide multiple ecosystem services including flood abatement, water quality improvement, and biodiversity support (Mitsch and Gosselink 2007). However, many marsh communities have been eliminated as a result of type conversions to agricultural production, changes to the natural hydrologic regime, and invasion of non-native species, thereby significantly reducing these services (Annen et al. 2008). The extensive alterations of lands adjacent to Pondered Floodplain Marshes may not allow for restoration back to the historic reference condition. But 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).

Dominant plant species

- hairy sedge (*Carex lacustris*), grass

Community 5.1 **Early Successional Reconstructed Marsh**

This community phase represents the early community assembly from marsh habitat reconstruction and is highly dependent on invasive species control, hydroperiod repair, and planting (Adams and Galatowitsch 2006). In addition, adaptive restoration tactics that incorporate multiple restoration methods should be implemented in order to more clearly identify cause-effect relationships of vegetative development (Zedler 2005).

Dominant plant species

- sedge (*Carex*), grass
- broadleaf arrowhead (*Sagittaria latifolia*), other herbaceous

Community 5.2 **Late Successional Reconstructed Marsh**

Community Phase 5.2 Late Successional Reconstructed Marsh– Appropriately timed disturbance regimes (e.g. hydroperiod, invasive species control) and nutrient management applied to the early successional community phase can help increase the species richness and improve ecosystem function, pushing the site into a late successional community phase over time (Mitsch and Gosselink 2007).

Dominant plant species

- hairy sedge (*Carex lacustris*), grass
- broadleaf arrowhead (*Sagittaria latifolia*), other herbaceous

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 transitions the site to the pasture state (3).

Transition T1C

State 1 to 4

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

Transition T2A

State 2 to 3

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

Restoration pathway 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 marsh state (5).

Transition T3A

State 3 to 2

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

Restoration pathway T3B

State 3 to 4

Installation of drain tiles, tillage, 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 marsh 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 transitions the site to the pasture 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 marsh 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 pasture 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)	Lisa Kluesner
Contact for lead author	
Date	01/10/2025
Approved by	Suzanne Mayne-Kinney
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

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

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

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

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

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

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

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

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

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

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

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

Dominant:

Sub-dominant:

Other:

Additional:

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:**
-