USDA Natural Resources Conservation Service

Ecological site R107XB018MO
Ponded Floodplain Marsh

Last updated: 5/21/2020
Accessed: 05/17/2024

General information

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

Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

MLRA notes

Major Land Resource Area (MLRA): 107X–Iowa and Missouri Deep Loess Hills

The Iowa and Missouri Deep Loess Hills (MLRA 107B) includes the Missouri Alluvial Plain, Loess Hills, Southern Iowa Drift Plain, and Central Dissected Till Plains landform regions (Prior 1991; Nigh and Schroeder 2002). It spans four states (Iowa, 53 percent; Missouri, 32 percent; Nebraska, 12 percent; and Kansas 3 percent), encompassing over 14,000 square miles (Figure 1). The elevation ranges from approximately 1565 feet above sea level (ASL) on the highest ridges to about 600 feet ASL along the Missouri River near Glasgow in central Missouri. Local relief varies from 10 to 20 feet in the major river floodplains, to 50 to 100 feet in the dissected uplands, and loess bluffs of 200 to 300 feet along the Missouri River. Loess deposits cover most of the area, with deposits reaching a thickness of 65 to 200 feet in the Loess Hills and grading to about 20 feet in the eastern extent of the region. Pre-Illinoian till, deposited more than 500,000 years ago, lies beneath the loess and has experienced extensive erosion and dissection. Pennsylvanian and Cretaceous bedrock, comprised of shale, mudstones, and sandstones, lie beneath the glacial material (USDA-NRCS 2006).

The vegetation in the MLRA has undergone drastic changes over time. Spruce forests dominated the landscape 30,000 to 21,500 years ago. As the last glacial maximum peaked 21,500 to 16,000 years ago, they were replaced with open tundras and parklands. The end of the Pleistocene Epoch saw a warming climate that initially prompted the return of spruce forests, but as the warming continued, spruce trees were replaced by deciduous trees (Baker et al. 1990). Not until approximately 9,000 years ago did the vegetation transition to prairies as climatic conditions continued to warm and subsequently dry. Between 4,000 and 3,000 years ago, oak savannas began intermingling within the prairie landscape, while the more wooded and forested areas maintained a foothold in sheltered areas. This prairie-forest transition ecosystem formed the dominant landscapes until the arrival of European settlers (Baker et al. 1992).

Classification relationships

Major Land Resource Area (MLRA): Iowa and Missouri Deep Loess Hills (107B) (USDA-NRCS 2006)

USFS Subregions: Central Dissected Till Plains Section (251C); Missouri River Alluvial Plain (251Cg) (Cleland et al. 2007)

U.S. EPA Level IV Ecoregion: Missouri Alluvial Plain (47d) (USEPA 2013)

Biophysical Setting (LANDFIRE 2009): Eastern Great Plains Wet Meadow-Prairie-Marsh (4214880)

Ecological Systems (National Vegetation Classification System, Nature Serve 2015): Eastern Great Plains Wet Meadow, Prairie and Marsh (CES205.687)

Eilers and Roosa (1994): Wet Depressions

Iowa Department of Natural Resources (INAI nd): River Bulrush Marsh

Missouri Natural Heritage Program (Nelson 2010): Marsh

Nebraska Game and Parks Commission (Steinauer and Rolfsmeier 2010): Eastern Bulrush Deep Marsh

Plant Associations (National Vegetation Classification System, Nature Serve 2015): Schoenoplectus fluviatilis - Schoenoplectus spp. Marsh (CEGL002221)

Ecological site concept

Ponded Floodplain Marshes are located within the green areas on the map (Figure 1). They occur on floodplains in depressions, oxbows, and sloughs of riverine systems. Soils are Entisols and Mollisols that are very poorly to poorly drained and very deep, formed from alluvium and loess. The site experiences seasonal flooding and subsequent ponding for a significant portion of the growing season, resulting in a plant community dominated by hydrophytic herbaceous vegetation.

The historic pre-European settlement vegetation on this site was dominated by emergent herbaceous vegetation adapted to flooded or saturated conditions. River bulrush (Bolboschoenus fluviatilis (Torr.) Soják) and broadleaf arrowhead (Sagittaria latifolia Willd.) are the dominant and diagnostic species for the site. Hardstem bulrush (Schoenoplectus acutus (Muhl. ex Bigelow) Á. Löve & D. Löve var. acutus), broadfruit bur-reed (Sparganium eurycarpum Engelm.), and water knotweed (Polygonum amphibium L.) are other common emergent associates. Herbaceous species typical of an undisturbed plant community associated with this ecological site include tufted loosestrife (Lysimachia thyrsiflora L.) and small beggarticks (Bidens discoidea (Torr. & A. Gray) Britton) (Drobney et al. 2001; Steinauer et al. 2003; Steinauer and Rolfsmeier 2010; Nelson 2010; Ladd and Thomas 2015). Historically, seasonal flooding and fire were the primary disturbance factors, while animal predation was a secondary factor (LANDFIRE 2009; Nelson 2010).

Relative to other floodplain prairie ecological sites in the MLRA, Ponded Floodplain Marshess occur lower on the landscape, closer to the waterways. Ponded Floodplain Marshes are also affected by both flooding and ponding, while other floodplain sites are only affected by flooding.

Associated sites

F107XB016MO	**Loamy Floodplain Forest** Silty alluvium soils on floodplains near stream channel including Blake, Danbury, Floris, Gilliam, Grable, Grable variant, Haynie, Haynie variant, Kenridge, Landes, Lossing, McPaul, Modale, Modale variant, Moniteau, Morconick, Motark, Moville, Nodaway, Omadi, Paxico, Ray, Rodney, Scroll, Ticonic, Udifluvents, Udorthents, and Waubonsie
F107XB017MO	**Clayey Floodplain Forest** Clayey alluvium soils on floodplains near stream channel including Albaton, Blencoe, Blend, Leta, Myrick, Onawa, Onawet, Owego, Parkville, Percival, and SansDessein
F107XB015MO	**Sandy/Loamy Floodplain Forest** Sandy alluvium soils on floodplains adjacent to channel including Alluvial land, Buckney, Carr, Grable, Haynie, Hodge, Kenmoor, Psammaquents, Riverwash, Sarpy, Treloar, and Waubonsie

Similar sites

R107XB023IA	**Natric Floodplain Prairie** Natric Floodplain Prairies have a significant component of salt/gypsum in the soils and do not pond
R107XB019MO	**Wet Floodplain Prairie** Loamy Floodplain Prairies have moderately well-drained soils and do not pond

R107XB025IA	**Loamy Floodplain Prairie** Wet Floodplain Prairies have somewhat poorly to poorly-drained soils and do not pond

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Bolboschoenus fluviatilis* (2) *Sagittaria latifolia*

Physiographic features

Ponded Floodplain Marshes occur on floodplains in depressions, oxbows, and sloughs associated with large riverine systems (Figure 2). They are situated on elevations ranging from approximately 350 to 1,700 feet ASL on slopes that are generally less than ten percent. These sites are subject to flooding and ponding and are usually inundated with 15 to 30 inches of water during most of the growing season.

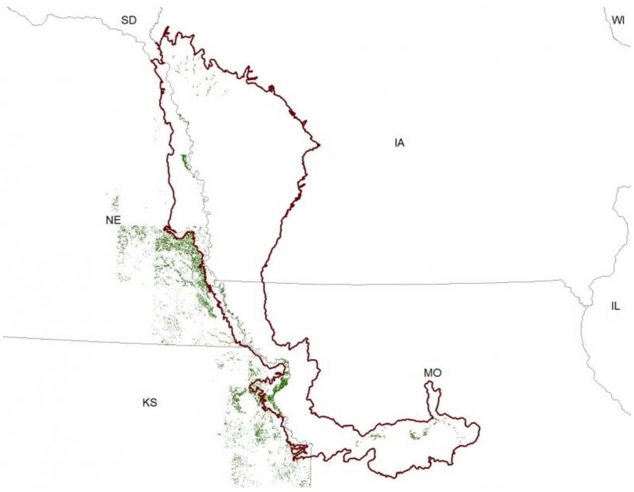


Figure 2. Figure 1. Location of Ponded Floodplain Marsh ecological site within MLRA 107B.

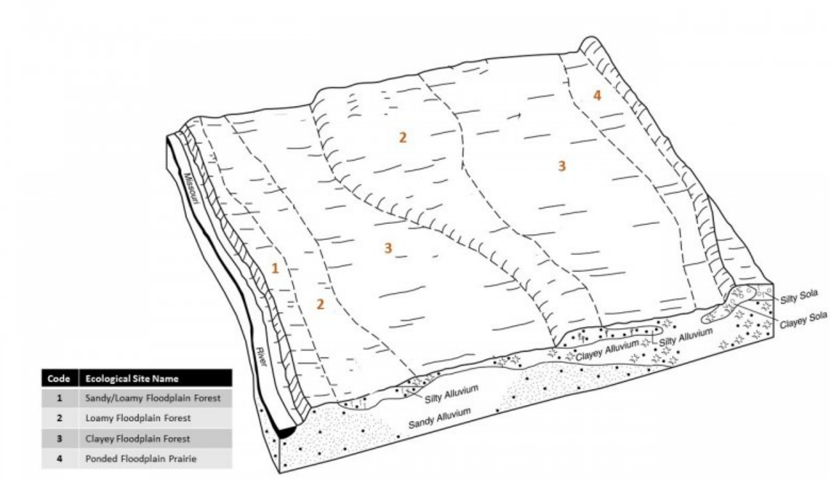


Figure 3. Figure 2. Representative block diagram of Ponded Floodplain Marsh and associated ecological sites.

Table 2. Representative physiographic features

Hillslope profile	(1) Toeslope
Slope shape across	(1) Concave
Slope shape up-down	(1) Concave
Landforms	(1) Flood plain

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	Rare to frequent
Elevation	104–518 m
Slope	0–9%
Ponding depth	0–76 cm
Water table depth	0–36 cm
Aspect	Aspect is not a significant factor

Climatic features

The Iowa and Missouri Deep Loess Hills falls into two Köppen-Geiger climate classifications (Peel et al. 2007): hot humid continental climate (Dfa) dominates the majority of the MLRA with small portions in the south falling into the humid subtropical climate (Cfa). In winter, dry, cold air masses periodically shift south from Canada. As these air masses collide with humid air, snowfall and rainfall result. In summer, moist, warm air masses from the Gulf of Mexico migrate north, producing significant frontal or convective rains (Decker 2017). Occasionally, high pressure will stagnate over the region, creating extended droughty periods. These periods of drought have historically occurred on 22-year cycles (Stockton and Meko 1983).

The soil temperature regime of MLRA 107B 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 188 days, while the frost-free period is about 165 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 36 inches, which includes rainfall plus the water equivalent from snowfall (Table 3). The average annual low and high temperatures are 41 and 63°F, respectively.

Climate data and analyses are derived from 30-year average gathered from five 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)	132-158 days
Freeze-free period (characteristic range)	164-188 days
Precipitation total (characteristic range)	787-965 mm
Frost-free period (actual range)	131-164 days
Freeze-free period (actual range)	159-192 days
Precipitation total (actual range)	787-1,041 mm
Frost-free period (average)	148 days
Freeze-free period (average)	178 days
Precipitation total (average)	889 mm

Climate stations used

- (1) LEXINGTON 3E [USC00234904], Lexington, MO
- (2) BLAIR [USC00250930], Blair, NE
- (3) ONAWA 3NW [USC00136243], Onawa, IA
- (4) OREGON [USC00236357], Oregon, MO
- (5) ATCHISON [USC00140405], Atchison, KS

Influencing water features

Ponded Floodplain Marshes are classified as a RIVERINE wetland under the Hydrogeomorphic (HGM) classification system (Smith et al. 1995; USDA-NRCS 2008) and as an Emergent Palustrine wetland under the National Wetlands Inventory (FGDC 2013). Overbank flow or subsurface hydraulic connections with the adjacent stream channel are the main sources of water for this ecological site, while precipitation replenishes and/or maintains water levels (Smith et al. 1995; Nelson 2010). Infiltration is very slow (Hydrologic Group D) for undrained soils, and surface runoff is high. Flooding generally occurs in winter and spring as well as during heavy rains. Ponding can be shallow to deep (0 to 30+ inches) and last for several months. Some depressions may dry out in mid-to-late summer from high evapotranspiration rates or periods of prolonged drought.

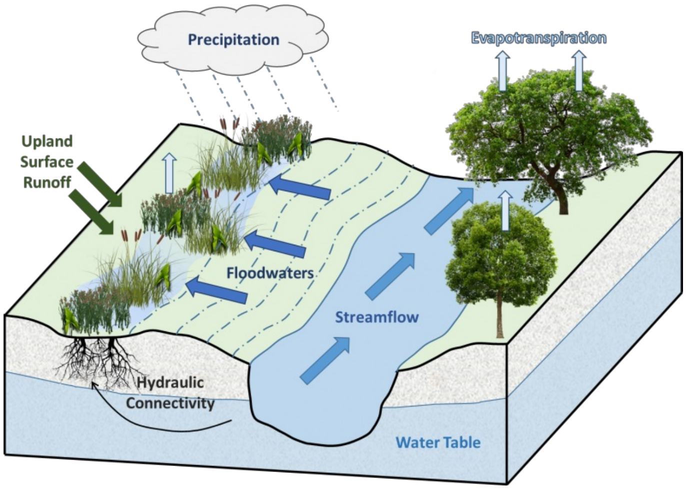


Figure 10. Figure 5. Hydrologic cycling in Ponded Floodplain Marsh ecological site.

Soil features

Soils of Ponded Floodplain Marshes are in the Entisol and Mollisol orders, further classified as Vertic Fluvaquents, Fluvaquentic Endoaquolls, and Fluvaquentic Vertic Endoaquolls with impermeable to moderate infiltration and negligible to high runoff potential. The soil series associated with this site includes Aquolls, Darwin, Fluvaquents, Forney, Levasy, and Ponded soils. The soils were formed under herbaceous wetland vegetation and have a dark, organic-rich surface horizon. The parent material is alluvium, and the soils are very-poorly to well-drained and very deep with seasonal high water tables. Soil pH classes are slightly acid to moderately alkaline. No rooting restrictions are noted for the soils of this ecological site.

Table 4. Representative soil features

Parent material	(1) Alluvium
Surface texture	(1) Clay (2) Silty clay (3) Silty clay loam
Family particle size	(1) Clayey
Drainage class	Very poorly drained to poorly drained
Permeability class	Very slow
Soil depth	51–203 cm
Available water capacity (0-101.6cm)	7.62–20.32 cm
Calcium carbonate equivalent (0-101.6cm)	0–30%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm

Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	6.1–8.4

Ecological dynamics

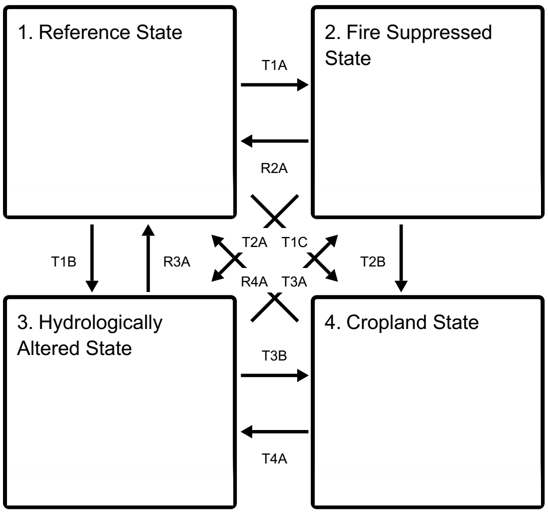
The Loess Hills region lies within the transition zone between the eastern deciduous forests and the Great Plains, with the Missouri River flowing through the middle. The heterogeneous topography of the area results in variable microclimates and fuel matrices that in turn are able to support prairies, savannas, woodlands, and forests (Novacek et al. 1985; Nelson 2010). Ponded Floodplain Marshes form an aspect of this vegetative continuum. This ecological site occurs on floodplains, drainageways, and depressions on very-poorly drained soils. Species characteristic of this ecological site consist of hydrophytic herbaceous vegetation.

Flooding and fire are the dominant disturbance factor in Ponded Floodplain Marshes. Seasonal flooding occurs every year in winter and spring, but can also follow heavy rains. Periodic, hot replacement fires every two to five years helped to reduce the build-up of heavy thatch as well as kept the site free of encroaching woody vegetation (LANDFIRE 2009). Animal predation is a secondary disturbance factor that can impact plant composition, diversity, and cover. Beaver activity from adjacent floodplain forest sites can increase ponded areas thus enhancing the extent of Ponded Floodplain Marshes. Muskrat foraging can alter the extent and distribution of rooted marsh plants (Nelson 2010).

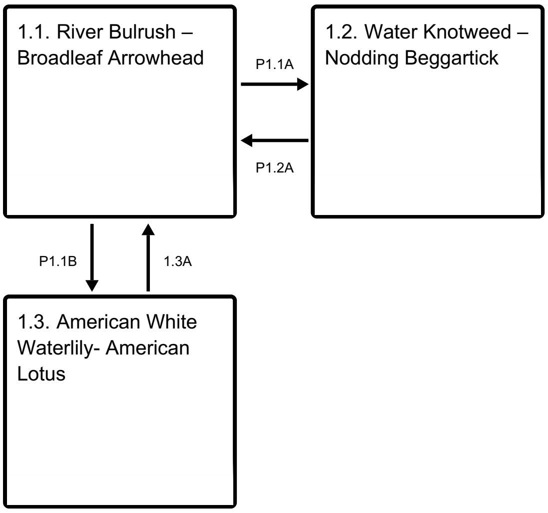
Today, most of the original extent of Ponded Floodplain Marshes have been reduced as a result of drainage and conversion to agriculture and development. Sites have also been degraded by stream channelization and levee construction (LANDFIRE 2009; Nelson 2010; Steinauer and Rolfsmeier 2010). These actions have altered hydrologic flood cycles and increased siltation and soil dehydration which, ultimately, changes the reference plant community. Invasive species, such as purple loosestrife (*Lythrum salicaria* L.), reed canarygrass (*Phalaris arundinacea* L.), common reed (*Phragmites australis* (Cav.) Trin. ex Steud.), and narrowleaf cattail (*Typha angustifolia* L.) have been invading this site and reducing native species diversity (Nelson 2010; Steinauer and Rolfsmeier 2010).

State and transition model

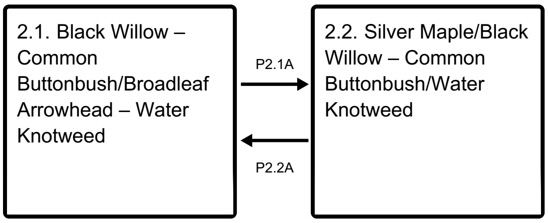
Ecosystem states



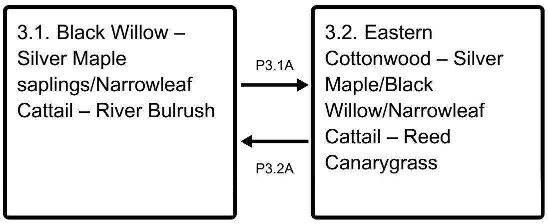
State 1 submodel, plant communities



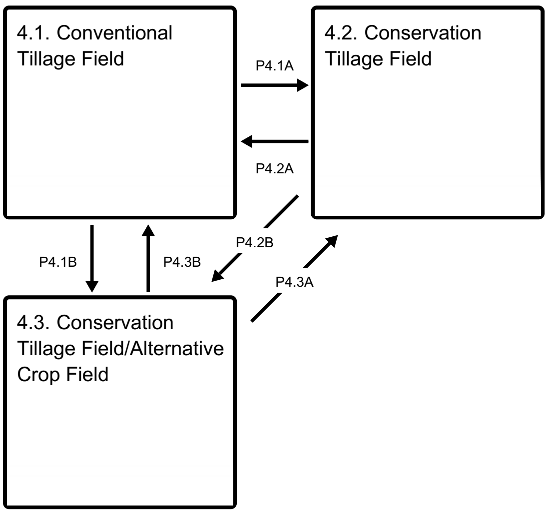
State 2 submodel, plant communities



State 3 submodel, plant communities



State 4 submodel, plant communities



State 1
Reference State

The reference plant community is categorized as a marsh dominated by hydrophytic vegetation. The three community phases within the reference state are dependent on seasonal flooding and precipitation as well as an average fire return interval of three years. The amount and duration of ponded water alters species composition, cover, and extent, while regular fire intervals and long duration ponding keep woody species from encroaching. Animal disturbances from beaver and muskrats have more localized impacts in the reference phases, but do contribute to overall species composition, diversity, cover, and productivity.

Dominant plant species

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

Community 1.1
River Bulrush – Broadleaf Arrowhead

Sites in this reference community phase are generally diverse and consist mostly of emergent species. Ponded water is typically one-to-three feet deep and vegetation cover is 80 to 100 percent. The dominant species for this reference community phase are river bulrush and broadleaf arrowhead. Other species characteristic of this phase include broadfruit bur-reed, hardstem bulrush, arumleaf arrowhead (*Sagittaria cuneata* Sheldon), and common duckweed (*Lemna minor* L.) (Nelson 2010; Steinauer and Rolfsmeier 2010).

Dominant plant species

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

Community 1.2
Water Knotweed – Nodding Beggartick

This reference community phase represents a reduction in the ponded water to less than one foot followed by drying out by late summer. This community occurs on the edges of the ecological site and in shallow depressions. Vegetation cover nears 100 percent. Water knotweed and nodding beggartick (*Bidens cernua* L.) are the dominant and diagnostic species for this phase. Other species that can occur during this phase include American water horehound (*Lycopus americanus* Muhl. ex W.P.C. Barton), jewelweed (*Impatiens capensis* Meerb.), smallspike false nettle (*Boehmeria cylindrica* (L.) Sw.), and rice cutgrass (*Leersia oryzoides* (L.) Sw.) (Nelson 2010; Steinauer and Rolfsmeier 2010).

Dominant plant species

- water knotweed (*Polygonum amphibium*), other herbaceous
- nodding beggartick (*Bidens cernua*), other herbaceous

Community 1.3
American White Waterlily- American Lotus

This reference community phase represents an increase in the depth and duration of the ponded water. Water levels are greater than three feet deep and are permanent. Vegetation covers are generally less than 80 percent. American white waterlily (*Nymphaea odorata* Aiton) and American lotus (*Nelumbo lutea* Willd.) are the dominant and diagnostic species of the site. Yellow pond lily (*Nuphar lutea* (L.) Sm.), humped bladderwort (*Utricularia gibba* L.), and pondweeds (Potamogeton L.) can also form the floating and aquatic plant community (Nelson 2010).

Dominant plant species

- American white waterlily (*Nymphaea odorata*), other herbaceous
- American lotus (*Nelumbo lutea*), other herbaceous

Pathway P1.1A
Community 1.1 to 1.2

Natural succession as a result of seasonal ponding less than one foot deep.

Pathway P1.1B
Community 1.1 to 1.3

Natural succession as a result of seasonal ponding greater than three feet deep.

Pathway P1.2A
Community 1.2 to 1.1

Natural succession as a result of seasonal ponding between one and three feet deep.

Pathway 1.3A
Community 1.3 to 1.1

Natural succession as a result of seasonal ponding between one and three feet deep.

State 2
Fire Suppressed State

Fire suppression can transition the reference herbaceous marsh community into a woody-dominated marsh. Historically, hot replacement fires occurred on a two to five year cycle and helped to reduce woody encroachment and thatch build-up (LANDFIRE 2009). Over the past 150 years, however, fire suppression policies have allowed shrubs and trees to succeed into areas where they did not historically occur.

Dominant plant species

- common buttonbush (*Cephalanthus occidentalis*), shrub
- water knotweed (*Polygonum amphibium*), other herbaceous

Community 2.1
Black Willow – Common Buttonbush/Broadleaf Arrowhead – Water Knotweed

In this community phase, fire has been eliminated from the landscape in excess of five years. Woody species have begun to encroach on the herbaceous marsh. The dominant shrubs are black willow (*Salix nigra* Marshall) and common buttonbush (*Cephalanthus occidentalis* L.). Broadleaf arrowhead is a characteristic herb of the phase, while water knotweed is a dominant herbaceous component. Knotweeds, cursed buttercup (*Ranunculus sceleratus* L.), and butterweed (*Packera glabella* (Poir.) C. Jeffrey) are common associates as well (Nelson 2010).

Dominant plant species

- black willow (*Salix nigra*), shrub
- common buttonbush (*Cephalanthus occidentalis*), shrub
- broadleaf arrowhead (*Sagittaria latifolia*), other herbaceous
- water knotweed (*Polygonum amphibium*), other herbaceous

Community 2.2
Silver Maple/Black Willow – Common Buttonbush/Water Knotweed

Sites in this community phase are under continued fire suppression, allowing the woody canopies to close and become denser. Silver maple (*Acer saccharinum* L.) becomes a dominant tree, and black willow and common buttonbush continue to maintain the shrub canopy. In between pockets of shrubs, herbaceous species such as water knotweed, duckweeds, and ricegrass may persist.

Dominant plant species

- silver maple (*Acer saccharinum*), tree
- black willow (*Salix nigra*), shrub
- common buttonbush (*Cephalanthus occidentalis*), shrub
- water knotweed (*Polygonum amphibium*), other herbaceous

Pathway P2.1A
Community 2.1 to 2.2

Continued fire suppression for over 20 years.

Pathway P2.2A
Community 2.2 to 2.1

Single fire event within 20 years.

State 3
Hydrologically Altered State

Agricultural drainage, stream channelization, and levee construction in hydrologically-connected waters has drastically changed the natural hydrologic cycle of Ponded Floodplain Marshes. Reduced backwater flooding and excessive siltation from upland erosion has caused accelerated soil dehydration. This has resulted in a type conversion from the species-rich herbaceous marsh to a simplified, woody-dominated state (Nelson 2010; Steinauer and Rolfsmeier 2010). In addition, the change in the hydrologic cycle (coupled with agricultural runoff) has resulted in a serious invasion of exotic species (Green and Galatowitsch 2002; Kercher et al. 2007; Nelson 2010).

Dominant plant species

- silver maple (*Acer saccharinum*), tree
- black willow (*Salix nigra*), shrub
- narrowleaf cattail (*Typha angustifolia*), grass

Community 3.1
Black Willow – Silver Maple saplings/Narrowleaf Cattail – River Bulrush

Sites in this community phase arise from hydrologic alterations within the watershed. In response to the increased siltation and soil dehydration, black willow and silver maple begin to form a woody overstory on the edges of the marsh. Cattails become co-dominant with river bulrush and include both broadleaf cattail (*Typha latifolia* L.) and the invasive narrowleaf cattail (Nelson 2010).

Dominant plant species

- black willow (*Salix nigra*), shrub
- river bulrush (*Bolboschoenus fluviatilis*), grass
- narrowleaf cattail (*Typha angustifolia*), other herbaceous
- river bulrush (*Bolboschoenus fluviatilis*), other herbaceous
- broadleaf cattail (*Typha latifolia*), other herbaceous

Community 3.2
Eastern Cottonwood – Silver Maple/Black Willow/Narrowleaf Cattail – Reed Canarygrass

This community phase represents increasing siltation and continuing soil dehydration. The overstory matures into eastern cottonwood (*Populus deltoides* W. Bartram ex Marshall) and silver maple, while black willow dominates the shrub canopy. Invasions by numerous exotic species continues and includes narrowleaf cattail, reed canarygrass, purple loosestrife, and common reed (Nelson 2010; Steinauer and Rolfsmeier 2010).

Dominant plant species

- eastern cottonwood (*Populus deltoides*), tree
- silver maple (*Acer saccharinum*), tree
- black willow (*Salix nigra*), shrub
- reed canarygrass (*Phalaris arundinacea*), grass
- narrowleaf cattail (*Typha angustifolia*), grass
- purple loosestrife (*Lythrum salicaria*), other herbaceous

Pathway P3.1A
Community 3.1 to 3.2

Increasing sedimentation and soil dehydration continues.

Pathway P3.2A
Community 3.2 to 3.1

Continuing sedimentation and soil dehydration is halted.

State 4
Cropland State

The Midwest is well-known for its highly-productive agricultural soils, and as a result, much of the MLRA has been converted to cropland, including portions of this ecological site (USGS 1999). Agricultural tile drains and surface drainage systems used to lower the water table and continuous use of tillage, row-crop planting, and chemicals (i.e., herbicides, fertilizers, etc.) have effectively eliminated the reference community and many of its natural ecological functions in favor of crop production. Corn (*Zea mays* L.) and soybeans (*Glycine max* (L.) Merr.) are the dominant crops for the site. 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 impact 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, or vertical-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. Compared to conventional tillage system, conservation tillage methods can reduce soil erosion, increase organic matter and water availability, improve water quality, and reduce soil compaction.

Community 4.3
Conservation Tillage Field/Alternative Crop Field

This condition 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. 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 P4.1A
Community 4.1 to 4.2

Tillage operations are greatly reduced, crop rotation occurs on a regular schedule, and crop residue is allowed to remain on the soil surface.

Pathway P4.1B
Community 4.1 to 4.3

Tillage operations are greatly reduced or eliminated, crop rotation is either reduced or eliminated, and crop residue is allowed to remain on the soil surface, and cover crops are implemented to prevent soil erosion.

Pathway P4.2A
Community 4.2 to 4.1

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

Pathway P4.2B
Community 4.2 to 4.3

Cover crops are implemented to prevent soil erosion.

Pathway P4.3B
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 P4.3A
Community 4.3 to 4.2

Cover crop practices are abandoned.

Transition T1A
State 1 to 2

Long-term fire suppression transitions this site to the fire-suppressed state (2).

Transition T1B
State 1 to 3

Altered hydrology from stream channelization and levee construction transition this site to the hydrologically-altered state (3).

Transition T1C
State 1 to 4

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

Restoration pathway R2A
State 2 to 1

Re-establishment of a historic fire regime transitions this site to the reference state (1).

Transition T2A
State 2 to 3

Altered hydrology from stream channelization and levee construction transition this site to the hydrologically-altered state (3).

Transition T2B
State 2 to 4

Woody overstory removal, installation of drain tiles, tillage, seeding of agricultural crops, and non-selective herbicide transition this site to the cropland state (4).

Restoration pathway R3A
State 3 to 1

Placement of water control structures to control siltation and flood patterns as well as woody species control transition this site to the reference state (1).

Restoration pathway T3A
State 3 to 2

Long-term fire suppression transitions this site to the fire-suppressed state (2).

Transition T3B
State 3 to 4

Woody overstory removal, installation of drain tiles, tillage, seeding of agricultural crops, and non-selective herbicide transition this site to the cropland state (4).

Restoration pathway R4A
State 4 to 1

Removal of drain tiles, site preparation, native seeding, and invasive species control transition this site to the reference state (1).

Transition T4A
State 4 to 3

Abandoned agricultural practices leaving the land fallow transition this site to the hydrologically-altered state (3).

Additional community tables

Animal community

Wildlife*

Game species that likely utilize this ecological site include: Waterfowl: Mallard, Blue-Winged Teal, Green-Winged Teal, American Black Duck, Northern Pintail, Gadwall, American Widgeon, and Northern Shoveler.

Other waterbirds: Sora, Virginia Rail, Common Snipe

Furbearers: Muskrat, Beaver, and Mink.

Bird species associated with this ecological site’s reference state condition: Breeding birds likely associated with herbaceous perennial plant dominated (Spartina pectinata, Typha species, Polygonum amphibium, Schoenoplectus fluviatilis, Carex species, Sparganium eurycarpum) areas of this ecological site (Palustrine Emergent Semipermanently Flooded): Sedge Wren, Red-Winged Blackbird, American Bittern, Least Bittern, Mallard, Sora, Common Moorhen, Marsh Wren, Common Yellowthroat, and Northern Harrier.

A number of migratory bird species are likely associated with annual plant (Eleocharis species, Bidens species, Cyperus species, Polygonum lapathifolium, Polygonum hydropiper) dominated areas and mudflats of this ecological site (Palustrine Emergent Seasonally Flooded, Palustrine Emergent Temporarily Flooded): Great Egret, Common Snipe, Pectoral Sandpiper, Greater Yellowlegs, Semipalmated Plover, and dabbling ducks (e.g., Mallard, Blue-

Winged Teal, Gadwall, and Northern Pintail).

Breeding birds associated with woody vegetation dominated areas of this ecological site: Common Yellowthroat, Yellow Warbler, and Song Sparrow.

Amphibian and reptile species that may be associated with this ecological site's reference state: Western Chorus Frog (Pseudacris triseriata triseriata), Plains Leopard Frog (Rana blairi), Bullfrog (Rana catesbeiana), Southern Leopard Frog (Rana sphenocephala), Western Painted Turtle (Chrysemys picta bellii), Diamond-backed Water Snake (Nerodia rhombifer rhombifer), Graham's Crayfish Snake (Regina grahamii), Midland Brown Snake (Storeria dekayi wrightourm), Northern Leopard Frog (Rana pipiens) and Western Ribbon Snake (Thamnophis proximus proximus).

Small mammals likely associated with this ecological site's reference state condition: Muskrat (Ondatra zibethicus), Southern Bog Lemming (Synaptomys cooperi), and Mink (Mustela vison).

Many native insect species are likely associated with this ecological site, especially native dragonflies and damselflies, beetles, and ants. However information on these groups is often lacking enough resolution to assign them to individual ecological sites.

Insect species known to be associated with this ecological site's reference state condition: Swamp Milkweed Leaf Beetle (Labidomera clivicollis), Cordgrass Planthopper (Prokelisia crocea), Dion Skipper butterfly (Euphyes dion), Duke's Skipper butterfly (Euphyes dukesi), Sedge Grasshopper (Stethophyma celatum), the Lance-tipped Darner dragonfly (Aeshna constricta) and the Ruby Meadowhawk dragonfly (Sympetrum rubicundulum).

Other invertebrates: Grassland Crayfish (Procambarus gracilis), Northern Crayfish (Orconectes virilis), Papershell Crayfish (O. immunis)

*This section prepared by Mike Leahy, Natural Areas Coordinator, Missouri Department of Conservation, 2013

Other information

Forestry

Management: This ecological site is not recommended for traditional timber management activity. Historically this site was dominated by a ground cover of native prairie grasses and forbs. Some scattered open grown trees may have also been present. May be suitable for non-traditional forestry uses such as windbreaks, environmental plantings, alley cropping (a method of planting, in which rows of trees or shrubs are interspersed with rows of crops) or woody bio-fuels.

Inventory data references

Tier 3 Sampling Plot(s) used to develop the reference state, community phase 1.1:

State County Ownership Legal Description Easting Northing
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Iowa Monona Badger Lake, Iowa Dept. of Natural Resources T85N R46W S29 728706 4670446

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Approval

Chris Tecklenburg, 5/21/2020

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Organization Name Title Location
Drake University:
Dr. Tom Rosburg Professor of Ecology and Botany Des Moines, IA

Iowa Department of Natural Resources:
Lindsey Barney District Forester Oakland, IA
John Pearson Ecologist Des Moines, IA

LANDFIRE (The Nature Conservancy):
Randy Swaty Ecologist Evanston, IL

Natural Resources Conservation Service:
Rick Bednarek IA State Soil Scientist Des Moines, IA
Stacey Clark Regional Ecological Site Specialist St. Paul, MN
Tonie Endres Senior Regional Soil Scientist Indianapolis, IA
John Hammerly Soil Data Quality Specialist Indianapolis, IN
Lisa Kluesner Ecological Site Specialist Waverly, IA
Sean Kluesner Earth Team Volunteer Waverly, IA
Jeff Matthias State Grassland Specialist Des Moines, IA
Kevin Norwood Soil Survey Regional Director Indianapolis, IN
Doug Oelmann Soil Scientist Des Moines, IA
James Phillips GIS Specialist Des Moines, IA
Dan Pulido Soil Survey Leader Atlantic, IA
Melvin Simmons Soil Survey Leader Gallatin, MO

Tyler Staggs Ecological Site Specialist Indianapolis, IN
Jason Steele Area Resource Soil Scientist Fairfield, IA
Doug Wallace Ecological Site Specialist Columbia, MO

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	05/17/2024
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:**