Ecological site R108XC525IA
Ponded Floodplain Marsh

Last updated: 7/01/2019
Accessed: 05/19/2024

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

The Illinois and Iowa Deep Loess and Drift, West-Central Part (MLRA 108C) encompasses the eastern portion of the Southern Iowa Drift Plain and the Lake Calvin basin of the Mississippi Alluvial Plain landforms (Prior 1991). It lies entirely in one state (Iowa), containing approximately 9,805 square miles (Figure 1). The elevation ranges from approximately 1,110 feet above sea level (ASL) on the highest ridges to about 505 feet ASL in the lowest valleys. Local elevation difference is mainly 10 to 20 feet. However, some valley floors can range from 80 to 200 feet, while some upland flats and valley floors only range between 3 and 6 feet. The MLRA is underlain by Pre-Illinoian glacial till, deposited more than 500,000 years ago and since undergone extensive erosion and dissection. In the northern half of the area the till thickness ranges from 150 to 350 feet and grades to less than 150 feet thick in the southern half. The till is covered by a mantle of Peoria Loess on the hillslopes and Holocene alluvium in the drainageways. Paleozoic bedrock, comprised of limestone, shale, and mudstones, lies 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

USFS Subregions: Central Dissected Till Plains (251C) Section, Central Dissected Till and Loess Plain (251Cc), Mississippi River and Illinois Alluvial Plains (51Cf), Southeast Iowa Rolling Loess Hills (251Ch) Subsections (Cleland et al. 2007)

U.S. EPA Level IV Ecoregion: Rolling Loess Prairies (47f), Upper Mississippi Alluvial Plain (72d) (USEPA 2013)

National Vegetation Classification – Ecological Systems: North-Central Interior Floodplain (CES202.694) (NatureServe 2015)

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

Biophysical Settings: Central Interior and Appalachian Floodplain Systems (BpS 4214710) (LANDFIRE 2009)

Natural Resources Conservation Service – Iowa Plant Community Species List: Marsh, River Bulrush; Marsh, Bulrush- Cattail – Bur-reed Shallow (USDA-NRCS 2007)

Iowa Department of Natural Resources: Floodplain Marsh (INAI 1984)

U.S. Army Corps of Engineers: Marshes (Eggers and Reed 2015)

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 Entisols and Mollisols that are very poorly to poorly-drained and deep, formed in alluvium. The site experiences seasonal flooding and subsequent 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. River bulrush (Bolboschoenus fluviatilis (Torr.) Soják) and broadleaf arrowhead (Sagittaria latifolia Willd.) are the dominant and diagnostic species for the site, respectively. Softstem bulrush (Schoenoplectus tabernaemontani (C.C. Gmel.) Palla), broadfruit bur-reed (Sparganium eurycarpum Engelm.), and common bladderwort (Utricularia macrorhiza Leconte) are other common emergent associates. Herbaceous species typical of an undisturbed plant community associated with this ecological site can include pickerelweed (Pontederia cordata L.), threepetal bedstraw (Galium trifidum L.), bluntleaf bedstraw (Galium obtusum Bigelow), Canadian waterweed (Elodea canadensis Michx.), and hairy sedge (Carex lacustris L.) (Drobney et al. 2001). 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; Eggers and Reed 2015).

Associated sites

F108XC528IA	**Floodplain Swamp Forest** Alluvial parent materials that are poorly-drained and experience flooding including Colo and Quiver soils
R108XC527IA	**Wet Floodplain Sedge Meadow** Alluvial parent materials that are poorly-drained and experience flooding including Ambraw, Chequest, Coland, Colo, Dolbee, Elvira, Humeston, Ossian, Radford, Shaffton, Vesser, and Zook soils
F108XC529IA	**Loamy Floodplain Forest** Alluvial parent materials that are somewhat poorly to moderately-well drained and experience flooding including Ackmore, Alluvial land, Amana, Arenzville, Lawson, Nodaway, Orion, and Spillville soils

Similar sites

R108XC524IA	**Ponded Organic Floodplain Shrub Swamp** Ponded Organic Floodplain Shrub Swamps are formed in herbaceous organic parent material

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 river valleys (Figure 2). They are situated on elevations ranging from approximately 400 to 2001 feet ASL. The site experiences occasional to frequent flooding and frequent ponding that can last from 2 to 30 days at a time. Ponding depths on average are about 12 inches.

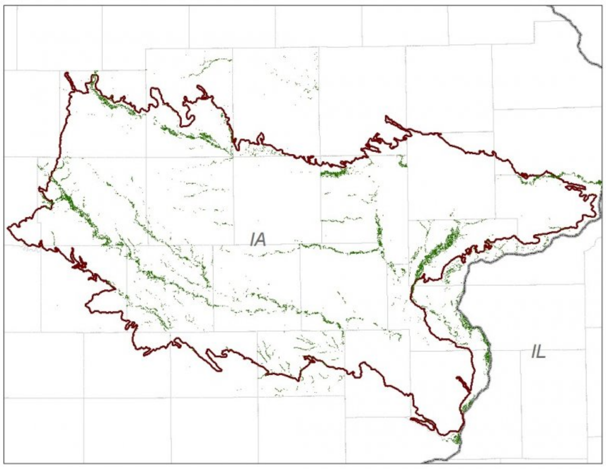


Figure 2. Figure 1. Location of Ponded Floodplain Marsh ecological site within MLRA 108C.

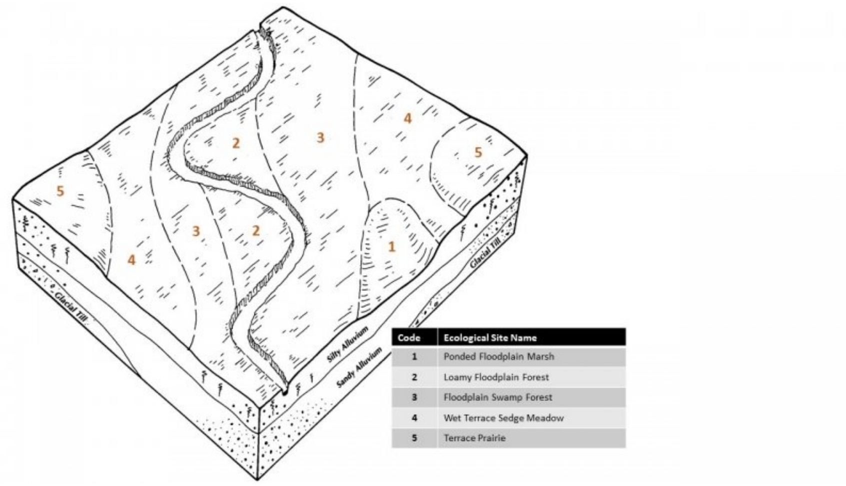


Figure 3. Figure 2. Representative block diagram of Ponded Floodplain Marsh and associated ecological sites.

Table 2. Representative physiographic features

Slope shape across	(1) Concave (2) Linear
Slope shape up-down	(1) Concave (2) Linear
Landforms	(1) River valley > Flood plain
Runoff class	Negligible to very high
Flooding duration	Brief (2 to 7 days) to long (7 to 30 days)
Flooding frequency	Occasional to frequent
Ponding duration	Brief (2 to 7 days) to long (7 to 30 days)
Ponding frequency	Frequent
Elevation	122–610 m
Slope	0–2%
Ponding depth	0–30 cm
Aspect	Aspect is not a significant factor

Climatic features

The Illinois and Iowa Deep Loess and Drift, West-Central Part falls into the hot humid continental climate (Dfa) Köppen-Geiger climate classification (Peel et al. 2007). 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. Occasionally, hot, dry winds originating from the Desert Southwest will stagnate over the region, creating extended droughty periods in the summer from unusually high temperatures. Air masses from the Pacific Ocean can also spread into the region and dominate producing mild, dry weather in the autumn known as Indian Summers (NCDC 2006).

The soil temperature regime of MLRA 108C 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 178 days, while the frost-free period is about 151 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 39 inches, which includes rainfall plus the water equivalent from snowfall (Table 3). The average annual low and high temperatures are 38 and 59°F, respectively.

Climate data and analyses are derived from 30-year averages gathered from three 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)	135-139 days
Freeze-free period (characteristic range)	164-166 days
Precipitation total (characteristic range)	940-991 mm
Frost-free period (actual range)	133-139 days
Freeze-free period (actual range)	164-166 days
Precipitation total (actual range)	914-991 mm
Frost-free period (average)	137 days
Freeze-free period (average)	165 days
Precipitation total (average)	965 mm

Climate stations used

- (1) BELLE PLAINE [USC00130600], Belle Plaine, IA
- (2) COLUMBUS JUNCT 1 N [USC00131731], Columbus Junction, IA
- (3) OSKALOOSA [USC00136327], Oskaloosa, IA

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 to slow (Hydrologic Groups C and D) for undrained soils, and surface runoff is negligible to very high (Figure 5).

Primary wetland hydrology indicators for an intact Ponded 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).

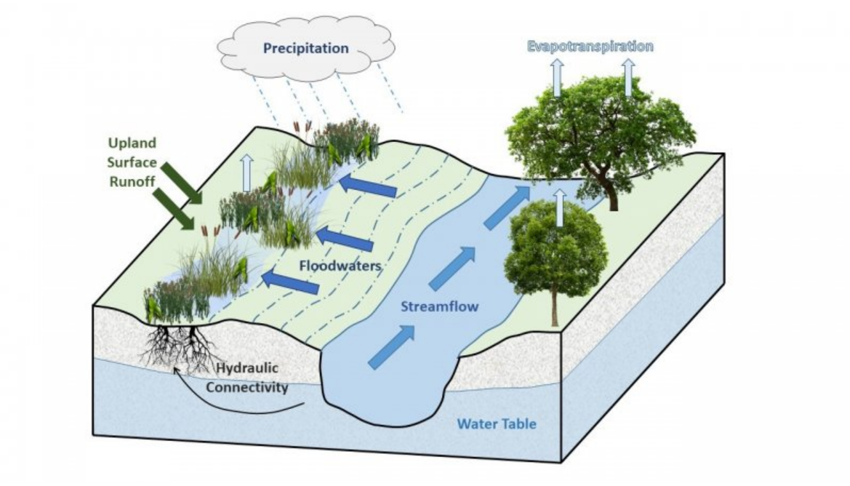


Figure 8. Figure 5. Hydrologic cycling in Ponded Floodplain Marsh ecological site.

Soil features

Soils of Ponded Floodplain Marshes are in the Entisols and Mollisols orders, further classified as Cumulic Endoaquolls, Cumulic Vertic Endoaquolls, and Fluvaquents with very slow to slow infiltration and negligible to very high runoff potential. The soil series associated with this site includes Aquents, Aquolls, Colo, Fluvaquents, Wabash, and Zook (Figure 6). The parent material is alluvium, and the soils are very poorly to poorly-drained and deep with seasonal high-water tables. Soil pH classes are strongly acid to slightly alkaline rooting restrictions are noted for the soils of this ecological site (Table 5).

Some soil map units in this ecological site, if not drained, may meet the definition of hydric soils and are listed as meeting criteria 2, 3, and 4 of the hydric soils list (77 FR 12234).

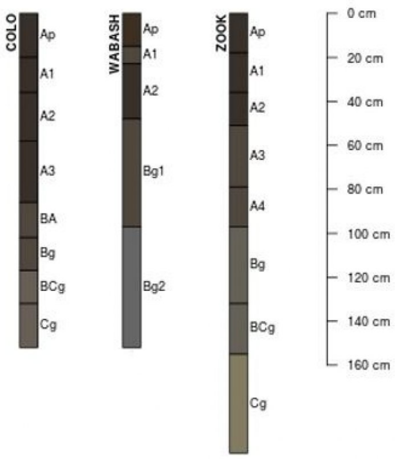


Figure 9. Figure 6. Profile sketches of soil series associated with Ponded Floodplain Marsh.

Table 4. Representative soil features

Parent material	(1) Alluvium
Family particle size	(1) Fine (2) Fine-silty
Drainage class	Very poorly drained to poorly drained
Permeability class	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 transition zone between the eastern deciduous forests and the tallgrass prairies. 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. Ponded Floodplain Marshes form an aspect of this vegetative continuum. This ecological site occurs on floodplains in river valleys on very poorly to poorly-drained soils. Species characteristic of this ecological site consist of hydrophytic and aquatic herbaceous vegetation.

Flooding is the dominant disturbance factor in Ponded 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 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 of the emergent vegetation, which won't re-establish until the next drought or drawdown event (Eggers and Reed 2015).

Today, Ponded 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 1 – REFERENCE STATE

The reference plant community is categorized as a marsh community, dominated by hydrophytic and aquatic 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.

Community Phase 1.1 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, common bladderwort, water knotweed (*Polygonum amphibium* L.), and curlytop knotweed (*Polygonum lapathifolium* L.). 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 1.2 while an increase in water level (above 2 feet) will shift the community to phase 1.3.

Pathway 1.1A – Ponded water depths decrease to <12 inches.

Pathway 1.1B – Ponded water depths increase to >24 inches.

Community Phase 1.2 Hairy Sedge – Broadleaf Arrowhead – This reference community phase can occur when the frequency and depth of ponding are reduced to less than 1 foot. Bulrushes are still present, but hairy sedge becomes the dominant monocot on the site. Broadleaf arrowhead is still the dominant forb, but forb diversity increases and can include touch-me-nots (Impatiens L.), smallspike false nettle (*Boehmeria cylindrica* (L.) Sw.), blue skullcap (*Scutellaria lateriflora* L.), and spotted joe pye weed (Eupatorium maculatum (L.) E.E. Lamont). Shallow ponded water depths (less than 1 foot) will maintain this phase, but an increase in water depths can shift the community back to phase 1.1.

Pathway 1.2A – Ponded water depths increase to 12 – 24 inches.

Community Phase 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 (Typha L.) are the dominant monocots. Aquatic vegetation becomes important characteristic species during this phase and can include species such as coon's tail (*Ceratophyllum demersum* L.), common duckmeat (*Spirodela polyrrhiza* (L.) Schleid), and American white waterlily (*Nymphaea odorata* Aiton ssp. tuberosa (Paine) Wiersma & Hellquist). 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 1.1.

Pathway 1.3A – Ponded water depths decrease to 12 – 24 inches.

Transition 1A – Direct and indirect alterations to the landscape hydrology from human-induced land development transition the site to the hydrologically-altered state (2).

Transition 1B – Cultural treatments to enhance forage quality and yield transitions this site to the forage state (3).

Transition 1C – Installation of drain tiles, tillage, seeding of agricultural crops, and non-selective herbicide transition the site to the cropland state (4).

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 Ponded Floodplain Marshes. Alterations such as agricultural tile draining and conversion to cropland on adjacent lands in addition to stream channelization and damming have changed the natural hydroperiod and rate of sedimentation as well as increased nutrient pollution (Mitsch and Gosselink 2007; Eggers and Reed 2015).

Community Phase 2.1 Reed Canarygrass – River Bulrush – 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).

Pathway 2.1A – Continuing alterations to the natural hydrology and increasing sedimentation

Community Phase 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 (Eggers and Reed 2015). 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; Eggers and Reed 2015).

Transition 2A – Cultural treatments to enhance forage quality and yield transition the site to the forage state (3).

Transition 2B – Installation of drain tiles, tillage, seeding of agricultural crops, and non-selective herbicide transition the site to the cropland state (4).

Restoration 2A – Hydroperiod restoration, site preparation, non-native species control, and seeding native species transition the site to the reconstructed marsh state (5).

STATE 3 – FORAGE STATE

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

Community Phase 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).

Pathway 3.1A – Mechanical harvesting is replaced with domestic livestock utilizing continuous grazing.

Pathway 3.1B – Mechanical harvesting is replaced with domestic livestock utilizing rotational grazing.

Community Phase 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.

Pathway 3.2A – Domestic livestock are removed and mechanical harvesting is implemented.

Pathway 3.2B – Rotational grazing replaces continuous grazing.

Community Phase 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 3.3A – Continuous grazing replaces rotational grazing.

Pathway 3.3B – Domestic livestock are removed and mechanical harvesting is implemented.

Transition 3A – Land is abandoned and left fallow; natural succession by opportunistic species transition this site the hydrologically-altered state (2).

Transition 3B – Installation of drain tiles, tillage, seeding of agricultural crops, and non-selective herbicide transition the site to the cropland state (4).

Restoration 3A – Hydroperiod restoration, site preparation, non-native species control, and seeding native species transition the site to the reconstructed marsh state (5).

STATE 4 – CROPLAND STATE

The low topographic relief across the MLRA has resulted in nearly the entire area being converted to agriculture (Eilers and Roosa 1994). Agricultural tile drains used to lower the water table and the 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 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 Phase 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).

Pathway 4.1A – Tillage operations are greatly reduced, crop rotation occurs on a regular interval, and crop residue remains on the soil surface.

Pathway 4.1B – 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.

Community Phase 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.

Pathway 4.2A – Intensive tillage is utilized and monoculture row-cropping is established.

Pathway 4.2B – Cover crops are implemented to minimize soil erosion.

Community Phase 4.3 Conservation Tillage with 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.

Pathway 4.3A – Cover crop practices are abandoned.

Pathway 4.3B – Intensive tillage is utilized, cover crops practices are abandoned, monoculture row-cropping is established, and crop rotation is reduced or eliminated.

Transition 4A – Agricultural production abandoned and left fallow; natural succession by opportunistic species transition this site to the hydrologically-altered state (2).

Transition 4B – Cultural treatments to enhance forage quality and yield transition the site to the forage state (3).

Restoration 4A – Hydroperiod restoration, site preparation, non-native species control and seeding native species transition this site to the reconstructed marsh state (5).

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 Ponded 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).

Community Phase 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).

Pathway 5.1A – Maintenance of proper hydrology and nutrient balances in line with a developed wetland management plant.

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).

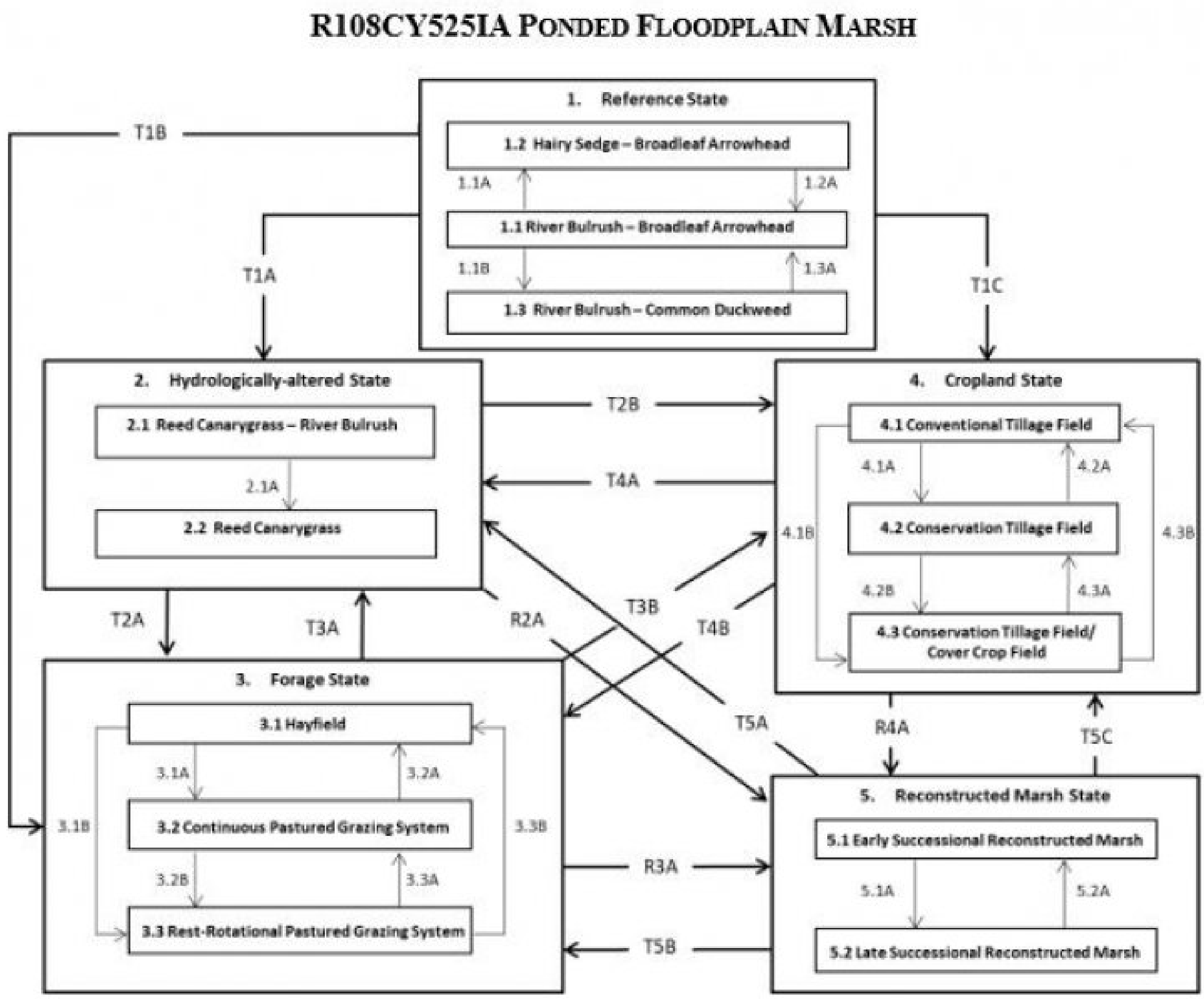
Pathway 5.2A – Reconstruction experiences a setback from extreme weather event or improper timing of management actions.

Transition 5A – Land is abandoned and left fallow; natural succession by opportunistic species transition this site the hydrologically-altered state (2).

Transition 5B – Cultural treatments to enhance forage quality and yield transition the site to the forage state (3).

Transition 5C – Installation of drain tiles, seeding of agricultural crops, and non-selective herbicide transition the site to the cropland state (4).

State and transition model



Code	Process
1.1A	Ponded water depths <12 inches
1.1B	Ponded water depths >24 inches
1.2A, 1.3A	Ponded water depths 12-24 inches
T1A, T3A, T4A, T5A	Changes to natural hydroperiod and/or land abandonment
2.1A	Increasing changes to hydrology and increasing sedimentation
T1B, T2A, T4B, T5B	Cultural treatments are implemented to increase forage quality and yield
3.1A	Mechanical harvesting is replaced with domestic livestock and continuous grazing
3.1B	Mechanical harvesting is replaced with domestic livestock and rest-rotational grazing
3.2A, 3.3B	Tillage, forage crop planting, and mechanical harvesting replace grazing
3.2B	Implementation of rest-rotational grazing
3.3A	Implementation of continuous grazing
T1C, T2B, T3B, T5C	Agricultural conversion via drainage, tillage, seeding, and non-selective herbicide
4.1A	Less tillage, residue management
4.1B	Less tillage, residue management, and implementation of cover cropping
4.2B	Implementation of cover cropping
4.2A, 4.3B	Intensive tillage, remove residue, and reinitiate monoculture row cropping
4.3A	Remove cover cropping
R2A, R3A, R4A	Site preparation, non-native species control, hydroperiod repair, and native seeding
5.1A	Invasive species control and implementation of disturbance regimes
5.2A	Drought or improper timing/use of management actions

Inventory data references

Tier 3 Sampling Plot used to develop the reference state, community phase 1.1:
State County Ownership Legal Description Easting Northing

Iowa Jasper Carpenter Wildlife Area – Iowa Department of Natural Resources T78N R18W S29 503364 4598256
Iowa Jasper Carpenter Wildlife Area – Iowa Department of Natural Resources T78N R18W S29 503230 4597660

Tier 3 Sampling Plot used to develop the reference state, community phase 1.2:
State County Ownership Legal Description Easting Northing
Iowa Louisa Cone Marsh – Iowa Department of Natural Resources T76N R5W S14 633156 4583350

Tier 3 Sampling Plot used to develop the reference state, community phase 1.3:
State County Ownership Legal Description Easting Northing
Iowa Muscatine Wiese Slough – Iowa Department of Natural Resources T78N R2W S18 655799 4601818

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Approval

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Acknowledgments

This project could not have been completed without the dedication and commitment from a variety of partners and staff (Table 6). Team members supported the project by serving on the technical team, assisting with the development of state and community phases of the state-and-transition model, providing peer review and technical editing, and conducting quality control and quality assurance reviews.

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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	
Approved by	
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):

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

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

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

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

    Dominant:

    Sub-dominant:

    Other:

    Additional:

---

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

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

---

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

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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:**

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17. **Perennial plant reproductive capability:**
