Ecological site R107XA215IA
Wet Floodplain Sedge Meadow

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General information

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

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 Minnesota Loess Hills (MLRA 107A) includes the Northwest Iowa Plains, Inner Coteau, and Coteau Moraines landforms (Prior 1991; MDNR 2005). It spans two states (Iowa, 89 percent; Minnesota, 11 percent), encompassing approximately 4,470 square miles (Figure 1). The elevation ranges from approximately 1,700 feet above sea level (ASL) on the highest ridges to about 1,115 feet ASL in the lowest valleys. Local relief is mainly 10 to 100 feet. However, some valley floors can range from 80 to 200 feet, while some upland flats only range between 3 and 6 feet. The eastern half of the MLRA is underlain by Wisconsin-age till, deposited between 20,000 and 30,000 years ago and is known as the Sheldon Creek Formation. The western half is underlain by Pre-Illinoian glacial till, deposited more than 500,000 years ago and has since undergone extensive erosion and dissection. Both surfaces are covered by approximately 4 to 20 feet of loess on the hillslopes, and Holocene alluvium covers the till in the drainageways. Cretaceous bedrock, comprised of sandstone and shale, 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

U.S. Forest Service Ecological Subregions: North Central Glaciated Plains (251B) Section, Outer Coteau des Prairies (251Bb), Northwest Iowa Plains (251Bd) Subsections (Cleland et al. 2007)

U.S. EPA Level IV Ecoregion: Loess Prairies (47a) (USEPA 2013)

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

National Vegetation Classification - Plant Associations: Carex utriculata – Carex lacustris (Carex vesicaria, Carex stricta) Wet Meadow (CEGL002257) (NatureServe 2015)

Biophysical Settings: Eastern Great Plains Wet Meadow-Marsh-Prairie System (BpS 4214880) (LANDFIRE 2009)

Natural Resources Conservation Service – Iowa Plant Community Species List: Wet meadow, Northern Sedge (USDA-NRCS 2007)

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

Minnesota Department of Natural Resources: WMs83a Seepage Meadow/Carr; RVx54b2 Permanent Stream Subtype (MDNR 2005)

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

Ecological site concept

Wet Floodplain Sedge Meadows are located within the green areas on the map (Figure 1). They occur on floodplains in river valleys. The soils are Mollisols and Entisols that are poorly-drained and deep, formed in alluvium. The site is associated with occasional flooding that can last up to 30 days.

The historic pre-European settlement vegetation on this site is dominated by herbaceous species adapted to flooded and saturated conditions. Blister sedge (Carex vesicaria L.) and bluejoint (Calamagrostis canadensis (Michx.) P. Beauv.) are the dominant species of Wet Floodplain Sedge Meadows. Other monocots that may be present include smoothcone sedge (Carex laeviconica Dewey), river bulrush (Bolboschoenus fluviatilis (Torr.) Soják), common spikerush (Eleocharis palustris (L.) Roem. & Schult.), and prairie cordgrass (Spartina pectinata Bosc ex Link) (MDNR 2005). Species typical of an undisturbed plant community associated with this ecological site include sweetflag (Acorus americanus (Raf.) Raf.), hairyfruit sedge (Carex trichocarpa Muhl. ex Willd.), and tufted loosestrife (Lysimachia thyrsiflora L.) (Drobney et al. 2001; MDNR 2005). Soil water levels are generally consistently high enough to prevent woody species from becoming established. Flooding and fire are the primary disturbance factors that maintain this site, while periodic drought is a secondary factor (MDNR 2005; LANDFIRE 2009).

Associated sites

R107XA212IA	**Stream Terrace Prairie** Silty or loamy alluvium over outwash on stream terraces that are not flooding including Allendorf, Estherville, Fairhaven, Hawick, Salida, and Wadena
F107XA213IA	**Loamy Floodplain Forest** Occasionally to frequently flooded, MW-drained alluvium that is not shallow to the water table (18-48 inches) including Colo, Omadi, and Spillville
R107XA214IA	**Loamy Floodplain Prairie** None to occasionally flooded, SWP to MW-drained alluvium that is not shallow to the water table (+12 inches) including Spillville and Turlin variant

Similar sites

R107XA208IA	**Ponded Upland Depression Sedge Meadow** Ponded Upland Depression Sedge Meadows are similar in plant community composition but occur in upland depressions and are a DEPRESSIONAL wetland
R107XA214IA	**Loamy Floodplain Prairie** Loamy Floodplain Prairies are similar in landscape position, but site does not have a shallow depth to the water depth

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified

Herbaceous	(1) *Carex vesicaria* (2) *Calamagrostis canadensis*

Physiographic features

Wet Floodplain Sedge Meadows occur on floodplains in river valleys (Figure 2). They are situated on elevations ranging from approximately 499 to 1801 feet ASL. The site experiences occasional flooding that can last up to 30 days.

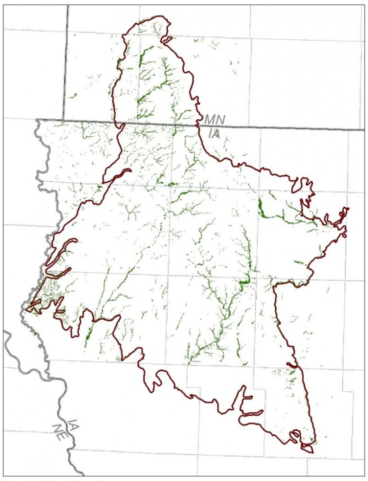


Figure 2. Figure 1. Location of Wet Floodplain Sedge Meadow ecological site within MLRA 107A.

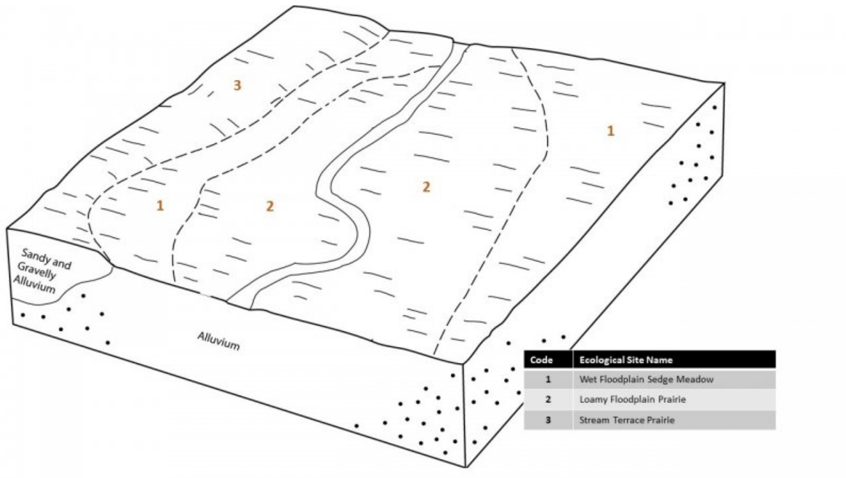


Figure 3. Figure 2. Representative block diagram of Wet Floodplain Sedge Meadow and associated ecological sites.

Table 2. Representative physiographic features

Slope shape across	(1) Linear
Slope shape up-down	(1) Linear
Landforms	(1) River valley > Flood plain
Runoff class	Low
Flooding duration	Very brief (4 to 48 hours) to long (7 to 30 days)
Flooding frequency	None to occasional
Elevation	152–549 m
Slope	0–2%
Water table depth	0–30 cm
Aspect	Aspect is not a significant factor

Climatic features

The Iowa and Minnesota Loess Hills 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 107A 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 159 days, while the frost-free period is about 136 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 31 inches, which includes rainfall plus the water equivalent from snowfall. The average annual low and high temperatures are 35 and 57°F, respectively (Table 3).

Climate data and analyses are derived from 30-year averages 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)	119-127 days
Freeze-free period (characteristic range)	136-152 days
Precipitation total (characteristic range)	737-787 mm
Frost-free period (actual range)	117-132 days
Freeze-free period (actual range)	133-155 days
Precipitation total (actual range)	711-787 mm
Frost-free period (average)	124 days
Freeze-free period (average)	145 days
Precipitation total (average)	737 mm

Climate stations used

- (1) LAKE WILSON [USC00214534], Lake Wilson, MN
- (2) LE MARS [USC00134735], Le Mars, IA
- (3) SHELDON [USC00137594], Sheldon, IA
- (4) SPENCER MUNI AP [USW00014972], Spencer, IA
- (5) IDA GROVE 5NW [USC00134038], Ida Grove, IA

Influencing water features

Wet Floodplain Sedge Meadows are classified as a RIVERINE: Floodplain, Occasionally Flooded, herbaceous wetland under the Hydrogeomorphic (HGM) classification system (Smith et al. 1995; USDA-NRCS 2008) and as a Palustrine, Emergent, Persistent, 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 additional sources can include upland surface runoff, tributary inflow, and precipitation (Smith et al. 1995). Infiltration is slow to moderate (Hydrologic Group B and C) for undrained soils, and surface runoff is low (Figure 5).

Primary wetland hydrology indicators for an intact Wet Floodplain Sedge Meadow may include: A1 Surface water, A2 High water table, and A3 Saturation. Secondary wetland hydrology indicators may include: B10 Drainage patterns, C2 Dry-season water table, and D5 FAC-neutral test (USACE 2010).

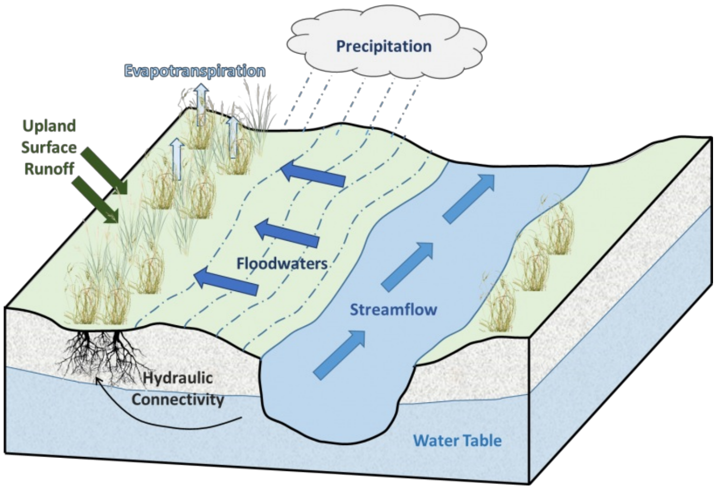


Figure 10. Figure 5. Hydrologic cycling in Wet Floodplain Sedge Meadow ecological site.

Soil features

Soils of Wet Floodplain Sedge Meadows are in the Mollisols and Entisols orders, further classified as Cumulic Endoaquolls, Cumulic Haplaquolls, Cumulic Hapludolls, Typic Udipsamments with slow to moderate infiltration and low runoff potential. The soil series associated with this site includes Calco, Coland, Colo, Comfrey, Fluvaquents, and Havelock (Figure 6). The parent material is alluvium, and the soils are poorly-drained and deep with seasonal high-water tables. Soil pH classes are moderately acid to moderately alkaline. No rooting restrictions are noted for the soils of this ecological site (Table 5).

Soil map units in this ecological site may meet the definition of hydric soils and are listed as meeting criteria 2 and 4 of the hydric soils list (77 FR 12234).

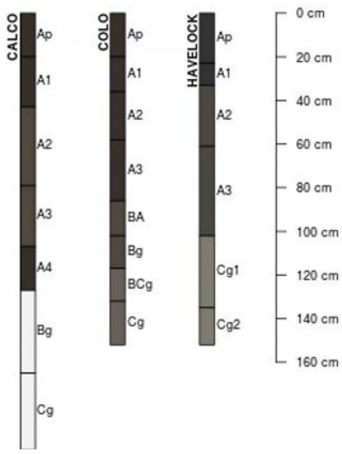


Figure 11. Figure 6. Profile sketches of soil series associated with Wet Floodplain Sedge Meadow.

Table 4. Representative soil features

Parent material	(1) Alluvium
Family particle size	(1) Fine-silty (2) Fine-loamy
Drainage class	Poorly drained
Permeability class	Slow to moderately slow
Soil depth	203 cm
Surface fragment cover >3"	0–3%

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.

MLRA 107A is defined by a relatively low relief landscape that experiences lower rainfall amounts and available moisture compared to other MLRAs occurring to the south and east. As a result, prairie vegetation communities dominate the uplands, while forested communities are restricted to medium and large streams (Prior 1991; Eilers and Roosa 1994; MDNR 2017a, b). Wet Floodplain Sedge Meadows form an aspect of this vegetative continuum. This ecological site occurs on floodplains in river valleys on poorly-drained soils. Species characteristic of this ecological site consist of hydrophytic herbaceous vegetation.

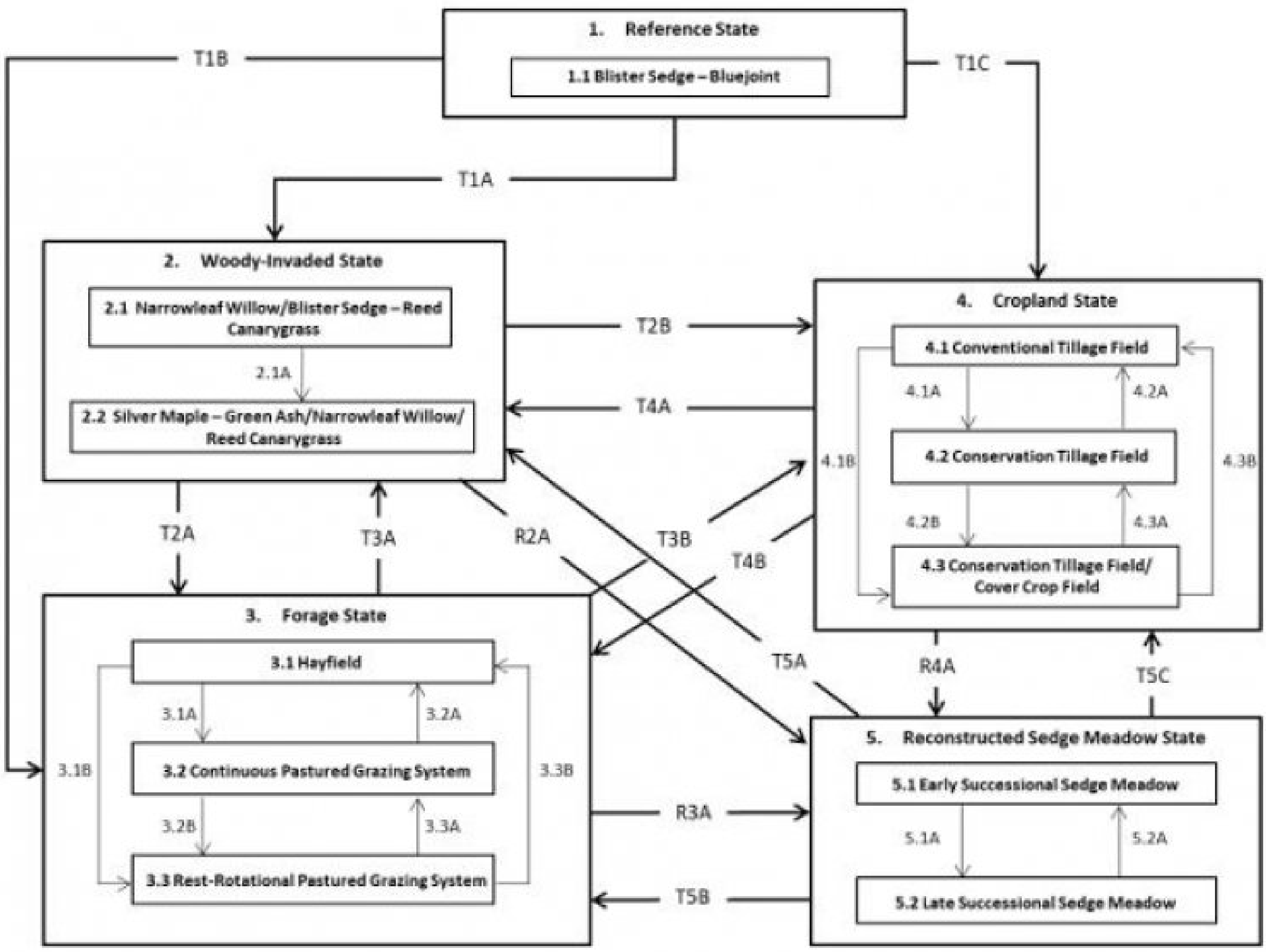
Flooding and fire are the primary disturbance factors of this ecological site. Seasonal flooding generally occurs following spring runoff and heavy rains causing alternating episodes of accretion and deposition. These fluctuations result in cyclic anaerobic and aerobic conditions (MDNR 2005). Fires were typically stand replacing, occurring approximately every 3 years (LANDFIRE 2009). The combination of annual flooding and periodic fire prevent the buildup of organic materials and associated plant community transition.

Drought has also played a role in shaping this ecological site. The periodic episodes of reduced soil moisture in conjunction with the poorly-drained soils have favored the proliferation of plant species tolerant of such conditions. Drought can also slow the growth of plants and result in dieback of certain species. When coupled with fire and flooding, periods of drought can greatly delay the establishment of woody vegetation (Pyne et al. 1996).

Today, Wet Floodplain Sedge Meadows have experienced numerous disturbances that reduced their historic range. Many areas have been converted to agricultural production land – either cropland dominated by corn (*Zea mays* L.) and soybeans (*Glycine max* (L.) Merr.) or as forage land for livestock. Other areas have had fire suppressed long enough to allow trees and shrubs to outcompete the historic sedge meadow. A return to the historic plant community may not be possible following extensive land modification and significant hydrologic and water quality changes in the watershed, but long-term conservation agriculture or meadow reconstruction efforts can help to restore some biotic 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

R107AY215IA WET FLOODPLAIN SEDGE MEADOW



Code	Process
T1A, T3A, T4A, T5A	Changes to natural hydroperiod, fire suppression, and/or land abandonment
2.1A	Increasing changes to hydrology, increasing sedimentation, continued fire suppression
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 tiling, 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, and native seeding
5.1A	Invasive species control and implementation of disturbance regimes
5.2A	Drought or improper timing/use of management actions

State 1
Reference State

The reference plant community is categorized as a sedge meadow community, dominated by hydrophytic vegetation. The one community phase within the reference state is dependent on flooding and fire. These disturbances occur with a high frequency, but do not result in a community shift (LANDFIRE 2009). Infrequent droughts have more localized impacts on the reference phase, but do contribute to overall species composition, diversity, cover, and productivity.

Dominant plant species

- blister sedge (*Carex vesicaria*), other herbaceous
- bluejoint (*Calamagrostis canadensis*), other herbaceous

Community 1.1
Blister Sedge-Bluejoint

Blister Sedge – Bluejoint – This reference community phase is dominated by blister sedge and bluejoint. Smoothcone sedge, river bulrush, common spikerush, and prairie cordgrass are other common monocot associates. Characteristic forbs include water knotweed (*Polygonum amphibium* L.), swamp milkweed (*Asclepias incarnata* L.), Shreve's iris (*Iris virginica* L. var. shrevei (Small E.S. Anderson), broadfruit bur-reed (*Sparganium eurycarpum* Engelm.), and rough bugleweed (*Lycopus asper* Greene) (MDNR 2005; NatureServe 2015). Mature plants typically range between 1.5 and 3 feet tall, and ground cover is continuous (up to 100 percent) (MDNR 2005; LANDFIRE 2009).

State 2
Woody Invaded State

The combination of regular flooding and stand-replacing fires prevented trees and shrubs from becoming established on Wet Floodplain Sedge Meadows. 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). Regular fires prevented the buildup of organic materials, thus helping to maintain the native vegetation. However, as humans settled the landscape, they greatly changed the natural hydrologic cycling and fire regimes. Alterations such as stream channelization, dam and levee construction, agricultural tile draining, conversion to cropland on adjacent lands, and long-term fire suppression have resulted in a shift in the plant community (Werner and Zedler 2003; MDNR 2005; Mitsch and Gosselink 2007).

Dominant plant species

- silver maple (*Acer saccharinum*), tree
- green ash (*Fraxinus pennsylvanica*), tree
- narrowleaf willow (*Salix exigua*), shrub
- reed canarygrass (*Phalaris arundinacea*), other herbaceous
- blister sedge (*Carex vesicaria*), other herbaceous

Community 2.1
Narrowleaf Willow/Blister Sedge - Reed Canarygrass

Narrowleaf Willow/ Blister Sedge – Reed Canarygrass – This community phase represents the early changes to the natural wetland hydroperiod, increasing sedimentation, unabated nutrient runoff, and fire suppression. Woody shrubs, such as narrowleaf willow (*Salix exigua* Nutt.) begin to form a strong canopy component. The native sedges and grasses continue to dominate 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 and nutrient cycling as well (Annen et al. 2008; Swanson et al. 2017).
Pathway 2.1A – Continuing alterations to the natural hydrology, increasing sedimentation, and fire suppression

Dominant plant species

- narrowleaf willow (*Salix exigua*), shrub
- blister sedge (*Carex vesicaria*), other herbaceous
- reed canarygrass (*Phalaris arundinacea*), other herbaceous

Community 2.2
Silver Maple – Green Ash/Narrowleaf Willow/Reed Canarygrass

Silver Maple – Green Ash/Narrowleaf Willow/Reed Canarygrass – Sites falling into this community phase have experienced significant sedimentation, nutrient enrichment, and fire suppression. Silver maple (*Acer saccharinum* L.) and green ash (Fraxinus pensylvanica L.) have become established on the site. Narrowleaf willow is still present, but the herbaceous layer has shifted to a monoculture of reed canarygrass. These monotypic stands create a positive feedback loop that perpetuates increasing sedimentation, altered hydrology, and dominance by this non-native species, especially in sites affected by nutrient enrichment from agricultural runoff (Vitousek 1995; Bernard and Lauve 1995; Green and Galatowitsch 2002; Kercher et al. 2007; Waggy 2010; Eggers and Reed 2015).

Dominant plant species

- silver maple (*Acer saccharinum*), tree
- green ash (*Fraxinus pennsylvanica*), tree
- narrowleaf willow (*Salix exigua*), shrub
- reed canarygrass (*Phalaris arundinacea*), other herbaceous

Pathway 2.1A
Community 2.1 to 2.2

Increasing changes to hydrology, increasing sedimentation and continued fire suppression

State 3
Forage State

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

Community 3.1
Hayfield

Hayfield – Sites in this community phase consist of forage plants that are planted and mechanically harvested. Mechanical harvesting removes much of the aboveground biomass and nutrients that feed the soil microorganisms (Franzluebbers et al. 2000; USDA-NRCS 2003). As a result, soil biology is reduced leading to decreases in nutrient uptake by plants, soil organic matter, and soil aggregation. Frequent biomass removal can also reduce the site's carbon sequestration capacity (Skinner 2008).

Community 3.2
Continuous Pastured Grazing System

Continuous Pastured Grazing System – This community phase is characterized by continuous grazing where domestic livestock are allowed to graze a pasture for the entire season. Depending on stocking density, this can result in lower forage quality and productivity, weed invasions, and uneven pasture use. Continuous grazing can also increase the amount of bare ground and erosion and reduce soil organic matter, cation exchange capacity, water-holding capacity, and nutrient availability and retention (Bharati et al. 2002; Leake et al. 2004; Teague et al. 2011). Smooth brome, Kentucky bluegrass, and white clover (*Trifolium repens* L.) are common pasture species used in this phase. Their tolerance to continuous grazing has allowed these species to dominate, sometimes completely excluding the native vegetation.

Community 3.3
Rest-Rotation Pastured Grazing System

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

Pathway 3.1A
Community 3.1 to 3.2

Mechanical harvesting is replaced with domestic livestock and continuous grazing

Pathway 3.1B
Community 3.1 to 3.3

Mechanical harvesting is replaced with domestic livestock and rest-rotational grazing

Pathway 3.2A
Community 3.2 to 3.1

Tillage, forage crop planting and mechanical harvesting replace grazing

Pathway 3.2B
Community 3.2 to 3.3

Implementation of rest-rotational grazing

Pathway 3.3B
Community 3.3 to 3.1

Tillage, forage crop planting and mechanical harvesting replace grazing

Pathway 3.3A
Community 3.3 to 3.2

Implementation of continuous grazing

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 4.1
Conventional Tillage Field

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

Community 4.2
Conservation Tillage Field

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

Community 4.3
Conservation Tillage with Cover Crop Field

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 4.1A
Community 4.1 to 4.2

Less tillage, residue management

Pathway 4.1B
Community 4.1 to 4.3

Less tillage, residue management and implementation of cover cropping

Pathway 4.2A
Community 4.2 to 4.1

Intensive tillage, remove residue and reinitialize monoculture row cropping

Pathway 4.2B
Community 4.2 to 4.3

Implementation of cover cropping

Pathway 4.3B

Community 4.3 to 4.1

Intensive tillage, remove residue and reinitialize monoculture row cropping

Pathway 4.3A
Community 4.3 to 4.2

Remove cover cropping

State 5
Reconstructed Sedge Meadow State

Sedge meadow habitats provide multiple ecosystem services including flood abatement, water quality improvement, and biodiversity support. However, many sedge meadow communities have been stressed from watershed-scale changes in hydrology or eliminated as a result of type-conversions to agricultural production or long-term fire suppression, thereby significantly reducing these services (Zedler 2003). The extensive alterations of lands adjacent to Wet Floodplain Sedge Meadows 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 5.1
Early Successional Sedge Meadow

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

Community 5.2
Late Successional Sedge Meadow

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

Pathway 5.1A
Community 5.1 to 5.2

Invasive species control and implementation of disturbance regimes

Pathway 5.2A
Community 5.2 to 5.1

Drought or improper timing/use of management actions

Transition T1A
State 1 to 2

Changes to natural hydroperiod, fire suppression, and/or land abandonment

Transition T1B
State 1 to 3

Cultural treatments are implemented to increase forage quality and yield

Transition T1C
State 1 to 4

Agricultural conversion via tilling, tillage, seeding and non-selective herbicide

Transition T2A
State 2 to 3

Cultural treatments are implemented to increase forage quality and yield

Transition T2B
State 2 to 4

Agricultural conversion via tilling, tillage, seeding and non-selective herbicides

Transition R2A
State 2 to 5

Site preparation, non-native species control and native seeding

Restoration pathway T3A
State 3 to 2

Changes to natural hydroperiod, fire suppression and/or land abandonment

Transition T3B
State 3 to 4

Agricultural conversion via tilling, tillage, seeding and non-selective herbicide

Transition R3A
State 3 to 5

Site preparation, non-native species control and native seeding

Restoration pathway T4A
State 4 to 2

Changes to natural hydroperiod, fire supression, and/or land abandonment

Restoration pathway T4B
State 4 to 3

Cultural treatments are implemented to increase forage quality and yield

Transition R4A
State 4 to 5

Site preparation, non-native species control and native seeding

Restoration pathway T5A
State 5 to 2

Changes to natural hydroperiod, fire suppression and/or land abandonment

Restoration pathway T5B
State 5 to 3

Cultural treatments are implemented to increase forage quality and yield

Restoration pathway T5C
State 5 to 4

Agricultural conversion via tilling, tillage, seeding and non-selective herbicide

Additional community tables

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 Clay Ocheyedan Wildlife Area – Iowa Department of Natural Resources T96N R37W S5 317509 4780772

Tier 2 Sampling Points used to develop the reference state, community phase 1.1:
State County Ownership Legal Description Points
Iowa Clay Hawk Valley Wildlife Area – Iowa Department of Natural Resources T96N R36W S26 1, 13
Iowa Clay Ocheyedan Wildlife Area – Iowa Department of Natural Resources T96N R37W S8 6, 7, 8
Iowa Clay Reiter Wildlife Area – Iowa Department of Natural Resources T97N R37W S36 11, 12

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Rangeland health reference sheet

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

Author(s)/participant(s)	
Contact for lead author	
Date	05/13/2025
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:**