

Ecological site R107XA209IA

Wet Upland Sedge Meadow

Last updated: 5/21/2020
Accessed: 04/30/2024

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 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: Northern Tallgrass Prairie (CES205.686) (NatureServe 2015)

National Vegetation Classification – Plant Associations: *Andropogon gerardii* – (*Panicum virgatum*) – *Muhlenbergia*

richardsonis Wet Meadow (CEGL002199) (NatureServe 2015)

Biophysical Setting: Northern Tallgrass Prairie (BpS 3914200) (LANDFIRE 2009)

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

Iowa Department of Natural Resources: Blacksoil Tallgrass Prairie (INAI 1984)

Minnesota Department of Natural Resources: Ups54b Wet Prairie (Southern) (MDNR 2005)

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

Ecological site concept

Wet Upland Sedge Meadows are located within the green areas on the map (Figure 1). They occur on uplands on slopes less than 2 percent, and the soils are Mollisols that are poorly drained and deep, formed in loess or loamy sediments. The site is associated with shallow depths to the water table during the growing season, resulting in a native plant community comprised of wet-mesic herbaceous vegetation.

The historic pre-European settlement vegetation on this site was dominated by hydrophytic, herbaceous species. Prairie cordgrass (*Spartina pectinata* Bosc ex Link) and hairyfruit sedge (*Carex trichocarpa* Muhl. Ex Willd.) are the dominant species of Wet Upland Sedge Meadows. Other grasses and grass-like that may occur include switchgrass (*Panicum virgatum* L.), limestone meadow sedge (*Carex granularis* Muhl. Ex Willd.), and Canada wildrye (*Elymus canadensis* L.). Forbs typical of an undisturbed plant community associated with this ecological site include marsh bellflower (*Campanula aparinoides* Pursh), falsegold groundsel (*Packera pseud aurea* (Rydb.) W.A. Weber & Á. Löve var. *semicordata* (Mack. & Bush) D.K. Trock & T.M. Barkley), and closed bottle gentian (*Gentiana andrewsii* Griseb.) (Drobney et al. 2001). Fire and native large mammal grazing are the primary disturbance factors that maintain this site, while drought is a secondary factor (LANDFIRE 2009).

Associated sites

R107XA201IA	Loess Upland Prairie Loess on upland summits and shoulders that are not shallow to the water table including Annieville, Galva, McCreath, Primghar, Primghar variant, Ransom, Sac, Sac variant, and Wilmonton
R107XA208IA	Ponded Upland Depression Sedge Meadow Loess on upland depressions that experience ponding including Sperry

Similar sites

R107XA210IA	Wet Upland Drainageway Prairie Wet Upland Drainageway Prairies are similar in landscape position, but site is a SLOPE wetland
R107XA214IA	Loamy Floodplain Prairie Loamy Floodplain Prairies are similar in plant community composition, but site is a RIVERINE wetland
R107XA208IA	Ponded Upland Depression Sedge Meadow Ponded Upland Depression Sedge Meadows are similar in landscape position, but site is a DEPRESSIONAL wetland

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) <i>Spartina pectinata</i> (2) <i>Carex trichocarpa</i>

Physiographic features

Wet Upland Sedge Meadows occur on uplands on slopes less than 2 percent (Figure 2). They are situated on elevations ranging from approximately 499 to 2001 ASL. The site does not experience ponding or flooding, but due to low hydraulic gradients have low vertical and lateral drainage.

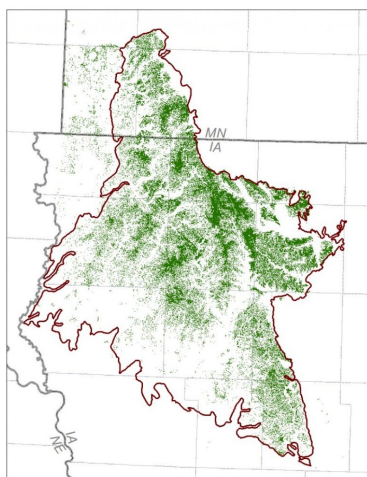


Figure 2. Figure 1. Location Wet Upland Sedge Meadow ecological site within MLRA 107A.

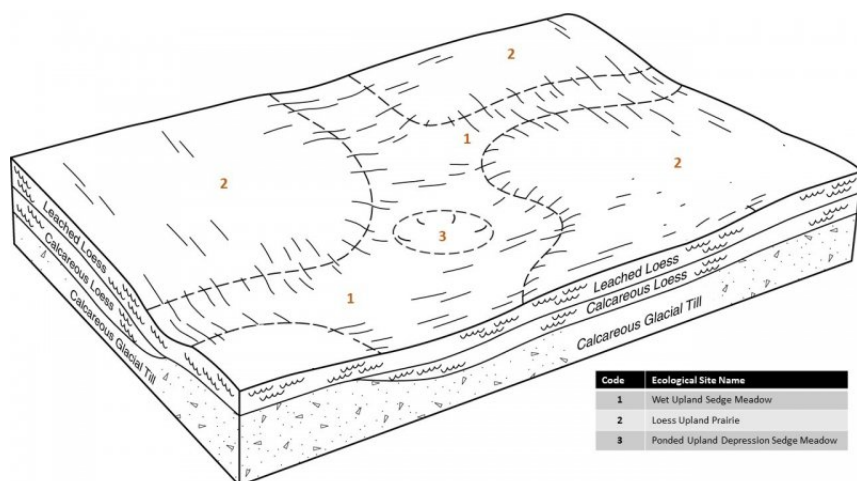


Figure 3. Figure 2. Representative block diagram of Wet Upland Sedge Meadow and associated ecological sites.

Table 2. Representative physiographic features

Slope shape across	(1) Linear
Slope shape up-down	(1) Linear
Landforms	(1) Upland
Runoff class	Low
Elevation	152–610 m
Slope	0–2%
Water table depth	0–15 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 139 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 36 and 58°F, respectively (Table 3).

Climate data and analyses are derived from 30-year averages gathered from six 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)	126-128 days
Freeze-free period (characteristic range)	145-148 days
Precipitation total (characteristic range)	762 mm
Frost-free period (actual range)	123-136 days
Freeze-free period (actual range)	143-149 days
Precipitation total (actual range)	737-787 mm
Frost-free period (average)	128 days
Freeze-free period (average)	146 days
Precipitation total (average)	762 mm

Climate stations used

- (1) SIOUX CTR 2 SE [USC00137700], Sioux Center, IA
- (2) LUVERNE [USC00214937], Luverne, MN
- (3) PRIMGHAR [USC00136800], Primghar, IA
- (4) CHEROKEE [USC00131442], Cherokee, IA
- (5) SIBLEY 3 NE [USC00137664], Sibley, IA
- (6) SPENCER 1 N [USC00137844], Spencer, IA

Influencing water features

Wet Upland Sedge Meadows are classified as a MINERAL SOIL FLATS: herbaceous Wetland under the Hydrogeomorphic (HGM) classification system (Smith et al. 1995; USDA-NRCS 2008) and as a Palustrine, Persistent, Emergent Wetland under the National Wetlands Inventory (FGDC 2013). Precipitation is the main source of water for this ecological site (Smith et al. 1995). Infiltration is slow (Hydrologic Group C) for undrained soils due to poor hydraulic gradients, and surface runoff is low (Figure 5).

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

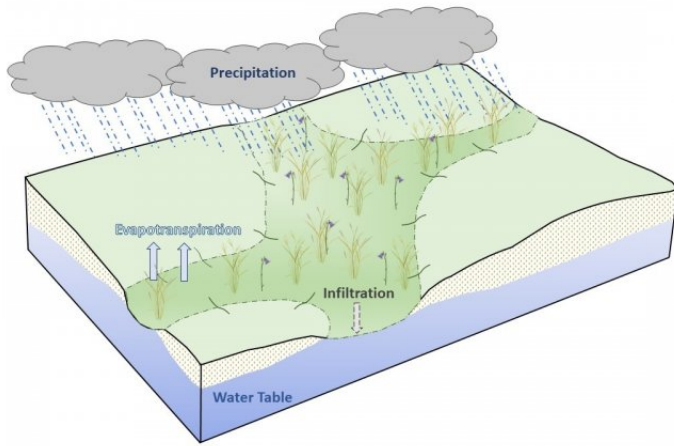


Figure 8. Figure 5. Hydrologic cycling in Wet Upland Sedge Meadow ecological site.

Soil features

Soils of Wet Upland Sedge Meadows are in the Mollisols order, further classified as Typic Endoaquolls and Typic Haplaquolls with slow infiltration and low runoff potential. The soil series associated with this site includes Gillett Grove, Letri, Marcus, Rushmore, and Spicer (Figure 6). The parent material is loess or loamy sediments, and the soils are poorly-drained and deep with seasonal high-water tables. Soil pH classes are slightly acid to moderately alkaline (Table 5). No rooting restrictions are noted for the soils of this ecological site.

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

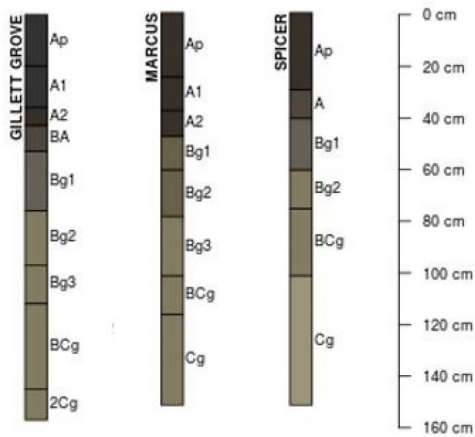


Figure 9. Figure 6. Profile sketches of soil series associated with Wet Upland Sedge Meadow.

Table 4. Representative soil features

Parent material	(1) Loess
Family particle size	(1) Fine-silty
Drainage class	Poorly drained
Permeability class	Very slow to 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.

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 Upland Sedge Meadows form an aspect of this vegetative continuum. This ecological site occurs on upland flats on slopes less than 2 percent on poorly-drained soils. Species characteristic of this ecological site consist of herbaceous vegetation tolerant of saturated soil conditions.

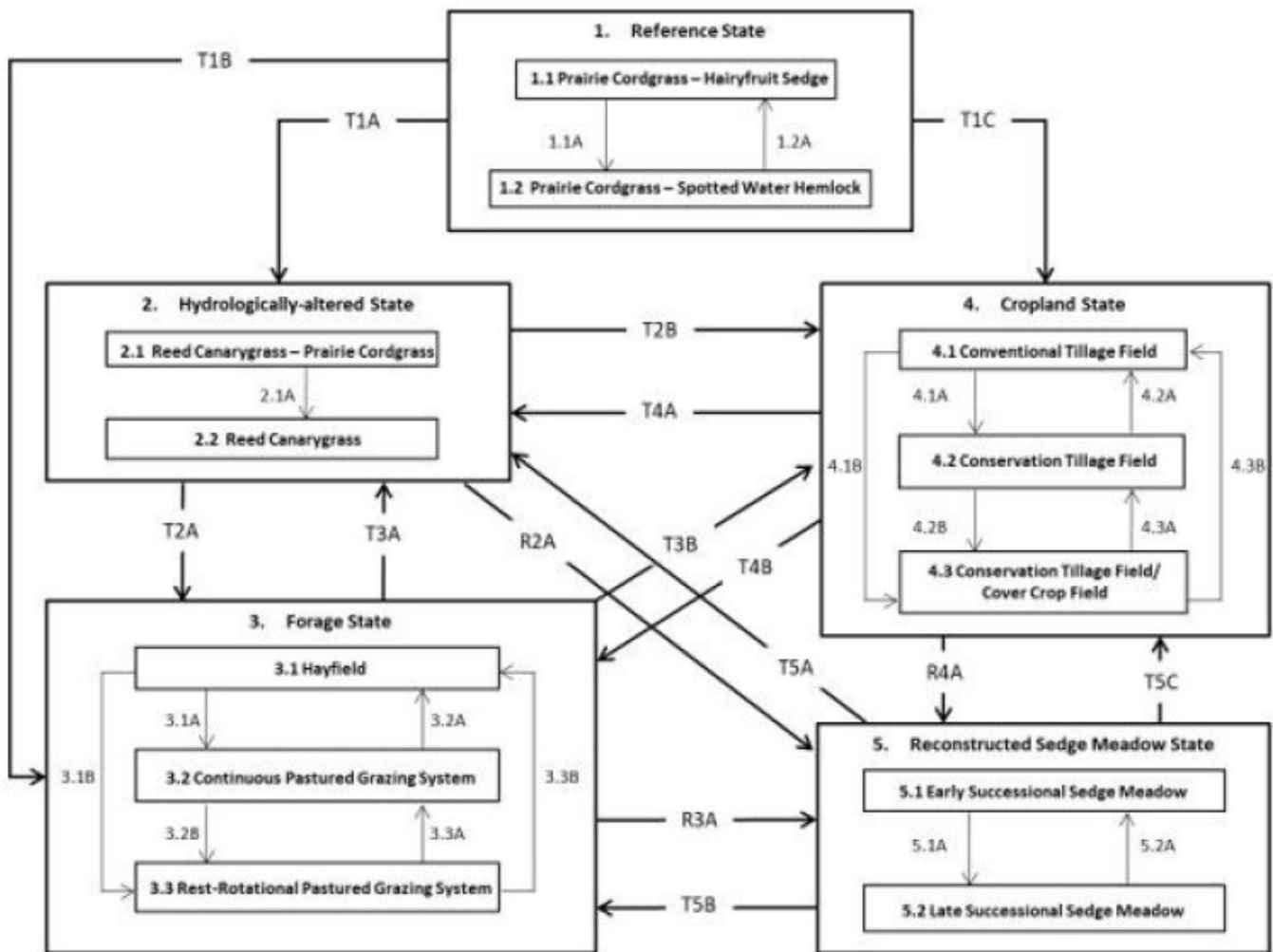
Fire and grazing are the dominant ecosystem drivers for maintaining the vegetation of Wet Upland Sedge Meadows. Fire intensity typically consisted of periodic, high severity surface fires occurring every 3 to 5 years (LANDFIRE 2009). Ignition sources included summertime lightning strikes from convective storms and bimodal, human ignitions during the spring and fall seasons. Native Americans regularly set fires to improve sight lines for hunting, driving large game, improving grazing and browsing habitat, agricultural clearing, and enhancing vital ethnobotanical plants (Barrett 1980). Bison (*Bos bison*) and prairie elk (*Cervus elaphus*) were the main herbivores in northern tallgrass prairies, favoring recently burned patches. Herbivory occurred via mob grazing with large herds of animals rapidly moving across the prairie as they grazed (LANDFIRE 2009). These continuous disturbances provided critical conditions for perpetuating the native prairie ecosystem (MDNR 2005).

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 herbivory, periods of drought can greatly delay the establishment of woody vegetation (Pyne et al. 1996).

Today, Wet Upland Sedge Meadows are limited in their extent, having been converted to agricultural production land. Corn (*Zea mays* L.) and soybeans (*Glycine max* (L.) Merr.) are the dominant crops grown on this ecological site, but small patches of forage land are present. 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 prairie 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

R107AY209IA WET UPLAND SEDGE MEADOW



Code	Process
T1A, T3A, T4A, T5A	Changes to natural hydroperiod and/or land abandonment
T1B, T2A, T4B, T5B	Cultural treatments are implemented to increase forage quality and yield
T1C, T2B, T3B, T5C	Agricultural conversion via tillage, seeding, and non-selective herbicide
1.1A	Recent fire or mob grazing event
1.2A	Natural succession following one year or more of no disturbances
2.1A	Increasing changes to hydrology and increasing sedimentation
R2A, R3A, R4A	Site preparation, non-native species control, and native seeding
3.1A	Mechanical harvesting is replaced with domestic livestock and continuous grazing
3.1B	Mechanical harvesting is replaced with domestic livestock and rest-rotational grazing
3.2A, 3.3B	Tillage, forage crop planting, and mechanical harvesting replace grazing
3.2B	Implementation of rest-rotational grazing
3.3A	Implementation of continuous grazing
4.1A	Less tillage, residue management
4.1B	Less tillage, residue management, and implementation of cover cropping
4.2B	Implementation of cover cropping
4.2A, 4.3B	Intensive tillage, remove residue, and reinitiate monoculture row cropping
4.3A	Remove cover cropping
5.1A	Maintenance of proper hydrology, fire, and nutrient balances
5.2A	Drought or improper timing/use of management actions

State 1 Reference State

The reference plant community is categorized as a wet-mesic sedge meadow community, dominated by

herbaceous vegetation. The two community phases within the reference state are dependent on periodic fire and herbivory. Episodic grazing alters species composition, cover, and extent, while regular fire intervals recycle nutrients, encourage flowering and seed production, and keep woody species from dominating (MDNR 2005). Drought has a more localized impact in the reference phases, but does contribute to overall species composition, diversity, cover, and productivity.

Dominant plant species

- prairie cordgrass (*Spartina pectinata*), other herbaceous
- hairyfruit sedge (*Carex trichocarpa*), other herbaceous
- spotted water hemlock (*Cicuta maculata*), other herbaceous

Community 1.1

Prairie Cordgrass-Hairyfruit Sedge

Prairie Cordgrass – Hairyfruit Sedge – Sites in this reference community phase represent a mature successional stage. Vegetative cover is continuous (75 to 100 percent) and the tallest plants reach heights greater than 3 feet tall (MDNR 2005; LANDFIRE 2009). Prairie cordgrass, switchgrass, and various sedges form the dominant community composition. Characteristic forbs include Virginia mountainmint (*Pycnanthemum virginianum* (L.) T. Dur. & B.D. Jacks. ex B.L. Rob. & Fernald), fringed loosestrife (*Lysimachia ciliata* L.), and sawtooth sunflower (*Helianthus grosseserratus* M. Martens). Shrubs are generally absent, but pussy willow (*Salix discolor* Muhl.) and redosier dogwood (*Cornus sericea* L.) may occasionally be encountered (MDNR 2005).

Dominant plant species

- prairie cordgrass (*Spartina pectinata*), other herbaceous
- hairyfruit sedge (*Carex trichocarpa*), other herbaceous

Community 1.2

Prairie Cordgrass - Spotted Water Hemlock

Prairie Cordgrass – Spotted Water Hemlock – This reference community phase represents the vegetative composition following a recent disturbance event. Vegetative cover is temporarily reduced, not exceeding about 40 percent, and grass heights are less than 3 feet tall. The perennial tallgrasses are still abundant, including prairie cordgrass. However, their reduction in stature allows shorter species and annual and biennial species, such as spotted water hemlock (*Cicuta maculata* L.), to reproduce (LANDFIRE 2009).

Dominant plant species

- prairie cordgrass (*Spartina pectinata*), other herbaceous
- spotted water hemlock (*Cicuta maculata*), other herbaceous

Pathway 1.1A

Community 1.1 to 1.2

Recent fire or mob grazing event

Pathway 1.2A

Community 1.2 to 1.1

Natural succession following one year or more of no disturbances

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 Wet Upland Sedge Meadows. Alterations such as agricultural tile draining and

conversion to cropland on adjacent lands have changed the natural hydroperiod and rate of sedimentation as well as increased nutrient pollution (Mitsch and Gosselink 2007; Eggers and Reed 2015).

Dominant plant species

- reed canarygrass (*Phalaris arundinacea*), other herbaceous
- prairie cordgrass (*Spartina pectinata*), other herbaceous

Community 2.1

Reed Canarygrass-Prairie Cordgrass

Reed Canarygrass – Prairie Cordgrass – This community phase represents the early changes to the natural wetland hydroperiod, increasing sedimentation, and unabated nutrient runoff. Native grasses, such as prairie cordgrass, 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).

Dominant plant species

- reed canarygrass (*Phalaris arundinacea*), grass
- prairie cordgrass (*Spartina pectinata*), grass

Community 2.2

Reed Canarygrass

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).

Dominant plant species

- reed canarygrass (*Phalaris arundinacea*), other herbaceous

Pathway 2.1A

Community 2.1 to 2.2

Increasing changes to hydrology and increasing sedimentation

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, 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 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 pratense* 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 (Mitsch and Gosselink 2007). However, many sedge meadow communities have been eliminated as a result of type conversions to agricultural production, wildfire suppression, 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 Wet Upland 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 invasive species control, hydroperiod repair, planting, and properly timed prescribed fire activities (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).

Community 5.2
Late Successional Sedge Meadow

Late Successional Sedge Meadow – Appropriately timed disturbance regimes (e.g. hydroperiod, prescribed fire, 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 5.1A
Community 5.1 to 5.2

Maintenance of proper hydrology, fire and nutrient balances

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 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 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 tillage, seeding and non-selective herbicide

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 and/or land abandonment

Transition T3B
State 3 to 4

Agricultural conversion via 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 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 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 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 Cherokee Prescott Prairie – Cherokee County Conservation Board T92N R39W S26 301903 4735822

Other references

Adams, C.R. and S.M. Galatowitsch. 2006. Increasing the effectiveness of reed canary grass (*Phalaris arundinacea* L.) control in wet meadow restorations. *Restoration Ecology* 14: 441-451.

Annen, C.A., E.M. Kirsch, and R.W. Tyser. 2008. Reed canarygrass invasions alter succession patterns and may reduce habitat quality in wet meadows. *Ecological Restoration* 26: 190-193.

Baker, R.G., C.A. Chumbley, P.M. Witinok, and H.K. Kim. 1990. Holocene vegetational changes in eastern Iowa. *Journal of the Iowa Academy of Science* 97: 167-177.

Baker, R.G., L.J. Maher, C.A. Chumbley, and K.L. Van Zant. 1992. Patterns of Holocene environmental changes in the midwestern United States. *Quaternary Research* 37: 379-389.

Barret, S.W. 1980. Indians and fire. *Western Wildlands Spring*: 17-20.

Bernard, J.B. and T.E. Lauve. 1995. A comparison of growth and nutrient uptake in *Phalaris arundinacea* L. growing in a wetland and a constructed bed receiving landfill leachate. *Wetlands* 15: 176-182.

Bharati, L., K.-H. Lee, T.M. Isenhardt, and R.C. Schultz. 2002. Soil-water infiltration under crops, pasture, and established riparian buffer in Midwestern USA. *Agroforestry Systems* 56: 249-257.

Changes in Hydric Soils Database Selection Criteria. 77 Federal Register 12234 (29 February 2012), pp. 12234-12235.

Cleland, D.T., J.A. Freeouf, J.E. Keys, G.J. Nowacki, C. Carpenter, and W.H. McNab. 2007. Ecological Subregions: Sections and Subsections of the Conterminous United States. USDA Forest Service, General Technical Report WO-76. Washington, DC. 92 pps.

Drobney, P.D., G.S. Wilhelm, D. Horton, M. Leoschke, D. Lewis, J. Pearson, D. Roosa, and D. Smith. 2001. Floristic Quality Assessment for the State of Iowa. Neal Smith National Wildlife Refuge and Ada Hayden Herbarium, Iowa State University, Ames, IA. 123 pps.

Eilers, L. and D. Roosa. 1994. The Vascular Plants of Iowa: An Annotated Checklist and Natural History. University of Iowa Press, Iowa City, IA. 319 pps.

Eggers, S.D. and D.M. Reed. 2015. Wetland Plants and Plant Communities of Minnesota and Wisconsin, Version 3.2. U.S. Army Corps of Engineers, Regulatory Branch, St. Paul District. St. Paul, MN. 478 pps.

Federal Geographic Data Committee. 2013. Classification of Wetlands and Deepwater Habitats of the United States. FGDC-STD-004-2013. Second Edition. Wetlands Subcommittee, Federal Geographic Data Committee and U.S. Fish and Wildlife Service, Washington, D.C. 90 pps.

Franzluebbers, A.J., J.A. Stuedemann, H.H. Schomberg, and S.R. Wilkinson. 2000. Soil organic C and N pools under long-term pasture management in the Southern Piedmont USA. *Soil Biology and Biochemistry* 32:469-478.

Iowa Natural Areas Inventory [INAI]. 1984. An Inventory of Significant Natural Areas in Iowa: Two Year Progress Report of the Iowa Natural Areas Inventory. Iowa Natural Areas Inventory, Iowa Department of Natural Resources, Des Moines, IA.

Kercher, S.M. A. Herr-Turnoff, J.B. Zedler. 2007. Understanding invasion as a process: the case of *Phalaris arundinacea* in wet prairies. *Biological Invasions* 9: 657-665.

LANDFIRE. 2009. Biophysical Setting 3914200 Northern Tallgrass Prairie. In: LANDFIRE National Vegetation Dynamics Models. USDA Forest Service and US Department of Interior. Washington, DC.

Leake, J., D. Johnson, D. Donnelly, G. Muckle, L. Boddy, and D. Read. 2004. Networks of power and influence: the role of mycorrhizal mycelium in controlling plant communities and agroecosystem functioning. *Canadian Journal of Botany* 82: 1016-1045.

Minnesota Department of Natural Resources [MDNR]. 2005. Field Guide to the Native Plant Communities of Minnesota: The Prairie Parkland and Tallgrass Aspen Parklands Provinces. Ecological Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research Program. Minnesota Department of Natural Resources, St. Paul, Minnesota.

Minnesota Department of Natural Resources [MDNR]. 2017a. Coteau Moraines Subsection. Minnesota Department of Natural Resources: Ecological Classification System. Available at: <http://www.dnr.state.mn.us/ecs/251Bb/index.html>. (Accessed 10 October 2017).

Minnesota Department of Natural Resources [MDNR]. 2017b. Inner Coteau Subsection. Minnesota Department of Natural Resources: Ecological Classification System. Available at: <http://www.dnr.state.mn.us/ecs/251Bc/index.html>. (Accessed 10 October 2017).

Mitsch, W.J. and J.G. Gosselink. 2007. Wetlands, Fourth Edition. John Wiley & Sons, Inc. Hoboken, NJ. 582 pps.

Mitsch, W.J. and S.E. Jørgensen. 2004. Ecological Engineering and Ecosystem Restoration. John Wiley & Sons, Inc. Hoboken, NJ. 428 pps.

National Climate Data Center [NCDC]. 2006. Climate of Iowa. Central Region Headquarters, Climate Services

Branch, National Climatic Data Center, Asheville, NC.

NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1 NatureServe, Arlington, VA. Available at <http://explorer.natureserve.org>. (Accessed 13 February 2017).

Peel, M.C., B.L. Finlayson, and T.A. McMahon. 2007. Updated world map of the Köppen-Geiger climate classification. *Hydrology and Earth System Sciences* 11: 1633-1644.

Prior, J.C. 1991. Landforms of Iowa. University of Iowa Press for the Iowa Department of Natural Resources, Iowa City, IA. 153 pps.

Pyne, S.J., P.L. Andrews, and R.D. Laven. 1996. *Introduction to Wildland Fire, Second Edition*. John Wiley and Sons, Inc. New York, New York. 808 pps.

Skinner, R.H. 2008. High biomass removal limits carbon sequestration potential of mature temperate pastures. *Journal for Environmental Quality* 37: 1319-1326.

Smith, R.D., A. Ammann, C. Bartoldus, and M.M. Brinson. 1995. *An Approach for Assessing Wetland Functions Using Hydrogeomorphic Classification, Reference Wetlands, and Functional Indices*. U.S. Army Corps of Engineers, Waterways Experiment Station, Wetlands Research Program Technical Report WRP-DE-9. 78 pps.

Smith, D.D. 1998. Iowa prairie: original extent and loss, preservation, and recovery attempts. *The Journal of the Iowa Academy of Sciences* 105: 94-108.

Teague, W.R., S.L. Dowhower, S.A. Baker, N. Haile, P.B. DeLaune, and D.M. Conover. 2011. Grazing management impacts on vegetation, soil biota and soil chemical, physical and hydrological properties in tall grass prairie. *Agriculture, Ecosystems and Environment* 141: 310-322.

Tomer, M.D., D.W. Meek, and L.A. Kramer. 2005. Agricultural practices influence flow regimes of headwater streams in western Iowa. *Journal of Environmental Quality* 34:1547-1558.

Undersander, D., B. Albert, D. Cosgrove, D. Johnson, and P. Peterson. 2002. *Pastures for Profit: A Guide to Rotational Grazing (A3529)*. University of Wisconsin-Extension and University of Minnesota Extension Service. 43 pps.

U.S. Army Corps of Engineers [USACE]. 2010. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Midwest Region (Version 2.0)*. U.S. Army Corps of Engineers, Wetlands Regulatory Assistance Program, U.S. Army Engineer Research and Development Center, Vicksburg, MS. 141 pps.

United States Department of Agriculture – Natural Resources Conservation Service (USDA-NRCS). 2003. *National Range and Pasture Handbook, Revision 1*. Grazing Lands Technology Institute. 214 pps.

United States Department of Agriculture – Natural Resource Conservation Service (USDA-NRCS). 2006. *Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin*. U.S. Department of Agriculture Handbook 296. 682 pps.

United States Department of Agriculture – Natural Resources Conservation Service (USDA-NRCS). 2007. *Iowa NRCS Plant Community Species Lists*. Des Moines, IA. Available at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/ia/technical/ecoscience/bio/?cid=nrcs142p2_008160. (Accessed 1 February 2018).

United States Department of Agriculture – Natural Resource Conservation Service (USDA-NRCS). 2008. *Hydrogeomorphic Wetland Classification: An Overview and Modification to Better Meet the Needs of the Natural Resources Conservation Service*. Technical Note No. 190-8-76. Washington, D.C. 8 pps.

U.S. Environmental Protection Agency [EPA]. 2013. *Level III and Level IV Ecoregions of the Continental United States*. Corvallis, OR, U.S. EPA, National Health and Environmental Effects Research Laboratory, map scale 1: 3,000,000. Available at <http://www.epa.gov/eco-research/level-iii-andiv-ecoregions-continental-united-states>. (Accessed 1 March 2017).

Vitousek, P.M. 1995. Biological invasions and ecosystem processes: towards an integration of population biology and ecosystem studies. *Oikos* 57: 7-13.

Waggy, M.A. 2010. *Phalaris arundinacea*. In: Fire Effects Information System [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. Available at <https://www.feis-crs.org/feis>. (Accessed 2 March 2018).

Zedler, J.B. 2005. Restoring wetland plant diversity: a comparison of existing and adaptive approaches. *Wetlands Ecology and Management* 13: 5-14.

Contributors

Lisa Kluesner
Dan Pulido

Approval

Chris Tecklenburg, 5/21/2020

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.

Table 6. List of primary contributors and reviewers.

Organization Name Title Location

Drake University:

Dr. Tom Rosburg, Professor of Ecology and Botany, Des Moines, IA

Iowa Department of Natural Resources:

John Pearson, Ecologist, Des Moines, IA

LANDFIRE (The Nature Conservancy):

Randy Swaty, Ecologist, Evanston, IL

Natural Resources Conservation Service:

Rick Bednarek, Iowa State Soil Scientist, Des Moines, IA

Patrick Chase, Area Resource Soil Scientist, Fort Dodge, IA

Stacey Clark, Regional Ecological Site Specialist, St. Paul, MN

James Cronin, State Biologist, Des Moines, IA

Tonie Endres, Senior Regional Soil Scientist, Indianapolis, IN

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

Louis Moran, PhD, Area Resource Soil Scientist, Sioux City, 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

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)	
Contact for lead author	
Date	04/30/2024
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:**
-