USDA Natural Resources
Conservation Service

Ecological site R107XB022IA
Wet Upland Depression Prairie

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Accessed: 05/21/2025

General information

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

Figure 1. Mapped extent

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

MLRA notes

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

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

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

Classification relationships

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

USFS Subregions: Central Dissected Till Plains Section (251C), Deep Loess Hills (251Ca), Loess Hills (251Cb) Subsection; Nebraska Rolling Hills Section (251H), Yankton Hills and Valleys (251Ha) (Cleland et al. 2007)

U.S. EPA Level IV Ecoregion: Steeply Rolling Loess Prairies (47e), Nebraska/Kansas Loess Hills (47h), Western Loess Hills (47m) (USEPA 2013)

Biophysical Setting (LANDFIRE 2009): Central Tallgrass prairie (4214210)

Ecological Systems (National Vegetation Classification System, Nature Serve 2015): Central Tallgrass Prairie (CES205.683)

Iowa Department of Natural Resources (INAI nd): Eastern Wet-Mesic Prairie

Lauver et al. (1999): Glaciated Tallgrass Prairie

Missouri Natural Heritage Program (Nelson 2010): Prairie Swale

Nebraska Game and Parks Commission (Steinauer and Rolfsmeier 2010): Lowland Tall-Grass Prairie

Plant Associations (National Vegetation Classification System, Nature Serve 2015): Andropogon gerardii – Panicum virgatum – *Helianthus grosseserratus* Wet Meadow (CEGL002024)

Ecological site concept

Wet Upland Depression Prairies are generally located within the green areas on the map (Figure 1). They occur on depressions with slopes generally less than two percent in uplands. Soils are Mollisols that are very poorly to poorly-drained and very deep, formed from fine-silty loess. The site experiences occasional to frequent, brief ponding as a result of fluctuations in the water table, precipitation, and overland flow. The native plant community is comprised of mesic herbaceous tallgrass vegetation.

The historic pre-European settlement vegetation on this site was dominated by tallgrass prairie species adapted to temporarily-flooded habitats. Prairie cordgrass (Spartina pectinata Bosc ex Link) is the dominant monocot species, while bluejacket (Tradescantia ohiensis Raf.) is a characteristic forb for the ecological site (Nelson 2010). Other dominant grasses include big bluestem (Andropogon gerardii Vitam), eastern gamagrass (Tripsacum dactyloides (L.) L.), Virginia wildrye (Elymus virginicus L.), and switchgrass (Panicum virgatum L.) (Nelson 2010; Steinauer and Rolfsmeier 2010). Forb species typical of an undisturbed plant community associated with this ecological site include prairie milkweed (Asclepias sullivantii Engelm. ex A. Gray), Michigan lily (Lilium michiganense Farw.), button eryngo (Eryngium yuccifolium Michx.), and Great Plains white fringed orchid (Platanthera praeclara Sheviak & Bowles) (Drobney et al. 2001; Ladd and Thomas 2015)). Fire and ponding were the primary disturbance factors that maintained this site, while native large mammal grazing and drought were secondary factors (LANDFIRE 2009; Nelson 2010; NatureServe 2015).

Associated sites

R107XB007MO	**Loess Upland Prairie** Loess soils on upland summits, shoulders, and backslopes, including Arisburg, Arispe, Arthur, Exira, Marshall, Minden, and Polo

Similar sites

R107XB024IA	**Wet Upland Drainageway Prairie** Wet Upland Drainageway Prairies are similar in landscape position but site is a SLOPE wetland on slopes less than five percent

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Spartina pectinata* (2) *Tradescantia ohiensis*

Physiographic features

Wet Upland Depression Prairies occur on in depressions on uplands and stream terraces on dissected till plains (Figure 2). This ecological site is situated on elevations ranging from approximately 800 to 1,560 feet ASL. This site is occasionally to frequently ponded to depths up to 30 inches. Ponding generally lasts two to less than seven days long.

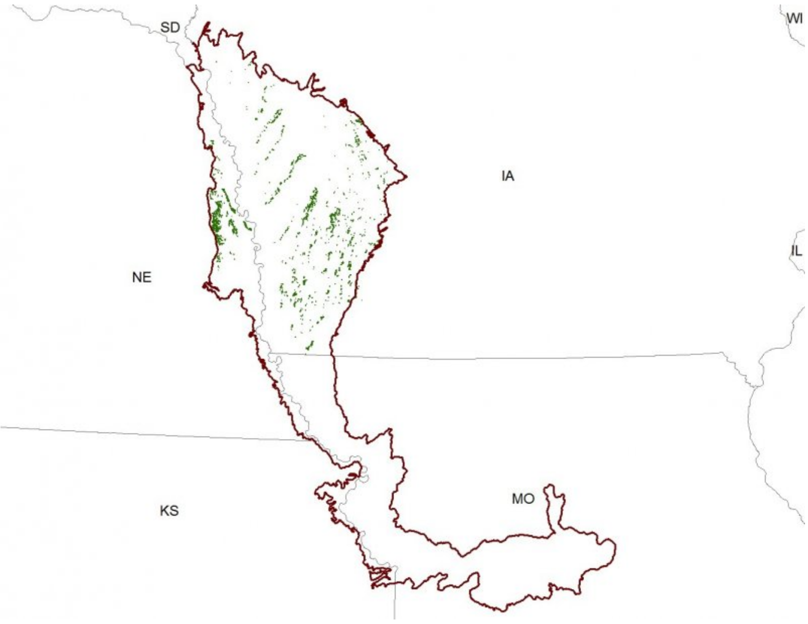


Figure 2. Figure 1. Location of Wet Upland Depression Prairie ecological site within MLRA 107B.

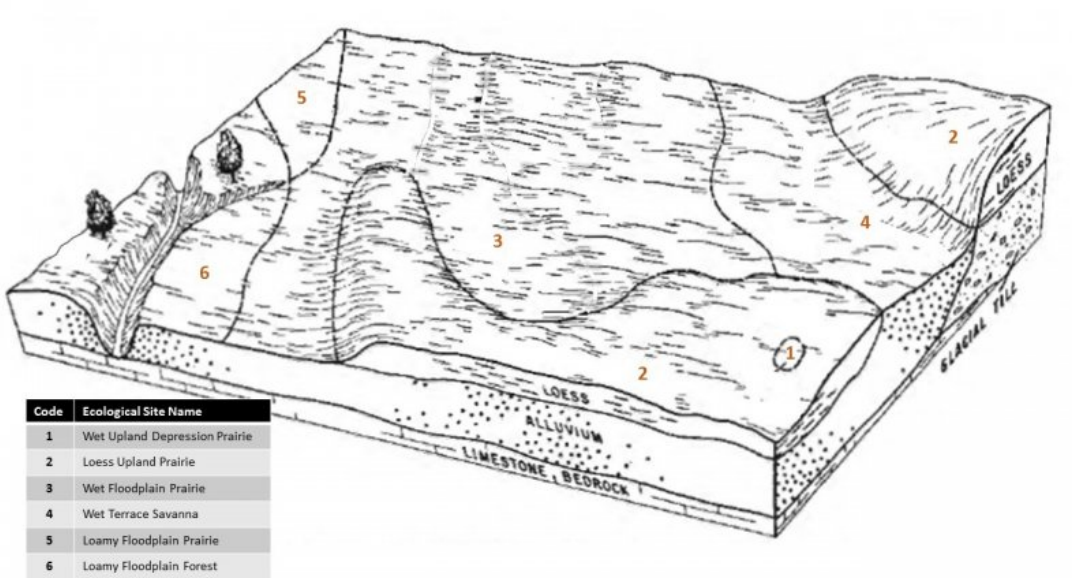


Figure 3. Figure 2. Representative block diagram of Wet Upland Depression Prairie and associated ecological sites.

Table 2. Representative physiographic features

Slope shape across	(1) Concave
Slope shape up-down	(1) Concave
Landforms	(1) Depression (2) Stream terrace
Flooding frequency	None
Ponding duration	Brief (2 to 7 days)
Ponding frequency	Occasional to frequent
Elevation	244–475 m

Slope	0–2%
Ponding depth	0–76 cm
Water table depth	0–30 cm
Aspect	Aspect is not a significant factor

Climatic features

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

The soil temperature regime of MLRA 107B is classified as mesic, where the mean annual soil temperature is between 46 and 59°F (USDA-NRCS 2006). Temperature and precipitation occur along a north-south gradient, where temperature and precipitation increase the further south one travels. The average freeze-free period of this ecological site is about 171 days, while the frost-free period is about 147 days (Table 2). The majority of the precipitation occurs as rainfall in the form of convective thunderstorms during the growing season. Average annual precipitation is 36 inches, which includes rainfall plus the water equivalent from snowfall (Table 3). The average annual low and high temperatures are 38 and 61°F, respectively.

Climate data and analyses are derived from 30-year average 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)	126-136 days
Freeze-free period (characteristic range)	151-165 days
Precipitation total (characteristic range)	864-940 mm
Frost-free period (actual range)	123-136 days
Freeze-free period (actual range)	146-166 days
Precipitation total (actual range)	813-940 mm
Frost-free period (average)	131 days
Freeze-free period (average)	159 days

Precipitation total (average)	889 mm

Climate stations used

- (1) HARLAN 1N [USC00133632], Harlan, IA
- (2) SHENANDOAH [USC00137613], Shenandoah, IA
- (3) ATLANTIC 1 NE [USC00130364], Atlantic, IA
- (4) MAPLETON NO.2 [USC00135123], Mapleton, IA
- (5) OAKLAND [USC00136151], Oakland, IA
- (6) RED OAK [USC00136940], Red Oak, IA

Influencing water features

Wet Upland Depression Prairies are classified as a DEPRESSIONAL wetland under the Hydrogeomorphic (HGM) classification system (Smith et al. 1995; USDA-NRCS 2008) and as a Palustrine Persistent Emergent Temporarily Flooded wetland under the National Wetlands Inventory (FGDC 2013). Water enters this ecological site via precipitation, seasonal groundwater level fluctuations, and surface flow from adjacent uplands, while water exits this site via evapotranspiration (Smith et al. 1995). Infiltration is slow to moderate (Hydrologic Groups B and C) for undrained soils, and surface runoff is negligible.

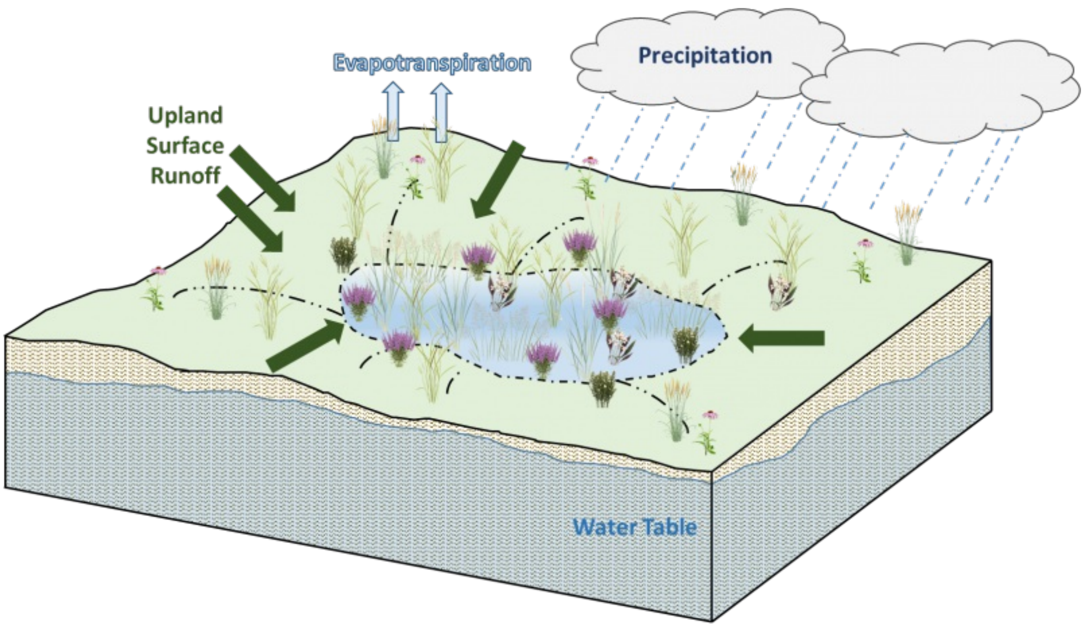


Figure 10. Figure 5. Hydrologic cycling in Wet Upland Depression Prairie ecological site.

Soil features

Soils of Wet Upland Depression Prairies are in the Mollisol order, further classified as Argiaquic Argialbolls. The soil series associated with this site includes Corley. The parent material is loess, and the soils are poorly-drained and very deep with no coarse fragments.

Soil pH classes are strongly acid to neutral. No rooting restrictions are noted for the soils of this ecological site.

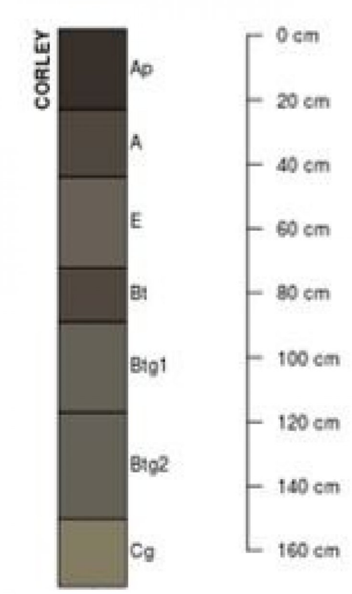


Figure 11. Figure 6. Profile sketch of soil series associated with Wet Upland Depression Prairie.

Table 4. Representative soil features

Parent material	(1) Loess
Family particle size	(1) Fine-silty
Drainage class	Poorly drained
Permeability class	Slow
Soil depth	203 cm
Available water capacity (0-101.6cm)	20.32–22.86 cm
Calcium carbonate equivalent (0-101.6cm)	0%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	5.1–7.3

Ecological dynamics

Prairie ecosystems are regarded as the most endangered ecosystem in North America where an estimated four percent of the tallgrass prairie habitat remains (Steinauer and

Collins 1996). The Loess Hills region of MLRA 107B were once dominated by tall- and midgrass prairies, extending across more than 90 percent of the area (Rosburg 1994; Farnsworth 2009). However, by the early twenty-first century much of the land had been converted to agriculture, leaving an estimated 20 percent of the region to be classified as “grassland” and another three percent classified as “remnant prairie” (Farnsworth 2009).

Wet Upland Depression Prairies form a vegetative continuum throughout the MLRA, where soil moisture serves as the primary influence on community composition (White 1983; White and Glenn-Lewin 1984). This ecological site occurs on upland depressions on poorly-drained loess soils. Species characteristic of this ecological site are herbaceous, tallgrass prairie species adapted to occasional to frequent, brief ponding.

Fire and ponding are the most important ecosystem drivers for maintaining this ecological site (Vogl 1974; Anderson 1990). Fire intensity typically consisted of periodic, low-intensity surface fires (Stambaugh et al. 2006; 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 and village clearing, and enhancing vital ethnobotanical plants (Day 1953; Barrett 1980). Fire frequency has been estimated to occur on average every 6.6 years in the Loess Hills region (Stambaugh et al. 2006). The amount and duration of ponding also affected species composition, cover, and production. These continuous disturbances provided critical conditions for perpetuating the native prairie ecosystem.

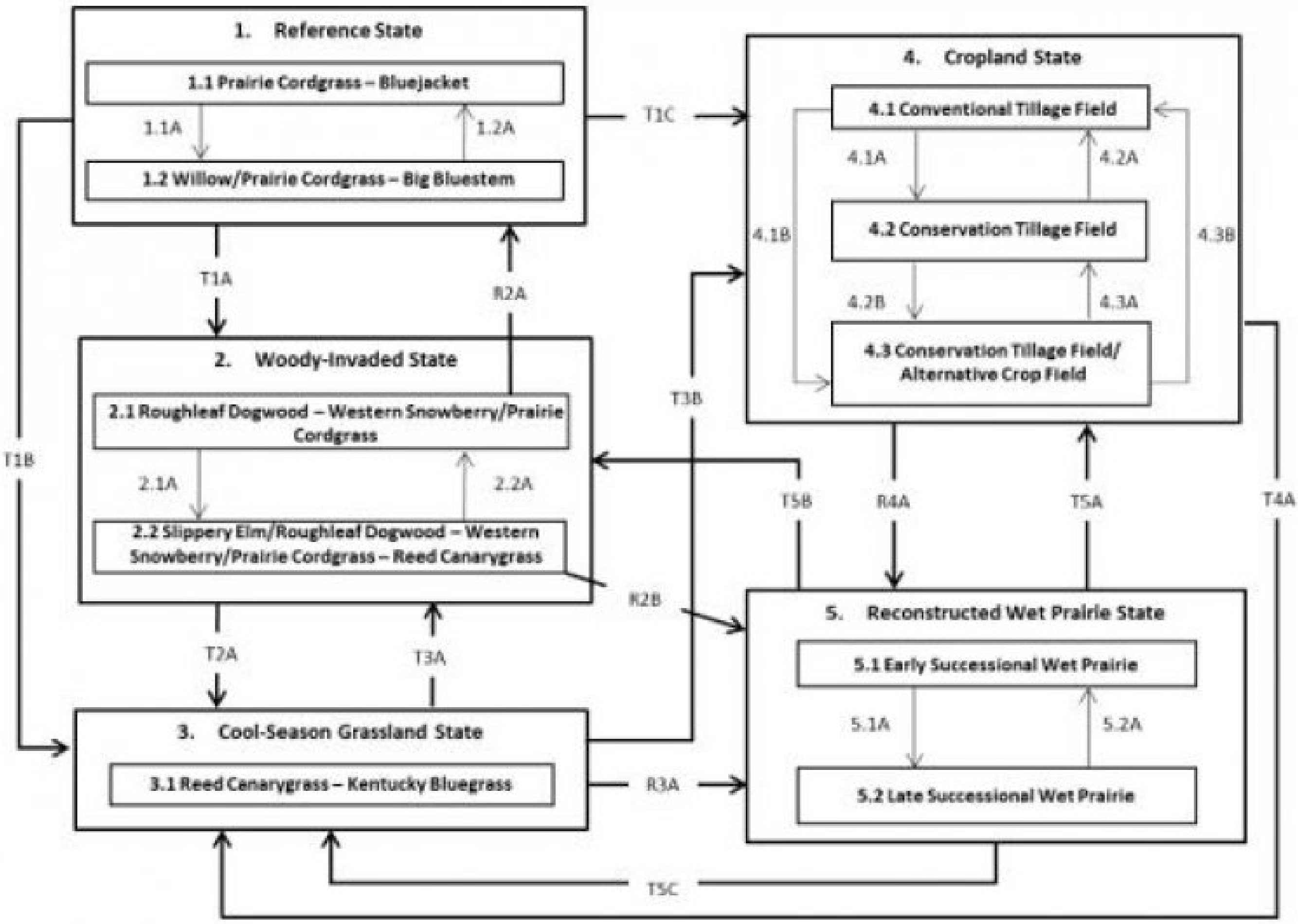
Grazing by native ungulates is often cited as an important disturbance regime of North American grasslands, with bison (Bison bison), prairie elk (Cervus elaphus), and white-tailed deer (Odocoileus virginianus) serving as the dominant herbivores of the area. However, plant community succession in the Loess Hills region does not necessarily follow this hypothesis. The steep and rugged topography of the Loess Hills has been considered an impediment to grazing by large ungulates such as bison. Any role bison played in the area was most likely relegated to the northwestern extent where the terrain is milder (Dinsmore 1994). However, deer and elk are believed to have played a relatively significant role in keeping woody vegetation at bay in the prairies of the Loess Hills (Farnsworth 2009; LANDFIRE 2009; Nelson 2010).

Drought has also played a role in shaping the prairie ecosystems in the Loess Hills. 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 (Stambaugh et al. 2006). In addition, drought can also slow the growth of plants and result in dieback of certain species. When coupled with fire, periods of drought can also greatly delay the recovery of woody vegetation, substantially altering the extent of shrubs and trees (Pyne et al. 1996).

Today, Wet Upland Depression Prairies have been virtually eliminated as the land has mostly been converted to cropland (NatureServe 2015). What remnants do exist show evidence of indirect anthropogenic influence as some non-native species (e.g.., Kentucky bluegrass (*Poa pratensis* L.), smooth brome (*Bromus inermis* L.), and Canada thistle (*Cirsium arvense* (L.) Scop.)) are present, if not dominant, in the current plant community (Steinauer and Rolfsmeier 2010). A return to the historic plant community is likely not possible, but long-term restoration efforts can help to restore some natural diversity and ecological functioning.

State and transition model

R107BY022IA WET UPLAND DEPRESSION PRAIRIE



Code	Process
T1A	Fire suppression
T1B, T4A, T5C	Overgrazing, brush control, and interseeding of non-native cool-season grasses
T1C, T3B, T5A	Agricultural conversion via drain tiles, tillage, seeding, and non-selective herbicide
1.1A	Fire-free period, 4-6 years
1.2A	Fire-free period, 1-4 years
R2A	Brush control, non-native species control and reintroduction of historic fire regime
2.1A	Fire-free period, >20 years
2.2A	Fire-free period, <20 years
T2A	Brush control and interseeding of non-native, cool-season grasses
R2B, R3A, R4A	Site preparation, invasive species control, and seeding native species
T3A, T5B	Abandoned land
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	Invasive species control and implementation of disturbance regimes
5.2A	Drought or improper timing/use of management actions

Figure 12. STM

State 1

Reference State

The reference plant community is categorized as a wet-mesic tallgrass prairie and includes grasses, sedges, forbs, and varying components of shrubs. The two community phases within the reference state are dependent on a fire frequency of approximately every one to six years as well as periodic ponding. Shorter fire intervals maintain dominance by grasses, while less frequent intervals allow woody vegetation to increase their importance in the plant canopy. Grazing and drought disturbances have less impact in the reference phases, but do contribute to overall species composition, diversity, cover, and productivity.

Dominant plant species

- prairie cordgrass (*Spartina pectinata*), grass
- big bluestem (*Andropogon gerardii*), grass

Community 1.1
Prairie Cordgrass – Bluejacket

This reference community phase is a diverse mix grasses, sedges, and forbs. Mature grasses can reach heights between four and six feet tall, and ground cover ranges from 71 to 100 percent (LANDFIRE 2009; Nelson 2010). Prairie cordgrass is the dominant species of this reference community phase, and bluejacket is a characteristic forb. Big bluestem, switchgrass, eastern gamagrass, and various sedges can also occur as characteristic components. Diagnostic forbs include common boneset (*Eupatorium perfoliatum* L.), Culver's root (*Veronicastrum virginicum* (L.) Farw.), sawtooth sunflower (*Helianthus grosseserratus* M. Martens), foxglove beardtongue (*Penstemon digitalis* Nutt. ex Sims), and obedient plant (*Physostegia virginiana* (L.) Benth.). A few shrubs may be infrequent to scattered throughout the community (Nelson 2010).

Dominant plant species

- prairie cordgrass (*Spartina pectinata*), grass
- bluejacket (*Tradescantia ohiensis*), grass

Community 1.2
Willow/Prairie Cordgrass – Big Bluestem

This reference community phase can occur when fire frequency is reduced to every four to six years (Stambaugh et al. 2006). The native prairie grasses continue to form the dominant herbaceous canopy cover, but the reduced fire interval allows woody species to increase shrub cover including willows (Salix L.), American plum (*Prunus americana* Marshall), and roughleaf dogwood (*Cornus drummondii* C.A. Mey) (Steinauer and Rolfsmeier 2010). Shrub canopy coverage is less than 30 percent (LANDFIRE 2009). Herbaceous species diversity may be slightly reduced as thatch increases during this phase, shading out some of the smaller-statured forb species.

Dominant plant species

- willow (*Salix*), shrub
- prairie cordgrass (*Spartina pectinata*), grass
- big bluestem (*Andropogon gerardii*), grass

Pathway P1.1A
Community 1.1 to 1.2

Natural succession as a result of an average fire return interval of four to six years.

Pathway P1.2A
Community 1.2 to 1.1

Natural succession as a result of an average fire return interval of four years or less.

State 2
Woody Invaded State

The woody-invaded state occurs as a result of long-term fire suppression efforts and exclusion of haying. Frequent, periodic fires historically kept shrubs and trees from invading the prairie, as well as maintained species diversity. However, as the prairies were settled fire suppression efforts were instituted. Similarly, wet prairies proved to be a challenge to early settlers and were often excluded from haying operations so as to avoid damage to equipment. The lack of disturbances resulted in rapid woody encroachment (LANDFIRE 2009; Nelson 2010).

Dominant plant species

- roughleaf dogwood (*Cornus drummondii*), shrub
- western snowberry (*Symphoricarpos occidentalis*), shrub
- prairie cordgrass (*Spartina pectinata*), grass
- reed canarygrass (*Phalaris arundinacea*), grass

Community 2.1
Roughleaf Dogwood – Western Snowberry/Prairie Cordgrass

This community phase represents the early stages of long-term fire suppression and lack of other disturbance regimes. Woody species, such as the fire-intolerant roughleaf dogwood and western snowberry (*Symphoricarpos occidentalis* Hook.), increase to more than 30 percent cover (Rosburg 1994; LANDFIRE 2009; Nelson 2010; Steinauer and Rolfsmeier 2010). Aspects of the reference plant community may continue to persist in the understory, but species diversity is greatly reduced.

Dominant plant species

- roughleaf dogwood (*Cornus drummondii*), shrub
- western snowberry (*Symphoricarpos occidentalis*), shrub
- prairie cordgrass (*Spartina pectinata*), grass

Community 2.2
Slippery Elm/Roughleaf Dogwood – Western Snowberry/Prairie Cordgrass – Reed Canarygrass

Sites falling into this community phase are strongly dominated by woody species as a result of over 20 years of fire suppression. The fire-intolerant slippery elm (*Ulmus rubra* Muhl.) becomes a dominant canopy species, while western snowberry co-dominates with roughleaf dogwood in the shrub canopy (Coladonato 1993; Rosburg 1994). The understory continues to simplify as the native community is reduced and replaced by such non-native invaders as reed canarygrass (*Phalaris arundinacea* L.). The continued absence of fire will allow this community to persist.

Dominant plant species

- slippery elm (*Ulmus rubra*), tree
- roughleaf dogwood (*Cornus drummondii*), shrub
- western snowberry (*Symphoricarpos occidentalis*), shrub
- prairie cordgrass (*Spartina pectinata*), grass
- reed canarygrass (*Phalaris arundinacea*), grass

Pathway P2.1A
Community 2.1 to 2.2

Fire is removed from the landscape in excess of 20 years.

Pathway P2.2A
Community 2.2 to 2.1

Fire is restored to the landscape within 20 years of initial encroachment.

State 3
Cool Season Grassland State

The cool-season grassland state occurs when the reference state has been anthropogenically-altered for livestock production. Fire suppression, seeding of non-native cool-season grasses, removal of woody vegetation, and grazing by domesticated livestock transition and maintain this simplified grassland state (Rosburg 1994). Early settlers seeded such non-native cool-season species as Kentucky bluegrass (*Poa pratensis* L.) in order to help extend the grazing season (Smith 1998). Over time, as lands were continually grazed by large herds of cattle, the non-native species were able to spread and expand across the prairie habitat, reducing the native species diversity.

Dominant plant species

- Kentucky bluegrass (*Poa pratensis*), grass
- reed canarygrass (*Phalaris arundinacea*), grass

Community 3.1
Reed Canarygrass – Kentucky Bluegrass

This community phase represents a simplified grassland state maintained by continuous grazing. Species characteristic of this community phase include plants that were readily seeded in pastures including reed canarygrass, Kentucky bluegrass, and smooth brome. Annuals and other ruderal plants (e.g., Canada thistle) are important components of this community phase and are indicative of the disturbed nature of the site (Nelson 2010; Steinauer and Rolfsmeier 2010).

Dominant plant species

- Kentucky bluegrass (*Poa pratensis*), grass
- reed canarygrass (*Phalaris arundinacea*), grass

State 4
Cropland State

Loess is the main contributing factor to the Midwest's highly-productive agricultural soils, and as a result, much of the MLRA has been converted to cropland including significant portions of this ecological site (USGS 1999). The installation of agricultural drain tiles 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 (*Zea mays* L.) and soybeans (*Glycine max* (L.) Merr.) are the dominant crops for the site. These areas are likely to remain in crop production for the foreseeable future.

Community 4.1
Conventional Tillage Field

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

Community 4.2

Conservation Tillage Field

This community phase is characterized by rotational crop production that utilizes various conservation tillage methods to promote soil health and reduce erosion. Conservation tillage methods include strip-till, ridge-till, 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 system, conservation tillage methods can reduce soil erosion, increase organic matter and water availability, improve water quality, and reduce soil compaction.

Community 4.3
Conservation Tillage Field/Alternative Crop Field

This condition applies conservation tillage methods as described above as well as adds cover crop practices. Cover crops typically include nitrogen-fixing species (e.g., legumes), small grains (e.g., rye, wheat, oats), or forage covers (e.g., turnips, radishes, rapeseed). The addition of cover crops not only adds plant diversity but also promotes soil health by reducing soil erosion, limiting nitrogen leaching, suppressing weeds, increasing soil organic matter, and improving the overall soil. In the case of small grain cover crops, surface cover and water infiltration are increased, while forage covers can be used to graze livestock or support local wildlife. Of the three community phases for this state, this phase promotes the greatest soil sustainability and improves ecological functioning within a cropland system.

Pathway P4.1A
Community 4.1 to 4.2

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

Pathway P4.1B
Community 4.1 to 4.3

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

Pathway P4.2A
Community 4.2 to 4.1

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

Pathway P4.2B
Community 4.2 to 4.3

Cover crops are implemented to prevent soil erosion.

Pathway P4.3B
Community 4.3 to 4.1

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

Pathway P4.3A
Community 4.3 to 4.2

Cover crop practices are abandoned.

State 5
Reconstructed Wet Prairie State

Prairie reconstructions have become an important tool for repairing natural ecological functioning and providing habitat protection for numerous grassland-dependent species. The historic plant community of wet prairies was extremely diverse and complex, and prairie replication is not considered to be possible once the native vegetation has been altered by post-European settlement land uses. Therefore ecological restoration should aim to aid the recovery of degraded, damaged, or destroyed ecosystems. A successful restoration 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). The reconstructed wet prairie state is the result of a long-term commitment involving a multi-step, adaptive management process. Diverse, species-rich seed mixes are important to utilize as they allow the site to undergo successional stages that exhibit changing composition and dominance over time (Smith et al. 2010). On-going post-planting management will help the site progress from an early successional community dominated by annuals and some weeds to a later seral stage composed of native perennial grasses, forbs, and shrubs (Steinauer et al. 2003). Establishing a prescribed fire regimen that mimics natural disturbance patterns can increase native species cover and diversity while reducing cover of non-native forbs and grasses. Controlled grazing that carefully regulates the location, intensity, and season of use can help promote species richness, reduce litter, and limit non-native cool-season grasses (Steinauer et al. 2003; Brudvig et al. 2007). Grazing accompanied with fire can control the encroachment of woody vegetation (Brudvig et al. 2007).

Community 5.1
Early Successional Reconstructed Wet Prairie

This community phase represents the early community assembly from prairie reconstruction and is highly dependent on the seed mix utilized and the timing and priority of planting operations. The seed mix should look to include a diverse mix of native cool-season and warm-season annual and perennial grasses and forbs typical of the reference state. Native, cool-season annuals can help to provide litter that promotes cool, moist soil conditions to the benefit of the other species in the seed mix. The first season following site preparation and seeding will typically result in annuals and other volunteer species forming the vegetative cover (Steinauer et al. 2003). Control of non-native species, particularly perennial species, is crucial at this point in order to ensure they do not establish before the native vegetation (Martin and Wilsey 2012). After the first season, native warm-season grasses should begin to become more prominent on the landscape and, over time, close the canopy.

Community 5.2
Late Successional Reconstructed Wet Prairie

Appropriately timed disturbance regimes (e.g., prescribed fire) applied to the early successional community phase can help increase the beta diversity, pushing the site into a late successional community phase over time. While prairie communities are dominated by grasses, these species can suppress forb establishment and reduce overall diversity and ecological functioning (Martin and Wilsey 2006; Williams et al. 2007). Reducing accumulated plant litter from taller-statured species allows more light and nutrients to become available for forb recruitment, allowing for greater ecosystem complexity (Wilsey 2008).

Pathway P5.1A
Community 5.1 to 5.2

Selective herbicides are used to control non-native species, and prescribed fire and/or light grazing help to increase the native species diversity and control woody vegetation.

Pathway P5.2A
Community 5.2 to 5.1

Reconstruction experiences a decrease in native species diversity from drought or improper timing of management actions (e.g., reduced fire frequency, use of non-selective herbicides).

Transition T1A

State 1 to 2

Fire suppression transitions this site to the woody-invaded state (2).

Transition T1B
State 1 to 3

Overgrazing, interseeding non-native cool-season grasses, and brush control transition this site to the cool-season grassland state (3).

Transition T1C
State 1 to 4

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

Restoration pathway R2A
State 2 to 1

Mechanical or chemical control of brush and non-native species and reintroduction of a historic fire regime restore the site back to the reference state (1).

Transition T2A
State 2 to 3

Brush control and interseeding of non-native, cool-season grasses transition this site to the cool-season grassland state (3).

Restoration pathway R2B
State 2 to 5

Site preparation, invasive species control, and seeding native species transition this site to the reconstructed wet prairie state (5).

Transition T3A
State 3 to 2

Land is abandoned and transitions this site to the woody-invaded state (2).

Transition T3B
State 3 to 4

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

Restoration pathway R3A
State 3 to 5

Site preparation, invasive species control, and seeding native species transition this site to the reconstructed wet prairie state (5).

Restoration pathway T4A
State 4 to 3

Non-selective herbicide and seeding of non-native cool-season grasses transitions the site to the cool-season grassland state (3).

Restoration pathway R4A
State 4 to 5

Site preparation, invasive species control (native and non-native), and seeding native species transition this site to the reconstructed wet prairie state (5).

Transition T5B
State 5 to 2

Fire suppression transitions this site to the woody-invaded state (2).

Restoration pathway T5C
State 5 to 3

Land is converted to the cool-season grassland state through the use of non-selective herbicide and seeding of non-native cool-seas.

Transition T5A
State 5 to 4

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

Additional community tables

Inventory data references

No field plots were available for this site. A review of the scientific literature and professional experience were used to approximate the plant communities for this provisional ecological site. Information for the state-and-transition model was obtained from the same sources. All community phases are considered provisional based on these plots and the sources identified in ecological site description.

Other references

Anderson, R.C. 1990. The historic role of fire in the North American grassland. In: S.L. Collins and L.L. Wallace, eds. Fire in North American Tallgrass Prairie. University of Oklahoma Press, Norman, OK.

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.

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

Brudvig, L.A., C.M. Mabry, J.R. Miller, and T.A. Walker. 2007. Evaluation of central North American prairie management based on species diversity, life form, and individual species metrics. Conservation Biology 21: 864-874.

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 Coterminous United States. USDA Forest Service, General Technical Report WO-76. Washington, DC. 92 pps.

Coladonato, M. 1993. *Ulmus rubra*. 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 6 June 2017.

Day, G. 1953. The Indian as an ecological factor in the northeastern forest. Ecology 34: 329-346.

Decker, W.L. 2017. Climate of Missouri. University of Missouri, Missouri Climate Center, College of Agriculture, Food and Natural Resources. Available at http://climate.missouri.edu/climate.php. (Accessed 24 February 2017).

Dinsmore, J.J. 1994. A Country So Full of Game: The Story of Wildlife in Iowa. University of Iowa Press, Iowa City, Iowa. 261 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.

Farnsworth, D.A. 2009. Establishing restoration baselines for the Loess Hills region. M.S. Thesis. Iowa State University, Ames, IA. 123 pps.

Federal Geographic Data Committee [FGDC]. 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, DC. 86 pps.

Iowa Natural Areas Inventory [INAI]. No date. Vegetation Classification of Iowa. Iowa Natural Areas Inventory, Iowa Department of Natural Resources, Des Moines, IA.

Ladd, D. and J.R. Thomas. 2015. Ecological checklist of the Missouri flora for Floristic Quality Assessment. Phytoneuron 12: 1-274.

LANDFIRE. 2009. Biophysical Setting 4214210 Central Tallgrass Prairie. In: LANDFIRE National Vegetation Dynamics Models. USDA Forest Service and US Department of Interior. Washington, DC.

Lauver, C.L., K. Kindscher, D. Faber-Langendoen, and R. Schneider. 1999. A classification of the natural vegetation of Kansas. The Southwestern Naturalist 44: 421-443.

Martin, L.M. and B.J. Wilsey. 2006. Assessing grassland restoration success: relative roles of seed additions and native ungulate activities. Journal of Applied Ecology 43: 1098-1110.

Martin, L.M. and B.J. Wilsey. 2012. Assembly history alters alpha and beta diversity, exotic-native proportions and functioning of restored prairie plant communities. Journal of Applied Ecology 49: 1436-1445.

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).

Nelson, P.W. 2010. The Terrestrial Natural Communities of Missouri. Missouri Natural Areas Committee, Missouri Department of Natural Resources. 550 pps.

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.

Rosburg, T. 1994. Community and Physiological Ecology of Native Grasslands in the Loess Hills of Western Iowa. PhD Dissertation. Iowa State University, Ames, IA. 228 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.

Smith, D.D., D. Williams, G. Houseal, and K. Henderson. 2010. The Tallgrass Prairie Center Guide to Prairie Restoration in the Upper Midwest. University of Iowa Press, Iowa City, IA. 338 pps.

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. Wetlands Research Program technical Report WRP-DE-9. U.S. Army Corps of Engineers, Waterways Experiment Station. 78 pps.

Society for Ecological Restoration [SER] Science & Policy Working Group. 2002. The SER Primer on Ecological Restoration. Available at: http://www.ser.org/. (Accessed 28 February 2017).

Stambaugh, M.C., R.P. Guyette, E.R. McMurry, and D.C. Dey. 2006. Fire history at the Eastern Great Plains Margin, Missouri River Loess Hills. Great Plains Research 16: 149-59.

Steinauer, E.M. and L. Collins. 1996. Prairie ecology: the tallgrass prairie. In: Samson, F.B. and F.L. Knopf, eds. Prairie Conservation: Preserving North America's Most Endangered Ecosystem. Island Press, Washington, D.C. 351 pps.

Steinauer, G. and S. Rolfsmeier. 2010. Terrestrial Natural Communities of Nebraska, Version IV. Unpublished report of the Nebraska Game and Parks Commission. Lincoln, NE. 224 pps.

Steinauer, G., B. Whitney, K. Adams, M. Bullerman, and C. Helzer. 2003. A Guide to Prairie and Wetland Restoration in Eastern Nebraska. Prairie Plains Resource Institute and Nebraska Game and Parks Commission. 80 pps.

Stockton, C.W. and D.M. Meko. 1983. Drought recurrence in the Great Plains as reconstructed from long-term tree-ring records. Journal of Climate and Applied Meteorology 22: 17-29.

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.

United States Department of Agriculture – Natural Resources 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). 2008. Hydrogeomorphic Wetland Classification System: An Overview and Modification to Better Meet the Needs of the Natural Resources Conservation Service. Technical Note No. 190-8-76. U.S. Department of Agriculture, Natural Resources Conservation Service. 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-and-iv-ecoregions-continental-united-states. (Accessed 1 March 2017).

U.S. Geological Survey. 1999. Geology of the Loess Hills, Iowa. Information Handout, July. U.S. Department of the Interior, U.S. Geological Survey. Available at https://pubs.usgs.gov/info/loess/. (Accessed 27 February 2017).

Vogl, R.J. 1974. Effects of fire on grasslands. In: T.T. Kozlowski and C.E. Ahlgren, eds. Fire and Ecosystems. Academic Press, New York, New York.

White, J.A. 1983. Regional and Local Variation in Composition and Structure of the Tallgrass Prairie Vegetation of Iowa and Eastern Nebraska. M.S. Thesis. Iowa State University, Ames, IA. 168 pps.

White, J.A. and S.C. Glenn-Lewin. 1984. Regional and local variation in tallgrass prairie remnants of Iowa and eastern Nebraska. Vegetatio 57: 65-78.

Williams, D.A., L.L. Jackson, and D.D Smith. 2007. Effects of frequent mowing on survival and persistence of forbs seeded into a species-poor grassland. Restoration Ecology 15: 24-33.

Wilsey, B.J. 2008. Productivity and subordinate species response to dominant grass species and seed source during restoration. Restoration Ecology 18: 628-637.

Approval

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Rangeland health reference sheet

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

Author(s)/participant(s)	Lisa Kluesner
Contact for lead author	
Date	05/21/2025
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:**