

Ecological site R104XY002IA Bedrock Prairie

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General information

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



Figure 1. Mapped extent

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

MLRA notes

Major Land Resource Area (MLRA): 104X–Eastern Iowa and Minnesota Till Prairies

The Eastern Iowa and Minnesota Till Prairies (MLRA 104) includes the Iowan Surface, Oak Savanna, and Western Coulee and Ridges landforms (Prior 1991; MDNR 2005; WDNR 2015). It spans three states (Iowa, 74 percent; Minnesota, 22 percent; Wisconsin, 4 percent), encompassing approximately 9,660 square miles (Figure 1). The elevation ranges from approximately 1,310 feet above sea level (ASL) on the highest ridges to about 985 feet ASL in the lowest valleys. Local relief is mainly 10 to 20 feet. Glacial till and outwash deposits cover the uplands of the MLRA with recent alluvium located in the major river valleys. Paleozoic bedrock sediments, comprised primarily of shale and limestone, lies beneath the glacial material. The depth to limestone is shallow, resulting in karst topography across much of the area (USDA-NRCS 2006).

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

et al. 1992).

Classification relationships

USFS Subregions: North Central U.S. Driftless and Escarpment (222L), Minnesota and Northeast Iowa Morainal-Oak Savannah (222M), Central Dissected Till Plains (251C) Sections; Menominee Eroded Pre-Wisconsin Till (222La), Mississippi-Wisconsin River Ravines (222Lc), Western Paleozoic Plateau (222Lf), Oak Savannah Till and Loess Plains (222Me), Southeast Iowa Rolling Loess Hills (251Ch) Subsections (Cleland et al. 2007)

U.S. EPA Level IV Ecoregion: Eastern Iowa and Minnesota Drift Plains (47c), Lower St. Croix and Vermillion Valleys (47g), Rochester/Paleozoic Plateau Upland (52c) (USEPA 2013)

National Vegetation Classification – Ecological Systems: Central Tallgrass Prairie (CES205.683) (NatureServe 2018)

National Vegetation Classification - Plant Associations: Schizachyrium scoparium – Sorghastrum nutans – Bouteloua curtipendula Dry-Mesic Grassland (CEGL002214) (Nature Serve 2018)

Biophysical Settings: Central Tallgrass Prairie (BpS 4214210) (LANDFIRE 2009)

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

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

Minnesota Department of Natural Resources: Ups13 Southern Dry Prairie (MDNR 2005)

Ecological site concept

Bedrock Prairies are located within the green areas on the map (Figure 1). They occur on uplands. The soils are Mollisols that are somewhat poorly to somewhat excessively-drained, formed from silty or loamy sediments that are shallow to bedrock.

The historic pre-European settlement vegetation on this ecological site was dominated by midgrass herbaceous vegetation. Little bluestem (*Schizachyrium scoparium* (Michx.) Nash) and prairie dropseed (*Sporobolus heterolepis* (A. Gray) A. Gray) are dominant species on the site. Other grasses present can include sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.), porcupinegrass (*Hesperostipa spartea* (Trin.) Barkworth), and composite dropseed (*Sporobolus compositus* (Poir.) Merr. var. *compositus*). Forbs typical of an undisturbed plant community associated with this ecological site can include candle anemone (*Anemone cylindrica* A. Gray), purple prairie clover (*Dalea purpurea* Vent.), Ontario blazing star (*Liatris cylindracea* Michx.), and prairie violet (*Viola pedatifida* G. Don) (Drobney et al. 2001). Shrubs, when present, are generally low-growing and sparse with species such as leadplant (*Amorpha canescens* Pursh). Fire is the primary disturbance factor that maintains this site, while herbivory and drought are secondary factors (LANDFIRE 2009).

Associated sites

R104XY003IA	Wet Bedrock Prairie Loamy sediments over bedrock that are shallow to a water table including Calamine, Faxon, and Rocksan
R104XY012IA	Wet Upland Drainageway Sedge Meadow Deep, loamy sediments that are shallow to a water table including Ackmore, Arenzville, Clyde, Coland, Colo, Ely, Harpster, Marshan, Nerwoods, Orion, Sawmill, and Terril
R104XY005IA	Loamy Upland Prairie Deep, loamy sediment parent material including Aredale, Ashdale, Atkinson, Bolan, Carmi, Cerlin, Cresco, Cresken, Dinsdale, Dinsmore, Floyd, Fort Dodge, Kenyon, Klinger, Klingmore, Marquis, Merton, Moland, Norville, Ostrander, Plano, Port Byron, Protivin, Readlyn, Tallula, Tama, Warsaw, and Winnebago

Similar sites

R104XY005IA	Loamy Upland Prairie Loamy Upland Prairies are in a similar landscape position but are not shallow to bedrock
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Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) <i>Schizachyrium scoparium</i> (2) <i>Sporobolus heterolepis</i>

Physiographic features

Bedrock Prairies occur on uplands (Figure 2). They are situated on elevations ranging from approximately 525 to 2001 feet ASL. The site does not experience flooding, but rather generates runoff to downslope, adjacent ecological sites (Table 1).

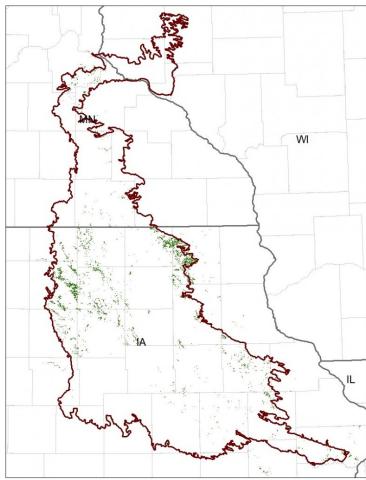


Figure 2. Figure 1. Location of Bedrock Prairie ecological site within MLRA 104.

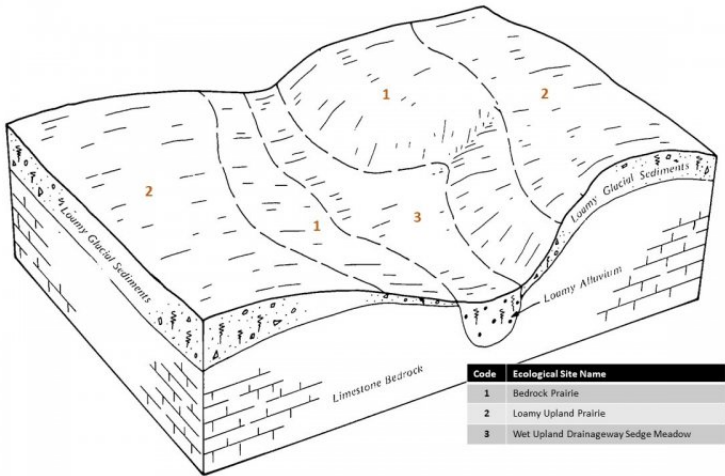


Figure 3. Figure 2. Representative block diagram of Bedrock Prairie and associated ecological sites.

Table 2. Representative physiographic features

Slope shape across	(1) Convex
Slope shape up-down	(1) Convex
Landforms	(1) Upland
Runoff class	Low to high
Elevation	160–610 m

Slope	0–18%
Water table depth	30–203 cm
Aspect	Aspect is not a significant factor

Climatic features

The Eastern Iowa and Minnesota Till Prairies falls into the hot-summer humid continental climate (Dfa) and warm-summer humid continental climate (Dfb) Köppen-Geiger climate classifications (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 104 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 148 days, while the frost-free period is about 127 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 35 inches, which includes rainfall plus the water equivalent from snowfall (Table 3). The average annual low and high temperatures are 35 and 55°F, respectively.

Climate data and analyses are derived from 30-year averages gathered from four 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)	145-151 days
Precipitation total (characteristic range)	864-889 mm
Frost-free period (actual range)	124-129 days
Freeze-free period (actual range)	142-152 days
Precipitation total (actual range)	864-914 mm
Frost-free period (average)	127 days
Freeze-free period (average)	148 days
Precipitation total (average)	889 mm

Climate stations used

- (1) CHARLES CITY [USC00131402], Charles City, IA
- (2) AUSTIN WWT FAC [USC00210355], Austin, MN
- (3) NORTHWOOD [USC00136103], Northwood, IA
- (4) CRESCO 1 NE [USC00131954], Cresco, IA

Influencing water features

Bedrock Prairies are not influenced by wetland or riparian water features. Precipitation is the main source of water for this ecological site. Infiltration is moderate to very slow (Hydrologic Groups B, C, and D), and surface runoff is low to high. Surface runoff contributes some water to downslope ecological sites (Figure 5).

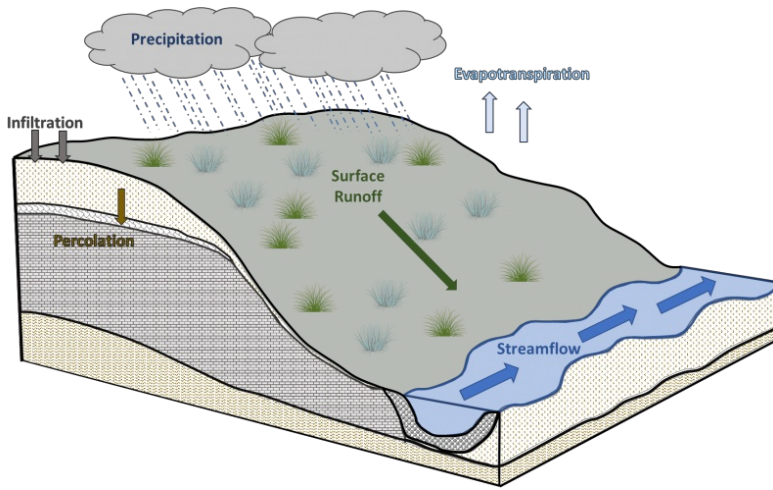


Figure 10. Figure 5. Hydrologic cycling in Bedrock Prairie ecological site.

Soil features

Soils of Bedrock Prairies are in the Mollisols order, further classified as Lithic Argiudolls, Lithic Hapludolls, Oxyaquic Argiudolls, Typic Argiudolls, Aquic Hapludolls, Entic Hapludolls, and Typic Hapludolls with very slow to moderate infiltration and low to high runoff potential. The soil series associated with this site includes Aureola, Bertram, Channahon, Copaston, Dodgeville, Emeline, Etter, Jacwin, Jacwin variant, Kensett, Limecreek, Marlean, Mottland, Ripon, Rossfield, Rossfield variant, Wagen Prairie, and Wangs. The parent material is silty or loamy sediments over bedrock, and the soils are somewhat poorly to somewhat excessively-drained and shallow to bedrock. Soil pH classes are strongly acid to moderately alkaline (Table 5).

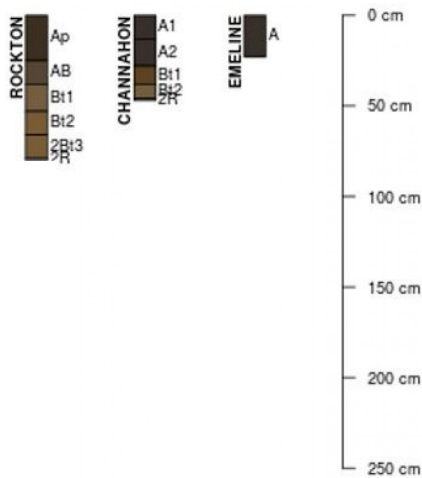


Figure 11. Figure 6. Profile sketches of soil series associated with Bedrock Prairie.

Table 4. Representative soil features

Family particle size	(1) Fine-loamy (2) Coarse-loamy
Drainage class	Somewhat poorly drained to somewhat excessively drained
Permeability class	Moderately slow
Depth to restrictive layer	23–102 cm
Soil depth	23–102 cm
Surface fragment cover <=3"	0–2%
Surface fragment cover >3"	0–1%

Ecological dynamics

The information in this Ecological Site Description, including the state-and-transition model (STM), was developed based on historical data, current field data, professional experience, and a review of the scientific literature. As a result, all possible scenarios or plant species may not be included. Key indicator plant species, disturbances, and ecological processes are described to inform land management decisions.

The MLRA lies within the transition zone between the eastern deciduous forests and the tallgrass prairies. The heterogeneous topography of the area results in variable microclimates and fuel matrices that in turn support prairies, savannas, woodlands, and forests. Bedrock Prairies form an aspect of this vegetative continuum. This ecological site occurs on uplands on somewhat poorly to somewhat excessively-drained soils. Species characteristic of this ecological site consist of dry-mesic, midgrass herbaceous vegetation.

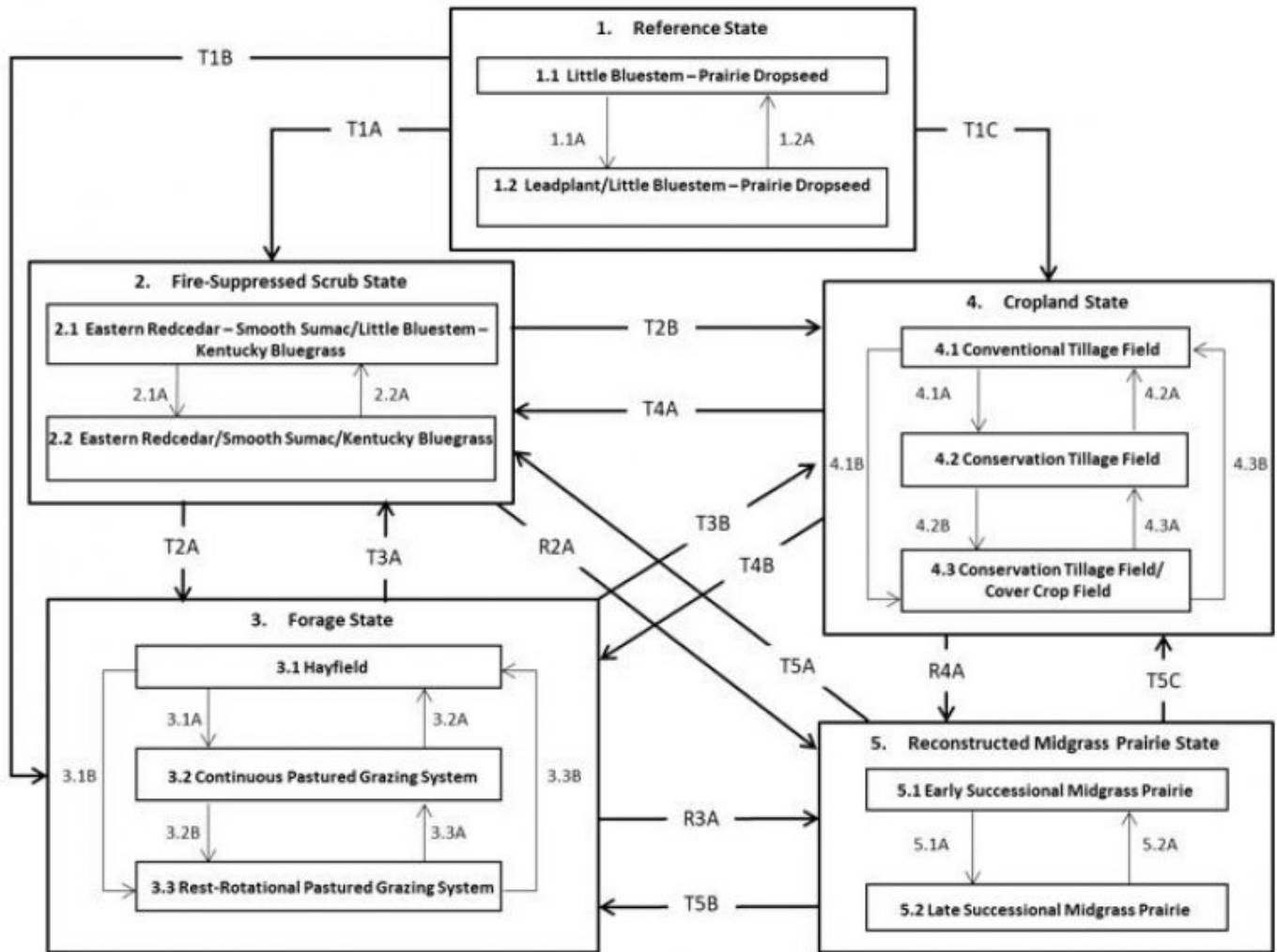
Fire is a critical disturbance factor that maintains Bedrock Prairies. Fire intensity typically consisted of periodic, low-intensity surface fires occurring every 1 to 3 years (LANDFIRE 2009). Ignition sources included summertime lightning strikes from convective storms and bimodal, human ignitions during 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).

Drought and herbivory by native ungulates have also played a role in shaping this ecological site. The periodic episodes of reduced soil moisture in conjunction with the somewhat poorly to somewhat excessively-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. Bison (*Bos bison*) grazing, while present, served a more limited role in community composition and structure than lands further west. Prairie elk (*Cervus elaphus*) and white-tailed deer (*Odocoileus virginianus*) likely contributed to woody species reduction but are also considered to be of a lesser impact compared to the west (LANDFIRE 2009). When coupled with fire, periods of drought and herbivory can further delay the establishment of woody vegetation (Pyne et al. 1996).

Today, Bedrock Prairies are limited in their extent, having been type-converted to agricultural production land. Remnants that do exist show evidence of indirect anthropogenic influences from fire suppression and non-native species invasion. A return to the historic plant community may not be possible following extensive land modification, 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

R104XY002IA BEDROCK PRAIRIE



Code	Process
1.1A	Reduced fire return interval
1.2A	Increased fire return interval
T1A, T3A, T4A, T5A	Long-term fire suppression and/or land abandonment
2.1A	Continued fire suppression in excess of 20 years
2.2A	Single large disturbance event
T1B, T2A, T4B, T5B	Cultural treatments are implemented to increase forage quality and yield
3.1A	Mechanical harvesting is replaced with domestic livestock and continuous grazing
3.1B	Mechanical harvesting is replaced with domestic livestock and rest-rotational grazing
3.2A, 3.3B	Domestic livestock grazing is replaced by mechanical harvesting
3.2B	Implementation of rest-rotational grazing
3.3A	Implementation of continuous grazing
T1C, T2B, T3B, T5C	Agricultural conversion via tillage, seeding, and non-selective herbicide
4.1A	Less tillage, residue management
4.1B	Less tillage, residue management, and implementation of cover cropping
4.2B	Implementation of cover cropping
4.2A, 4.3B	Intensive tillage, remove residue, and reinitiate monoculture row cropping
4.3A	Remove cover cropping
R2A, R3A, R4A	Site preparation, non-native species control, and native seeding
5.1A	Invasive species control and implementation of disturbance regimes
5.2A	Drought or improper timing/use of management actions

State 1
Reference State

The reference plant community is categorized as a dry-mesic midgrass community, dominated by herbaceous vegetation. The two community phases within the reference state are dependent on fire. The intensity and frequency alter species composition, cover, and extent, while regular fire intervals keep woody species from dominating. Drought and herbivory have more localized impacts in the reference phases, but do contribute to overall species composition, diversity, cover, and productivity.

Community 1.1

Little Bluestem – Prairie Dropseed

Sites in this reference community phase are dominated by a mix of grasses and forbs. Vegetative cover is continuous (95 to 100 percent), and plants can reach heights between 3 and 6 feet tall (LANDFIRE 2009); NatureServe 2018). Little bluestem, prairie dropseed, sideoats grama, porcupinegrass, and composite dropseed are common grasses present on the site. Characteristic forbs can include skyblue aster (*Symphotrichum oolentangiense* (Riddell) G.L. Nesom var. *oolentangiense*), bastard toadflax (*Comandra umbellata* (L.) Nutt.), and tall blazing star (*Liatris aspera* Michx.). Low intensity fire will maintain this community, but a reduced fire return interval will shift the site to community phase 1.2 (LANDFIRE 2009).

Community 1.2

Leadplant/Little Bluestem – Prairie Dropseed

This reference community phase represents a successional shift due to an increased fire return interval. As fires sweep across the landscape less frequently, subshrubs can develop including leadplant (NatureServe 2018). Perennial, warm-season grasses are still the dominant herbaceous component. Forb diversity may decrease as thatch builds up and reduced available light. An increased fire return interval will allow the community the shift back to community phase 1.1 (LANDFIRE 2009).

Pathway 1.1A

Community 1.1 to 1.2

Reduced fire return interval.

Pathway 1.2A

Community 1.2 to 1.1

Increased fire return interval.

State 2

Fire-suppressed Scrub State

Long-term fire suppression can transition the reference tallgrass prairie community into a woody-invaded shrub-prairie state. This state is evidenced by a well-developed shrub layer with an overstory of eastern redcedar (*Juniperus virginiana* L.) (LANDFIRE 2009). Proximity to lands that have been altered provide opportunities for non-native invasive species to readily colonize this state, thereby reducing the native biodiversity and changing the vegetative community and structure.

Community 2.1

Eastern Redcedar – Smooth Sumac/Little Bluestem – Kentucky Bluegrass

This community phase represents the early stages of fire-suppression. In as little as six fire-free years, the prairie is disrupted and succeeded by woody shrubs. Native species – e.g. eastern redcedar, smooth sumac (*Rhus glabra* L.), and black raspberry (*Rubus occidentalis* L.) – can form dense thickets with cover reaching up to 30 percent and plant heights as tall as 9 feet (LANDFIRE 2009). Some native prairie plants will persist, but non-native herbaceous species tolerant of moderate shading encroach on the site including Kentucky bluegrass (*Poa pratensis* L.) and smooth brome (*Bromus inermis* Leyss.).

Community 2.2

Eastern Redcedar/Smooth Sumac/Kentucky Bluegrass

Sites falling into this community phase have a well-established shrub layer, and eastern redcedars mature into small trees in the continued absence of fire. The shrub canopy can be diverse, including both native and non-native species. Smooth sumac and black raspberry are common natives, and common buckthorn (*Rhamnus cathartica* L.) and honeysuckle (*Lonicera* L.) are frequently invading non-native shrubs.

Pathway 2.1A Community 2.1 to 2.2

Continued fire suppression in excess of 20 years.

Pathway 2.2A Community 2.2 to 2.1

Single large disturbance event such as selective removal of woody species.

State 3 Forage State

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

Community 3.1 Hayfield

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

Community 3.2 Continuous Pastured Grazing

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 Periodic-rest Pastured Grazing

This community phase is characterized by periodic-rest grazing where the pasture has been subdivided into several smaller paddocks. Subdividing the pasture in this way allows livestock to 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). Periodic-rest pastured grazing include deferred periods, rest periods, and periods of 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 utilizing continuous grazing.

Pathway 3.1B **Community 3.1 to 3.3**

Mechanical harvesting is replaced with domestic livestock utilizing periodic-rest grazing.

Pathway 3.2A **Community 3.2 to 3.1**

Domestic livestock are removed, and mechanical harvesting is implemented.

Pathway 3.2B **Community 3.2 to 3.3**

Periodic-rest grazing replaces continuous grazing.

Pathway 3.3B **Community 3.3 to 3.1**

Domestic livestock are removed, and mechanical harvesting is implemented.

Pathway 3.3A **Community 3.3 to 3.2**

Continuous grazing replaces periodic-rest grazing.

State 4 **Cropland State**

The continuous use of tillage, row-crop planting, and chemicals (i.e., herbicides, fertilizers, etc.) has 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**

Sites in this community phase typically consist of monoculture row-cropping maintained by conventional tillage practices. They are cropped in either continuous corn or alternating periods of corn and soybean crops. 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**

This community phase is characterized by periodically alternating crops and utilizing 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 operations. 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 operations 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 operations, 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 Field/Alternative 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 row crop operation.

Pathway 4.1A

Community 4.1 to 4.2

Tillage operations are greatly reduced, alternating crops occurs on a regular interval, and crop residue remains on the soil surface.

Pathway 4.1B

Community 4.1 to 4.3

Tillage operations are greatly reduced or eliminated, alternating crops occurs on a regular interval, crop residue remains on the soil surface, and cover crops are planted following crop harvest.

Pathway 4.2A

Community 4.2 to 4.1

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

Pathway 4.2B

Community 4.2 to 4.3

Cover crops are implemented to minimize soil erosion.

Pathway 4.3B

Community 4.3 to 4.1

Intensive tillage is utilized, cover crops practices are abandoned, monoculture row-cropping is established on a more-or-less continuous basis.

Pathway 4.3A

Community 4.3 to 4.2

Cover crop practices are abandoned.

State 5

Reconstructed Midgrass Prairie State

Prairie reconstructions have become an important tool for repairing natural ecological functions and providing habitat protection for numerous grassland dependent species. Because the historic plant and soil biota communities of the prairie were highly diverse with complex interrelationships, historic prairie replication cannot be guaranteed on landscapes that have been so extensively manipulated for extended timeframes (Kardol and Wardle 2010; Fierer et al. 2013). 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 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 management via prescribed fire and/or light grazing can 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 a few shrubs. 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. Light grazing alone can help promote species richness, while grazing accompanied with fire can control the encroachment of woody vegetation (Brudvig et al. 2007).

Community 5.1

Early Successional Midgrass 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 cool-season and warm-season annual and perennial grasses and forbs typical of the reference state (e.g., little bluestem, prairie dropseed, tall blazingstar). Cool-season annuals can help 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 a majority of the vegetative cover. Control of non-native species, particularly perennial species, is crucial at this point 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.

Community 5.2

Late Successional Midgrass 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 function (Martin and Wilsey 2006; Williams et al. 2007). Reducing accumulated plant litter from perennial bunchgrasses allows more light and nutrients to become available for forb recruitment, allowing greater ecosystem complexity (Wilsey 2008).

Pathway 5.1A

Community 5.1 to 5.2

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

Pathway 5.2A

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

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

Transition T1B

State 1 to 3

Cultural treatments to enhance forage quality and yield transitions the site to the forage state (3).

Transition T1C

State 1 to 4

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

Transition T2A

State 2 to 3

Cultural treatments to enhance forage quality and yield transitions the site to the forage state (3).

Transition T2B

State 2 to 4

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

Restoration pathway R2A

State 2 to 5

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

Transition T3A

State 3 to 2

Land abandonment transitions the site to the fire-suppressed scrub state (2).

Transition T3B

State 3 to 4

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, tree planting, invasive species control, and seeding native species transition this site to the reconstructed midgrass prairie state (5).

Transition T4A

State 4 to 2

Land abandonment transitions the site to the fire-suppressed scrub state (2).

Transition T4B

State 4 to 3

Cultural treatments to enhance forage quality and yield transitions the site to the forage state (3).

Restoration pathway R4A

State 4 to 5

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

Transition T5A

State 5 to 2

Land abandonment transitions the site to the fire-suppressed scrub state (2).

Transition T5B

State 5 to 3

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

Transition T5C

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

Tier 3 Sampling Plots used to develop the reference state, community phase 1.1:

State County Ownership Easting Northing

Iowa Jones Breen Prairie – Iowa Natural Heritage Foundation 649275 4682711

Iowa Jones Breen Prairie – Iowa Natural Heritage Foundation 649092 4682860

Iowa Floyd Fossil & Prairie Park Preserve – Floyd County Conservation Board 501175 4766698

Iowa Clinton Manikowski Prairie – Clinton County Conservation Board 717502 4650185

Other references

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.

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.

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.

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.

Fierer, N., J. Ladau, J.C. Clemente, J.W. Leff, S.M. Owens, K.S. Pollard, R. Knight, J.A. Gilbert, and R.L. McCulley. 2013. Reconstructing the microbial diversity and function of pre-agricultural tallgrass prairie soils in the United States. *Science* 342: 621-624.

- 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.
- Kardol, P. and D.A. Wardle. 2010. How understanding aboveground-belowground linkages can assist restoration ecology. *Trends in Ecology and Evolution* 25: 670-679.
- LANDFIRE. 2009. Biophysical Setting 4214210 Central 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.
- 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.
- Minnesota Department of Natural Resources [MDNR]. 2005. Field Guide to the Native Plant Communities of Minnesota: The Eastern Broadleaf Forest Province. Ecological Land Classification Program, Minnesota County Biological Survey, Natural Heritage and Nongame Research Program, Minnesota Department of Natural Resources, St. Paul, MN.
- National Climate Data Center [NCDC]. 2006. Climate of Iowa. Central Region Headquarters, Climate Services Branch, National Climatic Data Center, Asheville, NC.
- NatureServe. 2018. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1 NatureServe, Arlington, VA. Available at <http://explorer.natureserve.org>. (Accessed 19 November 2018).
- 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, 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.
- 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).
- 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.

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 19 January 2018).

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).

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.

Wisconsin Department of Natural Resources (WDNR). 2015. *The Ecological Landscapes of Wisconsin: An Assessment of Ecological Resources and a Guide to Planning Sustainable Management*. Wisconsin Department of Natural Resources, PUB-SS-1131 2015, Madison, WI.

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Approval

Chris Tecklenburg, 5/18/2020

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Rangeland health reference sheet

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

Author(s)/participant(s)	
Contact for lead author	
Date	05/08/2024
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:**
-