USDA Natural Resources Conservation Service

Ecological site R108XB001IL
Limestone 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.

MLRA notes

Major Land Resource Area (MLRA): 108X–Illinois and Iowa Deep Loess and Drift

The Illinois and Iowa Deep Loess and Drift, East-Central Part (MLRA 108B) includes the Rock River Hill Country, Grand Prairie, and Western Forest-Prairie physiographic divisions (Schewman et al. 1973). It falls entirely in one state (Illinois), encompassing approximately 7,450 square miles (Figure 1). The elevation ranges from approximately 985 feet above sea level (ASL) in the northern and western parts to 660 feet ASL in south and west. Local relief is mainly 3 to 10 feet on the broad, upland flats and about 160 feet along the major streams and dissected drainageways. Wisconsin-aged loess forms a moderately thin to thick layer across the entire area with Illinoisan glacial drift below. Bedrock lies beneath the glacial material with Pennsylvania shales, siltstones, and limestones in the south and west and Ordovician and Silurian limestone in the extreme north. This bedrock can be exposed on bluffs along the major rivers (USDA-NRCS 2006).

The vegetation in the MLRA has undergone drastic changes over time. At the end of the last glacial episode – the Wisconsinan glaciation – the evolution of vegetation began with the development of tundra habitats, followed by a phase of spruce and fir forests, and eventually spruce-pine forests. Not until approximately 9,000 years ago did the climate undergo a warming trend which prompted the development of deciduous forests dominated by oak and hickory. As the climate continued to warm and dry, prairies began to develop approximately 8,300 years ago. Another shift in climate that resulted in an increase in moisture prompted the emergence of savanna-like habitats from 8,000 to 5,000 years before present. Moisture continued to increase in the southernmost region 5,000 years ago, resulting in an increase of forested systems (Taft et al. 2009). Fire, droughts, and grazing by native mammals helped to maintain the prairies and savannas until the arrival of European settlers, and the forests were maintained by droughts, wind, lightning, and occasional fire (Taft et al. 2009; NatureServe 2018).

Classification relationships

USFS Subregions: Southwestern Great Lakes Morainal (222K), Central Till Plains-Oak Hickory Section (223G), Central Dissected Till Plains (251C), and Central Till Plains and Grand Prairies (251D) Sections; Rock River Old Drift Country (222Kh), Effingham Plain (222Ga), Mississippi River and Illinois Alluvial Plains (251 Cf), East Mississippi River Hills (251Ci), Galesburg Dissected Till Plain (251Cj), Carlinville Dissected Till Plain (251Ck), Green River Lowland (251Da), Western Grand Prairie (251Db), Northern Grand Prairie (251Dc), Southern Grand Prairie (251De), and Springfield Plains (251Df) Subsections (Cleland et al. 2007)

U.S. EPA Level IV Ecoregion: Illinois/Indiana Prairies (54a), Sand Area (54d), Rock River Hills (54g), and Western Dissected Illinoian Till Plain (72i) (USEPA 2013)

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

National Vegetation Classification - Plant Associations: Schizachyrium scoparium – Sorghastrum nutans – *Clinopodium arkansanum* Limestone Grassland (CEGL005179) (Nature Serve 2018)

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

Illinois Natural Areas Inventory: Dry-mesic dolomite prairie (White and Madany 1978)

Ecological site concept

Limestone Prairies are located within the green areas on the map (Figure 1). They occur on uplands. The soils are Mollisols that are well-drained, formed from moderately deep loess or loamy sediments over dolomite.

The historic pre-European settlement vegetation on this ecological site was dominated by mid- and tallgrass prairie vegetation. Little bluestem (Schizachyrium scoparium (Michx.) Nash) and Indiangrass (Sorghastrum nutans (L.) Nash) are the dominant species on the site. Other grasses and grass-likes present can include porcupinegrass (Hesperostipa spartea (Trin.) Barkworth), big bluestem (Andropogon gerardii Vitman), and Mead's sedge (Carex meadii Dewey) (White and Madany 1978; NatureServe 2018). Forbs typical of an undisturbed plant community associated with this ecological site can include leafy prairie clover (Dalea foliosa (A. Gray) Barneby), Atlantic camas (Camassia scilloides (Raf.) Cory), pale purple coneflower (Echinacea pallida (Nutt.) Nutt.), and pale purple clover (Dalea purpurea Vent.) (Taft et al. 1997; Taft et al. 2009). Fire is the primary disturbance factor that maintains this site, while herbivory and drought are secondary factors (LANDFIRE 2009).

Associated sites

R108XB005IL	**Loess Upland Prairie** Loess parent material on uplands including Broadwell, Buckhart, Elkhart, Harrison, Osco, and Richwood soils

Similar sites

R108XB005IL	**Loess Upland Prairie** Loess Upland Prairies are in a similar landscape position, but the soils are formed in deep loess with no root restrictive layers.
R108XB002IL	**Shale Prairie** Shale Prairies are in a similar landscape position, but the soils are 40-60 inches deep over shale residuum

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Schizachyrium scoparium* (2) *Sorghastrum nutans*

Physiographic features

Limestone Prairies occur on uplands. They are situated on elevations ranging from approximately 699 to 1948 feet ASL. The site does not experience flooding, but rather generates some surface runoff to downslope, adjacent ecological sites (Table 1).

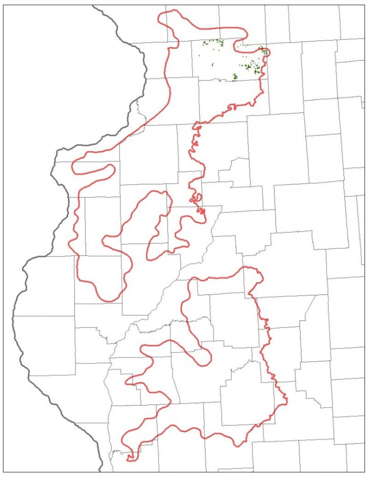


Figure 1. Figure 1. Location of Limestone Prairie ecological site within MLRA 108B.

Table 2. Representative physiographic features

Slope shape across	(1) Convex
Slope shape up-down	(1) Convex
Landforms	(1) Upland
Runoff class	Low to medium
Elevation	213–594 m
Slope	2–10%
Water table depth	203 cm
Aspect	Aspect is not a significant factor

Climatic features

The Illinois and Iowa Deep Loess and Drift, East-Central Part falls into the hot-summer humid continental climate (Dfa) and the humid subtropical continental climate (Cfa) Köppen-Geiger climate classifications (Peel et al. 2007). The two main factors that drive the climate of the MLRA are latitude and weather systems. Latitude, and the subsequent reflection of solar input, determines air temperatures and seasonal variations. Solar energy varies across the seasons, with summer receiving three to four times as much energy as opposed to winter. Weather systems (air masses and cyclonic storms) are responsible for daily fluctuations of weather conditions. High-pressure systems are responsible for settled weather patterns where sun and clear skies dominate. In fall, winter, and spring, the polar jet stream is responsible for the creation and movement of low-pressure systems. The clouds, winds, and precipitation associated with a low-pressure system regularly follow high-pressure systems every few days (Angel n.d.).

The soil temperature regime of MLRA 108B 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 124 days, while the frost-free period is about 168 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 34 inches, which includes rainfall plus the water equivalent from snowfall (Table 3). The average annual low and high temperatures are 38 and 58°F, respectively.

Climate data and analyses are derived from 30-year averages gathered from one 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)	124 days

Freeze-free period (characteristic range)	168 days
Precipitation total (characteristic range)	864 mm
Frost-free period (actual range)	124 days
Freeze-free period (actual range)	168 days
Precipitation total (actual range)	864 mm
Frost-free period (average)	124 days
Freeze-free period (average)	168 days
Precipitation total (average)	864 mm

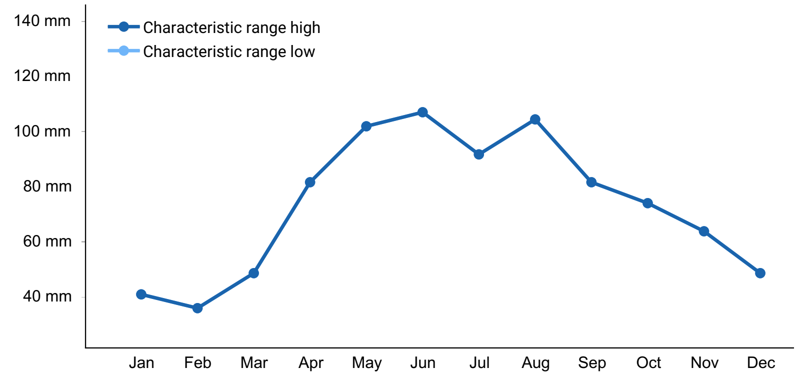


Figure 2. Monthly precipitation range

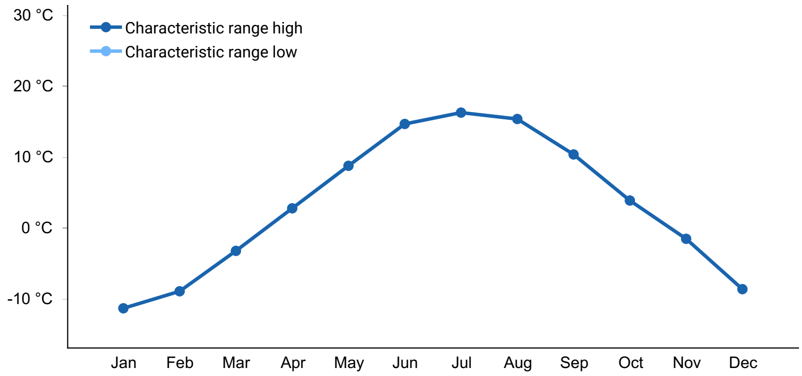


Figure 3. Monthly minimum temperature range

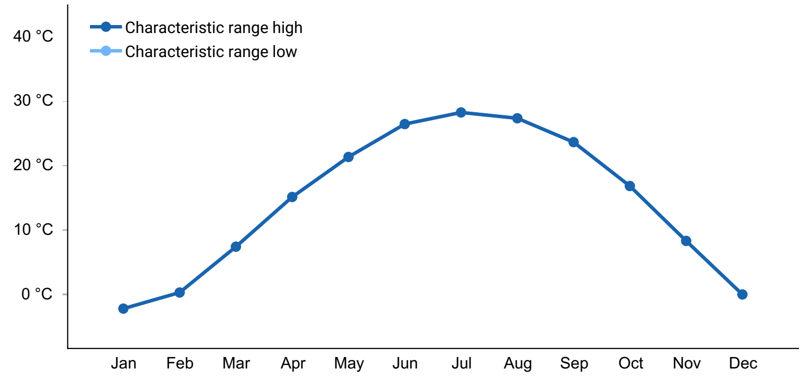


Figure 4. Monthly maximum temperature range

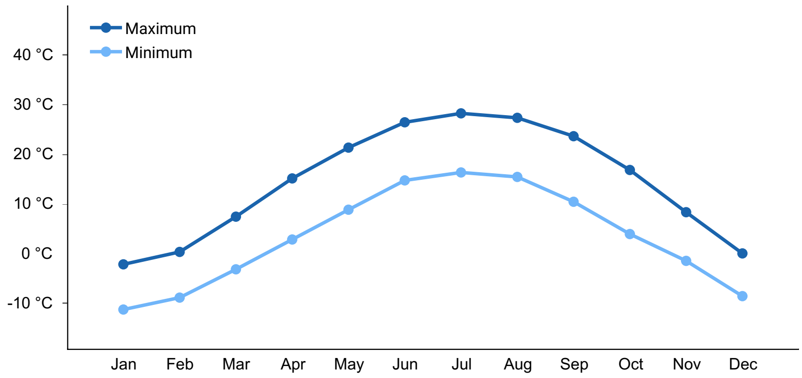


Figure 5. Monthly average minimum and maximum temperature

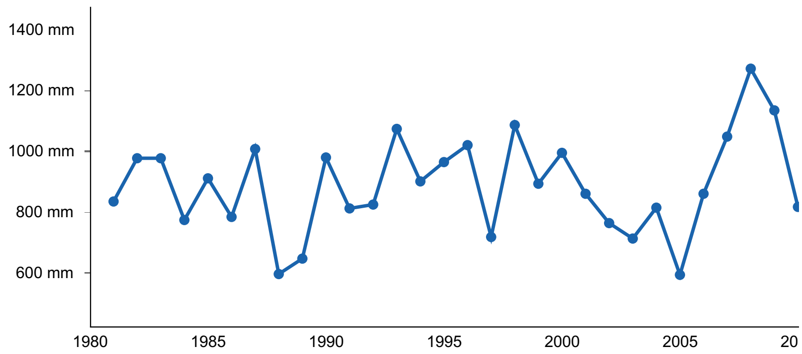


Figure 6. Annual precipitation pattern

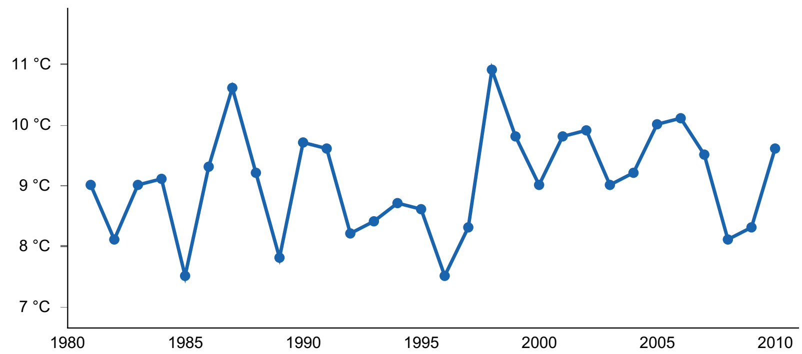


Figure 7. Annual average temperature pattern

Climate stations used

- (1) ROCHELLE [USC00117354], Rochelle, IL

Influencing water features

Limestone Prairies are not influenced by wetland or riparian water features. Precipitation is the main source of water for this ecological site. Infiltration is slow (Hydrologic Group C), and surface runoff is low to medium. Surface runoff contributes some water to downslope ecological sites (Figure 4).

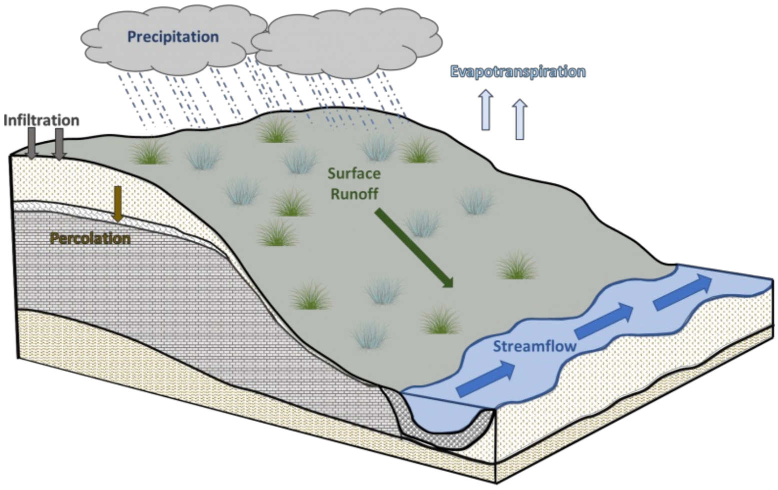


Figure 8. Figure 4. Hydrologic cycling in Limestone Prairie ecological site.

Soil features

Soils of Limestone Prairies are in the Mollisols order, further classified as Typic Argiudolls with slow infiltration and low to medium runoff potential. The soil series associated with this site includes Atkinson and Ripon. The parent material is loess or loamy sediments over dolomite, and the soils are well-drained and moderately deep. Soil pH classes are strongly acid to moderately alkaline. A lithic contact 31 to 43 inches deep is noted as a rooting restriction for the soils of this ecological site (Table 5).

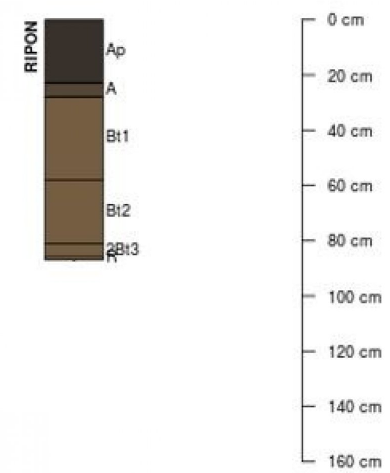


Figure 9. Figure 5. Profile sketch of soil series associated with Limestone Prairie.

Table 4. Representative soil features

Parent material	(1) Loess
Family particle size	(1) Fine-silty (2) Fine-loamy
Drainage class	Well drained
Permeability class	Very slow
Depth to restrictive layer	79–109 cm
Soil depth	79–109 cm

Ecological dynamics

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

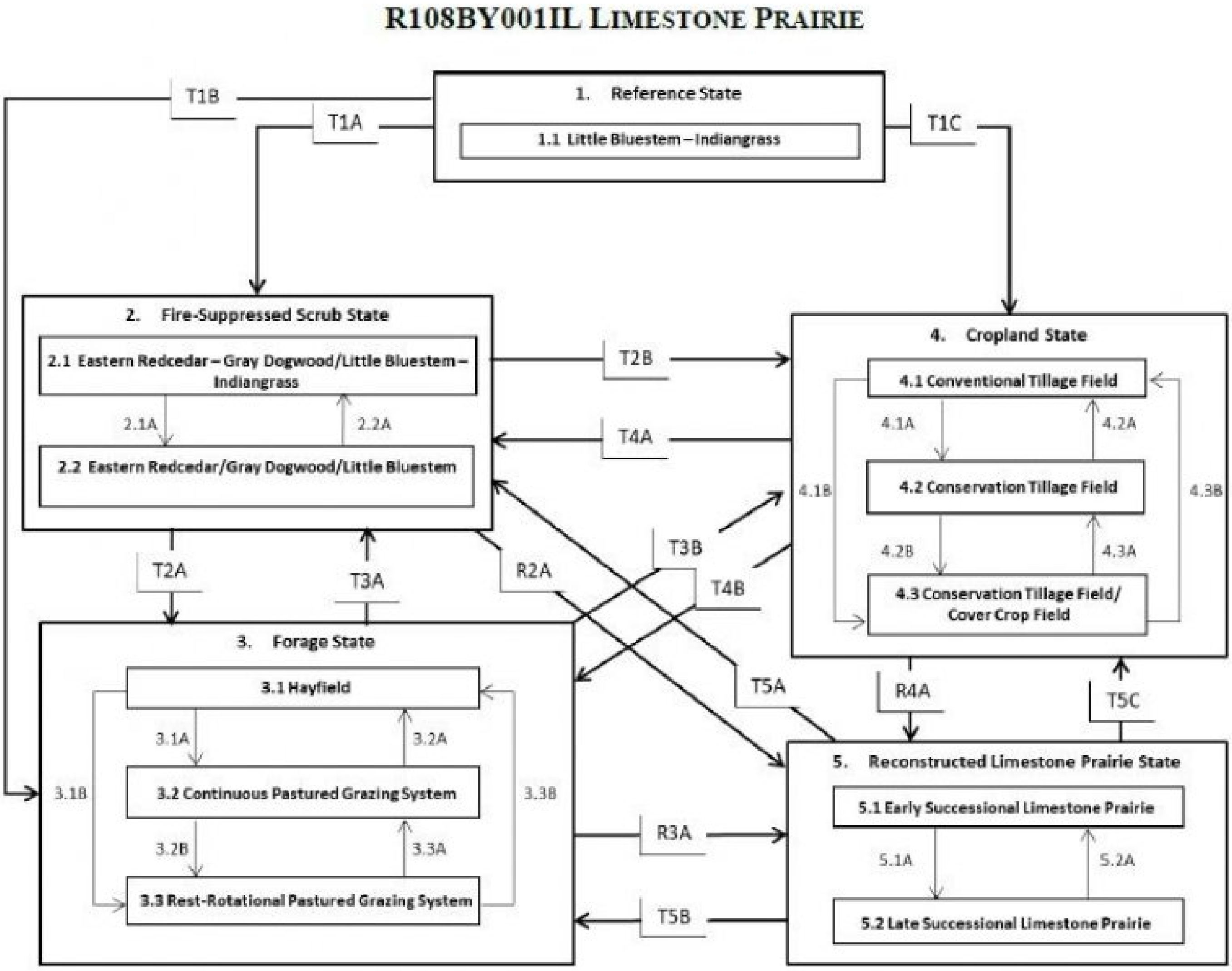
The MLRA lies within the tallgrass prairie ecosystem of the Midwest. The heterogeneous topography of the area results in variable microclimates and fuel matrices that in support prairies, savannas, and forests. Limestone Prairies form an aspect of this vegetative continuum. This ecological site occurs on uplands on well-drained soils that are moderately deep to bedrock. Species characteristic of this ecological site consist of mid- and tallgrass herbaceous vegetation.

Fire is a critical disturbance factor that maintains Limestone 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 well-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, Limestone Prairies are limited in their extent, having been type-converted to agricultural production land. Some remnants that remain show evidence of indirect anthropogenic influences from long-term fire suppression. A return to the historic plant community may not always 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



Code	Process
T1A, T3A, T4A, T5A	Long-term fire suppression and/or land abandonment
2.1A	Continued fire suppression more than 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 prairie community, dominated by herbaceous vegetation. The one community phase within the reference state is dependent on fire. The intensity and frequency alter species composition, cover, and extent. Drought and herbivory have more localized impacts in the reference state, but do contribute to overall species composition, diversity, cover, and productivity.

Dominant plant species

- little bluestem (*Schizachyrium*), other herbaceous
- Indiangrass (*Sorghastrum*), other herbaceous

Community 1.1
Little Bluestem - Indiangrass

Little Bluestem – Indiangrass – Sites in this reference community phase are dominated by a mix of grass and forbs. Vegetative cover is continuous (95 to 100 percent), and plants can reach heights between 3 and 6 feet tall (LANDFIRE 2009). Little bluestem, Indiangrass, porcupinegrass, big bluestem, and Mead's sedge are common monocots present on the site. Characteristic forbs can include butterfly milkweed (*Asclepias tuberosa* L.), pride of Ohio (*Dodecatheon meadia* L.), hoary puccoon (*Lithospermum canescens* (Michx.) Lehm.), and limestone calamint (*Clinopodium arkansanum* (Nutt.) House) (NatureServe 2018).

Dominant plant species

- big bluestem (*Andropogon gerardii*), other herbaceous
- Indiangrass (*Sorghastrum*), other herbaceous

State 2
Fire Supressed Scrub State

Long-term fire suppression can transition the reference 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). The establishment of woody species reduces the historic biodiversity thereby changing the vegetative community.

Dominant plant species

- eastern redcedar (*Juniperus virginiana*), tree
- gray dogwood (*Cornus racemosa*), shrub
- little bluestem (*Schizachyrium*), other herbaceous
- Indiangrass (*Sorghastrum*), other herbaceous

Community 2.1
Eastern Redcedar – Gray Dogwood/Little Bluestem – Indiangrass

Eastern Redcedar – Gray Dogwood/Little Bluestem – Indiangrass – This community phase represents the early stages of fire-suppression. In as little as six fire-free years, the prairie can become disrupted by woody shrubs (LANDFIRE 2009; NatureServe 2018). Native species, such as eastern red cedar and gray dogwood (*Cornus racemosa* Lam.), can form dense thickets with cover reaching up to 30 percent and plant heights as tall as 9 feet (LANDFIRE 2009). While the herbaceous layer is still present, diversity is reduced as some prairie plants become shaded out from the encroaching shrubs.

Dominant plant species

- eastern redcedar (*Juniperus virginiana*), tree
- gray dogwood (*Cornus racemosa*), tree
- little bluestem (*Schizachyrium*), other herbaceous
- Indiangrass (*Sorghastrum*), other herbaceous

Community 2.2
Eastern Redcedar/Gray Dogwood/Little Bluestem

Eastern Redcedar/Gray Dogwood/Little Bluestem – Site falling into this community phase have a well-established shrub layer, and eastern redcedars mature into small trees in the continued absence of fire. Herbaceous diversity continues to decline, and cover is reduced as grasses and forbs are replaced by woody species.

Dominant plant species

- eastern redcedar (*Juniperus virginiana*), tree
- gray dogwood (*Cornus racemosa*), shrub
- little bluestem (*Schizachyrium*), other herbaceous

Pathway 2.1A
Community 2.1 to 2.2

Continued fire supression more than 20 years

Pathway 2.2A
Community 2.2 to 2.1

Single large disturbance event

State 3
Forage State

The forage state occurs when the reference state is converted to a farming system that emphasizes domestic livestock production known as grassland agriculture. Fire suppression, periodic cultural treatments (e.g., clipping, drainage, soil amendment applications, planting new species and/or cultivars, mechanical harvesting) and grazing by domesticated livestock transition and maintain this state (USDA-NRCS 2003). Early settlers seeded non-native species, such as smooth brome (*Bromus inermis* Leyss.) and Kentucky bluegrass (*Poa pratensis* L.), to help extend the grazing season. 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

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

Community 3.2
Continuous Pastured Grazing System

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

Community 3.3
Rest-Rotation Pastured Grazing System

Rest-Rotation Pastured Grazing System – This community phase is characterized by rotational grazing where the pasture has been subdivided into several smaller paddocks. Through the development of a grazing plan, livestock utilize one or a few paddocks, while the remaining area is rested allowing plants to restore vigor and energy reserves, deepen root systems, develop seeds, as well as allow seedling establishment (Undersander et al. 2002;

USDA-NRCS 2003). Rest-rotation pastured grazing systems include deferred rotation, rest rotation, high intensity – low frequency, and short duration methods. Vegetation is generally more diverse and can include orchardgrass (*Dactylis glomerata* L.), timothy (Phleum pretense L.), red clover (*Trifolium pratense* L.), and alfalfa (*Medicago sativa* L.). The addition of native prairie species can further bolster plant diversity and, in turn, soil function. This community phase promotes numerous ecosystem benefits including increasing biodiversity, preventing soil erosion, maintaining and enhancing soil quality, sequestering atmospheric carbon, and improving water yield and quality (USDA-NRCS 2003).

Pathway 3.1A
Community 3.1 to 3.2

Mechanical harvesting is replaced with domestic livestock and continuous grazing

Pathway 3.1B
Community 3.1 to 3.3

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

Pathway 3.2A
Community 3.2 to 3.1

Domestic livestock grazing is replaced by mechanical harvesting

Pathway 3.2B
Community 3.2 to 3.3

Implementation of rest-rotational grazing

Pathway 3.3B
Community 3.3 to 3.1

Domestic livestock grazing is replaced by mechanical harvesting

Pathway 3.3A
Community 3.3 to 3.2

Implementation of continuous 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

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

Community 4.2
Conservation Tillage Field

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

Community 4.3
Conservation Tillage Field/Alternative Crop Field

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 cropland system.

Pathway 4.1A
Community 4.1 to 4.2

Less tillage, residue management

Pathway 4.1B
Community 4.1 to 4.3

Less tillage, residue management and implementation of cover cropping

Pathway 4.2A
Community 4.2 to 4.1

Intensive tillage, remove residue and reinitialize monoculture row cropping

Pathway 4.2B
Community 4.2 to 4.3

Implementation of cover cropping

Pathway 4.3B
Community 4.3 to 4.1

Intensive tillage, remove residue and reinitialize monoculture row cropping

Pathway 4.3A
Community 4.3 to 4.2

Remove cover cropping

State 5
Reconstructed Limestone 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 limestone 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 Limestone Prairie

Early Successional Limestone 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, Indiangrass, porcupinegrass, pale purple coneflower, hoary puccoon). 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 much 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 Limestone Prairie

Late Successional Limestone 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

Invasive species control and implementation of disturbance regimes

Pathway 5.2A
Community 5.2 to 5.1

Drought or improper timing/use of management actions

Transition T1A
State 1 to 2

Long term fire suppression and/or land abandonment

Transition T1B
State 1 to 3

Cultural treatments are implemented to increase forage quality and yield

Transition T1C
State 1 to 4

Agricultural conversion via tillage, seeding and non-selective herbicide

Transition T2A
State 2 to 3

Cultural treatments are implemented to increase forage quality and yield

Transition T2B
State 2 to 4

Agricultural conversion via tillage, seeding, non-selective herbicides

Transition T2A
State 2 to 5

Site preparation, non-native species control and native seeding

Restoration pathway T3A
State 3 to 2

Long-term fire suppression and/or land abandonment

Transition T3B
State 3 to 4

Agricultural conversion via tillage, seeding and non-selective herbicide

Transition R3A
State 3 to 5

Site preparation, non-native species control and native seeding

Restoration pathway T4A
State 4 to 2

Long-term fire suppresion and/or land abandonment

Restoration pathway T4B
State 4 to 3

Cultural treatments are implemented to increase forage quality and yield

Transition R4A

State 4 to 5

Site preparation, non-native species control and native seeding

Restoration pathway T5A
State 5 to 2

Long-term fire suppression and/or land abandonment

Restoration pathway T5B
State 5 to 3

Cultural treatments are implemented to increase forage quality and yield

Restoration pathway T5C
State 5 to 4

Agricultural conversion via tillage, seeding and non-selective herbicide

Additional community tables

Inventory data references

No field plots have been developed 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 this ecological site description.

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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	05/04/2024

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:

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

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

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

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16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:**

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17. **Perennial plant reproductive capability:**
