

Ecological site R108XB006IL

Loess Upland Savanna

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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 Illinoian 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 Wisconsin glacial episode – 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: North-Central Interior Oak Savanna (CES202.698) (NatureServe 2015)

National Vegetation Classification - Plant Associations: *Quercus macrocarpa* – (*Quercus alba*, *Quercus stellata*) Wooded Grassland (CEGL002159) (Nature Serve 2015)

Biophysical Settings: North-Central Interior Oak Savanna (BpS 4213940) (LANDFIRE 2009)

Illinois Natural Areas Inventory: Dry-mesic savanna, Mesic savanna (White and Madany 1978)

Ecological site concept

Loess Upland Savannas are located within the green areas on the map (Figure 1). They occur on uplands. The soils are Alfisols that are well-drained and deep, formed in loess.

The historic pre-European settlement vegetation on this ecological site was dominated by tallgrass prairie interspersed with trees. Bur oak (*Quercus macrocarpa* Michx.) is the dominant tree, and big bluestem (*Andropogon gerardii* Vitman) and longbract wild indigo (*Baptisia bracteata* Muhl. ex Elliott var. *leucophaea* (Nutt.) Kartesz & Gandhi) are the dominant and characteristic species on the site, respectively. Other grasses present can include little bluestem (*Schizachyrium scoparium* (Michx.) Nash), Indiangrass (*Sorghastrum nutans* (L.) Nash), and prairie dropseed (*Sporobolus heterolepis* (A. Gray) A. Gray) (White and Madany 1978; NatureServe 2018). Forbs typically associated with an undisturbed plant community associated with this ecological site can include button erylgo (*Eryngium yuccifolium* Michx.), white prairie clover (*Dalea candida* Michx. ex Willd.), and downy phlox (*Phlox pilosa* L.) (White and Madany 1978; Taft et al. 1997). Fire is the primary disturbance factor that maintains this site, while herbivory and drought are secondary factors (LANDFIRE 2009).

Associated sites

F108XB007IL	Loess Upland Forest Loess over eolian sand parent material including Middletown soils
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Similar sites

R108XB011IL	Till Upland Savanna Till Upland Savannas are in a similar landscape position, but the parent material is glacial till with a shallow loess mantle
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Table 1. Dominant plant species

Tree	(1) <i>Quercus macrocarpa</i> (2) <i>Quercus alba</i>
Shrub	Not specified
Herbaceous	(1) <i>Andropogon gerardii</i> (2) <i>Baptisia bracteata</i> var. <i>leucophaea</i>

Physiographic features

Loess Upland Savannas occur on uplands (Figure 2). They are situated on elevations ranging from approximately 449 to 3283 feet ASL. The site does not experience flooding, but rather generates runoff to downslope, adjacent ecological sites (Table 1).

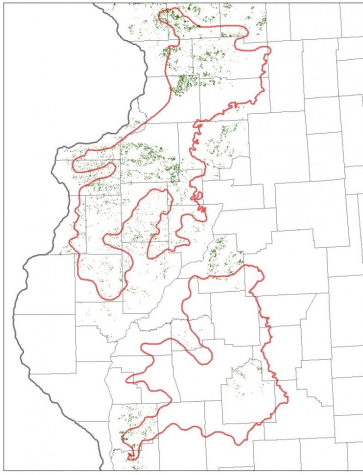
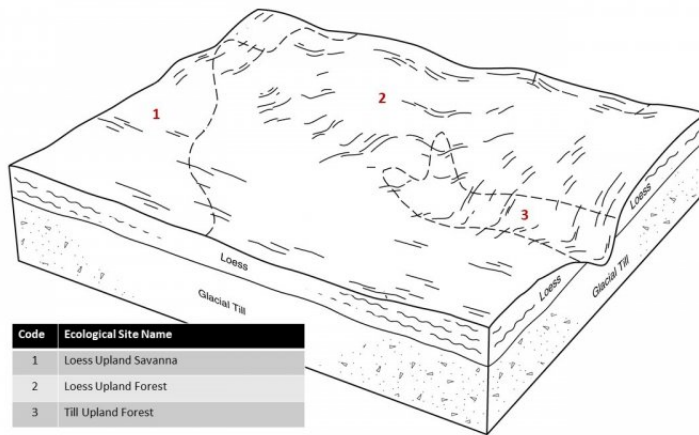


Figure 1. Figure 1. Location of Loess Upland Savanna ecological site within MLRA 108B.



Code	Ecological Site Name
1	Loess Upland Savanna
2	Loess Upland Forest
3	Till Upland Forest

Figure 2. Figure 2. Representative block diagram of Loess Upland Savanna 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
Elevation	137–1,001 m
Slope	0–10%
Water table depth	152 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 171 days, while the frost-free period is about 140 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 39 inches, which includes rainfall plus the water equivalent from snowfall (Table 3). The average annual low and high temperatures are 40 and 61°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)	134-146 days
Freeze-free period (characteristic range)	164-178 days
Precipitation total (characteristic range)	965-991 mm
Frost-free period (actual range)	129-148 days
Freeze-free period (actual range)	160-179 days
Precipitation total (actual range)	965-991 mm
Frost-free period (average)	140 days
Freeze-free period (average)	171 days
Precipitation total (average)	991 mm

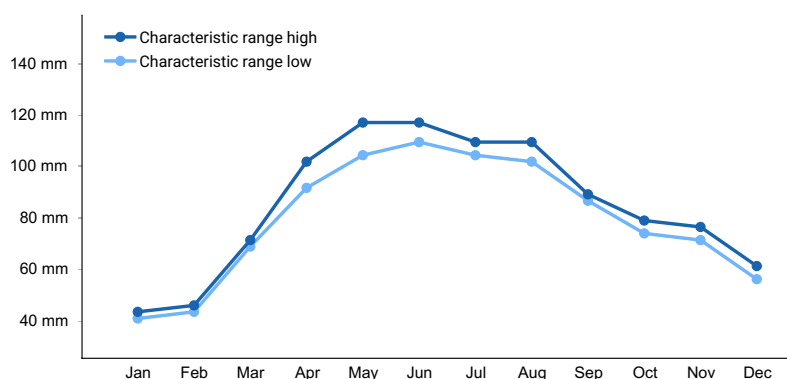


Figure 3. Monthly precipitation range

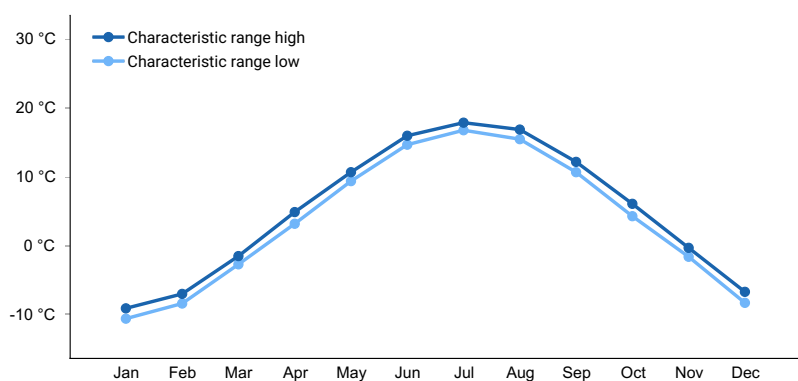


Figure 4. Monthly minimum temperature range

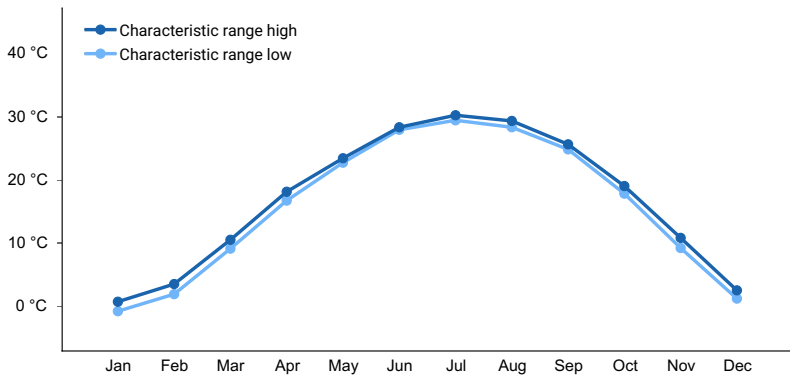


Figure 5. Monthly maximum temperature range

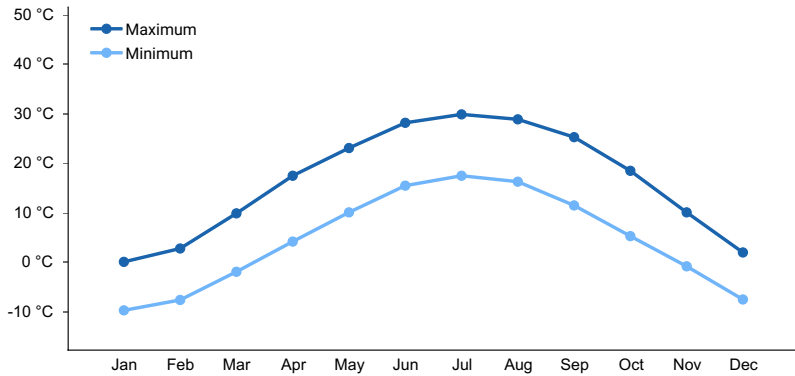


Figure 6. Monthly average minimum and maximum temperature

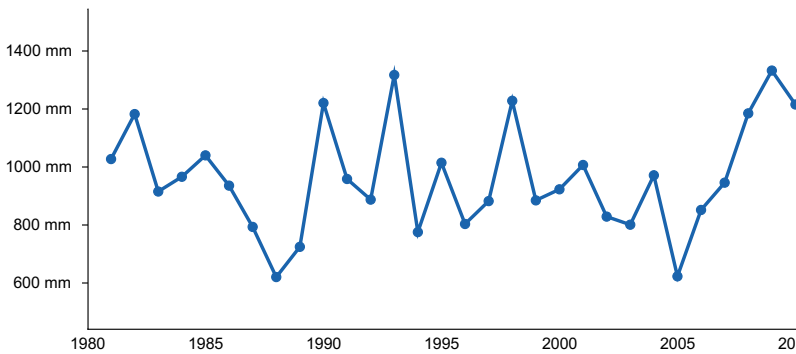


Figure 7. Annual precipitation pattern

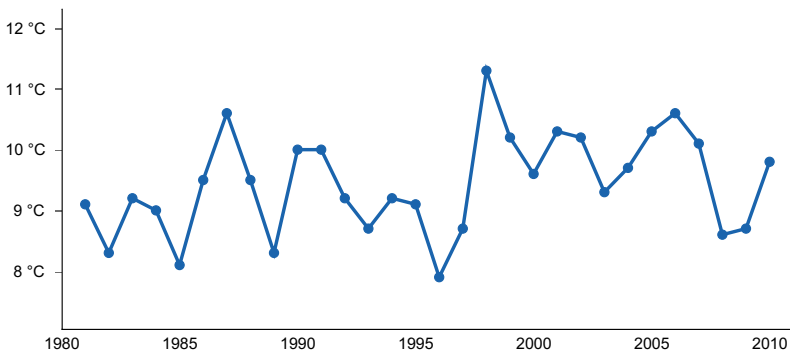


Figure 8. Annual average temperature pattern

Climate stations used

- (1) POLO 5NW [USC00116897], Polo, IL
- (2) GALVA [USC00113335], Galva, IL
- (3) MONMOUTH [USC00115768], Monmouth, IL

- (4) PRAIRIE CITY 2S [USC00116970], Bushnell, IL

Influencing water features

Loess Upland Savannas are not influenced by wetland or riparian water features. Precipitation is the main source of water for this ecological site. Infiltration is moderate (Hydrologic Group B), and surface runoff is low. Surface runoff contributes some water to downslope ecological sites (Figure 5).

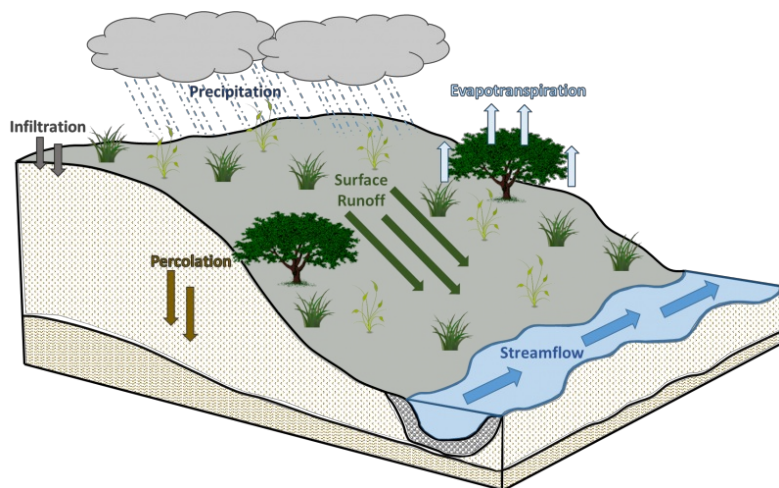


Figure 9. Figure 5. Hydrologic cycling in Loess Upland Savanna ecological site.

Soil features

Soils of Loess Upland Savannas are in the Alfisols orders, further classified as Mollic Hapludalfs with moderate infiltration and low runoff potential. The soil series associated with this site includes Greenbush. The parent material is loess, and the soils are well-drained and deep. Soil pH classes are very strongly acid to neutral. No rooting restrictions are noted for the soils of this ecological site (Table 5).

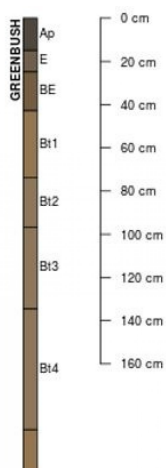


Figure 10. Figure 6. Profile sketch of soil series associated with Loess Upland Savanna

Table 4. Representative soil features

Parent material	(1) Loess
Family particle size	(1) Fine-silty
Drainage class	Well drained
Permeability class	Moderately slow
Depth to restrictive layer	203 cm

Soil depth	203 cm
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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. Loess Upland Savannas form an aspect of this vegetative continuum. This ecological site occurs on uplands on well-drained soils. Species characteristic of this ecological site consist of tallgrass herbaceous vegetation with scattered trees.

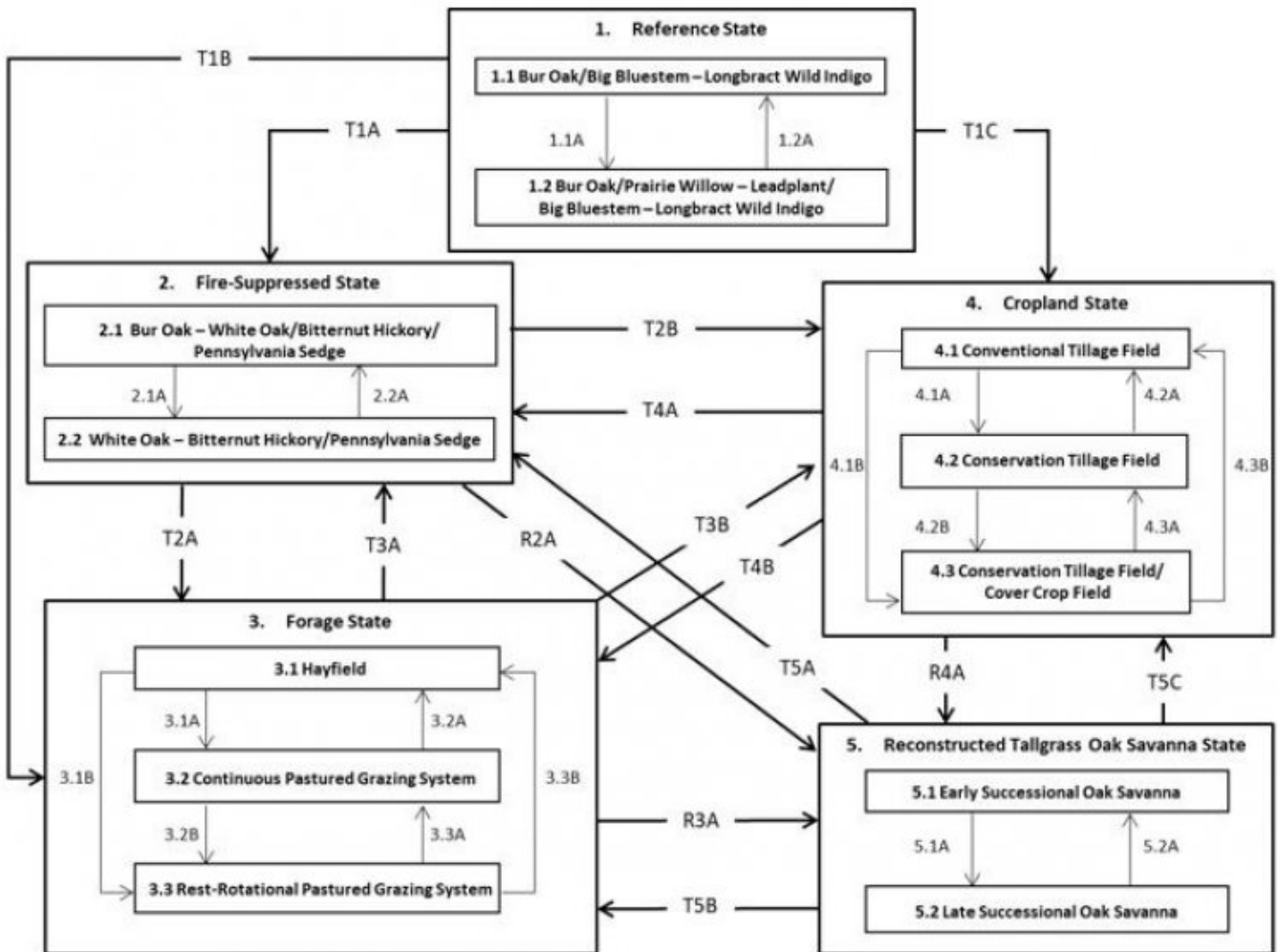
Fire is a critical disturbance factor that maintains Loess Upland Savannas. Fire intensity typically consisted of periodic fires occurring every 1 to 5 years (LANDFIRE 2009). Ignition sources included summertime lightning strikes from convective storms and bimodal, human ignitions during the spring and fall seasons. Native Americans regularly set fires to improve sight lines for hunting, driving large game, improving grazing and browsing habitat, agricultural clearing, and enhancing vital ethnobotanical plants (Barrett 1980; White 1994).

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 moderately well to 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, Loess Upland Savannas have been greatly reduced as a result of human-driven type-conversion to agricultural production land (NatureServe 2018). Lands that have not been put into production have had fire suppressed long enough to transition the site from an open savanna to a closed woodland or forest. A return to the historic plant community may not be possible following extensive land modification, but long-term conservation agriculture or savanna reconstruction 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

R108BY006IL LOESS UPLAND SAVANNA



Code	Process
1.1A	Extended fire return interval in excess of 5 years
1.2A	Mixed or replacement fire
T1A, T3A, T4A, T5A	Long-term fire suppression and/or land abandonment
2.1A	Continued fire suppression (30+ 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 mesic oak savanna, dominated by herbaceous vegetation and

scattered trees. The two community phases within the reference state are dependent on periodic fires. Surface fires are the dominant fire regime, comprising approximately 96 percent of all fires and occurring every five years. Mixed and replacement fires comprise the remaining 4 percent, occurring approximately every 3 and 1 years, respectively (LANDFIRE 2009). Fire intensity and return intervals alter species composition, cover, and extent, while regular fire intervals keep woody species from encroaching. Episodic droughts and storm damage have more localized impacts in the reference phases, but do contribute to overall species composition, diversity, cover, and productivity.

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- leadplant (*Amorpha canescens*), shrub
- prairie willow (*Salix humilis*), shrub
- longbract wild indigo (*Baptisia bracteata*), other herbaceous
- big bluestem (*Andropogon gerardii*), other herbaceous

Community 1.1

Bur Oak/Big Bluestem – Longbract Wild Indigo

Bur Oak/Big Bluestem – Longbract Wild Indigo – Sites in this reference community phase are dominated by a mix of grasses and forbs with scattered trees. Bur oak is the dominant tree on the site, but white oak (*Quercus alba* L.) may also be present. The tree layer comprises no more than 20 percent cover and trees size class is medium (9 to 21-inch DBH). Vegetative cover is continuous (up to 100 percent) and plants can reach heights up to 3 feet tall (LANDFIRE 2009). Big bluestem, little bluestem, Indiangrass, and prairie dropseed are the dominant warm-season grasses present on the site. Characteristic forbs can include longbract wild indigo, pride of Ohio (*Dodecatheon meadia* L.), prairie blazing star (*Liatris pycnostachya* Michx.), hoary puccoon (*Lithospermum canescens* (Michx.) Lehm.), and compassplant (*Silphium laciniatum* L.) (White and Madany 1978). Surface fires every 5 years will maintain this class, but an extended fire return interval will shift the community to phase 1.2 (LANDFIRE 2009).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- big bluestem (*Andropogon gerardii*), other herbaceous
- longbract wild indigo (*Baptisia bracteata*), other herbaceous

Community 1.2

Bur Oak/Prairie Willow – Leadplant/Big Bluestem – Longbract Wild Indigo

Bur Oak/Prairie Willow – Leadplant/Big Bluestem – Longbract Wild Indigo – This reference community phase represents a successional shift as a result of an extended fire return interval. This fire-free period allows woody shrubs to establish, including prairie willow (*Salix humilis* Marshall) and leadplant (*Amorpha canescens* Pursh). Tree cover increases to as much as 60 percent, and tree size class moves from medium to large (21 to 33-inch DBH). Surface fires every 5 years will maintain this class, but mixed or replacement fires will shift the community back to phase 1.1 (LANDFIRE 2009).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- prairie willow (*Salix humilis*), shrub
- leadplant (*Amorpha canescens*), shrub
- big bluestem (*Andropogon gerardii*), grass
- longbract wild indigo (*Baptisia bracteata*), grass

Pathway 1.1A

Community 1.1 to 1.2

Extended fire return interval in excess of 5 years

Pathway 1.2A

Community 1.2 to 1.1

Mixed or replacement fire

State 2

Fire-Suppressed State

Fire suppression can transition the reference plant community from an open savanna to a closed canopy forest. As the natural fire regime is removed from the landscape, encroachment and dominance by shade-tolerant, fire-intolerant species ensues (Asbjornsen et al. 2005). This results in a positive feedback loop of mesophication whereby plant community succession continuously creates cool, damp shaded conditions that perpetuate a closed canopy ecosystem (Nowacki and Abrams 2008). Succession to this closed canopy state can occur in as little as 25 years from the last fire (LANDFIRE 2009).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- white oak (*Quercus alba*), tree
- bitternut hickory (*Carya cordiformis*), shrub
- Pennsylvania sedge (*Carex pensylvanica*), other herbaceous

Community 2.1

Bur Oak – White Oak/Bitternut Hickory/Pennsylvania Sedge

Bur Oak – White Oak/Bitternut Hickory/Pennsylvania Sedge – This community represents the early stages of long-term fire suppression. The lack of fire allows the tree canopy to close (60 to 80 percent cover) and stem density to increase. Bur oak and white oak are the dominant trees, and bitternut hickory (*Carya cordiformis* (Wangenh.) K. Koch) begins to form a scattered subcanopy (LANDFIRE 2009). The sun-loving herbaceous layer is slowly replaced by more shade-tolerant species. Rare surface fires that escape suppression efforts will maintain this phase, but a complete lack of fire for 30 years will shift the community to phase 2.2 (LANDFIRE 2009).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- white oak (*Quercus alba*), tree
- bitternut hickory (*Carya cordiformis*), shrub
- Pennsylvania sedge (*Carex pensylvanica*), grass

Community 2.2

White Oak – Bitternut Hickory/Pennsylvania Sedge

White Oak – Bitternut Hickory/Pennsylvania Sedge – Sites falling into this community phase have transitioned into a closed canopy oak-hickory forest. Mature bur and white oaks are still present, but seedlings and saplings are generally absent as they do not establish well under the continuous canopies (Tirmenstein 1991; Gucker 2011). As fire suppression has continued, bitternut hickory saplings have matured and now become co-dominant with the oaks (Colandonato 1992; LANDFIRE 2009). The ground layer continues to be dominated by shade-tolerant species or non-native invasive species, such as garlic mustard (*Alliaria petiolata* (M. Bieb.) Cavara & Grande). A single, large disturbance event – such as a windstorm – can create open pockets that allow the community to temporarily shift back to phase 2.1.

Dominant plant species

- white oak (*Quercus alba*), tree
- bitternut hickory (*Carya cordiformis*), shrub
- Pennsylvania sedge (*Carex pensylvanica*), other herbaceous

Pathway 2.1A

Community 2.1 to 2.2

Continued fire suppression (30+ 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 pratense* L.), red clover (*Trifolium pratense* L.), and alfalfa (*Medicago sativa* L.). The addition of native prairie species can further bolster plant diversity and, in turn, soil function. This community phase promotes numerous ecosystem benefits including increasing biodiversity, preventing soil erosion, maintaining and enhancing soil quality, sequestering atmospheric carbon, and improving water yield and quality (USDA-NRCS 2003).

Pathway 3.1A

Community 3.1 to 3.2

Mechanical harvesting is replaced with domestic livestock and continuous grazing

Pathway 3.1B

Community 3.1 to 3.3

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

Pathway 3.2A

Community 3.2 to 3.1

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

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 Tallgrass Oak Savanna State

Savanna 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 tallgrass prairie were highly diverse with complex interrelationships, historic savanna 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 savanna state is the result of a long-term commitment involving a multi-step, adaptive management process. Bur oak plantings or selective tree thinning of non-oak species will be required to reproduce the overstory canopy (Asbjornsen et al. 2005). Diverse, species-rich seed mixes may be 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 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, shrubs, and eventually mature bur oaks. Establishing a prescribed fire regime 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 undesirable woody vegetation (Brudvig et al. 2007).

Community 5.1

Early Successional Reconstructed Oak Savanna

Early Successional Reconstructed Oak Savanna – This community phase represents early community assembly and is highly dependent on the timing and priority of planting and/or tree thinning operations and the herbaceous seed mix utilized. If bur oak planting is needed, acorns should be planted shortly after harvest as acorns germinate shortly after seedfall and require no cold stratification. Browse protection may need to be installed to protect newly established seedlings from animal predation (Gucker 2011). If selective tree removal is needed, canopy reduction should encompass between 16 to 45 percent of the undesirable species in a single year (Asbjornsen et al. 2005). 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 most 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 and over time close the canopy.

Community 5.2

Late Successional Reconstructed Oak Savanna

Late Successional Reconstructed Oak Savanna – 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 oak savanna 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 the tall grasses allows more light and nutrients to become available for forb recruitment, allowing for greater ecosystem complexity (Wilsey 2008). Prescribed fire should be used on a cycle no less than every five years to allow the oaks to establish and mature (Gucker 2011).

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 and non-selective herbicide

Transition R2A

State 2 to 5

Site preparation, non-native species control and native seeding

Restoration pathway T3A

State 3 to 2

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 suppression 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	05/06/2024
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:**
