

Ecological site R107XB002MO

Deep Loess Upland 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): 107X—Iowa and Missouri Deep Loess Hills

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

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

Classification relationships

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

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

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

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

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

Eilers and Roosa (1994): Loess Hills

Iowa Department of Natural Resources (INAI nd): Western Dry-Mesic Prairie

Missouri Natural Heritage Program (Nelson 2010): Dry-Mesic Loess/Glacial Till Prairie

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

Plant Associations (National Vegetation Classification System, Nature Serve 2015): *Andropogon gerardii* – *Sorghastrum nutans* – *Hesperostipa spartea* Loess Hills Herbaceous Vegetation (CEGL002025)

Ecological site concept

Deep Loess Upland Prairies are generally located within the green areas on the map (Figure 1). They occur on summits and shoulders on slopes less than fifteen percent. Soils are Entisols, Inceptisols, and Mollisols that are well-drained and very deep, formed from leached loess with a strongly acid to moderately alkaline (increased pH) environment. These fine-silty, fertile soils have high soil uniformity resulting in increased nutrient- and water-holding capacity, increased organic matter retention, and good soil aeration that allows deep penetration by plant roots, which generally results in high plant productivity (Catt 2001). Deep Loess Upland Prairies occur upslope from other deep loess ecological sites.

The historic pre-European settlement vegetation on this site was dominated by a variety of tallgrass prairie species. Little bluestem (*Schizachyrium scoparium* (Michx.) Nash) is the dominant monocot species, while prairie dropseed (*Sporobolus heterolepis* (A. Gray) A. Gray) is an important indicator species (Steinauer and Rolfsmeier 2010). Other grasses that can occur include big bluestem (*Andropogon gerardii* Vitman), Indiangrass (*Sorghastrum nutans* (L.) Nash), and sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.). Herbaceous species typical of an undisturbed plant community associated with this ecological site include white prairie clover (*Dalea candida* Michx. ex Willd.), Mead's milkweed (*Asclepias meadii* Torr. ex A. Gray), and prairie cinquefoil (*Potentilla arguta* Pursh) (Drobney et al. 2001; Nelson 2010; Ladd and Thomas 2015). Leadplant (*Amorpha canescens* Pursh) is a common shrub that can be found scattered throughout the prairie (Nelson 2010; Steinauer and Rolfsmeier 2010). Fire was the primary disturbance factor that maintained this site, while drought and large mammal grazing were secondary factors (LANDFIRE 2009; Nelson 2010).

Associated sites

R107XB003MO	Deep Loess Exposed Backslope Savanna Loess soils on slopes greater than 15 percent with south and west aspects, including Knox, Menfro, Marshall, Monona, and Udarents
F107XB004MO	Deep Loess Protected Backslope Woodland Loess soils on slopes greater than 15 percent with north and east aspects, including Knox, Menfro, and Udarents

Similar sites

R107XB012MO	Calcareous Loess Upland Prairie Calcareous Loess Upland Prairies are similar in landscape position but parent material is calcareous loess, and average clay content is lower
R107XB006MO	Calcareous Loess Exposed Backslope Prairie Calcareous Loess Exposed Backslope Prairies only occur on south and west aspects, parent material is calcareous loess, and average clay content is lower
R107XB007MO	Loess Upland Prairie Loess Upland Prairies are similar in landscape position but average clay content is higher

R107XB0271A

Calcareous Till Upland Prairie

Calcareous Till Upland Prairies are similar in landscape position but parent material is till, average clay content is higher, and soils have a significant component of calcium carbonate at or near the surface

Table 1. Dominant plant species

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

Physiographic features

Deep Loess Upland Prairies occur on summits and shoulders on slopes less than fifteen percent on dissected till plains (Figure 2). This ecological site is unique to the Loess Hills landform situated on elevations ranging from approximately 900 to 1,700 feet ASL. This site does not experience flooding but rather generates runoff to adjacent, downslope ecological sites.

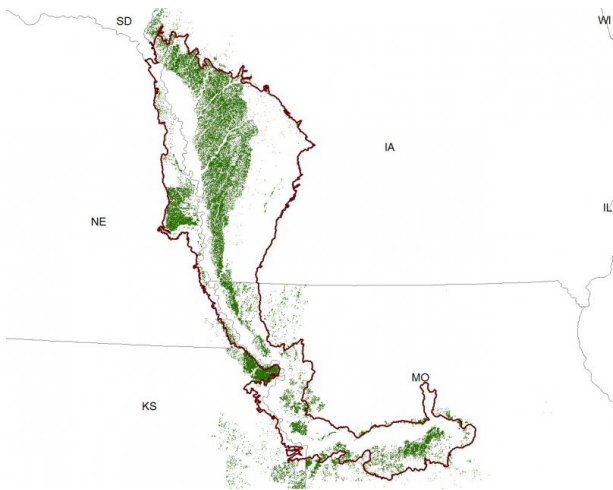
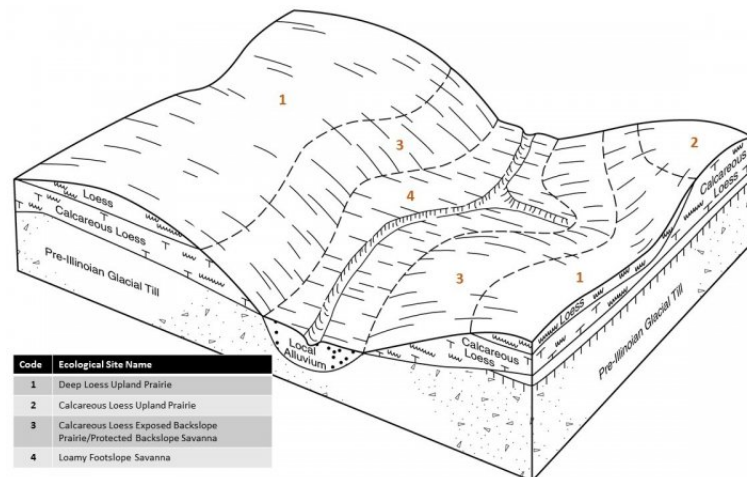


Figure 2. Figure 1. Location of Deep Loess Upland Prairie ecological site within MLRA 107B.



Code	Ecological Site Name
1	Deep Loess Upland Prairie
2	Calcareous Loess Upland Prairie
3	Calcareous Loess Exposed Backslope Prairie/Protected Backslope Savanna
4	Loamy Footslope Savanna

Figure 3. Figure 2. Representative block diagram of Deep Loess Upland Prairie and associated ecological sites.

Table 2. Representative physiographic features

Hillslope profile	(1) Summit (2) Shoulder
Slope shape across	(1) Convex
Slope shape up-down	(1) Convex

Landforms	(1) Ridge (2) Interfluve (3) Hillslope
Flooding frequency	None
Ponding frequency	None
Elevation	183–518 m
Slope	0–15%
Water table depth	203 cm
Aspect	Aspect is not a significant factor

Climatic features

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

The soil temperature regime of MLRA 107B is classified as mesic, where the mean annual soil temperature is between 46 and 59°F (USDA-NRCS 2006). Temperature and precipitation occur along a north-south gradient, where temperature and precipitation increase the further south you travel. The average freeze-free period of this ecological site is about 175 days, while the frost-free period is about 154 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 28 inches, which includes rainfall plus the water equivalent from snowfall (Table 3). The average annual low and high temperatures are 38 and 61°F, respectively.

Climate data and analyses are derived from 30-year average gathered from six National Oceanic and Atmospheric Administration (NOAA) weather stations contained within the range of this ecological site (Table 4).

Table 3. Representative climatic features

Frost-free period (characteristic range)	133-152 days
Freeze-free period (characteristic range)	156-179 days
Precipitation total (characteristic range)	787-864 mm
Frost-free period (actual range)	132-154 days
Freeze-free period (actual range)	156-184 days
Precipitation total (actual range)	711-864 mm
Frost-free period (average)	140 days
Freeze-free period (average)	165 days
Precipitation total (average)	813 mm

Climate stations used

- (1) GLENWOOD 3SW [USC00133290], Glenwood, IA
- (2) LOGAN [USC00134894], Logan, IA
- (3) TARKIO [USW00014945], Tarkio, MO
- (4) ONAWA 3NW [USC00136243], Onawa, IA
- (5) SIOUX CITY GATEWAY AP [USW00014943], Sioux City, IA
- (6) SIDNEY [USC00137669], Sidney, IA

Influencing water features

Deep Loess Upland 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 slow (Hydrologic Groups B and C), and surface runoff is low to medium. Precipitation infiltrates the soil surface and percolates downward through the horizons unimpeded by any restrictive layer. The Dakota bedrock aquifer in the northern region of this ecological site is typically deep and confined, leaving it generally unaffected by recharge. However, there are surficial aquifers in the Pennsylvanian strata in the southern extent of the ecological site that are shallow and allow some recharge (Prior et al. 2003). Surface runoff contributes some water to downslope ecological sites. Evapotranspiration rates occur on a latitudinal gradient, with the northern end of the ecological site receiving a greater number of days with sun and high winds resulting in a higher average evapotranspiration rate compared to the southern end (Visher 1954).

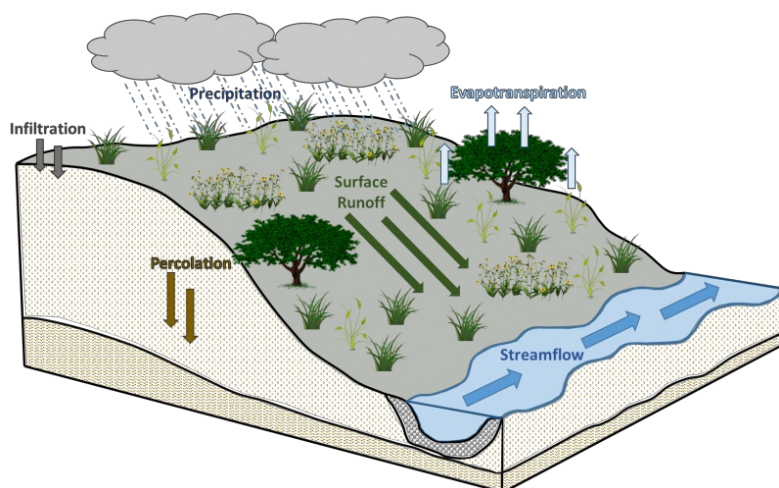


Figure 10. Figure 5. Hydrologic cycling in Deep Loess Upland Prairie ecological site.

Soil features

Soils of Deep Loess Upland Prairies are in the Entisol, Inceptisol, and Mollisol orders, further classified as Aquic Argiudolls, Dystric Eutrudepts, Pachic Hapludolls, Typic Argiudolls, Typic Hapludolls, or Typic Dystrudepts. They were formed under prairie vegetation. The soil series associated with this site includes Arents, Contrary, Deroin, Higginsville, Melia, Monona, Ponca, Sibley, Sibleyville, Strahan, Udarents, Udorthents, and Wakenda. The parent material is loess, and the soils are mostly well-drained and very deep with no coarse fragments. Soil pH classes are strongly acid to moderately alkaline. No rooting restrictions are noted for the soils of this ecological site. Average clay content is between 20 and 30 percent limiting extreme compaction, but erosion from wind and water can be high.

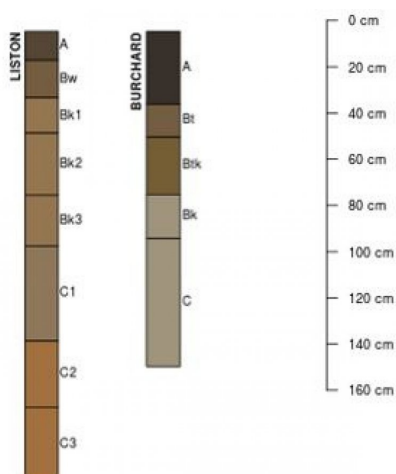


Figure 11. Figure 6. Profile sketches of soil series associated with Deep Loess Upland Prairie.

Table 4. Representative soil features

Parent material	(1) Loess
Surface texture	(1) Silt loam (2) Silty clay loam
Family particle size	(1) Fine-silty
Drainage class	Somewhat poorly drained to well drained
Permeability class	Very slow to moderately slow
Soil depth	203 cm
Available water capacity (0-101.6cm)	15.24–22.86 cm
Calcium carbonate equivalent (0-101.6cm)	0–20%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	5.1–8.4

Ecological dynamics

Prairie ecosystems are regarded as the most endangered ecosystem in North America where an estimated four percent of the tallgrass prairie habitat remains (Steinauer and Collins 1996). The Loess Hills region of MLRA 107B were once dominated by tall and mixed-grass prairies, extending across more than 90 percent of the area (Rosburg 1994; Farnsworth 2009). However, by the early twenty-first century much of the land had been converted to agriculture, leaving an estimated 20 percent of the region to be classified as “grassland” and another three percent classified as “remnant prairie” (Farnsworth 2009).

Deep Loess Upland Prairies form a vegetative continuum throughout the Loess Hills, where soil moisture serves as the primary influence on community composition (White 1983; White and Glenn-Lewin 1984). This ecological site can occur on nearly any aspect. Species characteristic of this ecological site are sun-loving, fire- and drought-adapted plants.

Fire is arguably the most important ecosystem driver for maintaining this ecological site (Vogl 1974; Anderson 1990; Eilers and Roosa 1994). Fire intensity typically consisted of periodic, low-intensity surface fires (Stambaugh et al. 2006; LANDFIRE 2009). Ignition sources included summertime lightning strikes from convective storms and bimodal, human ignitions during the spring and fall seasons. Native Americans regularly set fires to improve sight lines for hunting, driving large game, improving grazing and browsing habitat, agricultural and village clearing, and enhancing vital ethnobotanical plants (Day 1953; Barrett 1980; White 1994). Fire frequency has been estimated to occur on average every 6.6 years in the Loess Hills region (Stambaugh et al. 2006). This continuous disturbance provided critical conditions for perpetuating the native prairie ecosystem.

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

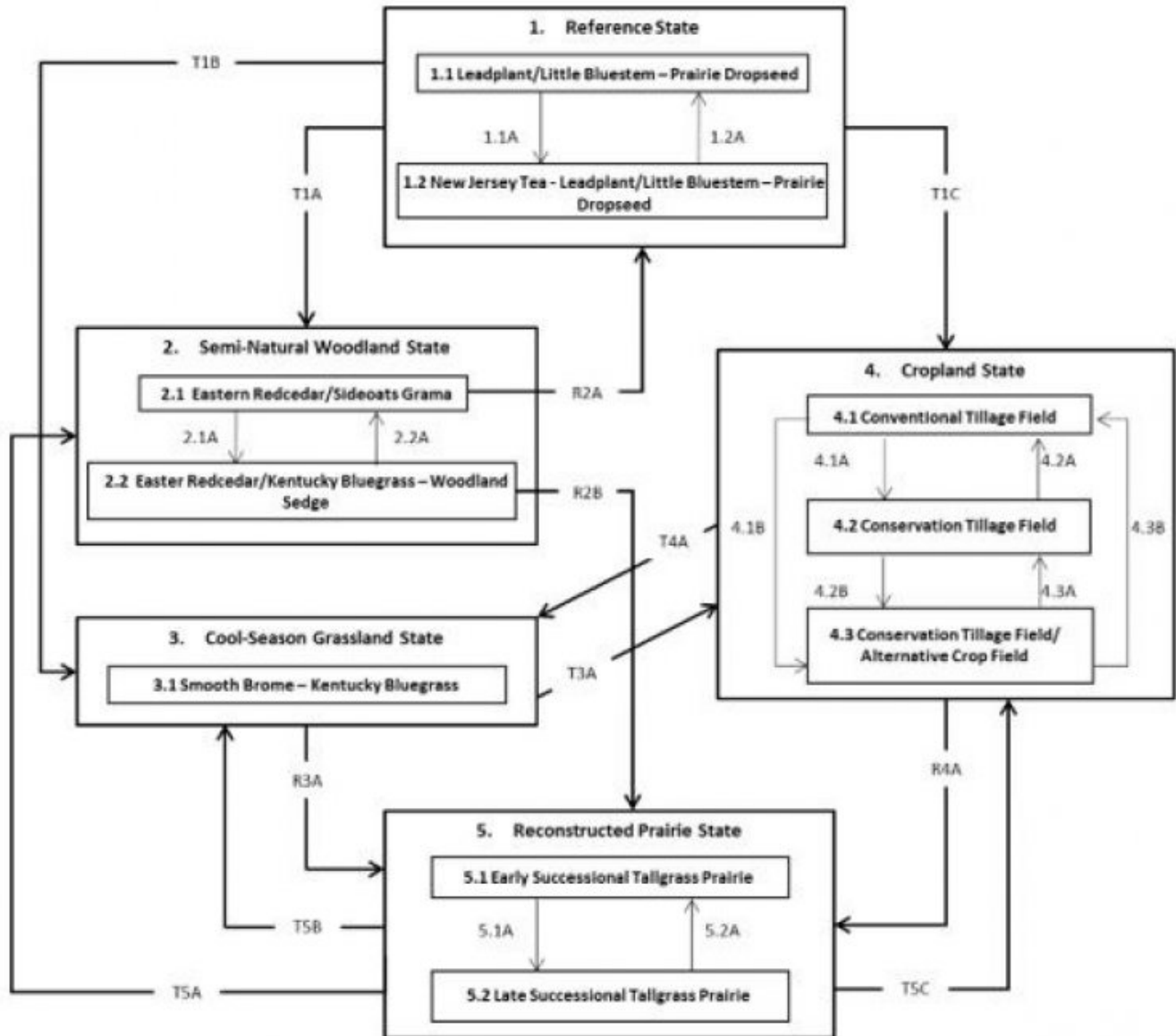
Drought has also played a role in shaping the prairie ecosystems in the Loess Hills. The periodic episodes of reduced soil moisture in conjunction with the well-drained soils have favored the proliferation of plant species tolerant of such conditions (Stambaugh et al. 2006). In addition, drought can also slow the growth of plants and

result in dieback of certain species. When coupled with fire, periods of drought can also greatly delay the recovery of woody vegetation, substantially altering the extent of shrubs and trees (Pyne et al. 1996).

Today, Deep Loess Upland Prairies are limited in their extent, having been converted to pasture or agricultural land. What remnants do exist have been degraded by woody species encroachment and invaded by non-native species (e.g., Kentucky bluegrass (*Poa pratensis* L.), sericea lespedeza (*Lespedeza cuneata* (Dum. Cours.) G. Don), and nodding plumeless thistle (*Carduus nutans* L.)) (Nelson 2010; Steinauer and Rolfsmeier 2010). A return to the historic plant community may not always be possible, but long-term restoration efforts can help to restore some natural diversity and ecological functioning.

State and transition model

R107BY002MO DEEP LOESS UPLAND PRAIRIE



Code	Process
T1A, T5A	Fire suppression
T1B, T4A	Brush control, interseeding of non-native cool-season grasses
T1C, T3A, T5C	Agricultural conversion via tillage, seeding, and non-selective herbicide
1.1A	Reduced fire return interval
1.1B	Increased fire return interval
R2A	Historic fire regime re-introduced
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
R2B, R3A, R4A	Site preparation, native seeding, non-native species control
5.1A	Invasive species control, native seeding, and implementation of natural disturbance regime
5.2A	Drought or improper timing/use of management actions

**State 1
Reference State**

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

Dominant plant species

- leadplant (*Amorpha canescens*), shrub
- prairie dropseed (*Sporobolus heterolepis*), grass

Community 1.1

Leadplant/Little Bluestem – Prairie Dropseed

Many grass species are present on the site, with little bluestem, big bluestem, and Indiangrass being the dominant ones (Nelson 2010; Steinauer and Rolfsmeier 2010). Prairie dropseed is an important, sometimes co-dominant, species characteristic of sites with higher clay content (Steinauer and Rolfsmeier 2010). Important forbs for this site include rush skeletonplant (*Lygodesmea juncea* (Pursh) D. Don ex Hook.), bastard toadflax (*Comandra umbellata* (L.) Nutt.), white heath aster (*Symphotrichum ericoides* (L.) G.L. Nesom var. *ericoides*), and prairie blazing star (*Liatris pycnostachya* Michx.). Shrubs, such as leadplant, are scattered throughout the community (Nelson 2010; Steinauer and Rolfsmeier 2010).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- American sycamore (*Platanus occidentalis*), tree
- elm (*Ulmus*), shrub
- Virginia wildrye (*Elymus submuticus*), grass
- wingstem (*Verbesina alternifolia*), other herbaceous

Community 1.2

New Jersey Tea – Leadplant/Little Bluestem – Prairie Dropseed

This reference community phase can occur when fire frequency is reduced to every four to six years (Stambaugh et al. 2006). The native prairie grasses continue to form the dominant herbaceous ground layer, but the reduced fire interval allows woody and suffruticose species to increase shrub cover species across the prairie with canopy coverage ranging from about ten to 30 percent (LANDFIRE 2009). Important shrub species in this phase include New Jersey tea, leadplant, Jersey tea (*Ceanothus herbaceus* Raf.), and prairie rose (*Rosa arkansana* Porter) (Nelson 2010; Steinauer and Rolfsmeier 2010).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- American sycamore (*Platanus occidentalis*), tree
- elm (*Ulmus*), tree
- American plum (*Prunus americana*), shrub
- coralberry (*Symphoricarpos orbiculatus*), shrub
- sedge (*Carex*), grass
- wingstem (*Verbesina alternifolia*), other herbaceous

Pathway P1.1A

Community 1.1 to 1.2

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

Pathway P1.2A

Community 1.2 to 1.1

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

State 2

Semi-Natural Woodland State

Fire suppression can transition the reference prairie community into a semi-natural woodland state dominated by eastern redcedar (*Juniperus virginiana* L.) (Briggs et al. 2002; Anderson 2003). Eastern redcedar is a species native to the eastern half of North America with a range spanning from Ontario east to Nova Scotia, south across the Great Plains into eastern Texas, and east to the Atlantic coast (Lawson 1990; Lee 1996). It is a long-lived (450+ years), slow-growing, fire-intolerant dioecious conifer and historically was found in areas that were protected from fire (e.g., bluffs, rocky hillsides, sandstone cliffs, granite outcrops, etc.) (Ferguson et al. 1968; Anderson 2003). Today, however, decades of fire suppression have allowed this species to spread and it can now be found occupying sites with highly variable aspects, topography, soils, and formerly stable plant communities (Anderson 2003).

Dominant plant species

- eastern redcedar (*Juniperus virginiana*), tree
- sideoats grama (*Bouteloua curtipendula*), grass

Community 2.1

Eastern Redcedar/Sideoats Grama

This community phase represents the early stages of eastern redcedar invasion into the prairie. Native grass species that can persist during this stage include big bluestem, little bluestem, sideoats grama, and Scribner's rosette grass (*Dichanthelium oligosanthos* (Sult.) Gould var. *scribnerianum* (Nash) Gould), however sideoats grama is the only species known to increase its cover during this phase. Candle anemone (*Anemone cylindrica* A. Gray), cutleaf anemone (*Pulsatilla patens* (L.) Mill. ssp. *multifida* (Pritz.) Zamels), and Cuman ragweed (*Ambrosia psilostachya* DC.) comprise the persistent forb component of the plant community (Gehring and Bragg 1992; Rosburg 1994).

Dominant plant species

- eastern redcedar (*Juniperus virginiana*), tree
- sideoats grama (*Bouteloua curtipendula*), grass
- little bluestem (*Schizachyrium scoparium*), grass
- big bluestem (*Andropogon gerardii*), grass

Community 2.2

Eastern Redcedar/Kentucky Bluegrass – Eastern Woodland Sedge

Sites falling into this community phase are strongly dominated by eastern redcedar as a result of over 20 years of fire suppression. As the canopies of the trees increase, light availability is greatly reduced to the ground layer and soil moisture increases, allowing more shade tolerant species, such as Kentucky bluegrass and eastern woodland sedge (*Carex blanda* Dewey), to replace the heliophytic tallgrass prairie species (Gehring and Bragg 1992; Brantley and Young 2010; Pierce and Reich 2010). Over time, the diversity and productivity of the herbaceous understory is greatly reduced (Smith and Stubbendieck 1990; Gehring and Bragg 1992; Rosburg 1994). The continued absence of fire and other disturbances will allow this community to expand its range.

Dominant plant species

- eastern redcedar (*Juniperus virginiana*), tree
- eastern woodland sedge (*Carex blanda*), grass
- Kentucky bluegrass (*Poa pratensis*), grass

Pathway P2.1A

Community 2.1 to 2.2

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

Pathway P2.2A

Community 2.2 to 2.1

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

State 3

Cool Season Pasture State

The cool-season pasture state occurs when the reference state has been anthropogenically-altered for livestock production. Fire suppression, seeding of non-native cool-season grasses, removal of woody vegetation, periodic cultural treatments, and grazing by domesticated livestock transition and maintain this simplified grassland state (Rosburg 1994; USDA-NRCS 2003). Early settlers seeded such non-native cool-season species as smooth brome (*Bromus inermis* Leyss.) and Kentucky bluegrass in order to help extend the grazing season (Smith 1998). Over time, as lands were continually grazed by large herds of cattle, the non-native species were able to spread and expand across the prairie habitat, reducing the native species diversity.

Dominant plant species

- smooth brome (*Bromus inermis*), grass
- Kentucky bluegrass (*Poa pratensis*), grass

Community 3.1

Smooth Brome– Kentucky Bluegrass

Species characteristic of this community phase include smooth brome, Kentucky bluegrass, and sweetclovers (*Melilotus* Mill.) (Steinauer and Rolfsmeier 2010). While native grasses may still occur, the non-native species oftentimes occur in higher frequencies across the site. Annuals and biennials are important components of this community phase and are indicative of the disturbed nature of the site (Rosburg 1994).

Dominant plant species

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

State 4

Cropland State

The Midwest is well-known for its highly-productive agricultural soils, and as a result, much of the MLRA has been converted to cropland, including portions of this ecological site. The continuous use of tillage, row-crop planting, and chemicals (i.e., herbicides, fertilizers, etc.) have effectively eliminated the reference community and many of its natural ecological functions in favor of crop production. Corn (*Zea mays* L.) and soybeans (*Glycine max* (L.) Merr.) are the dominant crops for the site. These areas are likely to remain in crop production for the foreseeable future.

Community 4.1

Conventional Tillage Field

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

Community 4.2

Conservation Tillage Field

This community phase is characterized by rotational crop production that utilizes various conservation tillage methods to promote soil health and reduce erosion. Conservation tillage methods include strip-till, ridge-till, vertical-till, or no-till planting systems. Strip-till keeps seedbed preparation to narrow bands less than one-third the width of

the row where crop residue and soil consolidation are left undisturbed in-between seedbed areas. Strip-till planting may be completed in the fall and nutrient application either occurs simultaneously or at the time of planting. Ridge-till uses specialized equipment to create ridges in the seedbed and vegetative residue is left on the surface in between the ridges. Weeds are controlled with herbicides and/or cultivation, seedbed ridges are rebuilt during cultivation, and soils are left undisturbed from harvest to planting. Vertical-till systems employ machinery that lightly tills the soil and cuts up crop residue, mixing some of the residue into the top few inches of the soil while leaving a large portion on the surface. No-till management is the most conservative, disturbing soils only at the time of planting and fertilizer application. Compared to conventional tillage system, conservation tillage methods can reduce soil erosion, increase organic matter and water availability, improve water quality, and reduce soil compaction.

Community 4.3

Conservation Tillage Field/Alternative Crop Field

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

Pathway P4.1A

Community 4.1 to 4.2

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

Pathway P4.1B

Community 4.1 to 4.3

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

Pathway P4.2A

Community 4.2 to 4.1

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

Pathway P4.2B

Community 4.2 to 4.3

Cover crops are implemented to prevent soil erosion.

Pathway P4.3B

Community 4.3 to 4.1

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

Pathway P4.3A

Community 4.3 to 4.2

Cover crop practices are abandoned.

State 5

Reconstructed Tallgrass Prairie

Prairie reconstructions have become an important tool for repairing natural ecological functioning and providing habitat protection for numerous grassland-dependent species. The historic plant community of the tallgrass prairie was extremely diverse and complex, and prairie replication is not considered to be possible once the native vegetation has been altered by post-European settlement land uses. Therefore ecological restoration should aim to aid the recovery of degraded, damaged, or destroyed ecosystems. A successful restoration will have the ability to structurally and functionally sustain itself, demonstrate resilience to the natural ranges of stress and disturbance, and create and maintain positive biotic and abiotic interactions (SER 2002). The reconstructed 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 will help the site progress from an early successional community dominated by annuals and some weeds to a later seral stage composed of native perennial grasses, forbs, and shrubs. 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 Tallgrass Prairie

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

Community 5.2

Late Successional Tallgrass Prairie

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

Pathway P5.1A

Community 5.1 to 5.2

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

Pathway P5.2A

Community 5.2 to 5.1

Restoration 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 this site to the semi-natural woodland state (2).

Transition T1B

State 1 to 3

Interseeding non-native cool-season grasses and brush control transition this site to the cool-season pasture state (3).

Transition T1C

State 1 to 4

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

Restoration pathway R2B

State 2 to 5

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

Transition T3A

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

Restoration pathway T4A

State 4 to 3

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

Restoration pathway R4A

State 4 to 5

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

Transition T5A

State 5 to 2

Active management of the restored prairie is ceased and woody encroachment transitions this site to the semi-natural woodland state (2).

Restoration pathway T5B

State 5 to 3

Land is converted to the cool-season pasture state through the use of non-selective herbicide and seeding of non-native cool-season grasses (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

Animal community

Wildlife*

Game species that utilize this ecological site include:

Northern Bobwhite will utilize this ecological site for food (seeds, insects) and cover needs (escape, nesting and roosting cover).

Cottontail rabbits will utilize this ecological site for food (seeds, soft mast) and cover needs.

Turkey will utilize this ecological site for food (seeds, green browse, soft mast, insects) and nesting and brood-rearing cover. Turkey poults feed heavily on insects provided by this site type.

White-tailed Deer will utilize this ecological site for browse (plant leaves in the growing season, seeds and soft mast in the fall/winter). This site type also can provide escape cover.

Bird species associated with this ecological site's reference state condition:

Breeding birds as related to vegetation structure (related to time since fire, grazing, haying, and mowing):

Vegetation Height Short (< 0.5 meter, low litter levels, bare ground visible):

Grasshopper Sparrow, Horned Lark, Upland Sandpiper, Greater Prairie Chicken, Northern Bobwhite

Mid-Vegetation Height (0.5 – 1 meter, moderate litter levels, some bare ground visible):

Eastern Meadowlark, Dickcissel, Field Sparrow, Upland Sandpiper, Greater Prairie Chicken, Northern Bobwhite, Eastern Kingbird, Bobolink, Lark Sparrow

Tall Vegetation Height (> 1 meter, moderate-high litter levels, little bare ground visible):

Henslow's Sparrow, Dickcissel, Greater Prairie Chicken, Field Sparrow, Northern Bobwhite, Sedge Wren, Northern Harrier

Brushy – Mix of grasses, forbs, native shrubs (e.g., *Rhus copallina*, *Prunus americana*, *Rubus* spp., *Rosa carolina*) and small trees (e.g., *Cornus racemosa*): Bell's Vireo, Yellow-Breasted Chat, Loggerhead Shrike, Brown Thrasher, Common Yellowthroat

Winter Resident: Short-Eared Owl, Le Conte's Sparrow

Amphibian and reptile species associated with this ecological site's reference state condition: prairies with or nearby to fishless ponds/pools (may be ephemeral) may have Eastern Tiger Salamander (*Ambystoma tigrinum tigrinum*) and Western Chorus Frog (*Pseudacris triseriata triseriata*); prairies with crawfish burrows may have Northern Crawfish Frog (*Rana areolata circulosa*); other species include Northern Prairie Skink (*Eumeces septentrionalis septentrionalis*), Ornate Box Turtle (*Terrapene ornata ornata*), Western Slender Glass Lizard (*Ophisaurus attenuatus attenuatus*), Eastern Yellow-bellied Racer (*Coluber constrictor flaviventris*), Prairie Ring-necked Snake (*Diadophis punctatus arnyi*), and Bullsnake (*Pituophis catenifer sayi*).

Small mammals associated with this ecological site's reference state condition: Least Shrew (*Cryptotis parva*), Franklin's Ground Squirrel (*Spermophilus franklinii*), Plains Pocket Gopher (*Geomys bursarius*), Prairie Vole (*Microtus ochrogaster*), Southern Bog Lemming (*Synaptomys cooperi*), Meadow Jumping Mouse (*Zapus hudsonius*), Thirteen-lined Ground Squirrel (*Spermophilus tridecemlineatus*) and Badger (*Taxidea taxus*).

Invertebrates:

Many native insect species are likely associated with this ecological site, especially native bees, ants, beetles, butterflies and moths, and crickets, grasshoppers and katydids. However information on these groups is often lacking enough resolution to assign them to individual ecological sites.

Insect species known to be associated with this ecological site's reference state condition: Regal Fritillary butterfly (*Speyeria idalia*) whose larvae feed primarily on native prairie violets (*Viola pedata*, *V. pedatifida*, and *V. sagittata*);

Mottled Dusky Wing butterfly (*Erynnis martialis*), Golden Byssus butterfly (*Problema byssus kumskaka*), Delaware Skipper butterfly (*Atryone logan logan*), and Crossline Skipper butterfly (*Polites origenes*). The larvae of the moth *Eucosma bipunctella* bore into compass plant (*Silphium laciniatum*) roots and feed and the larvae of the moth *Eucosma giganteana* bore into a number of *Silphium* species roots and feed. Native bees, important pollinators, that may be associated with this ecological site's reference condition include: *Colletes brevicornis*, *Andrena beameri*, *A. helianthiformis*, *Protandrena rudbeckiae*, *Halictus parallelus*, *Lasioglossum albipennis*, *L. coreopsis*, *L. disparilis*, *L. nymphaeum*, *Ashmeadiella buconis*, *Megachile addenda*, *Anthidium psoraleae*, *Eucera hamata*, *Melissodes coloradensis*, *M. coreopsis*, and *M. vernoniae*. The Short-winged Katydid (*Amblycorypha parvipennis*), Green Grasshopper (*Hesperotettix speciosus*) and Two-voiced Conehead katydid (*Neoconcephalus bivocatus*) are possible orthopteran associates of this ecological site.

Other invertebrate associates include the Grassland Crayfish (*Procambarus gracilis*).

*This section prepared by Mike Leahy, Natural Areas Coordinator, Missouri Department of Conservation, 2013

Other information

Forestry

Management: This ecological site is not recommended for traditional timber management activity. Historically this site was dominated by a ground cover of native prairie grasses and forbs. Some scattered open grown trees may have also been present. May be suitable for non-traditional forestry uses such as windbreaks, environmental plantings, alley cropping (a method of planting, in which rows of trees or shrubs are interspersed with rows of crops) or woody bio-fuels.

Inventory data references

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

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Approval

Chris Tecklenburg, 5/21/2020

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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)	Lisa Kluesner
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:
-
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:**
-