USDA Natural Resources
Conservation Service

Ecological site F115XC006IL
Loess Upland Flatwoods

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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): 115X–Central Mississippi Valley Wooded Slopes

This MLRA is characterized by deeply dissected, loess-covered hills bordering well defined valleys of the Illinois, Mississippi, Missouri, Ohio, and Wabash Rivers and their tributaries. It is used to produce cash crops and livestock. About one-third of the area is forested, mostly on the steeper slopes. This area is in Illinois (50 percent), Missouri (36 percent), Indiana (13 percent), and Iowa (1 percent) in two separate areas. It makes up about 25,084 square miles (64,967 square kilometers).

Most of this area is in the Till Plains section and the Dissected Till Plains section of the Central Lowland province of the Interior Plains. The Springfield-Salem plateaus section of the Ozarks Plateaus province of the Interior Highlands occurs along the Missouri River and the Mississippi River south of the confluence with the Missouri River. The nearly level to very steep uplands are dissected by both large and small tributaries of the Illinois, Mississippi, Missouri, Ohio, and Wabash Rivers. The Ohio River flows along the southernmost boundary of this area in Indiana. Well defined valleys with broad flood plains and numerous stream terraces are along the major streams and rivers. The flood plains along the smaller streams are narrow. Broad summits are nearly level to undulating. Karst topography is common in some parts along the Missouri and Mississippi Rivers and their tributaries. Well-developed karst areas have hundreds of sinkholes, caves, springs, and losing streams. In the St. Louis area, many of the karst features have been obliterated by urban development.

Elevation ranges from 90 feet (20 meters) on the southernmost flood plains to 1,030 feet (320 meters) on the highest ridges. Local relief is mainly 10 to 50 feet (3 to 15 meters) but can be 50 to 150 feet (15 to 45 meters) in the steep, deeply dissected hills bordering rivers and streams. The bluffs along the major rivers are generally 200 to 350 feet (60 to 105 meters) above the valley floor.

The uplands in this MLRA are covered almost entirely with Peoria Loess. The loess can be more than 7 feet (2 meters) thick on stable summits. On the steeper slopes, it is thin or does not occur. In Illinois, the loess is underlain mostly by Illinoian-age till that commonly contains a paleosol. Pre-Illinoian-age till is in parts of this MLRA in Iowa and Missouri and to a minor extent in the western part of Illinois. Wisconsin-age outwash, alluvial deposits, and sandy eolian material are on some of the stream terraces and on dunes along the major tributaries. The loess and glacial deposits are underlain by several bedrock systems. Pennsylvanian and Mississippian bedrock are the most extensive. To a lesser extent are Silurian, Devonian, Cretaceous, and Ordovician bedrock. Karst areas have formed where limestone is near the surface, mostly in the southern part of the MLRA along the Mississippi River and some of its major tributaries. Bedrock outcrops are common on the bluffs along the Mississippi, Ohio, and Wabash Rivers and their major tributaries and at the base of some steep slopes along minor streams and drainageways.

The annual precipitation ranges from 35 to 49 inches (880 to 1,250 millimeters) with a mean of 41 inches (1,050 millimeters). The annual temperature ranges from 48 to 58 degrees F (8.6 to 14.3 degrees C) with a mean of 54 degrees F (12.3 degrees C). The freeze-free period ranges from 150 to 220 days with a mean of 195 days.

Soils The dominant soil orders are Alfisols and, to a lesser extent, Entisols and Mollisols. The soils in the area have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed or smectitic mineralogy. They are shallow to very deep, excessively drained to poorly drained, and loamy, silty, or clayey.

The soils on uplands in this area support natural hardwoods. Oak, hickory, and sugar maple are the dominant species. Big bluestem, little bluestem, and scattered oak and eastern redcedar grow on some sites. The soils on flood plains support mixed forest vegetation, mainly American elm, eastern cottonwood, river birch, green ash, silver maple, sweetgum, American sycamore, pin oak, pecan, and willow. Sedge and grass meadows and scattered trees are on some low-lying sites. (United States Department of Agriculture, Natural Resources Conservation Service, 2022)

LRU notes

The Central Mississippi Valley Wooded Slopes, Northern part (Land Resource Unit (LRU) (115XC) encompasses the Wyaconda River Dissected Till Plains, Mississippi River Hills, and Mississippi River Alluvial Plain (Schwegman et al. 1973; Nelson 2010). It spans three states – Illinois (73 percent), Iowa (6 percent), and Missouri (21 percent) – comprising about 13,650 square miles (Figure 1). The elevation ranges from 420 feet above sea level (ASL) along the Mississippi River floodplains to 885 feet on the upland ridges. Local relief varies from 10 to 20 feet but can be as high as 50 to 100 feet along drainageways and streams and the bluffs on the major rivers reaching 250 feet above valley floors. Wisconsin-aged loess covers the uplands, while Illinoian glacial drift lies directly below. The loess and drift deposits are underlain by several bedrock systems, including the Cretaceous, Pennsylvania, Mississippian, Silurian, Devonian, and Ordovician Systems. Wisconsin outwash deposits and sandy eolian material occur along stream terraces of major tributaries (USDA-NRCS 2006).

The vegetation across the region 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 (Taft et al. 2009). During the most recent climatic shifts, forested ecosystems maintained footholds on steep valley sides and wet floodplains. Due to the physiography of the MLRA, forests were the dominant ecosystems and were affected by such natural disturbances as droughts, wind, lightning, and occasional fire (Taft et al. 2009).

Classification relationships

Major Land Resource Area (MLRA) (USDA-NRCS, 2022):
115X–Central Mississippi Valley Wooded Slopes

USFS Subregions: Central Dissected Till Plains (251C)Section; Western Mississippi River Hills (251Ce), Mississippi River and Illinois Alluvial Plains (251Cf), Eastern Mississippi River Hills (251Ci), Galesburg Dissected Till Plain (251Cj), and Wyaconda River Dissected Till Plain (251Cm) Subsections (Cleland et al. 2007)

U.S. EPA Level IV Ecoregion: Upper Mississippi River Alluvial Plain (72d), River Hills (72f), and Western Dissected Illinoian Till Plain (72i) (USEPA 2013)

National Vegetation Classification – Ecological Systems: North-Central Interior Wet Flatwoods (CES202.700) (NatureServe 2018)

National Vegetation Classification – Plant Associations: Quercus stellata/Cinna arundinacea Flatwoods (CEGL002405) (Nature Serve 2018)

Biophysical Settings: North-Central Interior Wet Flatwoods (BpS 4315180) (LANDFIRE 2009)

Natural Resources Conservation Service – Iowa Plant Community Species List: Forest, Pin Oak Mixed Hardwood (USDA-NRCS 2007)

Illinois Natural Areas Inventory: Southern Flatwoods (White and Madany 1978)

Iowa Department of Natural Resources: Upland Forest (INAI 1984)

Missouri Terrestrial Natural Communities: Upland Flatwoods (Nelson 2010)

Ecological site concept

Loess Upland Flatwoods are located within the green areas on the map. They occur on upland flats. The soils are Alfisols that are poorly drained and very deep, formed in loess. Low hydraulic gradients create a shallow depth to a perched water table.

The historic pre-European settlement vegetation on this ecological site was dominated by an open oak woodland community. Post oak (Quercus stellata Wangenh.) is the dominant overstory species and little bluestem (Schizachyrium scoparium (Michx.) Nash) and sweet woodreed (Cinna arundinacea L.) are the dominant and characteristic herbaceous species on the site, respectively. Other canopy associates likely include white oak (Quercus alba L.), swamp white oak (Quercus bicolor Willd.), blackjack oak (Quercus marilandica Münchh.), and pin oak (Quercus palustris Münchh.) (White and Madany 1978; NatureServe 2018). Seasonal high-water tables, windthrow, periodic fires, and drought are important disturbances that maintain this ecological site (LANDFIRE 2009).

Associated sites

F115XC005IL	**Loess Upland Forest** Loess and loess-covered substrate parent material that is not shallow to a high-water table including Atlas, Baylis, Bunkum, Caseyville, Creal, Derinda, Dodge, Fayette, Fishhook, Hickory, Kendall, Keomah, Keswick, Menfro, Metea, Navlys, Rozetta, Seaton, Stookey, Stronghurst, Sylvan, Thebes, Timula, Ursa, and Winfield soils

Table 1. Dominant plant species

Tree	(1) *Quercus stellata*
Shrub	Not specified
Herbaceous	(1) *Schizachyrium scoparium* (2) *Cinna arundinacea*

Physiographic features

Loess Upland Flatwoods occur on upland flats (Figure 2). They are situated on elevations ranging from approximately 331 to 3346 feet ASL. The site does not experience flooding, but rather allows for groundwater recharge due to low hydraulic gradients.

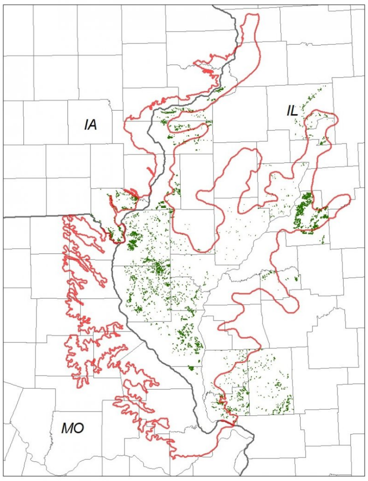


Figure 1. Location of Loess Upland Flatwoods ecological site within LRU 115XC.

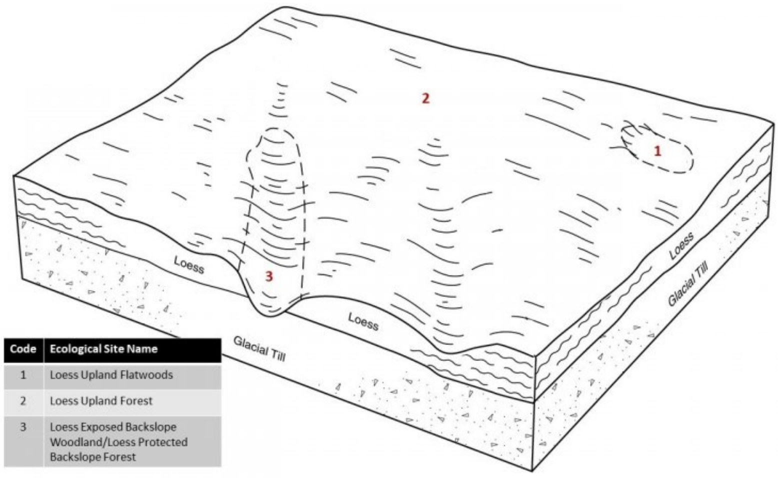


Figure 2. Representative block diagram of Loess Upland Flatwoods and associated ecological sites.

Table 2. Representative physiographic features

Slope shape across	(1) Linear (2) Concave
Slope shape up-down	(1) Linear (2) Concave
Landforms	(1) Upland
Runoff class	Very low to low
Flooding frequency	None
Ponding frequency	None
Elevation	101–1,020 m
Slope	0–2%
Water table depth	0–15 cm
Aspect	Aspect is not a significant factor

Climatic features

The Central Mississippi Valley Wooded Slopes, Northern Part falls into the humid subtropical (Cfa) and hot-summer humid continental climate (Dfa) 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 LRU 115XC 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 182 days, while the frost-free period is about 146 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 39 inches, which includes rainfall plus the water equivalent from snowfall (Table 3). The average annual low and high temperatures are 42 and 63°F, respectively.

Table 3. Representative climatic features

Frost-free period (characteristic range)	139-150 days

Freeze-free period (characteristic range)	169-199 days
Precipitation total (characteristic range)	965-1,041 mm
Frost-free period (actual range)	135-162 days
Freeze-free period (actual range)	167-204 days
Precipitation total (actual range)	914-1,041 mm
Frost-free period (average)	146 days
Freeze-free period (average)	182 days
Precipitation total (average)	991 mm

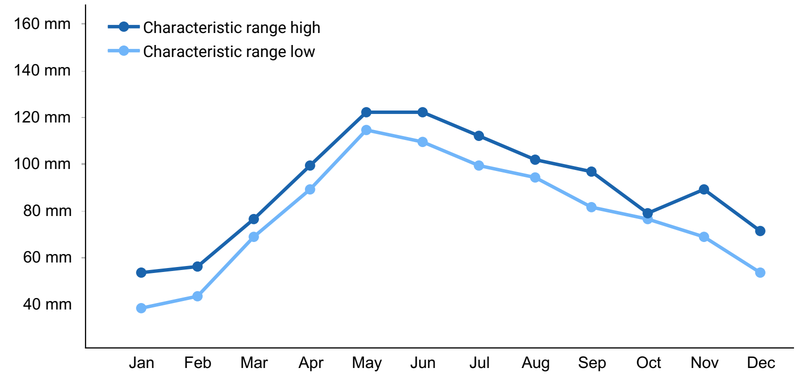


Figure 3. Monthly precipitation range

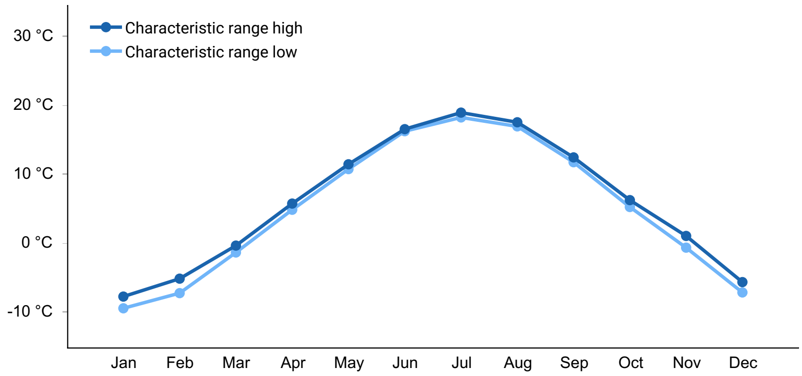


Figure 4. Monthly minimum temperature range

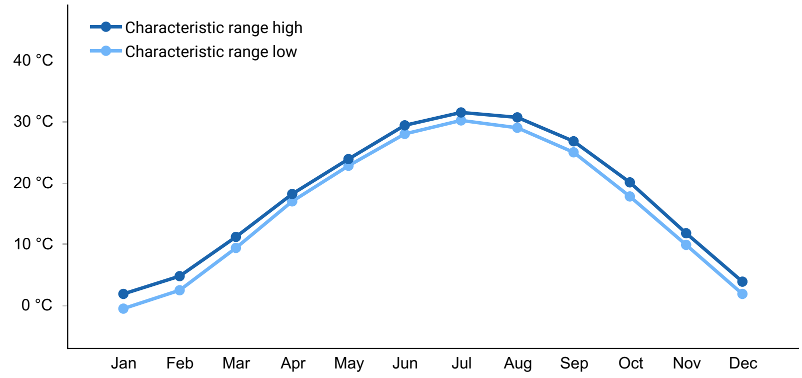


Figure 5. Monthly maximum temperature range

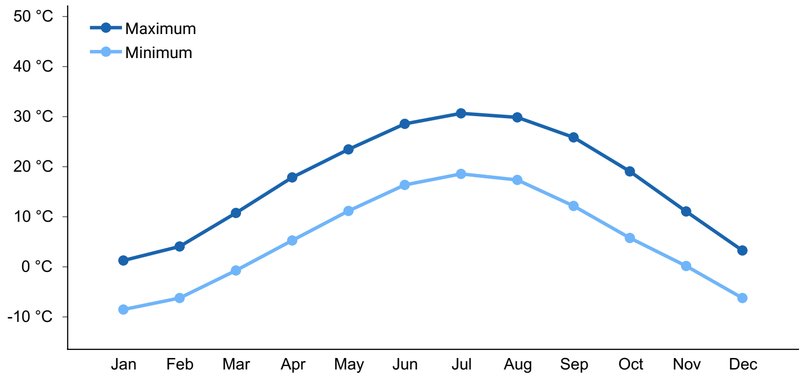


Figure 6. Monthly average minimum and maximum temperature

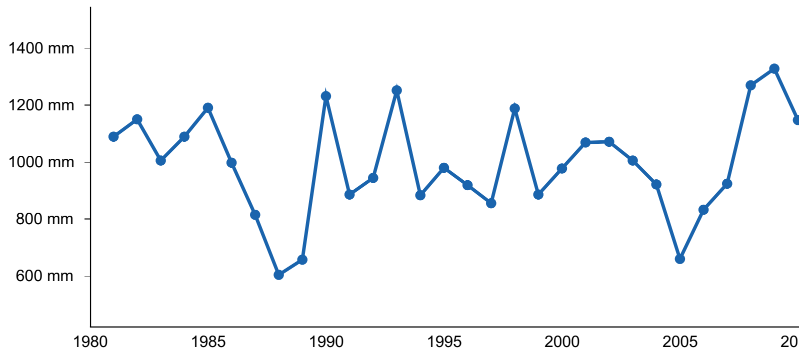


Figure 7. Annual precipitation pattern

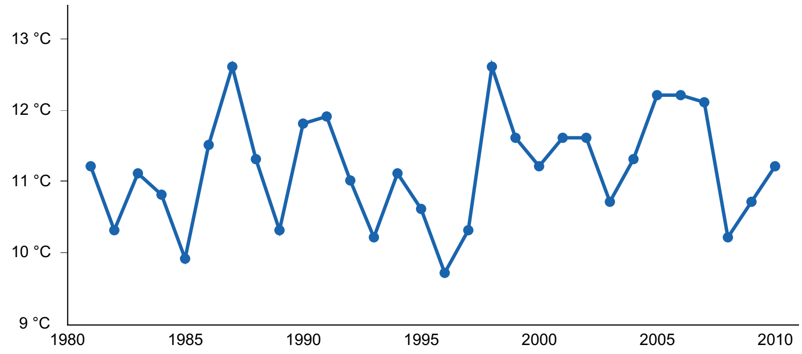


Figure 8. Annual average temperature pattern

Climate stations used

- (1) MORRISON [USC00115833], Morrison, IL
- (2) HAVANA [USC00113940], Lewistown, IL
- (3) NEW BOSTON DAM 17 [USC00116080], Wapello, IL
- (4) LA HARPE [USC00114823], La Harpe, IL
- (5) PITTSFIELD #2 [USC00116837], Pittsfield, IL
- (6) ST CHARLES CO AP [USW00053904], Portage des Sioux, MO

Influencing water features

Loess Upland Flatwoods are classified as a MINERAL SOIL FLATS: saturated, recharge, forested wetland under the Hydrogeomorphic (HGM) classification system (Smith et al. 1995; USDA-NRCS 2008) and as a Palustrine, Forested, Broad-leaved Deciduous, Seasonally Saturated wetland under the National Wetlands Inventory (FGDC 2013). Precipitation is the main source of water for this ecological site (Smith et al. 1995). Infiltration is very slow (Hydrologic Group D) for undrained soils, and surface runoff is negligible to low.

Wetland description

Primary wetland hydrology indicators for an intact Loess Upland Flatwoods may include: A2 High water table and A3 Saturation. Secondary wetland hydrology indicators may include: C2 Dry-season water table and D5 FAC-neutral test (USACE 2010).

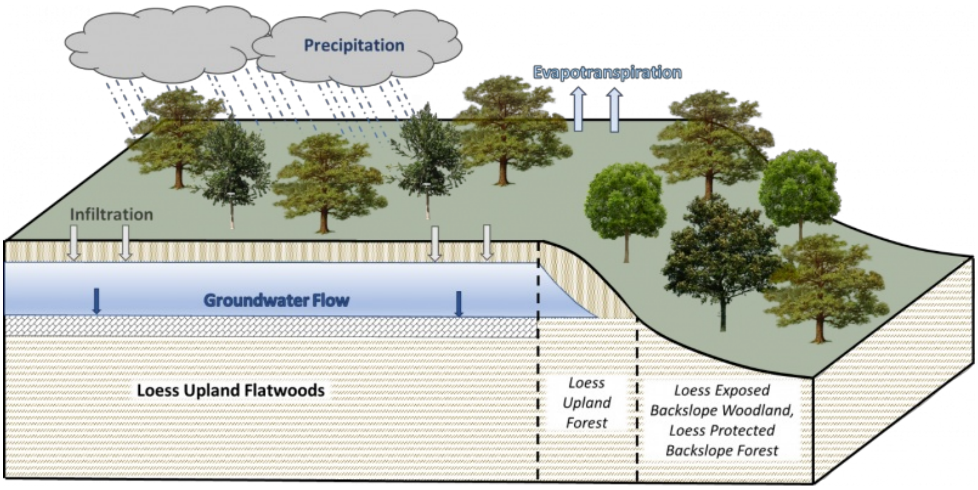


Figure 9. Hydrologic cycling on Loess Upland Flatwoods ecological site.

Soil features

Soils of Loess Upland Flatwoods are in the Alfisols order, further classified as Typic Albaqualfs and Vertic Albaqualfs with very slow infiltration and negligible to low runoff potential. The soil series associated with this site includes Rubio and Rushville. The parent material is loess, and the soils are poorly drained and very deep with seasonal high-water tables. Soil pH classes are very strongly acid to moderately alkaline. A shallow, abrupt textural change is noted as a rooting restriction for the soils of this ecological site.

Some soil map units in this ecological site, if not drained, may meet the definition of hydric soils and are listed as meeting criteria 2 of the hydric soils list (77 FR 12234).

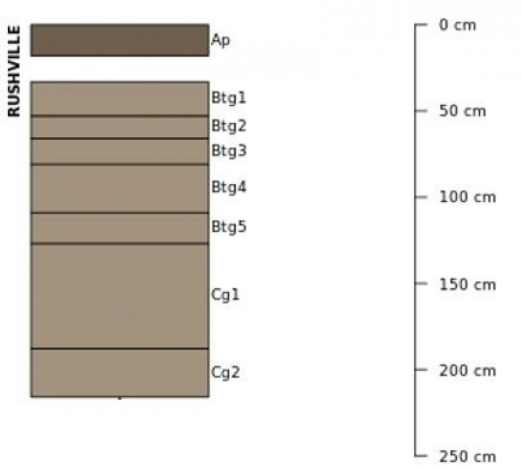


Figure 10. Profile sketches of soil series associated with Loess Upland Flatwoods.

Table 4. Representative soil features

Parent material	(1) Loess
Surface texture	(1) Silt loam
Family particle size	(1) Fine
Drainage class	Very poorly drained to poorly drained
Permeability class	Very slow

Depth to restrictive layer	203 cm
Soil depth	203 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (Depth not specified)	7.62–17.78 cm
Calcium carbonate equivalent (Depth not specified)	0–15%
Electrical conductivity (Depth not specified)	0 mmhos/cm
Sodium adsorption ratio (Depth not specified)	0
Soil reaction (1:1 water) (Depth not specified)	4.5–8.4
Subsurface fragment volume <=3" (Depth not specified)	0%
Subsurface fragment volume >3" (Depth not specified)	0%

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, but a variety of environmental and edaphic factors resulted in a landscape that historically supported upland hardwood forests, lowland mixed forests, and scattered grass and sedge meadows. Loess Upland Flatwoods form an aspect of this vegetative continuum. This ecological site occurs on upland flats on poorly drained soils. Species characteristic of this ecological site consist of an open canopy of oaks with herbaceous understory vegetation.

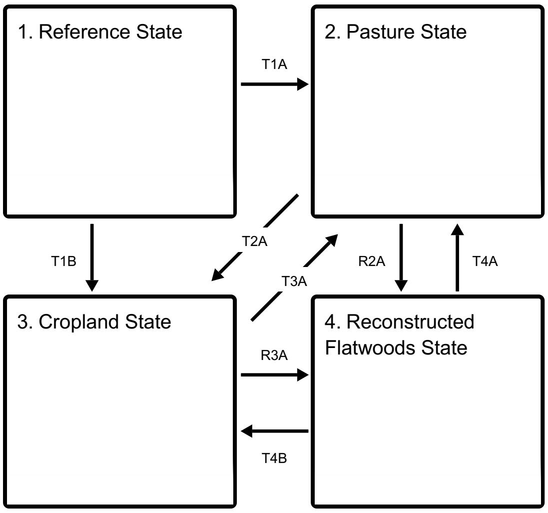
Seasonal high-water tables, windthrow, and periodic fire are critical factors that maintain Loess Upland Flatwoods. Saturated soil conditions play an important role in woody and herbaceous species diversity by limiting seed germination. Damage to trees from storms can vary from minor, patchy effects of individual trees to stand effects that temporarily affect community structure and species richness and diversity (Irland 2000; Peterson 2000). Fire typically consisted of high-intensity, low-frequency fires projected to occur every 700-1000 years and generally followed large wind events or extended periods of drought (LANDFIRE 2009).

Drought has also played a role in shaping this ecological site. The periodic episodes of reduced soil moisture in conjunction with the poorly-drained soils have favored the proliferation of plant species tolerant of such conditions. Drought can also slow the growth of plants and result in dieback of certain species. When coupled with fire, periods of drought events can greatly delay the establishment and maturation of woody vegetation (Pyne et al. 1996).

Today, Loess Upland Flatwoods have been greatly reduced, if not extirpated, as lands have been cleared and type-converted for agricultural production. The state-and-transition model that follows provides a detailed description of each state, community phase, pathway, and transition. A return to the historic plant community may not be possible following extensive land modification, but long-term conservation agriculture or woodland reconstruction efforts can help to restore some biotic diversity and ecological function. This model is based on available experimental research, field observations, literature reviews, professional consensus, and interpretations.

State and transition model

Ecosystem states



T1A - Cultural treatments are implemented to increase forage quality and yield.

T1B - Ag conversion via tillage, seeding and non-selective herbicide.

T2A - Ag conversion via tillage, seeding and non-selective herbicide.

R2A - Site preparation; tree planting; non-native species control; native seeding.

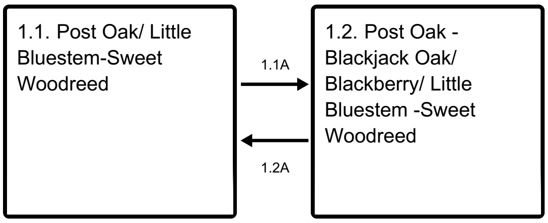
T3A - Cultural treatments are implemented to increase forage quality and yield.

R3A - Site preparation; tree planting; non-native species control; native seeding.

T4A - Cultural treatments are implemented to increase forage quality and yield.

T4B - Ag conversion via tillage, seeding and non-selective herbicide.

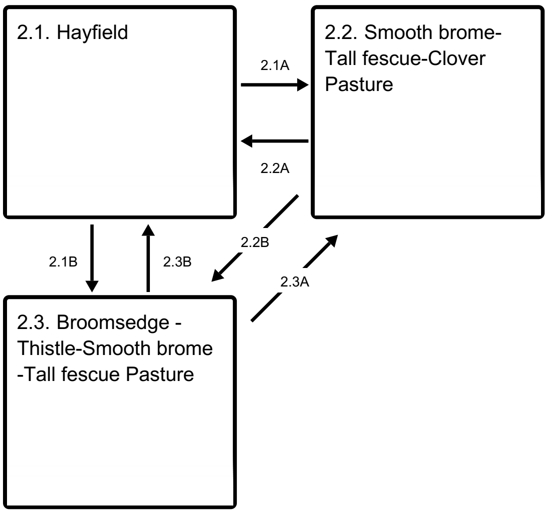
State 1 submodel, plant communities



1.1A - Natural succession following no disturbance for 30-50 years

1.2A - Fire or other disturbance event

State 2 submodel, plant communities



2.1A - Livestock grazing; proper animal to forage balance

2.1B - Livestock grazing with overutilization of the forage plants.

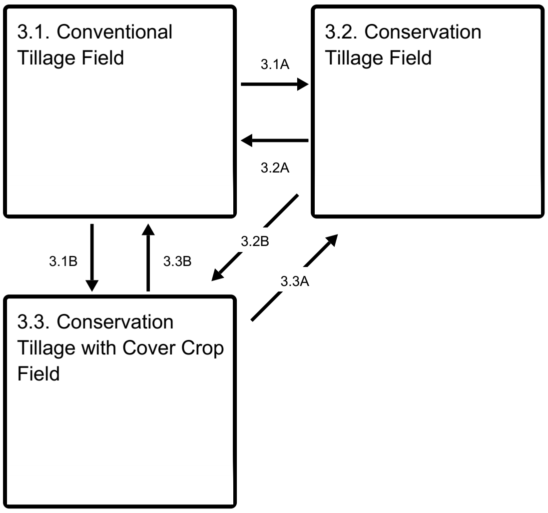
2.2A - Mechanical harvest

2.2B - Grazing; overutilization of forage species

2.3B - Mechanical harvest

2.3A - Grazing with proper forage to animal balance

State 3 submodel, plant communities



3.1A - Less tillage; residue management

3.1B - Less tillage; residue mgmt.; cover crops

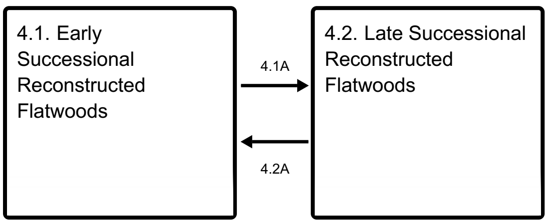
3.2A - intensive tillage; remove residue; row cropping

3.2B - Implement cover crops

3.3B - Intensive tillage; remove residue; row cropping

3.3A - Absence of cover crops

State 4 submodel, plant communities



4.1A - Successful stand improvement practices

4.2A - Setback in restoration

State 1
Reference State

The reference plant community is categorized as an open oak woodland community. The two community phases within the reference state are dependent on seasonal high-water tables, fire, or storm damage. These disturbances alter species composition, cover, and extent. Drought has more localized impacts in the reference phases, but does contribute to overall species composition, diversity, and productivity.

Dominant plant species

- post oak (*Quercus stellata*), tree
- sweet woodreed (*Cinna arundinacea*), grass
- little bluestem (*Schizachyrium scoparium*), grass

Community 1.1
Post Oak/ Little Bluestem-Sweet Woodreed

Sites in this reference community phase are an open canopy woodland. Post oak is the dominant tree species, but blackjack oak, swamp white oak, white oak, and pin oak are common canopy associates. Trees are medium (9 to 21-inch DBH) and cover is over 31 to 60 percent. The herbaceous layer varies from sparse to patchy due to seasonal high saturation. Characteristic and dominant species include little bluestem, sweet woodreed, and Muskingum sedge (*Carex muskingumensis* Schwein.) (White and Madany 1978). Shrubs are infrequent to sparse. Infrequent windthrow of single trees to small patches and low-intensity surface fires will maintain this phase, but an extended period of no disturbances would shift the community to phase 1.2 (LANDFIRE 2009).

Dominant plant species

- post oak (*Quercus stellata*), tree
- little bluestem (*Schizachyrium scoparium*), grass
- sweet woodreed (*Cinna arundinacea*), grass

Community 1.2
Post Oak - Blackjack Oak/ Blackberry/ Little Bluestem -Sweet Woodreed

This reference community phase represents natural succession of the site. Community structure has matured with tree size class increasing to large (21 to 33-inch DBH) and canopy cover over 60 percent (LANDFIRE 2009). The shrub layer can become well-developed during this phase and include various blackberries (Rubus L.) (LANDFIRE 2009). A medium-intensity fire or other large disturbance event will shift the community to phase 1.1 (LANDFIRE 2009).

Dominant plant species

- post oak (*Quercus stellata*), tree
- blackjack oak (*Quercus marilandica*), tree
- blackberry (*Rubus*), shrub
- little bluestem (*Schizachyrium scoparium*), grass
- sweet woodreed (*Cinna arundinacea*), grass

Pathway 1.1A
Community 1.1 to 1.2

Natural successional following 30-50+ years of no disturbances.

Pathway 1.2A
Community 1.2 to 1.1

Fire or other large disturbance event.

State 2
Pasture State

The pasture state occurs when the site 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 (Smith 1998). Over time, as lands were continuously harvested or grazed by herds of cattle, the non-native species were able to spread and expand across the landscape, reducing the native species diversity and ecological function.

Dominant plant species

- smooth brome (*Bromus inermis*), grass
- tall fescue (*Schedonorus arundinaceus*), grass
- Kentucky bluegrass (*Poa pratensis*), grass

Community 2.1
Hayfield

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

Dominant plant species

- smooth brome (*Bromus inermis*), grass
- tall fescue (*Schedonorus arundinaceus*), grass
- Kentucky bluegrass (*Poa pratensis*), grass
- timothy (*Phleum pratense*), grass
- orchardgrass (*Dactylis glomerata*), grass
- clover (*Trifolium*), other herbaceous
- alfalfa (*Medicago*), other herbaceous

Community 2.2
Smooth brome- Tall fescue-Clover Pasture

This community is characterized by seeded cool-season grass and forbs. Species will depend upon landowner goals and objectives and may include many different grasses and forbs. Common species include smooth brome (*Bromus inermis*), tall fescue (Festuca arundinacea), Kentucky bluegrass (*Poa pratensis*), timothy (*Phleum pratense*), red clover (*Trifolium pratense*) and white clover (*Trifolium repens* L.). Management inputs include control of weeds and brush. These sites are managed to ensure a proper forage/animal balance. Plants are not over utilized and have adequate rest and recovery.

Dominant plant species

- smooth brome (*Bromus inermis*), grass
- tall fescue (*Schedonorus arundinaceus*), grass
- Kentucky bluegrass (*Poa pratensis*), grass
- timothy (*Phleum pratense*), grass
- red clover (*Trifolium pratense*), other herbaceous
- white clover (*Trifolium repens*), other herbaceous

Community 2.3
Broomsedge -Thistle-Smooth brome -Tall fescue Pasture

Over utilization of the pasture will result in a shift to include more undesirable species such as thistle (Cirsium spp.), broomsedge (*Andropogon virginicus* L.), ironweed (*Vernonia gigantea*), and berries (Rubus spp.). Many woody and weed species may be present depending on seed sources and level of soil disturbance. This community reflects an improper forage-to-animal balance which will negatively impact forage productivity and reproduction, soil health, and water quality. Ecological resiliency is compromised under these conditions.

Dominant plant species

- blackberry (*Rubus*), shrub
- broomsedge bluestem (*Andropogon virginicus*), grass
- tall fescue (*Schedonorus arundinaceus*), grass
- smooth brome (*Bromus inermis*), grass
- ironweed (*Vernonia*), other herbaceous
- thistle (*Cirsium*), other herbaceous

Pathway 2.1A
Community 2.1 to 2.2

Mechanical harvesting is replaced with domestic livestock grazing.

Pathway 2.1B
Community 2.1 to 2.3

Mechanical harvesting is replaced with domestic livestock grazing

Pathway 2.2A
Community 2.2 to 2.1

Livestock are removed and mechanical harvesting is implemented.

Pathway 2.2B
Community 2.2 to 2.3

Mechanical harvesting is replaced by grazing of livestock with overutilization of the forage plants.

Pathway 2.3B
Community 2.3 to 2.1

Domestic livestock are removed, and mechanical harvesting is implemented.

Pathway 2.3A
Community 2.3 to 2.2

Forage plants are not overutilized and the site has a proper forage-to-animal balance.

State 3
Cropland State

The low topographic relief across the MLRA has resulted in nearly the entire area being converted to agriculture (Eilers and Roosa 1994). Subsurface drainage and the continuous use of tillage, row-crop planting, and chemicals (i.e., herbicides, fertilizers, etc.) have effectively eliminated the reference community and many of its natural ecological functions in favor of crop production. Corn 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.

Dominant plant species

- oat (*Avena*), grass
- corn (*Zea mays*), other herbaceous
- soybean (*Glycine max*), other herbaceous
- alfalfa (*Medicago sativa*), other herbaceous

Community 3.1
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 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).

Dominant plant species

- soybean (*Glycine max*), other herbaceous
- corn (*Zea mays*), other herbaceous

Community 3.2
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 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.

Dominant plant species

- corn (*Zea mays*), other herbaceous
- soybean (*Glycine max*), other herbaceous

Community 3.3
Conservation Tillage with Cover 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.

Dominant plant species

- corn (*Zea mays*), other herbaceous
- soybean (*Glycine max*), other herbaceous
- wheat (*Triticum*), other herbaceous
- rye (*Secale*), other herbaceous
- clover (*Trifolium*), other herbaceous
- radish (*Raphanus*), other herbaceous

Pathway 3.1A
Community 3.1 to 3.2

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

Pathway 3.1B
Community 3.1 to 3.3

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

Pathway 3.2A
Community 3.2 to 3.1

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

Pathway 3.2B
Community 3.2 to 3.3

Cover crops are implemented to minimize soil erosion.

Pathway 3.3B
Community 3.3 to 3.1

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

Pathway 3.3A
Community 3.3 to 3.2

Cover crop practices are abandoned.

State 4
Reconstructed Flatwoods State

The combination of natural and anthropogenic disturbances occurring today has resulted in numerous forest health issues, and restoration back to the historic reference condition may not be possible. Woodlands are being stressed by non-native diseases and pests, habitat fragmentation, permanent changes in soil hydrology, and overabundant deer populations on top of naturally-occurring disturbances (severe weather and native pests) (Flickinger 2010). However, these habitats provide multiple ecosystem services including carbon sequestration; clean air and water; soil conservation; biodiversity support; wildlife habitat; timber, fiber, and fuel products; as well as a variety of cultural activities (e.g., hiking, camping, hunting) (Millennium Ecosystem Assessment 2005; Flickinger 2010). Therefore, conservation of forests and woodlands should still be pursued. Woodland reconstructions are an important tool for repairing natural ecological functioning and providing habitat protection for numerous species associated with these sites. 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 ranges of stress and disturbance, and create and maintain positive biotic and abiotic interactions (SER 2002). The reconstructed state is the result of a long-term commitment involving a multi-step, adaptive management process.

Dominant plant species

- oak (*Quercus*), tree

Community 4.1
Early Successional Reconstructed Flatwoods

This community phase represents the early community assembly from woodland reconstruction. It is highly dependent on the current condition of the woodland based on past and current land management actions, invasive species, and proximity to land populated with non-native pests and diseases. Therefore, no two sites will have the same early successional composition. Technical forestry assistance should be sought to develop suitable conservation management plans.

Dominant plant species

- oak (*Quercus*), tree

Community 4.2
Late Successional Reconstructed Flatwoods

Appropriately timed management practices (e.g., prescribed fire, hazardous fuels management, forest stand improvement, continuing integrated pest management) applied to the early successional community phase can help increase the stand maturity, pushing the site into a late successional community phase over time. A late successional reconstructed woodland will have an uneven-aged canopy and a well-developed shrub layer and understory.

Dominant plant species

- oak (*Quercus*), tree

Pathway 4.1A
Community 4.1 to 4.2

Application of stand improvement practices in line with a developed management plan.

Pathway 4.2A
Community 4.2 to 4.1

Reconstruction experiences a setback from extreme weather event or improper timing of management actions.

Transition T1A
State 1 to 2

Cultural treatments to enhance forage quality and yield transitions the site to the pasture state (2).

Transition T1B
State 1 to 3

Tillage, seeding of agricultural crops, and non-selective herbicide transition this site to the cropland state (3).

Transition T2A
State 2 to 3

Tillage, seeding of agricultural crops, and non-selective herbicide transition this site to the cropland state (3).

Restoration pathway R2A
State 2 to 4

Site preparation, tree planting, invasive species control, and seeding native species transition this site to the reconstructed flatwoods state (4).

Transition T3A
State 3 to 2

Cultural treatments to enhance forage quality and yield transitions the site to the pasture state (2).

Restoration pathway R3A
State 3 to 4

Site preparation, tree planting, invasive species control, and seeding native species transition this site to the reconstructed flatwoods state (4).

Transition T4A
State 4 to 2

Cultural treatments to enhance forage quality and yield transition the site to the pasture state (2).

Transition T4B
State 4 to 3

Tillage, seeding of agricultural crops, and non-selective herbicide transition this site to the cropland state (3).

Additional community tables

Inventory data references

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