USDA Natural Resources
Conservation Service

Ecological site R107XB021MO
Wet Terrace 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.

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 1,565 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, but as the warming continued, spruce trees were replaced by deciduous trees (Baker et al. 1990). Not until approximately 9,000 years ago did the vegetation transition to prairies as climatic conditions continued to warm and subsequently dry. Between 4,000 and 3,000 years ago, oak savannas began intermingling within the prairie landscape, while the more wooded and forested areas maintained a foothold in sheltered areas. This prairie-forest transition ecosystem formed the dominant landscapes until the arrival of European settlers (Baker et al. 1992).

Classification relationships

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

USFS Subregions: Central Dissected Till Plains Section (251C); Missouri River Alluvial Plain (251Cg) (Cleland et al. 2007)

U.S. EPA Level IV Ecoregion: Missouri Alluvial Plain (47d) (USEPA 2013)

Biophysical Setting (LANDFIRE 2009): Eastern Great Plains Floodplain System (4214690)

Ecological Systems (National Vegetation Classification System, Nature Serve 2015): North-Central Interior Floodplain (CES202.694)

Eilers and Roosa (1994): Missouri River Alluvium Region: Riverine Systems

Iowa Department of Natural Resources (INAI n.d.): Bur Oak – Swamp White Oak Floodplain Forest

Missouri Natural Heritage Program (Nelson 2010): Wet-Mesic Bottomland Woodland

Plant Associations (National Vegetation Classification System, Nature Serve 2015): Quercus macrocarpa – Quercus bicolor – Carya laciniosa/Leersia spp. – Cinna spp. Floodplain Forest (CEGL002098)

Ecological site concept

Wet Terrace Savannas are located within the green areas on the map (Figure 1). They occur on elevated terraces in floodplains. Soils are Mollisols and Vertisols that are somewhat poorly to poorly-drained and very deep, formed from alluvium. The site experiences shallow, backwater flooding every two to five years, resulting in a plant community comprised of both upland and hydrophytic woody and herbaceous vegetation (Nelson 2010). These sites occur adjacent to Loamy Terrace Savannas and below Loamy Footslope Savannas.

The historic pre-European settlement vegetation on this site consisted of a canopy of trees and a dense understory of tall and mixed grasses, sedges, and forbs. Bur oak (Quercus macrocarpa Michx.) and swamp white oak (Quercus bicolor Willd.) are the dominant trees in this ecological site, while prairie cordgrass (Spartina pectinata Bosc ex Link) and sawtooth sunflower (Helianthus grosseserratus M. Martens) are the dominant and characteristic species of the herbaceous layer. Herbaceous species typical of an undisturbed plant community associated with this ecological site include Gray's sedge (Carex grayii Carey) and soft fox sedge (Carex conjuncta Boott) (Drobney et al. 2001; Steinauer and Rolfsmeier 2010; Nelson 2010; Ladd and Thomas 2015). Historically, fire and flooding were the primary disturbance factors of this ecological site (LANDFIRE 2009; Nelson 2010).

Associated sites

R107XB020MO	**Loamy Terrace Savanna** Alluvial soils that are moderately well to well-drained including Ankeny, Anthon, Cott, Cotter, Keg, Norborne, Salix, and Wiota
R107XB008MO	**Loamy Footslope Savanna** Colluvium soils including Castana, Colo, Danbury, Deloit, Ely, Judson, Napier, Nodaway, Olmitz, Udarents, and Udorthents

Similar sites

R107XB008MO	**Loamy Footslope Savanna** Loamy Footslope Savannas occur high on a higher landscape position and soils are formed from colluvium
R107XB020MO	**Loamy Terrace Savanna** Loamy Terrace Savannas occur in a similar landscape position but soils are better drained and herbaceous vegetation is a less mesic composition

Table 1. Dominant plant species

Tree	(1) *Quercus macrocarpa* (2) *Quercus bicolor*
Shrub	Not specified
Herbaceous	(1) *Spartina pectinata* (2) *Helianthus grosseserratus*

Physiographic features

Wet Terrace Savannas occur on stream terraces in floodplains within the Missouri River alluvial valley (Figure 2). This ecological site is unique to the Loess Hills landform situated on elevations ranging from approximately 500 to 1,560 feet ASL. This site experiences rare to occasional flooding with surface water or soil saturation lasting for extended periods during the early growing season (Nelson 2010).

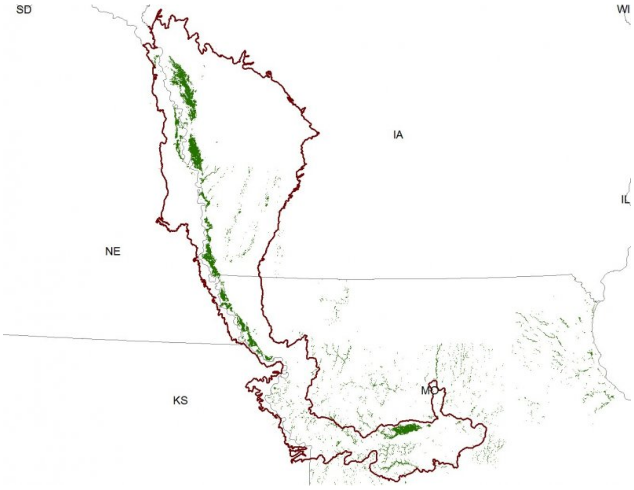


Figure 2. Figure 1. Location of Wet Terrace Savanna ecological site within MLRA 107B.

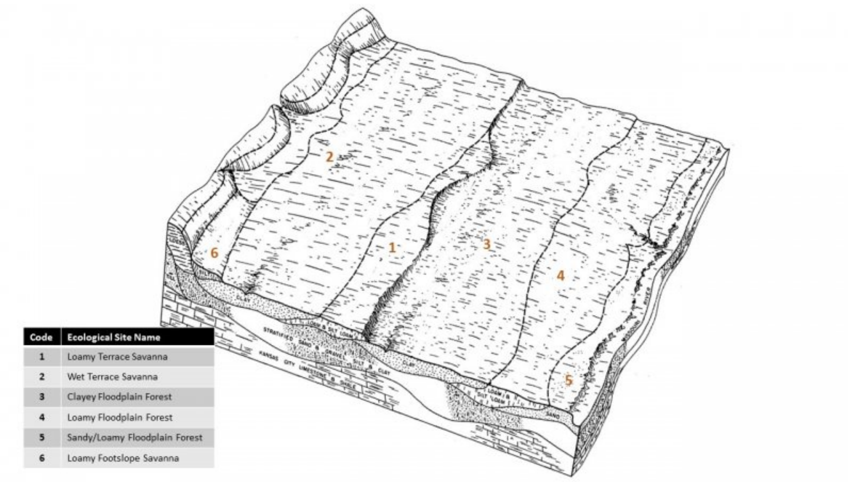


Figure 3. Figure 2. Representative block diagram of Wet Terrace Savanna and associated ecological sites.

Table 2. Representative physiographic features

Hillslope profile	(1) Toeslope
Slope shape across	(1) Linear
Slope shape up-down	(1) Linear
Landforms	(1) Stream terrace (2) Flood-plain step
Flooding duration	Brief (2 to 7 days) to long (7 to 30 days)
Flooding frequency	Rare to occasional
Ponding frequency	None
Elevation	499–1,558 ft
Slope	0–2%
Water table depth	0–24 in
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 one travels. The average freeze-free period of this ecological site is about 182 days, while the frost-free period is about 161 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 37 inches, which includes rainfall plus the water equivalent from snowfall (Table 3). The average annual low and high temperatures are 41 and 63°F, respectively.

Climate data and analyses are derived from 30-year average gathered from seven 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)	157-188 days
Precipitation total (characteristic range)	31-42 in
Frost-free period (actual range)	132-162 days
Freeze-free period (actual range)	156-190 days
Precipitation total (actual range)	29-42 in
Frost-free period (average)	143 days
Freeze-free period (average)	172 days
Precipitation total (average)	35 in

Climate stations used

- (1) LEXINGTON 3E [USC00234904], Lexington, MO
- (2) KANSAS CITY INTL AP [USW00003947], Kansas City, MO
- (3) SIOUX CITY GATEWAY AP [USW00014943], Sioux City, IA
- (4) GLENWOOD 3SW [USC00133290], Glenwood, IA
- (5) ONAWA 3NW [USC00136243], Onawa, IA
- (6) OMAHA EPPLEY AIRFIELD [USW00014942], Omaha, NE
- (7) CARROLLTON [USC00231340], Carrollton, MO

Influencing water features

Wet Terrace Savannas are classified as a RIVERINE wetland under the Hydrogeomorphic (HGM) classification system (Smith et al. 1995; USDA-NRCS 2008) and as Palustrine, Forested, Broad-Leaved Deciduous, Temporarily Flooded under the National Wetlands Inventory (FGDC 2013). The site can experience occasional, shallow (less than three feet) backwater flooding from the nearby stream. Infiltration is slow to very slow (Hydrologic Groups C and D) for undrained soils, and surface runoff is medium to very high. When flooding does occur, surface water or soil saturation can persist for extended periods, particularly during the early growing season (Nelson 2010).

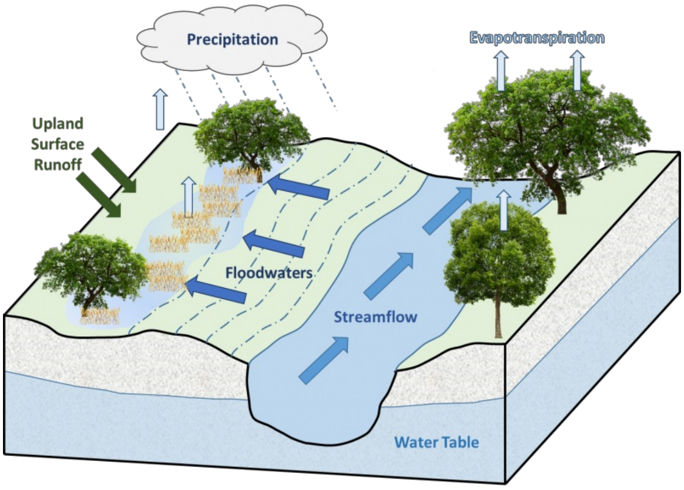


Figure 10. Figure 5. Hydrologic cycling in Wet Terrace Savanna ecological site.

Soil features

Soils of Wet Terrace Savannas are in the Mollisol and Vertisol orders, further classified as Aquertic Hapludolls, Aquic Argiudolls, Aquic Hapludolls, Aquic Pachic Argiudolls, Cumulic Vertic Endoaquolls, Fluvaquentic Endoaquolls, Typic Argiaquolls, Vertic Endoaquolls, Vertic Haplaquolls, and Typic Endoaquerts with slow to very slow infiltration and medium to very high runoff potential. The soil series associated with this site includes Blackoar, Blencoe, Bremer, Burcham, Hornick, Luton, and Nevin. The parent material is alluvium, and the soils are somewhat-poor to poorly drained and very deep with seasonal high water tables. Soil pH classes are moderately acid to moderately alkaline. No rooting restrictions are noted for the soils of this ecological site.

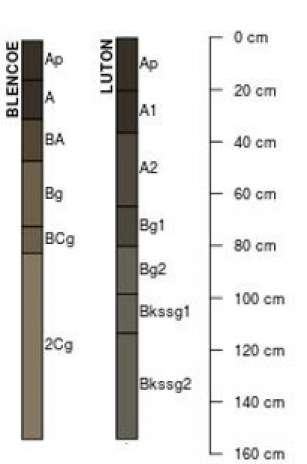


Figure 11. Figure 6. Profile sketches of soil series associated with Wet Terrace Savanna.

Table 4. Representative soil features

Parent material	(1) Alluvium
Surface texture	(1) Silty clay loam (2) Silty clay (3) Clay
Family particle size	(1) Clayey
Drainage class	Very poorly drained to somewhat poorly drained
Permeability class	Very slow
Soil depth	80 in
Available water capacity (0-40in)	5–8 in

Calcium carbonate equivalent (0-40in)	0–25%
Electrical conductivity (0-40in)	0–2 mmhos/cm
Sodium adsorption ratio (0-40in)	0
Soil reaction (1:1 water) (0-40in)	5.6–8.4

Ecological dynamics

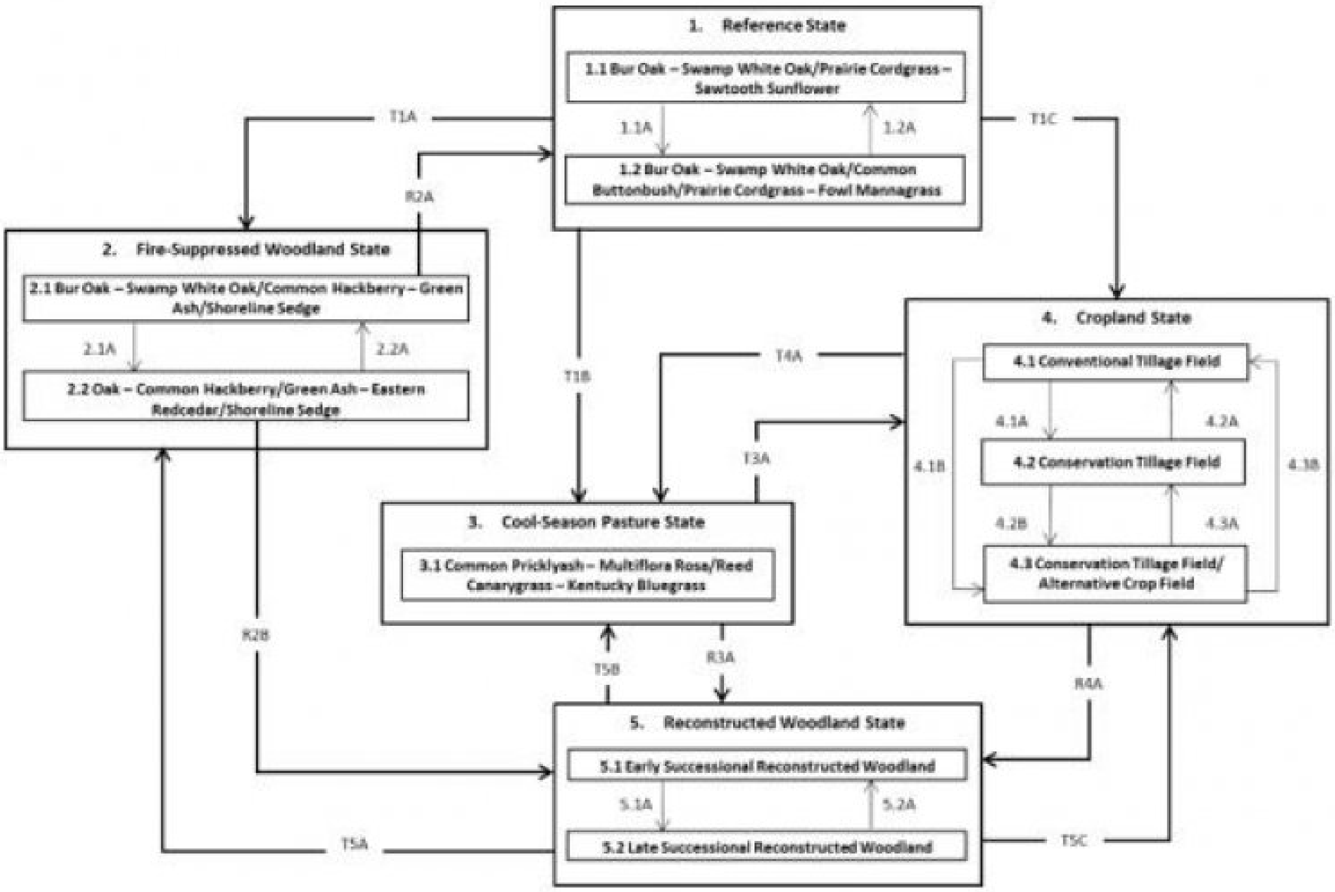
The Loess Hills region lies within the transition zone between the eastern deciduous forests and the Great Plains, with the Missouri River flowing through the middle. The heterogeneous topography of the area results in variable microclimates and fuel matrices that in turn are able to support prairies, savannas, woodlands, and forests (Nelson 2010). Wet Terrace Savannas form an aspect of this vegetative continuum. This ecological site occurs on stream terraces on somewhat poorly to poorly-drained alluvial soils. Species characteristic of this ecological site consist of upland and hydrophytic woody and herbaceous species (Nelson 2010; Steinauer and Rolfsmeier 2010).

Fire and flooding are the dominant disturbance factors in Wet Terrace Savannas. The significant presence of oaks in the community indicate the importance of fire as a natural process to maintain the site, but fire return intervals are currently unknown. Historically, seasonal backwater flooding of shallow depths (less than 36 inches) occurred every two to five years and could last for more than a month. Flooding occurred in fall, winter, and spring (Nelson 2010).

Today, many Wet Terrace Savannas have been reduced as a result of drainage and clearing for crop production and, to a smaller extent, livestock grazing. Long-term fire suppression has allowed the canopy to close and species composition to shift from a savanna to a woodland. Sites have also been degraded by stream channelization and levee construction which alters the hydrologic flood cycles and, ultimately, the reference plant community (Nelson 2010). Invasive species, such as eastern redcedar (*Juniperus virginiana* L.) have been invading this site and reducing native species diversity (LANDFIRE 2009).

State and transition model

F107BY021MO Wet Terrace Savanna



Code	Process
T1A, T5A	Fire suppression
T1B, T4A, T5B	Tree removal and interseeding of non-native cool-season grasses
T1C, T3A, T5C	Agricultural conversion via tillage, seeding, and non-selective herbicide
1.1A	Fire return interval reduced and flooding increased
1.2A	Fire return interval increased and flooding reduced
R2A	Selective tree thinning and prescribed fire
2.1A	Fire suppression
2.2A	Single fire event
R2B, R3A, R4A	Tree planting, timber stand improvement, and prescribed fire
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
5.1A	Application of stand improvement practices
5.2A	Reconstruction experiences a setback from extreme weather event or improper timing of management action

State 1
Reference State

The reference plant community is categorized as a wet-mesic bottomland oak woodland. The two community phases within the reference state are dependent on seasonal flooding regimes and infrequent fires. The amount of water occurring at flood stages and fire intensity affects species composition, cover, and extent. Windthrow events and pest outbreaks have more localized impacts in the reference phases, but do contribute to overall plant community composition, diversity, cover, and productivity.

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- American sycamore (*Platanus occidentalis*), tree
- sedge (*Carex*), grass
- Virginia wildrye (*Elymus submuticus*), grass

Community 1.1
Bur oak - Swamp White Oak / Prairie Cordgrass - Sawtooth Sunflower

Sites in this reference community represent an open-canopy (five to twenty percent cover) savanna with a reduced flood regime. Bur oak and swamp white oak are the dominant tree species for this reference community phase, but white oak (*Quercus alba* L.), common hackberry (*Celtis occidentalis* L.) and American elm (*Ulmus americana* L.) can also occur to a smaller extent (Nelson 2010; NatureServe 2015). Tree heights are generally between 60 and 90 feet tall and tree size class is medium (9 to 21 inches DBH) (LANDFIRE 2009; Nelson 2010). Periodic fires maintain the open-canopy structure. The understory is moderate, consisting mainly of tall- and mid-grasses, sedges, and perennial forbs. Prairie cordgrass is the dominant grass, and sawtooth sunflower is characteristic of this phase. Swamp verbena (*Verbena hastata* L.) and giant ironweed (*Vernonia gigantea* (Walter) Trel.) are common forbs that may be encountered (Nelson 2010).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- swamp white oak (*Quercus bicolor*), tree
- prairie cordgrass (*Spartina pectinata*), grass
- sawtooth sunflower (*Helianthus grosseserratus*), other herbaceous

Community 1.2
Bur oak - Swamp White Oak / Common Buttonbush / Prairie Cordgrass - Fowl Mannagrass

This reference community phase can occur following a prolonged fire-free interval that allows the canopy to close, as well as an increased flood regime. Bur oak and swamp white oak are still the dominant tree species, and the canopy has closed (twenty to sixty percent). Common buttonbush (*Cephalanthus occidentalis* L.) becomes an important shrub component, while the understory shifts to more shade- and flood-tolerant species including an increase in prairie cordgrass, fowl mannagrass (*Glyceria striata* (Lam.) Hitchc.), and various sedges (Carex L.) (NatureServe 2015).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- swamp white oak (*Quercus bicolor*), tree
- prairie cordgrass (*Spartina pectinata*), grass
- fowl mannagrass (*Glyceria striata*), grass

Pathway P1.1A
Community 1.1 to 1.2

– Natural succession as a result of a prolonged, flood and/or fire-free period.

Pathway P1.2A
Community 1.2 to 1.1

Natural succession as a result of a prolonged, fire-free period and decreased flood regime.

State 2
Fire Suppressed Woodland State

Periodic fire maintained a moderate tree canopy and an understory more reminiscent of a wet prairie. However, the past 150 years of fire suppression efforts have transitioned the reference oak savanna community into a closed-canopy woodland state. Along with fire suppression, the channelization of streams and rivers and the development of reservoirs has also contributed to a closing of the canopy as well as causing a significant shift in species composition. (Nelson 2010; NatureServe 2015).

Dominant plant species

- oak (*Quercus*), tree
- common hackberry (*Celtis occidentalis*), tree
- green ash (*Fraxinus pennsylvanica*), shrub
- shoreline sedge (*Carex hyalinolepis*), grass

Community 2.1
Bur Oak – Swamp White Oak/Common Hackberry – Green Ash/Shoreline Sedge

This community phase represents a shift in plant community composition as a result of human-induced fire suppression. Mature bur oak and swamp white oak are the dominant overstory species, while common hackberry and green ash (*Fraxinus pennsylvanica* Marshall) increase in the subcanopy (NatureServe 2015). As the canopy beings to close (more than 60 percent cover), the understory becomes comprised by more shade-tolerant species such as shoreline sedge (*Carex hyalinolepis* Steud.) (Nelson 2010).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- swamp white oak (*Quercus bicolor*), tree
- common hackberry (*Celtis occidentalis*), shrub
- green ash (*Fraxinus pennsylvanica*), shrub
- shoreline sedge (*Carex hyalinolepis*), grass

Community 2.2
Oak – Common Hackberry /Green Ash – Eastern Redcedar /Shoreline Sedge

Sites in this community phase are further impacted by lack of fire and flooding. Common hackberry becomes co-dominant with the mature bur oak and swamp white oak overstory. Green ash continues to remain a subcanopy component, and the extended absence of flooding and fire has allowed eastern redcedar to invade the site (LANDFIRE 2009). Canopy coverage increases to between 60 and 80 percent.

Dominant plant species

- oak (*Quercus*), tree
- common hackberry (*Celtis occidentalis*), tree
- green ash (*Fraxinus pennsylvanica*), shrub
- eastern redcedar (*Juniperus virginiana*), shrub
- shoreline sedge (*Carex hyalinolepis*), grass

Pathway P2.1A
Community 2.1 to 2.2

Continued fire suppression and altered hydrologic regime.

Pathway P2.2A
Community 2.2 to 2.1

Single fire event.

State 3
Cool Season Pasture State

The cool-season pasture state occurs when the reference state has been anthropogenically-altered for livestock production. Early settlers harvested the trees for timber and fuel and seeded such non-native cool-season species as Kentucky bluegrass (*Poa pratensis* L.), converting the woodland to pasture (Smith 1998; IDNR 2013). Over time, as lands were continually grazed by large herds of cattle, the non-native species were able to spread and expand across the site, reducing the native species diversity. However, these sites are difficult to maintain due to frequent flooding and low available water capacity.

Dominant plant species

- multiflora rose (*Rosa multiflora*), shrub
- common pricklyash (*Zanthoxylum americanum*), shrub
- Kentucky bluegrass (*Poa pratensis*), grass
- reed canarygrass (*Phalaris arundinacea*), grass

Community 3.1
Common Pricklyash – Multiflora Rose/Reed Canarygrass – Kentucky Bluegrass

Sites in this community phase arise from selective tree removal and seeding of non-native cool-season grasses (Steinauer and Rolfsmeier 2010). Elm, oak, ash, and hackberry all have some timber value and were harvested to supply the timber market for early settlers. Tree regeneration may occur for some time, but livestock can trample and eat tree seedlings thereby reducing the overstory. Unpalatable woody species, such as common pricklyash (*Zanthoxylum americanum* Mill.) and multiflora rose (*Rosa multiflora* Thunb.), can invade under excessive grazing (Randall and Herring 2012). Reed canarygrass (*Phalaris arundinacea* L.) and Kentucky bluegrass were common species used for pasture planting.

Dominant plant species

- common pricklyash (*Zanthoxylum americanum*), shrub
- multiflora rose (*Rosa multiflora*), shrub
- 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 Savanna State

The combination of natural and anthropogenic disturbances occurring today has resulted in a number of ecosystem health issues, and restoration back to the historic reference condition is likely not possible. Many natural lowland communities are being stressed by non-native diseases and pests, habitat fragmentation, permanent changes in hydrologic regimes, fire suppression, and overabundant deer populations on top of naturally-occurring disturbances (severe weather and native pests) (Flickinger 2010; Nelson 2010). However, these habitats provide multiple ecosystem services including carbon sequestration; clean air and water; soil conservation; biodiversity support; as well as a variety of cultural activities (e.g., hiking, hunting) (Millennium Ecosystem Assessment 2005; Flickinger 2010). Therefore, conservation of lowland savannas should still be pursued. Habitat reconstructions are an important tool for repairing natural ecological functioning and providing habitat protection for numerous species of Wet Terrace Savannas. 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 savanna state is the result of a long-term commitment involving a multi-step, adaptive management process.

Community 5.1
Early Successional Reconstructed Savanna

This community phase represents the early community assembly from savanna reconstruction. It is highly dependent on the current condition of the site 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 stewardship management plans.

Community 5.2
Late Successional Reconstructed Savanna

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 savanna will have an uneven-aged, semi-closed canopy and a well-developed understory.

Pathway P5.1A
Community 5.1 to 5.2

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

Pathway P5.2A
Community 5.2 to 5.1

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

Transition T1A
State 1 to 2

Fire suppression and hydrologic alterations transition this site to the fire-suppressed woodland state (2).

Transition T1B
State 1 to 3

Woody species reduction, interseeding of non-native, cool-season grasses, and continuous grazing transition this site to the cool-season pasture state (3).

Transition T1C
State 1 to 4

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

Restoration pathway R2A
State 2 to 1

Selective tree thinning and prescribed fire is used to restore this site to the reference state (1).

Restoration pathway R2B
State 2 to 5

Site preparation, invasive species control (native and non-native), tree planting, and prescribed fire transition this site to the reconstructed savanna state (5).

Transition T3A
State 3 to 4

Installation of drain tiles, 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), tree planting, and prescribed fire transition this site to the reconstructed savanna 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), tree planting, and prescribed fire transition this site to the reconstructed savanna state (5).

Transition T5A
State 5 to 2

Fire (or fire surrogate) suppression efforts transition this site to the fire-suppressed forest state (2).

Restoration pathway T5B
State 5 to 3

Tree removal and interseeding non-native cool-season grasses transition this site to the cool-season pasture state (3).

Transition T5C
State 5 to 4

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

Additional community tables

Animal community

Wildlife*

Prairie Phase:
Game species that utilize this ecological site include:
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.

Migratory Waterbirds: Sora, Common Snipe and Virginia Rail

Furbearers: Muskrat, Beaver, and Mink.

Bird species associated with this ecological site's reference state condition:
Breeding birds: Sedge Wren, Red-Winged Blackbird, American Bittern, Marsh Wren, and Common Yellowthroat.

Migratory birds: Sora, Virginia Rail, Sedge Wren, American Bittern, Yellow Rail and Common Snipe.

Amphibian and reptile species associated with this ecological site's reference state condition: Western Chorus Frog (Pseudacris triseriata triseriata), Plains Leopard Frog (Rana blairi), Graham's Crayfish Snake (Regina grahamii), Midland Brown Snake (Storeria dekayi wrightourm), Western Fox Snake (Elaphe vulpina vulpina), and Western Massasauga rattlesnake (Sistrurus catenatus tergeminus).

Small mammals associated with this ecological site's reference state condition: Muskrat (Ondatra zibethicus), Southern Bog Lemming (Synaptomys cooperi), and Mink (Mustela vison).

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: Swamp Milkweed Leaf Beetle (Labidomera clivicollis), Cordgrass Planthopper (Prokelisia crocea), Dion Skipper butterfly (Euphyes dion), Duke's Skipper butterfly (Euphyes dukesi), native bees (Lasioglossum hartii, Hesperapis carinata, Svastra atripes and Cemolobus ipomoeae), Bullate Meadow katydid (Orchelimum bullatum) and Sedge Grasshopper (Stethophyma celatum).

Other invertebrates: Grassland Crayfish (Procambarus gracilis)

Savanna Phase:
Both snags and live cavity or den trees provide important food and cover for vertebrate wildlife. Snags are also very important to invertebrate species. Wood Duck and Red-headed Woodpecker utilize snags and den trees for foraging, nesting or shelter. "Wolf" trees are a particularly valuable type of live cavity tree. These large diameter, often open-grown, old-ages, hollow trees provide both cavities for wildlife and usually hard or soft mast food sources. Large diameter snags and den trees are particularly important wildlife habitat features to retain.

Extremely little is known about this phase of this ecological site. It is assumed that many of the animal species described under the prairie phase of this ecological site are found in the savanna phase. Additional species that might be expected in the savanna phase: Red-headed Woodpecker, Wood Duck, Yellow Warbler, Fox Squirrel, and Indiana Bat.

*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	02/10/2025
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):**

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5. **Number of gullies and erosion associated with gullies:**

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6. **Extent of wind scoured, blowouts and/or depositional areas:**

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7. **Amount of litter movement (describe size and distance expected to travel):**

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

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11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

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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):**

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:**