

Ecological site R115XC014IL 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.

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 Wisconsin glacialiation – 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

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 Oak Savanna (CES202.698) (NatureServe 2015)

National Vegetation Classification - Plant Associations: *Quercus macrocarpa* – *Quercus bicolor* – (*Celtis occidentalis*) Woodland (CEGL002140) (Nature Serve 2015)

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

Illinois Natural Areas Inventory: Mesic savanna (White and Madany 1978)

Missouri Terrestrial Natural Communities: Mesic bottomland woodland (Nelson 2010)

Ecological site concept

Terrace Savannas are located within the green areas on the map (Figure 1). They occur on stream terraces in river

valleys. The soils are Mollisols, Alfisols, and Inceptisols that are somewhat poorly to well drained and very deep, formed in outwash or alluvium.

The historic pre-European settlement vegetation on this ecological site was dominated by an herbaceous understory with scattered trees. Bur oak (*Quercus macrocarpa* Michx.) and eastern cottonwood (*Populus deltoides* W. Bartram ex Marshall) are the dominant and characteristic trees species, respectively, and Virginia wildrye (*Elymus virginicus* L.) and eastern purple coneflower (*Echinacea purpurea* (L.) Moench) are common herbs of Terrace Savannas (DeLong and Hooper 1996; Dettman et al. 2009; NatureServe 2015). Shrubs and vines can form an important component of the understory, including species such as American plum (*Prunus americana* Marshall) and American bittersweet (*Celastrus scandens* L.) (DeLong and Hooper 1996; Dettman et al. 2009). The highly conservative American witchhazel (*Hamamelis virginiana* L.) can be indicative of an undisturbed savanna community (Drobney et al. 2001; Dettman et al. 2009). Fire and infrequent flooding are the primary disturbance factors that maintain this site, while herbivory and drought are secondary factors (Dettman et al. 2009; LANDFIRE 2009).

Associated sites

R115XC015IL	Wet Terrace Sedge Meadow Outwash, alluvial, glaciolacustrine, and organic over outwash parent materials that are shallow to a high-water table on low stream terraces including Adrian, Aholt, Copperas, Faxon, Gilford, Mudhen, Niota, Palms, and Wagner soils
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Similar sites

R115XC002IL	Loess Upland Prairie Loess Upland Savannas occur on uplands and parent material is loess and loess-covered substrates
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Table 1. Dominant plant species

Tree	(1) <i>Quercus macrocarpa</i> (2) <i>Populus deltoides</i>
Shrub	Not specified
Herbaceous	(1) <i>Elymus virginicus</i> (2) <i>Echinacea purpurea</i>

Physiographic features

Terrace Savannas occur on low stream terraces on river valleys. They are situated on elevations ranging from approximately 341 to 1948 feet ASL. The site can experience rare flooding that can last up to seven days.

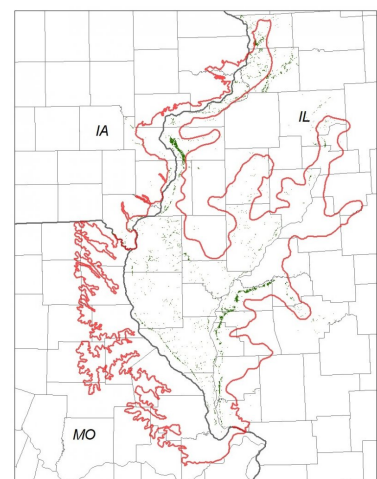


Figure 1. Location of Terrace Savanna ecological site within LRU 115XC.

Table 2. Representative physiographic features

Slope shape across	(1) Convex (2) Convex
Landforms	(1) River valley > Stream terrace
Runoff class	Low to very high
Flooding duration	Extremely brief (0.1 to 4 hours) to brief (2 to 7 days)
Flooding frequency	None to rare
Ponding frequency	None
Elevation	341–1,948 ft
Slope	0–10%
Water table depth	18–80 in
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 184 days, while the frost-free period is about 152 days. The majority of the precipitation occurs as rainfall in the form of convective thunderstorms during the growing season. Average annual precipitation is 38 inches, which includes rainfall plus the water equivalent from snowfall. The average annual low and high temperatures are 42 and 62°F, respectively.

Table 3. Representative climatic features

Frost-free period (characteristic range)	141-168 days
Freeze-free period (characteristic range)	170-196 days
Precipitation total (characteristic range)	35-40 in
Frost-free period (actual range)	140-170 days
Freeze-free period (actual range)	169-203 days
Precipitation total (actual range)	35-40 in
Frost-free period (average)	152 days
Freeze-free period (average)	184 days
Precipitation total (average)	38 in

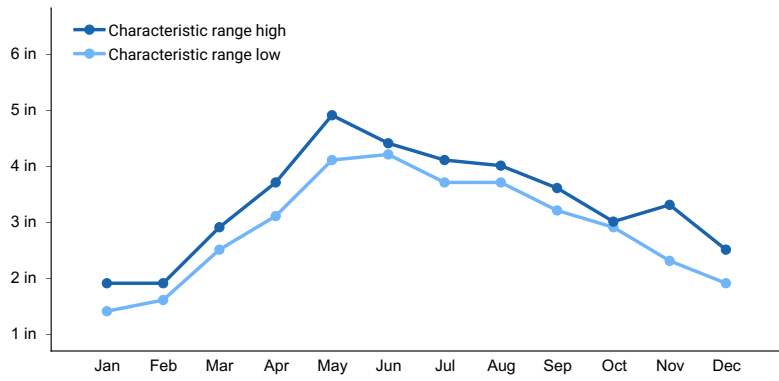


Figure 2. Monthly precipitation range

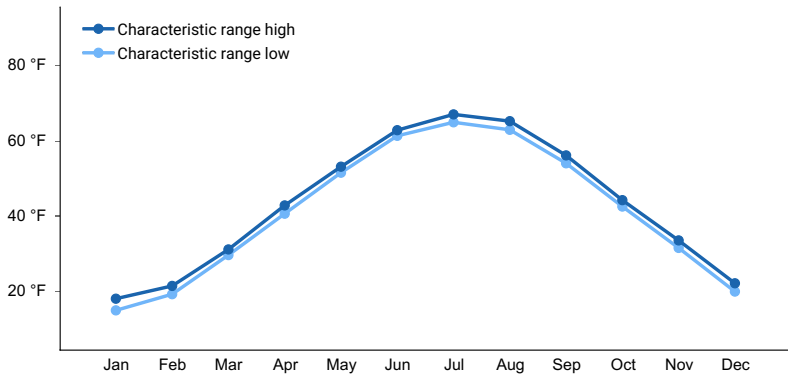


Figure 3. Monthly minimum temperature range

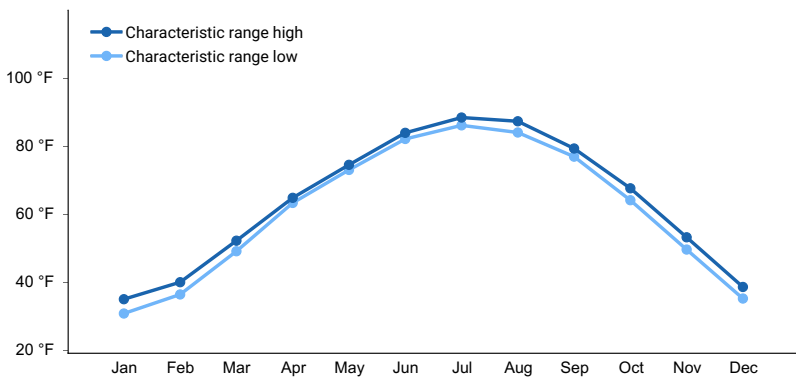


Figure 4. Monthly maximum temperature range

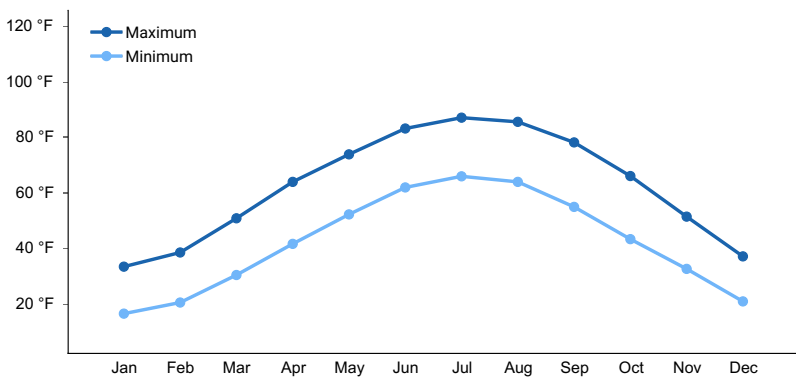


Figure 5. Monthly average minimum and maximum temperature

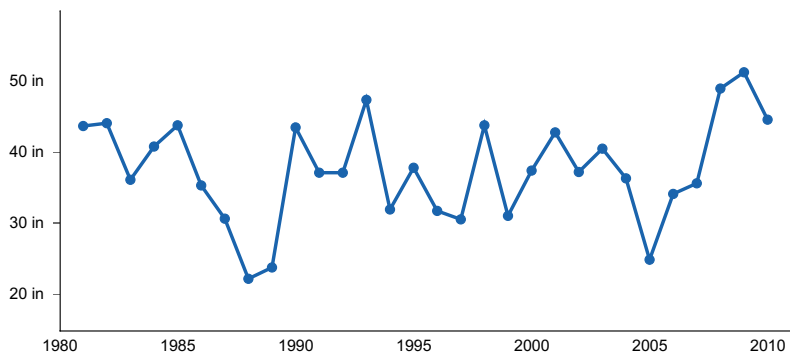


Figure 6. Annual precipitation pattern

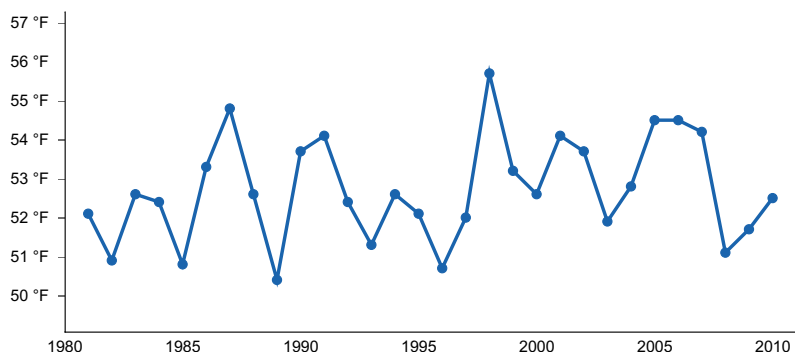


Figure 7. Annual average temperature pattern

Climate stations used

- (1) CLINTON #1 [USC00131635], Camanche, IA
- (2) NEW BOSTON DAM 17 [USC00116080], Wapello, IL
- (3) CANTON L&D 20 [USC00231275], Canton, MO
- (4) CLARKSVILLE L&D 24 [USC00231640], Clarksville, MO
- (5) HAVANA [USC00113940], Lewistown, IL

Influencing water features

Terrace Savannas are classified as a RIVERINE: bottomland, rarely flooded, herbaceous wetland under the Hydrogeomorphic (HGM) classification system (Smith et al. 1995; USDA-NRCS 2008). Overbank flow from the stream, subsurface hydraulic connections, overland flow from adjacent uplands, and precipitation are the main sources of water for this ecological site (Smith et al. 1995). Infiltration is moderate to slow (Hydrologic Groups B and C) for undrained soils, and surface runoff is low to very high (Figure 4).

Wetland description

Wetland hydrology indicators may be present on undrained Terrace Savannas (e.g., A1 Surface water) but are not indicative of wetland hydrology due to the flooding frequency being less than 50 percent (USACE 2010).

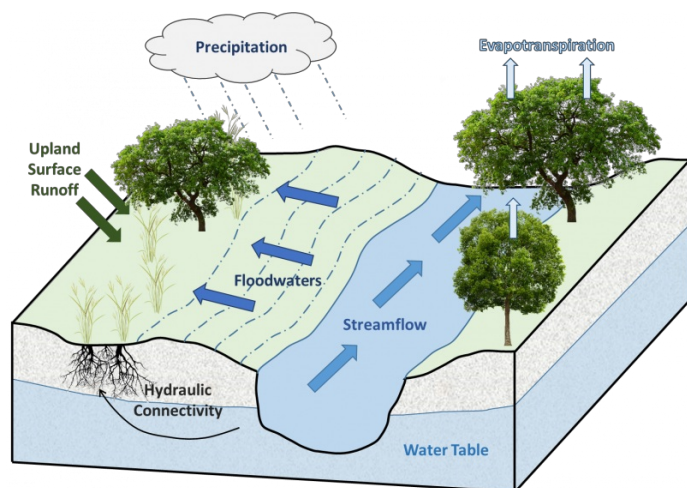


Figure 8. Hydrologic cycling in Terrace Savanna ecological site.

Soil features

Soils of Terrace Savannas are in the Mollisols, Alfisols, and Inceptisols orders, further classified as Aquic Argiudolls, Aquic Cumulic Hapludolls, Aquic Hapludolls, Cumulic Hapludolls, Typic Hapludolls, Typic Hapludalfs, Udollic Endoaqualfs, Dystric Eutrudepts with slow to moderate infiltration and low to very high runoff potential. The soil series associated with this site includes Beardstown, Bertrand, Coot, Drury, Elrin, Littleton, Raddle, Ross, and Worthen. The parent material is alluvium or outwash, and the soils are somewhat poorly to well drained and very deep. Soil pH classes are very strongly acid to moderately alkaline. No rooting restrictions are noted for the soils of this ecological site.

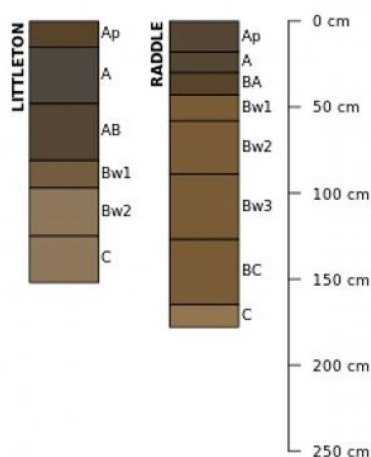


Figure 9. profile sketches of soil series associated with Terrace Savanna.

Table 4. Representative soil features

Parent material	(1) Alluvium (2) Outwash
Surface texture	(1) Loam (2) Silt loam
Family particle size	(1) Fine-silty (2) Fine-loamy (3) Coarse-loamy
Drainage class	Somewhat poorly drained to well drained
Permeability class	Slow to moderately slow
Depth to restrictive layer	80 in
Soil depth	80 in

Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (Depth not specified)	6–9 in
Calcium carbonate equivalent (Depth not specified)	0–30%
Electrical conductivity (Depth not specified)	5–8 mmhos/cm
Soil reaction (1:1 water) (Depth not specified)	5.6–7.8
Subsurface fragment volume <=3" (Depth not specified)	2–7%
Subsurface fragment volume >3" (Depth not specified)	1–2%

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. Terrace Savannas form an aspect of this vegetative continuum. This ecological site occurs on stream terraces on somewhat poorly to well drained soils. . Species characteristic of this ecological site consist of a mix of herbaceous vegetation with scattered trees.

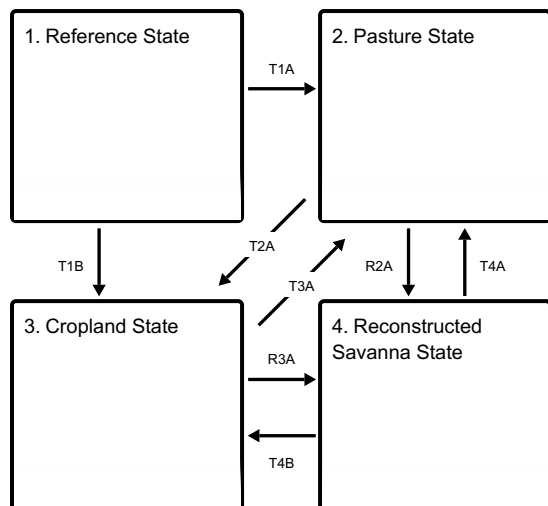
Fire and rare flooding are critical disturbance factors that maintain Terrace Savannas. Fire intensity typically consisted of periodic fires occurring every 1 to 5 years (LANDFIRE 2009). Ignition sources included summertime lightning strikes from convective storms and bimodal, human ignitions during the spring and fall seasons. Native Americans regularly set fires to improve sight lines for hunting, driving large game, improving grazing and browsing habitat, agricultural clearing, and enhancing vital ethnobotanical plants (Barrett 1980; White 1994). Infrequent flooding influenced plant community composition as evidenced by the co-dominance of oak species with floodplain associated species (Dettman et al. 2009).

Drought and herbivory by native ungulates have also played a role in shaping this ecological site. The periodic episodes of reduced soil moisture in conjunction with the somewhat poorly to well-drained soils have favored the proliferation of plant species tolerant of such conditions. Drought can also slow the growth of plants and result in dieback of certain species. Bison (*Bos bison*) grazing, while present, served a more limited role in community composition and structure than lands further west. Prairie elk (*Cervus elaphus*) and white-tailed deer (*Odocoileus virginianus*) likely contributed to woody species reduction but are also considered to be of a lesser impact compared to the west (LANDFIRE 2009). When coupled with fire, periods of drought and herbivory can further delay the establishment of woody vegetation (Pyne et al. 1996).

Today, Terrace Savannas may be extirpated from the MLRA as a result of type-conversions to agricultural production lands. A return to the historic plant community may not be possible following extensive land modification, but long-term conservation agriculture or savanna reconstruction can help to restore some biotic diversity and ecological function. The state-and-transition model that follows provides a detailed description of each state, community phase, pathway, and transition. This model is based on available experimental research, field observations, literature reviews, professional consensus, and interpretations.

State and transition model

Ecosystem states



T1A - Establish and manage for forage species

T1B - Establish and manage for row crop agriculture

T2A - Establish and manage for row crop agriculture

R2A - Restoration inputs such as planting, weed control

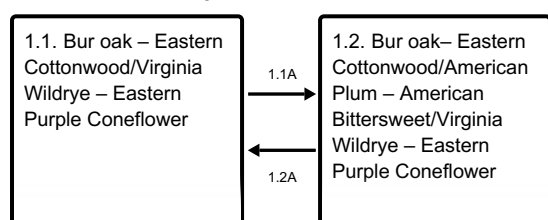
T3A - Establish and manage for forage species

R3A - Restoration inputs such as planting, weed control

T4A - Establish and manage forage species

T4B - Establish and manage for row crop agriculture

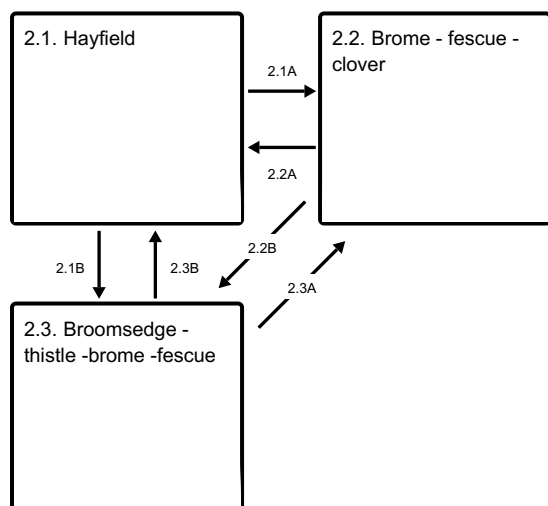
State 1 submodel, plant communities



1.1A - Extended fire return interval in excess of 5 years

1.2A - Mixed or high intensity fire.

State 2 submodel, plant communities

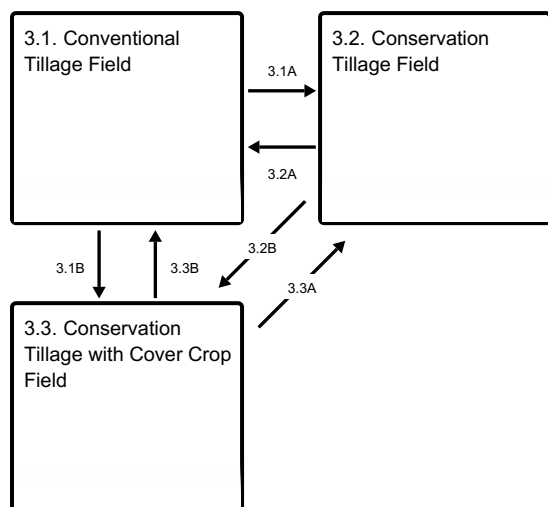


2.1A - Mechanical harvesting; proper animal to forage balance

2.1B - Mechanical harvesting; forage plants are overutilized

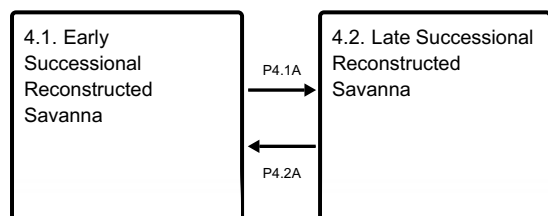
- 2.2A - Mechanical harvesting
- 2.2B - Grazing; forage plants are overutilized
- 2.3B - Mechanical harvesting
- 2.3A - Grazing; proper animal to forage balance

State 3 submodel, plant communities



- 3.1A - Less tillage, residue management
- 3.1B - Less tillage, residue management, and implementation of cover cropping
- 3.2A - Intensive tillage, remove residue, reinitiate monoculture row cropping
- 3.2B - Implementation of cover cropping
- 3.3B - Intensive tillage, remove residue, reinitiate monoculture row cropping
- 3.3A - Remove cover cropping

State 4 submodel, plant communities



- P4.1A - Invasive species control and implementation of disturbance regimes
- P4.2A - Drought or improper timing/use of management actions

State 1 Reference State

The reference plant community is categorized as a lowland savanna community, dominated by herbaceous vegetation with scattered trees. The two community phases within the reference state are dependent on fire and infrequent flooding. The frequency, intensity, and duration of these disturbances alter species composition, cover, and extent. Surface fires are the dominant fire regime, comprising approximately 96 percent of all fires and occurring every five years. Mixed and high intensity fires comprise the remaining 4 percent, occurring approximately every 3 and 1 years, respectively (LANDFIRE 2009). Flooding was infrequent, occurring once every 20 to 100 years, and influenced tree canopy composition. Drought and herbivory have more localized impacts in the reference phases, but do contribute to overall species composition, diversity, cover, and productivity.

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- eastern cottonwood (*Populus deltoides*), tree
- Virginia wildrye (*Elymus submuticus*), grass

- eastern purple coneflower (*Echinacea purpurea*), other herbaceous

Community 1.1

Bur oak – Eastern Cottonwood/Virginia Wildrye – Eastern Purple Coneflower

Sites in this reference community phase are dominated by a mix of grasses and sedges with scattered trees. Oaks are the predominant genus, including bur oak, black oak (*Quercus velutina* Lam.), white oak (*Quercus alba* L.), chinquapin oak (*Quercus muehlenbergii* Engelm.), and northern red oak (*Quercus rubra* L.). Lowland species, however, are a significant component of the canopy and include eastern cottonwood, common hackberry, (*Celtis occidentalis* L.), American sycamore (*Platanus occidentalis* L.), and elms (*Ulmus* L.) (Dettman et al. 2009). The tree layer comprises no more than 20 percent cover and tree size class is medium (9 to 21-inch DBH). Vegetative cover is continuous (up to 100 percent) and can include a mix of grasses and forbs including Virginia wildrye and eastern purple coneflower. Surface fires every 5 years will maintain this class, but an extended fire return interval will shift the community to phase 1.2 (LANDFIRE 2009).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- eastern cottonwood (*Populus deltoides*), tree
- Virginia wildrye (*Elymus submuticus*), grass
- eastern purple coneflower (*Echinacea purpurea*), other herbaceous

Community 1.2

Bur oak– Eastern Cottonwood/American Plum – American Bittersweet/Virginia Wildrye – Eastern Purple Coneflower

This reference community phase represents a successional shift as a result of an extended fire return interval. This fire-free period allows woody shrubs and vines to establish, including American plum, American bittersweet, eastern poison ivy (*Toxicodendron radicans* (L.) Kuntze), and burningbush (*Euonymus atropurpureus* Jacq.) (DeLong and Hooper 1996; Dettman et al. 2009; NatureServe 2015). Tree cover increases to as much as 60 percent, and tree size class moves from medium to large (21 to 33-inch DBH). Surface fires every 5 years will maintain this class, but mixed or high intensity fires will shift the community back to phase 1.1 (LANDFIRE 2009).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- eastern cottonwood (*Populus deltoides*), tree
- Virginia wildrye (*Elymus submuticus*), grass
- eastern purple coneflower (*Echinacea purpurea*), other herbaceous

Pathway 1.1A

Community 1.1 to 1.2

Extended fire return interval in excess of 5 years

Pathway 1.2A

Community 1.2 to 1.1

Mixed or high intensity fire.

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

Community 2.1

Hayfield

Community Phase 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).

Dominant plant species

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

Community 2.2

Brome - fescue -clover

These sites are being grazed and there is a proper balance between the animal use and the forage growth.

Dominant plant species

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

Community 2.3

Broomsedge - thistle -brome -fescue

These sites are grazing and the forage plants are being overutilized. The site is overgrazed and various weedy species will be present and forage production will be reduced.

Dominant plant species

- broomsedge bluestem (*Andropogon virginicus*), grass
- smooth brome (*Bromus inermis*), grass
- tall fescue (*Schedonorus arundinaceus*), grass
- crabgrass (*Digitaria*), grass
- thistle (*Cirsium*), other herbaceous
- buttercup (*Ranunculus*), other herbaceous
- ironweed (*Vernonia*), other herbaceous

Pathway 2.1A

Community 2.1 to 2.2

Mechanical harvesting is replaced with domestic livestock. Sites have a proper animal to forage balance.

Pathway 2.1B

Community 2.1 to 2.3

Mechanical harvesting is replaced with domestic livestock. Forage plants are overutilized.

Pathway 2.2A

Community 2.2 to 2.1

Domestic livestock are removed, and mechanical harvesting is implemented.

Pathway 2.2B

Community 2.2 to 2.3

Forage plants are being grazed and overutilized. Various weedy species are increasing.

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

Sites are being grazed with a proper animal to forage 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

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

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

- oat (*Avena hybrida*), grass
- wheat (*Triticum*), grass
- rye (*Secale*), grass
- soybean (*Glycine max*), other herbaceous
- corn (*Zea mays*), other herbaceous
- alfalfa (*Medicago*), other herbaceous
- clover (*Trifolium*), 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 Savanna State

Savanna reconstructions have become an important tool for repairing natural ecological functions and providing habitat protection for numerous grassland dependent species. Because the historic plant and soil biota communities of the tallgrass prairie were highly diverse with complex interrelationships, historic savanna replication cannot be guaranteed on landscapes that have been so extensively manipulated for extended timeframes (Kardol and Wardle 2010; Fierer et al. 2013). Therefore, ecological restoration should aim to aid the recovery of degraded, damaged, or destroyed ecosystems. A successful restoration will have the ability to structurally and functionally sustain itself, demonstrate resilience to the natural ranges of stress and disturbance, and create and maintain positive biotic and abiotic interactions (SER 2002). The reconstructed savanna state is the result of a long-term commitment involving a multi-step, adaptive management process. Tree plantings may be required in order to reproduce the overstory canopy (Asbjornsen et al. 2005; Dettman and Mabry 2008). Diverse, species-rich seed mixes may be important to utilize as they allow the site to undergo successional stages that exhibit changing composition and dominance over time (Smith et al. 2010). On-going management via prescribed fire and/or light grazing can help the site progress from an early successional community dominated by annuals and some weeds to a later seral stage composed of native perennial grasses, forbs, shrubs, and eventually mature bur oaks. Establishing a prescribed fire regime that mimics natural disturbance patterns can increase native species cover and diversity while reducing cover of non-native forbs and grasses. Light grazing alone can help promote species richness, while grazing accompanied with fire can control the encroachment of undesirable woody vegetation (Brudvig et al. 2007).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- Virginia wildrye (*Elymus virginicus*), grass
- purple coneflower (*Echinacea*), other herbaceous

Community 4.1

Early Successional Reconstructed Savanna

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

native cool-season and warm-season annual and perennial grasses and forbs typical of the reference state. Native, cool-season annuals can help to provide litter that promotes cool, moist soil conditions to the benefit of the other species in the seed mix. The first season following site preparation and seeding will typically result in annuals and other volunteer species forming a majority of 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.

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- Virginia wildrye (*Elymus virginicus*), grass

Community 4.2

Late Successional Reconstructed Savanna

Appropriately timed disturbance regimes (e.g., prescribed fire) applied to the early successional community phase can help increase the beta diversity, pushing the site into a late successional community phase over time. While oak savanna communities are dominated by grasses, these species can suppress forb establishment and reduce overall diversity and ecological functioning (Martin and Wilsey 2006; Williams et al. 2007). Reducing accumulated plant litter from such tallgrasses as big bluestem and Indiangrass allows more light and nutrients to become available for forb recruitment, allowing for greater ecosystem complexity (Wilsey 2008). Prescribed fire should be used on a cycle no less than every five years in order to allow the oaks to establish and mature (Gucker 2011).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- Virginia wildrye (*Elymus virginicus*), grass
- eastern purple coneflower (*Echinacea purpurea*), other herbaceous

Pathway P4.1A

Community 4.1 to 4.2

Pathway 4.1A – 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 non-oak woody vegetation.

Pathway P4.2A

Community 4.2 to 4.1

Pathway 4.2B – Reconstruction 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

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 savanna 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 savanna 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
Contact for lead author	
Date	05/10/2025
Approved by	Suzanne Mayne-Kinney
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:**
