USDA Natural Resources
Conservation Service

Ecological site R112XY101KS
Claypan Upland

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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): 112X–Cherokee Prairies

MLRA 112 (Cherokee Prairies) is in Kansas (48 percent), Oklahoma (29 percent), and Missouri (23 percent) makes up about 20,885 square miles (54,092 square kilometers).

This area is in the Osage Plains Section of the Central Lowland Province of the Interior Plains. It is a gently sloping to rolling dissected plains. Elevation ranges from 120 to 1,540 feet (30 to 470 meters). Even though the area is thoroughly dissected, local relief typically is only 3 to 10 feet (1 to 3 meters) and major valleys generally are less than 8 feet (2 meters) below the adjacent uplands.

The extent of the major hydrologic unit area is made up of major rivers such as the Neosho, Verdigris, Osage, and Marais des Cygnes. The Harry Truman reservoir lies in the western part of Lake of the Ozarks in Missouri and is on the Osage and Grand Rivers.

This area is dominantly underlain by Pennsylvanian and in some areas, Permian and Mississippian sandstone, shale, and limestone bedrock. The northern part of the area has a thin mantle of loess. The dominant soils within this region are Mollisols and Entisols. Alfisols occur in the eastern part of the MLRA. There are small areas of Vertisols throughout the MLRA. It also contains small areas of Vertisols. Soils in this region are developed in residuum, loess, colluvium, and alluvium. These soils were developed under big bluestem, little bluestem, Indiangrass, and switchgrass on the western part of this area. The eastern part of the area and the valleys in the western part support hardwoods, mainly northern red oak, white oak, and shagbark hickory with islands of tall prairie grasses being common. Major wildlife species of this area are deer, cottontail rabbit, fox squirrel, and bobwhite quail.

This MLRA is mostly rangeland, hayland, and pasture. More than two-fifths of the area supports pasture grasses and legumes. The western part of this area generally supports tall prairie grasses. Big bluestem, little bluestem, Indiangrass, and switchgrass are the main species. The cropland is used to produce winter wheat, soybeans, corn, grain sorghum, and other feed grains. The forested areas are mainly on steep valley sides and in low-lying areas on flood plains.

Classification relationships

U.S. Department of Agriculture
Major Land Resource Area (MLRA) 112 - Cherokee Prairies

US Forest Service Ecoregions (1994-1995):
Domain name: Humid Temperate Domain
Division name: Prairie Division
Province name: Prairie Parkland (Temperate) Province
Province code: 251

Terrestrial Natural Community Type in Missouri (Nelson, 2010):
The reference state for this ecological site is most similar to a Hardpan Prairie.

National Vegetation Classification System Vegetation Association (NatureServe, 2010):
The reference state for this ecological site is most similar to Schizachyrium scoparium - Bouteloua curtipendula - Agrostis hyemalis - Eleocharis spp. Hardpan Herbaceous Vegetation (CEGL002249).

Geographic relationship to the Missouri Ecological Classification System (Nigh & Schroeder, 2002):
This ecological site occurs throughout the Cherokee Plains Subsection, and in southern Land Type Associations of the Scarped Osage Plains Subsection.

NatureServe (2018):
Class: Shrub & Herb Vegetation
Subclass: Temperate & Boreal Grassland & Shrubland
Formation: Temperate Grassland & Shrubland
Division: Central North American Grassland & Shrubland
Macrogroup: Central Lowlands Tallgrass Prairie
Group: Central Tallgrass Prairie
Alliance: Central Dry & Dry-Mesic Tallgrass Prairie

Ecological site concept

The Claypan Upland ecological site is widely distributed on broad interfluve summits. This site has soils with an abrupt textural change (from silt loam to silty clay or clay) and an E horizon (mineral soil) at about 10 to 15 inches. The Claypan Upland site has a clay subsoil that perches water in the spring and affects rooting depth and species composition. Plant rooting depth affects ecosystem resilience to environmental stress such as drought.

Associated sites

R112XY102KS	**Clayey Upland** This Clayey Upland ecological site is below the Claypan ecological site. This site is made up of poorly to moderately well drained soils with silt loam to silty clay surface layers, and clayey subsoils. It is generally on a slope range of 1 to 15 percent.
R112XY103KS	**Loamy Upland** This Loamy Upland ecological site is downslope from the Claypan ecological site. This site is made up of somewhat poorly to well drained soils with a surface layer of silt loam, loam, and silty clay loam and a loamy or clayey subsoil. It is generally on a slope range of 1 to 15 percent.

Similar sites

R112XY102KS	**Clayey Upland** This Clayey Upland ecological site is similar to the Claypan Upland ecological site because of the clayey subsoils and similar species composition. However, the Clayey Upland lacks a claypan and E horizon below the surface horizon.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Andropogon gerardii* (2) *Schizachyrium scoparium*

Physiographic features

This site is on broad upland summit interfluves and divides, with slopes of less than 3 percent. The site generates runoff to adjacent, downslope ecological sites. This site does not have a flooding frequency.

The block diagram below (adapted from Hughes, 1974) shows the typical landscape position of this ecological site, and landscape relationships with other ecological sites. Claypan Upland is within the area labeled “1” on the figure. A variety of ecological sites may occur downslope, such as the Loamy Uplands (2) shown here.

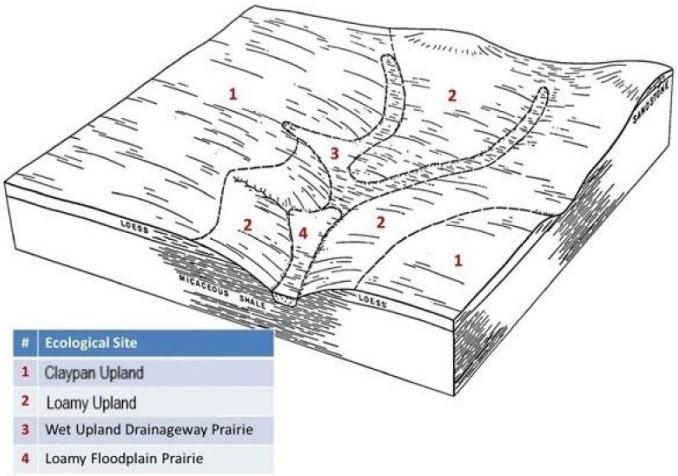


Figure 1. Representative diagram of Claypan Upland sites (#1) and associated ecological sites.

Table 2. Representative physiographic features

Landforms	(1) Plains > Interfluve (2) Divide
Runoff class	Low to high
Flooding frequency	None
Ponding frequency	None
Elevation	145–351 m
Slope	0–3%
Water table depth	15–107 cm
Aspect	Aspect is not a significant factor

Climatic features

MLRA 112 (Cherokee Prairies) has a continental climate marked by strong seasonality. In winter, dry-cold air masses periodically swing south from the northern plains and Canada. If they invade reasonably humid air, snowfall and rainfall result. In summer, moist, warm air masses swing north from the Gulf of Mexico and can produce abundant amounts of rain, either by fronts or by convectional processes. In some summers, high pressure stagnates over the region, creating extended droughty periods. Spring and fall are transitional seasons when abrupt changes in temperature and precipitation may occur due to successive, fast-moving fronts separating contrasting air masses. Seasonality in precipitation is very pronounced due to strong continental influences. June precipitation, for example, averages three to four times greater than January precipitation. During years when precipitation comes in a fairly normal manner, moisture is stored in the top layers of the soil during the winter and early spring, when evaporation and transpiration are low. During the summer months the loss of water by evaporation and transpiration is high, and if rainfall fails to occur at frequent intervals, drought will result. Drought directly influences ecological communities by limiting water supplies, especially at times of high temperatures and high evaporation rates.

Representative climatic features shown in Table 3 were derived from the climate stations selected for use within the MLRA.

Table 3. Representative climatic features

Frost-free period (characteristic range)	161-189 days

Freeze-free period (characteristic range)	186-210 days
Precipitation total (characteristic range)	1,067-1,168 mm
Frost-free period (actual range)	156-191 days
Freeze-free period (actual range)	177-215 days
Precipitation total (actual range)	1,067-1,168 mm
Frost-free period (average)	177 days
Freeze-free period (average)	198 days
Precipitation total (average)	1,118 mm

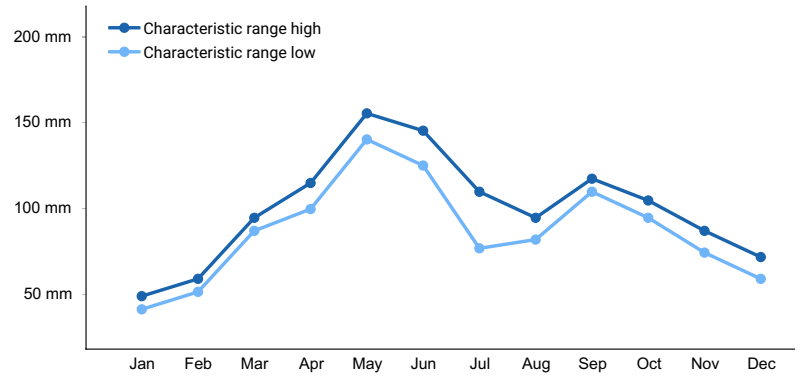


Figure 2. Monthly precipitation range

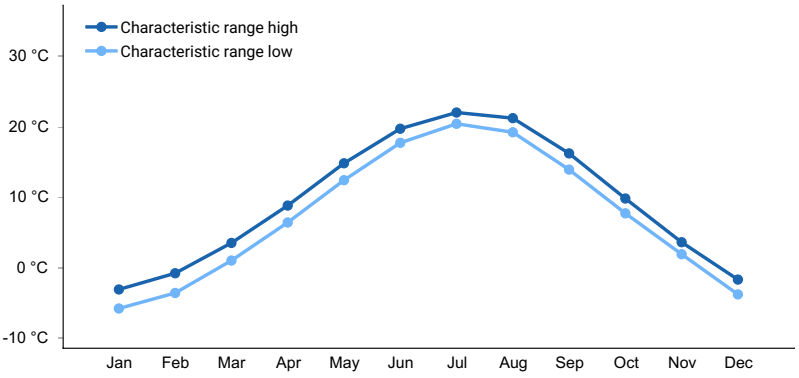


Figure 3. Monthly minimum temperature range

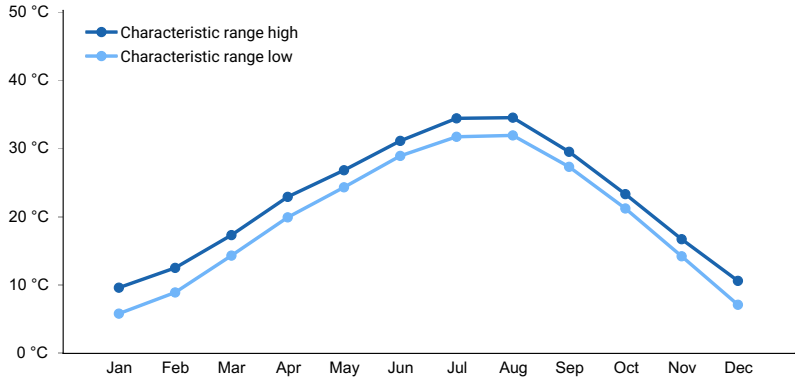


Figure 4. Monthly maximum temperature range

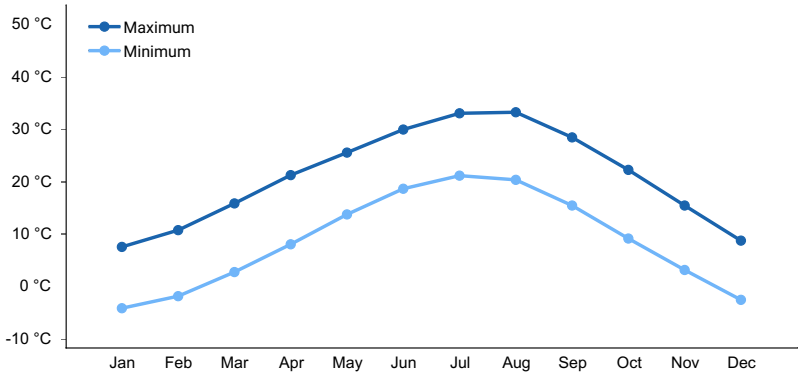


Figure 5. Monthly average minimum and maximum temperature

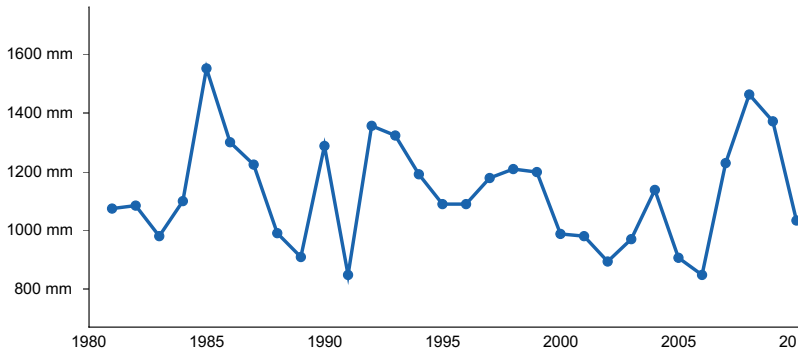


Figure 6. Annual precipitation pattern

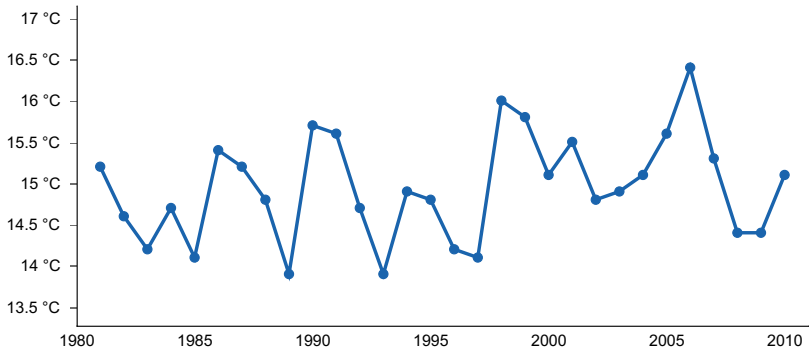


Figure 7. Annual average temperature pattern

Climate stations used

- (1) HOLDENVILLE 2SSE [USC00344235], Holdenville, OK
- (2) WAGONER [USC00349247], Wagoner, OK
- (3) NOWATA [USC00346485], Nowata, OK
- (4) COLUMBUS [USC00141740], Columbus, KS
- (5) HUMBOLDT [USC00143867], Humboldt, KS
- (6) ELDORADO SPRINGS [USC00232511], El Dorado Springs, MO

Influencing water features

Claypan Upland soils take in water very slowly and consequently large amounts of rainfall will run off the site. The water holding capacity is high but the slow release of water by the clay subsoil to plants results in this site being droughty.

Soil features

Soils that characterize the Claypan Upland site have an abrupt textural change to silty clay or clay at about 10 to 15 inches. Abrupt textural changes impede but do not exclude rooting. The soils were formed under prairie vegetation,

and have dark, organic-rich surface horizons. They have silt loam surface horizons, and silty clay to clay subsoils. Parent material is loess underlain by residuum, alluvium or colluvium from shale. A seasonal high water table is perched above the clayey subsoil during the spring months in most years. Soil series associated with this site include Hartwell, Medoc, Opolis, Parsons, and Taloka.

The picture of the Parsons series below shows a dark silt loam surface horizon over a thin, light-colored leached layer called an E or albic horizon at about 9 inches. Below this is the claypan, a clay horizon that impedes water movement and root penetration. Indicators of seasonal wetness (redoximorphic features) are visible in the picture below about 27 inches.

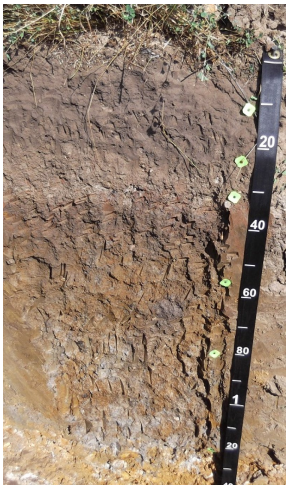


Figure 8. Soil profile of the Parsons series. Picture courtesy of Gene Campbell; scale is in centimeters.

Table 4. Representative soil features

Parent material	(1) Residuum–shale (2) Alluvium–shale (3) Colluvium–shale (4) Loess
Surface texture	(1) Silt loam
Family particle size	(1) Clayey
Drainage class	Poorly drained to moderately well drained
Permeability class	Very slow to slow
Soil depth	152–203 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	15.24–22.86 cm
Calcium carbonate equivalent (0-101.6cm)	0%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	4.5–7.3
Subsurface fragment volume <=3" (Depth not specified)	0%

Subsurface fragment volume >3" (Depth not specified)	0%

Ecological dynamics

The complex interaction of many ecological factors and processes influenced plant communities historically found and currently present on the Claypan Upland site. Primary influences are climate, fire, and grazing. Upon European settlement, non-native seed introduction and extreme disturbance (tillage) became potential influences on the site.

The reference plant community for this site is dominated by warm-season perennial grasses, a composite of predominantly tallgrasses and midgrasses interspersed with numerous perennial forbs. A small component of shrubs and cool-season grasses also occurs on this site. The reference plant community withstood extreme conditions of excessive moisture and extended drought, fire that occurred frequently (every 1 to 3 years) and in varying seasons, and grazing by large herbivores that varied in intensity, timing, frequency, duration, and distribution.

Reduction in fire intensity and frequency allows fire-intolerant trees and shrubs to establish and increase on the site. The density and spatial proximity of tree and shrub seed sources affects the sites vulnerability to trees and shrubs in conjunction with the reduction in fire intensity and frequency. Drought conditions and excessive grazing directly influence the quantity of herbaceous material present and thus the intensity a fire could have, if ignited. Fragmented landscapes and fire suppression efforts directly impact the frequency at which fires can occur on the site.

Grazing by large herbivores that had great variability in intensity, timing, frequency, duration, and distribution on the landscape is now performed by livestock confined by fencing and variability dictated by the livestock manager. Excessive grazing, plants experiencing intensive and frequent leaf removal, is now more likely to occur and not only reduces herbaceous material present for fire, but also influences plant composition and structure. Plant species in the reference plant community are highly preferred by grazing livestock and when excessively grazed, will diminish when endured for several consecutive years. At the same time, less preferred plants or plants that require less leaf material to persist will increase their presence, shifting dominance of species and/or functional and structural groups.

Non-native seed introduction to the site occurs indirectly and/or directly. Indirect introduction is the most common and occurs based on the spatial presence of the non-native species and the method of seed dispersal (wind, wildlife, water, vehicles, machinery, livestock, etc.). Direct introduction could have occurred from overseeding the site with an introduced species without full knowledge of the ecological consequences of the seed introduction.

While fire and grazing can be significant disturbances, tillage of the site causes drastic changes in ecological processes. Past tillage caused total destruction of the original native plant community, and while being farmed, major degradation of the inherent structure and fertility of the surface soil layer occurred along with the loss of surface soil in the form of water erosion. Current species composition of these sites, after tillage ceased, depends on seed introduction from surrounding native seed sources (natural succession) or on the species mixture reseeded.

The state and transition model is provided to diagram the complex interactions briefly discussed here. The model includes states, plant communities, transitions, and restoration pathways detailing what experts have gathered from available experimental research, field observations, professional consensus, and interpretations. There may be other states or plant communities, with additional transitions and restoration pathways, not shown in the model, as well as noticeable variations within those illustrated.

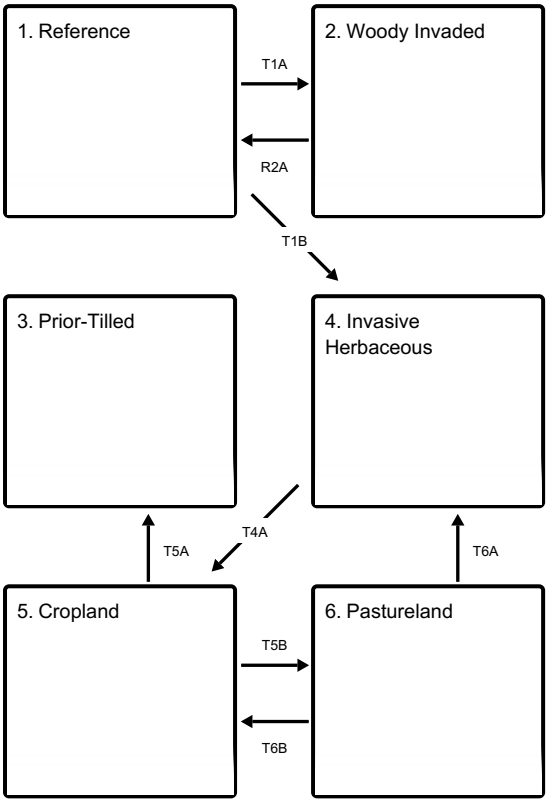
The state and transition model consists of six states and nine community phases. These states and community phases interact based on the timing, intensity, and frequency of prescribe burning and prescribed grazing, introduction of invasive species, and tillage practices. The Reference State (1) typically burned every 1 to 3 years. Fire removes dead plant litter and provides room for a lush growth of prairie vegetation. Fires also keeps woody species from invading the rangeland. The reference state is managed by controlling the intensity, frequency, duration, timing, and number of grazing animals. Grazing modifies vegetation structure and influences ecological processes.

The Woody Invaded State (2) is characterized by a fire frequency and return interval greater than 20 years and a

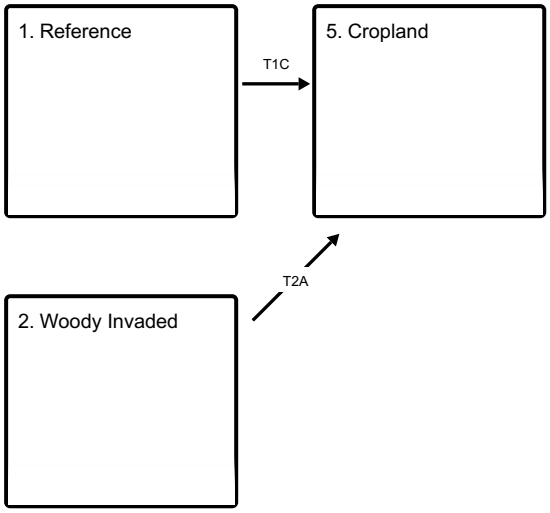
canopy cover percent between 40 and 60 percent. The Prior-Tilled State (3) consists of sites that were allowed to regenerate through natural revegetation or artificially reseeded after tillage practices have ceased. The Invasive Herbaceous State (4) is characterized by invasive, non-native grasses and forbs. The Cropland State (5) consists of land converted to agricultural cropland and dominated by row crops. The Pastureland State (6) is characterized by seeded grasses, usually cool season, that receive fertilizer and irrigation inputs to maintain the pasture, often used for grazing.

State and transition model

Ecosystem states



States 1, 5 and 2 (additional transitions)



T1A - Long term fire suppression (20+ years).

T1B - Invaded by non-native grasses and forbs.

T1C - Tillage and seeding of agricultural crops.

R2A - Removal of woody species by fire and/or mechanical methods.

T2A - Tillage and seeding of agricultural crops.

T4A - Tillage and seeding of agricultural crops.

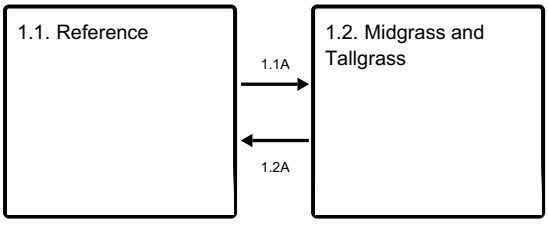
T5A - Natural revegetation or reseeding.

T5B - Seeding of grasses and pasture management

T6A - Invaded by non-native grasses and forbs.

T6B - Tillage and seeding of agricultural crops

State 1 submodel, plant communities



1.1A - Continued, excessive leaf removal of dominant species in reference community.

1.2A - Adaptive grazing that ensures adequate leaf retention of tallgrass species and incorporates periods of growing season deferment

State 2 submodel, plant communities

2.1. Shrub and/or Tree

State 3 submodel, plant communities

3.1. Go-Back

3.2. Reseed

State 4 submodel, plant communities

4.1. Caucasian Bluestem

4.2. Sericea Lespedeza

State 5 submodel, plant communities

5.1. Cropland

State 6 submodel, plant communities

6.1. Fescue, Brome, Bluegrass

State 1
Reference

The Reference State is dominated by warm-season perennial grasses, a composite of predominantly native species of tallgrasses and midgrasses, interspersed with numerous perennial forbs. A small component of shrubs and cool-season grasses also occur. This state has two plant community phases that are dynamic in nature and are dependent on fire frequency and grazing impacts.

Characteristics and indicators. An introduction and/or increase of woody plants can occur in the Reference State and initiates the transition to the Woody State. The lengthening of fire return interval, lack of fire intensity, and lack of competition from the warm-season perennial grasses, the greater the chance of woody species to establish and increase. Within the Reference State, the woody vegetation will generally be less than 15 percent canopy cover per acre. An introduction of seed from introduced, invasive or noxious plants can occur in the Reference State and is the starting point for transition to the Pastureland State. If introduced, invasive, or noxious plants are present, they should not exceed those percentages shown in the plant communities identified in the Pastureland State. Tillage has not been a disturbance in the Reference State.

Resilience management. The Reference State is maintained through fire, grazing, and management. Fire will have a return interval of one to three years that includes the timing and intensity to negatively impact undesirable species. Grazing will include a forage-animal balance and adaptive decision-making to ensure the dominant plants within the reference plant community can maintain vigor. Management will include strategies to prevent non-native seed introduction (woody or herbaceous) and scouting with targeted control methods if initial establishment occurs.

Dominant plant species

- big bluestem (*Andropogon gerardii*), grass
- little bluestem (*Schizachyrium scoparium*), grass
- switchgrass (*Panicum virgatum*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- dotted blazing star (*Liatris punctata*), other herbaceous
- white heath aster (*Symphyotrichum ericoides*), other herbaceous

Community 1.1
Reference

Figure 9. Reference Plant Community 1.1

The interpretive plant community for the Claypan Upland ecological site is the Reference Plant Community and represents the original plant community that existed prior to European settlement. Characterized as open grassland essentially free of trees and large shrubs, it is dominated by tall, warm-season grasses including big bluestem, switchgrass, and Indiangrass. Little bluestem, a midgrass, is also a major component of this community. These grasses will account for 70 to 80 percent of vegetation produced annually. Other prevalent midgrasses are sideoats grama, purple lovegrass, and prairie junegrass. Native shortgrasses such as buffalograss and blue grama were a minor component of this community. The site supports a wide variety of native legumes and forbs interspersed throughout the grass sward. The most abundant are dotted gayfeather, heath aster, Missouri goldenrod, slimflower scurfpea, stiff goldenrod, western ragweed, and upright prairie coneflower. Other prominent forbs include Louisiana sagewort, field pussytoes, wooly verbena, and western yarrow. Leadplant and New Jersey Tea are low-growing, fire-tolerant shrubs that occur over the site. A few small clumps of smooth sumac may be found in areas where they partially escape the effects of intense fires.

Resilience management. This is a stable plant community when grazing and fire are adequately managed. A prescribed grazing program that incorporates periods of grazing rest and recovery of key forage species during the growing season benefits the tallgrasses as well as the more palatable forb species. Excessive grazing and livestock trailing can quickly impact soil stability and lead to sheet and gully erosion. Because this site often occurs on summits, shoulders, and other high elevations on the landscape, it is preferred by grazing animals during the hot days of late summer. Cattle and other livestock commonly graze into the prevailing southerly winds and find loafing areas in this site to gain relief from heat and insects. Concentrated livestock use, such as winter-feeding areas, can cause compaction of the wet, clay soils and stress the dominant tallgrasses.

Forest understory. The Understory Species list is based commonly occurring species listed in Nelson (2010).

Dominant plant species

- big bluestem (*Andropogon gerardii*), grass
- little bluestem (*Schizachyrium scoparium*), grass
- switchgrass (*Panicum virgatum*), grass
- Indiangrass (*Sorghastrum nutans*), grass

Community 1.2
Midgrass and Tallgrass

This plant community developed as a result of many years of repeated, heavy grazing. Midgrasses tend to dominate the site and comprise 40 to 50 percent of the annual production. Most abundant grasses include little bluestem, sideoats grama, composite dropseed, purpletop tridens, western wheatgrass, silver beardgrass, and purple lovegrass. Although tallgrasses have been reduced to a secondary component, they still contribute 20 to 30 percent of the total herbage production and maintain a visible presence in the community aspect. Composite dropseed has increased as a tallgrass species. Cool season species such as Kentucky bluegrass, smooth brome, tall fescue, and sedges become a minor (2-10% composition by weight) component of the plant community. Although little bluestem is the predominant species, big bluestem, Indiangrass, and switchgrass plants with reduced vigor and stature are commonly found throughout the site. This plant community is relatively stable under long-term grazing unless negatively impacted by additional stresses like extended drought and grazing pressure that exceeds production potential of the site. Of these remnants, big bluestem is generally the most abundant, having rhizomes that can persist for many years in a weakened condition. In this stage, new growth will emerge as three to five prostrate leaves, providing partial relief from grazing. These tallgrass remnants respond favorably to periods of rest from grazing and may regain enough vigor to produce viable seed heads with two to three years of careful grazing management. Forb production is quite variable and may range from 10 to 25 percent of the total vegetation depending on amounts and timing of rainfall events. Perennial forbs include slimflower scurfpea, white sagebrush, Missouri goldenrod, Baldwin ironweed, white heath aster, and Cuman ragweed. In some locations shrubs such as smooth sumac, roughleaf dogwood, and coralberry comprise up to 10 percent of the vegetation. A variety of invasive trees such as Osage orange, honeylocust, and eastern redcedar may also be present.

Resilience management. The Midgrass/Tallgrass plant community persists with the use of a forage-animal imbalance as a grazing strategy and a longer fire return interval, approximately 5 to 7 years. The forage-animal imbalance results in excessive grazing (plants experiencing intensive and frequent leaf removal) on preferred species such as big bluestem, Indiangrass, and palatable legumes. Lack of fire allows residual build-up of old growth on less palatable species and a potential increase in woody species that further amplifies animal selection of desirable plants.

Dominant plant species

- coralberry (*Symphoricarpos orbiculatus*), shrub
- roughleaf dogwood (*Cornus drummondii*), shrub
- smooth sumac (*Rhus glabra*), shrub
- little bluestem (*Schizachyrium scoparium*), grass
- sideoats grama (*Bouteloua curtipendula*), grass
- composite dropseed (*Sporobolus compositus*), grass
- purpletop tridens (*Tridens flavus*), grass
- big bluestem (*Andropogon gerardii*), grass
- Cuman ragweed (*Ambrosia psilostachya*), other herbaceous
- Baldwin's ironweed (*Vernonia baldwinii*), other herbaceous
- white heath aster (*Symphyotrichum ericoides*), other herbaceous

Pathway 1.1A
Community 1.1 to 1.2

The mechanisms that transition the Reference Plant Community to a Midgrass/Tallgrass Plant Community include repetitive, excessive leaf removal of the key tallgrass forage species in conjunction with longer fire return intervals than historically occurred in the Reference Plant Community. The repetitive, excessive leaf removal is driven by a forage-animal imbalance (no rest or recovery). Drought conditions with below average rainfall during the first half of the growing season will amplify the annual imbalance due to overall reduced forage production and extended (>3 years) drought will accelerate the rate of transition. Having longer fire return intervals and a forage-animal

imbalance lasting for periods greater than 10 years will shift functional and structural plant group dominance towards a midgrass plant community. Initial increases in forbs, as tallgrasses are reduced in vigor, could trigger a desire by land managers to utilize herbicides to reduce forb presence. Broadcast application of broadleaf herbicides will remove legumes and forbs and result in a grass dominated community but not improve tallgrass species vigor.

Context dependence. Plant community composition shifts from Tallgrass to Midgrass dominant.

Pathway 1.2A
Community 1.2 to 1.1

The restoration from a Midgrass/Tallgrass Plant Community to a Reference Plant Community requires a shift in management (prescribed grazing) that includes a forage-animal balance allowing sufficient leaf material to remain on the key tallgrass forage species (big bluestem, switchgrass, Indiangrass) and palatable legumes within the Reference Plant Community. Adaptive decision-making is required to allow adequate rest and recovery for the key plants and to meet a forage-animal balance, especially when drought conditions are encountered. If woody species are present, prescription fires every 1-3 years will be necessary for their removal and/or maintenance. Targeted spot treatment of non-native plants (herbaceous and woody) is needed if present.

Context dependence. Short-term (less than 5 years) adjustment in management can improve tallgrass vigor, but functional and structural group dominance change is likely to require 7 to 10 years depending on growing season moisture during that time-frame.

Conservation practices

Brush Management
Prescribed Burning
Prescribed Grazing

State 2
Woody Invaded

The Woody State is dominated by a shrub and/or tree plant community. The increase and spread of shrubs and trees resulted from an absence of fire and will be accelerated by seed introduction and/or spread. Woody plants can increase up to 34% from a lack of fire according to a study from 1937 to 1969, in contrast to a 1% increase on burned areas (Bragg and Hulbert, 1976). Periodic burning will hinder the establishment of most woody species and favor forbs and grasses. However, not all unburned areas have a woody plant invasion. Birds, small mammals, and livestock are instrumental in the distribution and spread of seed for most tree and shrub species common to this site. The speed of encroachment varies considerably and can occur on both grazed and non-grazed sites.

Characteristics and indicators. Hydrologic function in the Woody State is affected by the amount of shrub and/or tree cover compared to the Reference State. Canopy interception loss can vary from 25.4% to 36.7% (Thurow and Hester, 1997). A small rainfall event is usually retained in the foliage and does not reach the litter layer at the base of the tree. Only when canopy storage is reached and exceeded does precipitation fall to the soil surface. Interception losses associated with the accumulation of leaves, twigs, and branches at the bases of trees are considerably higher than losses associated with the canopy. The decomposed material retains approximately 40% of the water that is not retained in the canopy (Thurow and Hester, 1997). Soil properties affected include biological activity, infiltration rates, and soil fertility. The Woody State has not had tillage as a disturbance and could have plants identified in the Herbaceous Invaded State present on the site.

Resilience management. The Woody State is sustained by lack of fire and lack of woody plant control methods such as mechanical, chemical, or biological. Livestock that utilize browse will have greater livestock production potential in this state than those preferring plants in the Reference State. The lack of sunlight, due to shading by the shrubs and/or trees, will favor cool-season grasses that can reduce fire intensity if fire timing is during their active growth period and would help sustain the Woody State.

Dominant plant species

- honeylocust (*Gleditsia triacanthos*), tree

- Osage-orange (*Maclura pomifera*), tree
- eastern redcedar (*Juniperus virginiana*), tree
- roughleaf dogwood (*Cornus drummondii*), shrub
- coralberry (*Symphoricarpos orbiculatus*), shrub
- little bluestem (*Schizachyrium scoparium*), grass
- big bluestem (*Andropogon gerardii*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- sedge (*Carex*), grass

Community 2.1
Shrub and/or Tree

Figure 10. Shrub and/or Tree Plant Community

The Shrub and/or Tree Plant Community is dominated by shrubs consisting primarily of coralberry, roughleaf dogwood, american plum, and smooth sumac. Trees including osage orange, honeylocust, elms, pin oak, and eastern redcedar are common invaders that become established in some areas. Coralberry is generally the most abundant shrub and often forms low, dense thickets throughout the site. Shrubs and trees may produce 40 to 60 percent of the total vegetation. The spread of shrubs and trees results from the absence of fire because periodic burning tends to hinder the establishment of most these woody species and favors grasses and forbs. It should be noted, however, that not all unburned areas have a woody plant problem and that the rate of encroachment varies considerably depending on seed availability in surrounding areas. Longtime overgrazing can also lead to encroachment. In these situations, the associated grasses will usually consist of composite dropseed, purple lovegrass, Kentucky bluegrass, fescue, and Scribner's rosette grass. Shrubs and trees will also invade areas where both grazing and fire have been excluded for many years because the heavy accumulation of plant mulch and litter retards herbage growth and provides a favorable habitat for seed germination and establishment of many shrub species. The associated grasses in this situation may include big bluestem, little bluestem, Indiangrass, switchgrass, sedges, and Canada wildrye. Grass production is significantly reduced by competition from forbs and woody species. Grass yields vary from 20 to 45 percent of the total vegetative production while forbs often produce 10 to 50 percent of the total. Major forbs include white sagebrush, Cuman ragweed, Baldwin ironweed, and common yarrow.

Resilience management. The Shrub and/or Tree Community is sustained by lack of fire and lack of woody plant control methods such as mechanical, chemical, or biological. Usually, a well-planned burning program accompanied by prescribed grazing will gradually return the plant community to one dominated by desirable grasses and forbs. Special planning will be necessary to assure that sufficient amounts of fine fuel are available to carry fires with enough intensity to control wood species. Use of labeled herbicides as a brush management tool will usually be necessary to reduce populations of fire-resistant species like Osage orange and honeylocust and accelerate the recovery of desired vegetative cover. Recently, some landowners have relied on the browsing habits of goats to suppress the woody growth.

Forest understory. The Understory Species list is based commonly occurring species listed in Nelson (2010).

Dominant plant species

- Osage-orange (*Maclura pomifera*), tree
- eastern redcedar (*Juniperus virginiana*), tree
- honeylocust (*Gleditsia triacanthos*), tree
- coralberry (*Symphoricarpos orbiculatus*), shrub
- roughleaf dogwood (*Cornus drummondii*), shrub
- smooth sumac (*Rhus glabra*), shrub
- American plum (*Prunus americana*), shrub
- composite dropseed (*Sporobolus compositus*), grass
- tall fescue (*Schedonorus arundinaceus*), grass
- sedge (*Carex*), grass
- Baldwin's ironweed (*Vernonia baldwinii*), other herbaceous

State 3
Prior-Tilled

The Prior-Tilled State consists of abandoned cropland where the original plant community was destroyed through inversion by tillage but revegetation has occurred. Two plant communities are identified in the Prior-Tilled State and are identified by revegetation factors. The communities are identified as being naturally revegetated through succession (Go-back) or planted/seeded to species similar in composition to the reference plant community (Reseed). Plant species composition in the Prior-Tilled State is difficult to define due to the variability of plant communities that can exist.

Characteristics and indicators. The Prior-Tilled State is an alternative state since the energy, hydrologic, and nutrient cycles are significantly altered to that of the Reference State in its natural disturbance regime. Repeated tillage and planting of annual crops resulted in major changes in soil conditions. Reductions in organic matter, mineral levels, soil structure, oxygen levels, and water holding capacity, along with increased runoff/erosion and shifts in the populations of soil-dwelling organisms, are common in this state. The extent of these changes are dependent upon duration of cropping, crop types grown, and other management practices. Bulk density, aggregate stability, soil structure, and plant functional and structural groups are not fully restored to that of the Reference State. Mechanical tillage can destroy soil aggregation. Soil aggregates are an example of dynamic soil property change. Aggregate stability is critical for infiltration, root growth, and resistance to water and wind erosion (Brady and Weil, 2008).

Resilience management. The Prior-Tilled State is a result of a land use management decision and is sustained by diminished soil function. Implementation of practices that positively impact plant community diversity, energy flow, and nutrient and water cycle, should benefit rehabilitation. Documentation does not support rehabilitation to a Reference State within known management time frames.

Dominant plant species

- big bluestem (*Andropogon gerardii*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- switchgrass (*Panicum virgatum*), grass
- dropseed (*Sporobolus*), grass
- broomsedge bluestem (*Andropogon virginicus*), grass
- Cuman ragweed (*Ambrosia psilostachya*), other herbaceous
- white sagebrush (*Artemisia ludoviciana*), other herbaceous

Community 3.1
Go-Back

This plant community occurs on areas that were formerly farmed. When tillage operations ceased, the areas were allowed to revegetate or “go back” naturally in contrast to artificial reseeding to a selected species or group of species. The go-back process is a slow, gradual transformation that requires many years and many successional changes or stages in the plant community. The speed and extent of revegetation depends on the size of the area, level of grazing management and the proximity of the area to existing seed sources. In the initial stages of revegetation, the site is usually dominated by annual forbs such as annual ragweed, Canadian horseweed, common sunflower, annual marshelder, and Korean clover. Gradually these are replaced by annual grasses including prairie

threeawn, prairie cupgrass, buffalo bur, yellow foxtail, little barley, cheatgrass, and witchgrass. As plant succession progresses the plant community gradually becomes dominated by perennials. The major grasses include sand dropseed, composite dropseed, purpletop tridens, marsh bristlegrass, silver beardgrass, broomsedge bluestem, tumble windmillgrass, buffalograss, sedges, Scribner's rosette grass, and Carolina crabgrass. Common forbs are Cuman ragweed, white sagebrush, wavyleaf thistle, hoary verbena, Baldwin ironweed, brown eyed susan, white heath aster, Canada goldenrod, and Green antelopehorn milkweed. Combinations of these plants can form a stable community. Some go-back areas are invaded by trees and shrubs. The more common include Siberian elm, common hackberry, eastern redcedar, eastern cottonwood, roughleaf dogwood, hawthorn, persimmon, blackberry, and coralberry. Occasional burning is effective in controlling these woody plants.

Resilience management. Following termination of cultivation, total annual production is quite variable and full recovery of the original plant community, including forbs and legumes, may take many decades. Additions of organic matter and minerals, prescribed grazing prescribed burning, and related management practices described earlier for this ecological site can be beneficial to the rehabilitation.

Dominant plant species

- dropseed (*Sporobolus*), grass
- thin paspalum (*Paspalum setaceum*), grass
- windmill grass (*Chloris*), grass
- panicgrass (*Panicum*), grass
- Cuman ragweed (*Ambrosia psilostachya*), other herbaceous
- white sagebrush (*Artemisia ludoviciana*), other herbaceous
- Canada goldenrod (*Solidago canadensis*), other herbaceous

Community 3.2
Reseed

This plant community occurs on areas that were formerly farmed and reseeded with a mixture of native species common in the Reference Plant Community. Most seeding mixtures consisted of a blend of grasses that include big bluestem, Indiangrass, switchgrass, little bluestem, and sideoats grama. In some locations, seed of legumes and forbs such as prairie bundleflower and Maximilian sunflower were included in the mixture. If introduced, warm-season plants were seeded on the site, the plant community should be evaluated in a separate land use model such as Pasture. Once these areas become fully established, and the natural historical disturbances such as grazing and burning are included in management, production is comparable to that of the Reference Plant Community. Total annual production varies according to the species planted, established plant density, and the integrity of the soil profile to infiltrate and hold water, and provide nutrients. When reseeded areas and areas supporting native rangeland exist in the same pasture, they seldom are utilized at the same intensity because domestic livestock usually prefer plants growing on the native rangeland areas. When feasible, reseeded plant communities should be managed as separate pastures or units. Some seeded areas are invaded by trees and shrubs during the establishment period of the desired plants. These invader species commonly include elm, common hackberry, eastern redcedar, and eastern cottonwood. Burning is effective in controlling establishment of these woody plants.

Resilience management. The Reseed Plant Community is sustained by diminished soil function due to past tillage. Soil fertility, biodiversity, structure, and other properties were significantly altered and need rehabilitation. Ensuring the plant community, especially those identified within the reference plant community, remain healthy and productive through a proper forage-animal balance (prescribed grazing) and periodic use of prescribed fire will facilitate rehabilitation. Implementation of additional practices that positively impact plant community diversity, energy flow, and the nutrient and water cycle, should benefit rehabilitation.

Dominant plant species

- big bluestem (*Andropogon gerardii*), grass
- little bluestem (*Schizachyrium scoparium*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- switchgrass (*Panicum virgatum*), grass
- Illinois bundleflower (*Desmanthus illinoensis*), other herbaceous
- Maximilian sunflower (*Helianthus maximiliani*), other herbaceous

State 4
Invasive Herbaceous

The Invasive Herbaceous State is identified by a significant presence of non-native herbaceous plant species and is characterized by the composition of plant species and soil functions that govern the ecological processes. These two plant communities occur and function independent of one another.

Characteristics and indicators. Species that define this state include sericea lespedeza and Caucasian bluestem. Sericea lespedeza and Caucasian bluestem community phases are partially defined by the total production exceeding 15% by weight on a per acre basis. Ecological processes within this state that are affected and differ from the Reference State are hydrologic cycle and nutrient cycle. Water content and infiltration rates are also affected by the species in the plant community phase.

Resilience management. The Invasive Herbaceous State is sustained through continued reduction in health and vigor of native plant species and the increase in health and vigor, including seed production, of non-native herbaceous species. Ensuring a lack of forage quality due to season of grazing, and type of grazing animal, of the non-native plants will deter grazing of non-native plant species and increase grazing pressure on native plant species. A general lack of treatment measures for individual species control, maintenance, and/or eradication will also allow persistence of this state.

Dominant plant species

- sericea lespedeza (*Lespedeza cuneata*), shrub
- Caucasian bluestem (*Bothriochloa bladhii*), grass

Community 4.1
Caucasian Bluestem

Caucasian bluestem is present at levels exceeding 15% by weight on a per acre basis and governing the ecological processes and potential uses of this community. Caucasian bluestem might be the most serious threat and most aggressive of the introduced, invasive, and noxious species of this time. Interspatial erosion can be present due to the clumpy growth of the plant which leads to a rough surface to walk or drive on. Caucasian bluestem is allelopathic (producing toxic chemicals that negatively impact the germination and/or growth of other plants) and often exists as a monoculture due to its competitive ability. Having this species present on a site can and will allow further invasion of adjacent sites if proactive prevention and control measures are not implemented. Research and trial studies are continuously being conducted on control measures for Caucasian bluestem. Soil dynamic property changes include infiltration, biological activity, and soil fertility.

Resilience management. Caucasian bluestem is extremely competitive with its allelopathic nature, lower palatability compared to native species, ability to persist with heavy utilization, and tolerance to drought. To prevent further loss of native plant composition, ensure native plant vigor remains high via a forage-animal balance based on forage composition and palatability, and utilize spot application of herbicides to control new and existing Caucasian bluestem plants. Fire can be utilized to remove standing dead growth and increase palatability of Caucasian bluestem in a mixed plant community, especially initial spring growth. Impacts to Caucasian bluestem via alternate timing of fire (late summer) is currently being investigated. There have been cases where the native taller grasses appear to shade and out-compete the Caucasian bluestem, but more commonly, it is crowding out the native grass as it spreads. There are ungrazed places on the Konza Prairie Research and biological station where Caucasian bluestem was introduced from feeding livestock contaminated hay and it is now crowding out the native grass.

Dominant plant species

- Caucasian bluestem (*Bothriochloa bladhii*), grass

Community 4.2
Sericea Lespedeza

Sericea lespedeza (*Lespedeza cuneata*) is present at levels exceeding 15% by weight on a per acre basis and governing the ecological processes and potential uses of this community. Sericea lespedeza is invasive and listed

as a statewide noxious weed in Kansas. It competes with the native plant community for sunlight, water, and nutrients, and produces allelopathic compounds (toxic chemicals that negatively impact the germination and/or growth of other plants). It also contains tannins, that limit palatability, and produces copious amounts of seed that remain viable in the soil for decades. This species will quickly invade rangelands without proactive control measures.

Resilience management. Sericea lespedeza (*Lespedeza cuneata*) is extremely competitive with its allelopathic nature, lower palatability compared to native species, and good seedling vigor. To prevent further loss of native plant composition, ensure native plant vigor remains high via a forage-animal balance based on forage composition and palatability, utilize spot application of herbicides to control new and existing sericea lespedeza plants, and consider diversifying grazing livestock type. Control measures for sericea lespedeza involve herbicide application following extension recommendations and product label for proper rates and timing. Utilization and control can also be provided through sheep and goat grazing. Conventional management practices such as prescribed grazing with cattle and dormant-season fire have been less than effective in preventing the spread of sericea lespedeza in rangelands. Some suppression of sericea lespedeza has been observed after mowing or summer burning. Late summer fire significantly reduces seed production the year of burn. An integrated approach is needed when treating this species.

Dominant plant species

- sericea lespedeza (*Lespedeza cuneata*), shrub

State 5
Cropland

The Cropland State is dominated by row crops such as corn, soybeans, and wheat. It occurs on sites that have been mechanically tilled and converted to agricultural cropland. After tillage, efforts are then taken to plant various crops through a conservation cropping system.

Dominant plant species

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

Community 5.1
Cropland

This community occurs on areas where land use has been converted to intensive agriculture cropland through mechanical tillage and a conservation cropping system. Primary crops include corn, soybeans, and wheat.

Dominant plant species

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

State 6
Pastureland

The Pastureland State is identified by a significant presence of non-native herbaceous plant species and is characterized by the composition of plant species, agronomic inputs from direct fertilization, and soil functions that govern the ecological processes. Sites consisting of introduced species and managed for their continued presence or spread should not be evaluated within this model and instead, consider using a separate land use model such as Pasture.

Characteristics and indicators. Tall fescue, smooth brome, and Kentucky bluegrass are partially defined by the total production exceeding 40% by weight on a per acre basis. Ecological processes within this state that are affected and differ from the Reference State are hydrologic cycle and nutrient cycle. Water content and infiltration

rates are also affected by the species in the plant community phase.

Resilience management. Pastureland is sustained through continued reduction in health and vigor of native plant species and the increase in health and vigor, including seed production, of non-native herbaceous species. Agronomic inputs from direct fertilization or nutrient-rich runoff from adjacent crop fields will provide advantages for non-native cool-season grass species growth. Ensuring a lack of forage quality due to season of grazing, type of grazing animal, or chemical composition of the non-native plants will deter grazing of non-native plant species and increase grazing pressure on native plant species. A general lack of treatment measures for individual species control, maintenance, and/or eradication will also allow persistence of this state.

Dominant plant species

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

Community 6.1
Fescue, Brome, Bluegrass

Tall fescue, smooth brome, and Kentucky bluegrass (all being cool-season grasses) are present at levels exceeding 40% by weight on a per acre basis and are governing the ecological processes and potential uses of this community. Timing of plant growth has shifted from summer (May through August) and now mostly occurs in spring and fall (March to May and September to November). Fire intensity of late spring burns can be greatly impeded due to the significant quantity of cool-season grass present. Any one or a combination of these species can be considered an invaded community. Soil dynamic property changes include biological activity and soil fertility.

Resilience management. Tall fescue, smooth brome, and Kentucky bluegrass are sustained or increased with nutrient additions and absence of fire. To prevent further loss of native plant composition, avoid nutrient additions, ensure native plant vigor remains high via a forage-animal balance based on forage composition and seasonal availability, utilize herbicides when natives are dormant but cool-seasons are actively growing, and utilize consecutive late spring prescribed burns. Chemical control will involve herbicide application following extension recommendations and product label for proper rates and timing. Intensifying grazing pressure (leaf removal of cool-season grasses) during the spring and fall and removing grazing pressure during the summer will reduce cool-season grass vigor and allow native warm-season plants an opportunity to maximize growth and gain vigor. Prescribed burning will require sufficient standing dead material in order to conduct a burn in late spring as warm-season grasses initiate growth. If the goal is continued presence or spread of tall fescue, smooth brome, or Kentucky bluegrass, consider using a separate land use model such as Pasture.

Dominant plant species

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

Transition T1A
State 1 to 2

Long term fire suppression (20+ years) will transition the Reference State to a Woody Invaded State. A lack of fire events will allow woody species to establish and increase, shifting the site to dominant trees and shrubs with a reduction in desirable grasses and forbs in the understory.

Transition T1B
State 1 to 4

A transition from Reference to an Invasive Herbaceous State occurs when the site is invaded by either Caucasian bluestem and/or Sericea lespedeza with the total production exceeding 15% by weight on a per acre basis.

Transition T1C

State 1 to 5

Tillage (or no-till if that management style is preferred) and seeding of agricultural crops will transition this site from a Reference State to a Cropland State.

Restoration pathway R2A
State 2 to 1

Restoration actions to return to a Reference State may include machinery woody removal and prescribed fire. Efforts will be costly, labor-intensive, and can take many years, if not decades. Once canopy levels reach greater than 20 percent, estimated cost to remove trees is very expensive and includes high energy inputs.

Transition T2A
State 2 to 5

Tillage (or no-till if that management style is preferred) and seeding of agricultural crops will transition this site from a Woody State to a Cropland State.

Transition T4A
State 4 to 5

Tillage (or no-till if that management style is preferred) and seeding of agricultural crops will transition this site from an Invasive Herbaceous State to a Cropland State.

Transition T5A
State 5 to 3

Allowing the site to naturally revegetate as it regenerates, or reseeding the site with native grasses and forbs with proper management afterwards will transition this site from a Cropland to a Prior-Tilled State.

Transition T5B
State 5 to 6

Seeding of cool season grasses and forbs and proper pasture management will transition this Cropland to a Pastureland.

Transition T6A
State 6 to 4

A transition from Pastureland to an Invasive Herbaceous State occurs when the site is invaded by either Caucasian bluestem and/or Sericea lespedeza with the total production exceeding 15% by weight on a per acre basis.

Transition T6B
State 6 to 5

Tillage (or no-till if that management style is preferred) and seeding of agricultural crops will transition this site from a Pastureland to a Cropland.

Additional community tables

Animal community

Wildlife*

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

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

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

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

Bird species associated with this ecological site's reference state condition:
Breeding birds as related to vegetation structure (related to time since fire, grazing, haying, and mowing):

Vegetation Height Short (0.5 meter, low litter levels, bare ground visible):
Grasshopper Sparrow, Horned Lark, Upland Sandpiper, Greater Prairie Chicken, Northern Bobwhite

Vegetation Height Moderate (0.5 – 1 meter, moderate litter levels, some bare ground visible): Eastern Meadowlark, Dickcissel, Field Sparrow, Upland Sandpiper, Greater Prairie Chicken, Northern Bobwhite, Blue Grosbeak, Scissor-Tailed Flycatcher, Eastern Kingbird, Lark Sparrow

Vegetation Height Tall (> 1 meter, moderate-high litter levels, little bare ground visible):
Henslow's Sparrow, Dickcissel, Greater Prairie Chicken, Field Sparrow, Northern Bobwhite, Sedge Wren, Northern Harrier

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

Winter Resident: Short-Eared Owl, Northern Harrier

Amphibian and reptile species associated with this ecological site's reference state condition: prairies with crawfish burrows may have Northern Crawfish Frog (Rana areolata circulosa); Ornate Box Turtle (Terrapene ornata ornata), Western Slender Glass Lizard (Ophisaurus attenuatus attenuatus), Prairie Ring-necked Snake (Diadophis punctatus arnyi), Prairie Kingsnake (Lampropeltis calligaster calligaster), and Bullsnake (Pituophis catenifer sayi).

Prairies with ephemeral vernal fishless wetlands: Western Chorus Frog (Pseudacris triseriata triseriata), Plains Leopard Frog (Rana blairi), Eastern Tiger Salamander (Ambystoma tigrinum), and Great Plains Narrow-mouthed Toad (Gastrophryne olivacea).

Small mammals associated with this ecological site's reference state condition:
Least Shrew (Cryptotis parva), Plains Pocket Gopher (Geomys bursarius), Prairie Vole (Microtus ochrogaster), Meadow Jumping Mouse (Zapus hudsonius), and Badger (Taxidea taxus).

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

Insect species known to be associated with this ecological site's reference state condition: Regal Fritillary butterfly (Speyeria idalia) whose larvae feed primarily on native prairie violets (Viola pedata, V. pedatifida, and V. sagittata); Mottled Dusky Wing butterfly (Erynnis martialis), Ottoe Skipper butterfly (Hesperia ottoe), Arogos Skipper butterfly (Atrytone arogos iowa), Golden Byssus butterfly (Problema byssus kumskaka), Delaware Skipper butterfly (Atryone logan logan), and Crossline Skipper butterfly (Polites origenes). The larvae of the moth Eucosma bipunctella bore into compass plant (Silphium laciniatum) roots and feed and the larvae of the moth Eucosma giganteana bore into a number of Silphium species roots and feed. Native bees, important pollinators, that may be associated with this ecological site's reference condition include: Colletes brevicornis, Andrena beameri, A. helianthiformis, Protandrena rudbeckiae, Halictus parallelus, Lasioglossum albipennis, L. coreopsis, L. disparilis, L. nymphaereum, Ashmeadiella bucconis, Megachile addenda, Anthidium psoraleae, Eucera hamata, Melissodes coloradensis, M. coreopsis, and M. vernoniae. The Short-winged Katydid (Amblycorypha parvipennis), Prairie Mole Cricket (Gryllotalpa major), Green Grasshopper (Hesperotettix speciosus) and Two-voiced Conehead katydid (Neoconcephalus bivocatus) are possible orthopteran associates of this ecological site.

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

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

Other information

Forestry

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

Inventory data references

Information presented here has been derived from NRCS clipping data, numerous ocular estimates and other inventory data. Field observations from experienced range-trained personnel was used extensively to develop this ecological site description.

Other references

Bestelmeyer, B., J.R. Brown, K.M. Havstad, B. Alexander, G. Chavez, and J.E. Herrick. 2003. Development and Use of State and Transition Models for Rangelands. Journal of Range Management 56:114–126. Las Cruces, NM.

Bestelmeyer, B. and J.R. Brown. 2005. State-and-Transition Models 101: a Fresh Look at Vegetation Change. Las Cruces, NM.

Bestelmeyer, B.T., K. Moseley, P.L. Shaver, H. Sanchez, D.D. Briske, and M.E. Fernandez-Gimenez. 2010. Practical guidance for developing state-and-transition models. Rangelands 32:23–30. Las Cruces, NM.

Bestelmeyer, B.T., J.C. Williamson, C.J. Talbot, G.W. Cates, M.C. Duniway, and J.R. Brown. 2016. Improving the Effectiveness of Ecological Site Descriptions: General State-and-Transition Models and the Ecosystem Dynamics Interpretive Tool (EDIT). Rangelands 38:329–335. Las Cruces, NM.

Brady, N. and R. Weil. 2008. The nature and properties of soils,14th ed. New York City, NY.

Bragg, T. and L. Hulbert. 1976. Woody plant invasion of unburned Kansas bluestem prairie. Journal of Range Management., 29:19-23. Manhattan, KS.

Caudle, D., H. Sanchez, J. DiBenedetto, C. Talbot, and M. Karl. 2013. Interagency Ecological Site Handbook for Rangelands.

Comer, P.J., D. Faber-Langendoen, R. Evans, S. Gawler, C. Josse, G. Kittel, S. Menard, M. Pyne, M. Reid, K. Schulz, K. Snow, and J. Teague. 2003 (Date accessed). Ecological Systems of the United States: A Working Classification of U.S. Terrestrial Systems.

Dyksteruis, E.J. 1958. Range conservation as based on sites and condition classes. J. Soil and Water Conserv. 13: 151-155.

Eddleman, L. 1983. Some ecological attributes of western juniper. P. 32-34 in Research in rangeland management. Agric. Exp. Stan. Oregon State Univ., Corvallis Spec. Rep. 682.

Fitzgerald, J.A. and D.N. Pashley. 2000a. Partners in Flight bird conservation plan for the Ozark/Ouachitas. American Bird Conservancy. Brentwood, MO

Fitzgerald, J.A. and D.N. Pashley. 2000b. Partners in Flight bird conservation plan for the Dissected Till Plains.

American Bird Conservancy. Brentwood, MO

Heitzman, J.R. and J.E. Heitzman. 1996. Butterflies and moths of Missouri. 2nd ed. Missouri Department of Conservation, Jefferson City, MO

Herrick J. E., J.W. Van Zee, K.M. Havstad, L.M. Burkett, and W.G. Whitford. 2005. Monitoring Manual for Grassland, Shrubland, and Savanna Ecosystems. Volume 1: Quick Start.

Herrick, J.E., J.W. Van Zee, K.M. Havstad, L.M. Burkett, and W.G. Whitford. 2005. Monitoring Manual for Grassland, Shrubland, and Savanna Ecosystems. Volume II: Design, Supplimentary Methods, and Interpretation..

Hester, J.W. 1996. Influence of woody dominated rangelands on site hydrology and herbaceous production, Edwards Plateau, Texas. M.S. Thesis, Texas A&M University, College State, TX.

Holechek, J., R. Pieper, and C. Herbel. Range Management: principles and practices.—5th ed.

Jacobs, B. 2001. Birds in Missouri. Missouri Department of Conservation, Jefferson City, Missouri.

Johnson, T.R. 2000. The amphibians and reptiles of Missouri. 2nd ed. Missouri Department of Conservation, Jefferson City, Missouri.

Kuchler, A., A new vegetation map of Kansas. Ecology (1974) 55: pp. 586-604.

Launchbaugh, John. Clenton Owensby. Kansas Rangelands, their management based on a half century of research. Bull. 622 Kansas Agricultural Experiment Station, October, 1978.

Moore, R., J. Frye, J. Jewett, W. Lee, and H. O'Connor. 1951. The Kansas rock column. Univ. Kans. Pub., State Geol. Survey Kans. Bull. 89. 132p.

National Climatic Data Center. Weather data. http://www.ncdc.noaa.gov/. Accessed online 04/05/2017.

National Cooperative Soil Survey (NCSS). 2018 (Date accessed). National Cooperative Soil Characterization Database. https://ncsslabdatamart.sc.egov.usda.gov/.

National Oceanic and Atmospheric Administration (NOAA). 2018 (Date accessed). Climate Data 1980-2010. https://www.ncdc.noaa.gov/data-access/land-based-stationdata/
find-station.

Natural Resources Conservation Service. 2018 (Date accessed). Web Soil Survey (SSS NRCS WSS). https://websoilsurvey.sc.egov.usda.gov/.

Nelson, Paul W. 2010. The Terrestrial Natural Communities of Missouri. Missouri Department of Conservation, Jefferson City, Missouri.

Nigh, Timothy A., & Walter A. Schroeder. 2002. Atlas of Missouri Ecoregions. Missouri Department of Conservation, Jefferson City, Missouri.

Pitts, D.E. and W.D. McGuire. 2000. Wildlife management for Missouri landowners. 3rd ed. Missouri Department of Conservation, Jefferson City.

Sauer, Carl. 1950. Grassland climax, fire, and man. J. Range Manage. 3: 16-21.

Schwartz, C.W., E.R. Schwartz and J.J. Conley. 2001. The wild mammals of Missouri. University of Missouri Press, Columbia and Missouri Department of Conservation, Jefferson City.

Society for Rangeland Management. 1994. Rangeland cover types of the United States. Denver, CO.

SSS NRCS OSD. 2018 (Date accessed). Official Soil Series Descriptions.

https://soilseries.sc.egov.usda.gov/osdname.aspx.

Thurow, T. and J. Hester. 1997. How an increase or reduction in juniper cover alters rangeland hydrology. In: C.A. Taylor, Jr. (ed.). Proc. 1997 Juniper Symposium. Texas Agr. Exp. Sta. Tech. Rep. 97-1. San Angelo, TX: 4:9-22.

U.S. Department of Agriculture, Natural Resources Conservation Service. National Ecological Site Handbook. https://directives.sc.egov.usda.gov

United States Department of Agriculture. 2006. Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin. Washington, D.C.

USDA-NRCS. 1997. National range and pasture handbook, , Chapter 7, rangeland and pastureland hydrology and erosion.

USDA, NRCS. 2018 (Date accessed). The PLANTS Database. http://plants.usda.gov.

U.S. Dept. of Agric. Soil Conservation Service. 1974. Soil Survey of Barton County, Missouri. Washington, D.C.

Waller, S., L. Moser, P. Reece., and G. Gates. 1985. Understanding grass growth. Weaver, J. and F. Albertson. April 1940. Deterioration of midwestern ranges. Ecology, Vol. 21, No. 2. pp. 216-236.

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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)	Original Authors in February 2006 from Claypan site: David Kraft, John Henry, Doug Spencer, and Dwayne Rice. All KS NRCS employees. Corrections and Update version Author: Chris Tecklenburg, Ecological Site Specialist, Soil Survey Division, Region 5.
Contact for lead author	Doug Spencer, State Grazing Lands Specialist for Kansas.
Date	07/15/2020
Approved by	Suzanne Mayne-Kinney
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** None. The potential for rills to occur on this site is extremely rare due to the the amount of cover and slope percentage (0-3%).

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2. **Presence of water flow patterns:** Water flow patterns are rare due to slope percentage (0-3) and amount of ground cover. Small depressional areas can serve as holding areas that increase the time for infiltration, and as a result reduce the ability for flow patterns to occur

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3. **Number and height of erosional pedestals or terracettes:** None, due to the slope percentage (0-3) and amount of cover. Pedestals and terracettes are indicators of soil being moved by water and/or wind.

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not**

bare ground): Less than 5% of bare ground is found on this site. Bare ground is the remaining ground cover after accounting for ground surface covered by vegetation (basal and canopy (foliar) cover,), litter, standing dead vegetation, gravel/rock, and visible biological crust (e.g., lichen, mosses, algae).

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5. **Number of gullies and erosion associated with gullies:** None. There are no channels that are being cut into the soil by moving water. Gullies are not a natural feature of this landscape and site.

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6. **Extent of wind scoured, blowouts and/or depositional areas:** The vegetative cover in the reference state is sufficient to limit wind-scoured or blowout areas. This site is not a depositional area for offsite wind erosion.

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7. **Amount of litter movement (describe size and distance expected to travel):** None. The inherent capacity for litter movement on a soil is a function of its slope and landscape position. This site is located on a summit landscape position with a slope range of 0-3 percent.

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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):** The soil characteristic of this site is resistant to erosion. No physical crusts apparent. Soil stability scores will range from 5-6.

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** A--0 to 23 cm (0 to 9 inches); very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak medium granular structure; slightly hard, friable; few fine dark manganese concretions in the matrix; strongly acid; gradual smooth boundary. [10 to 30 cm (4 to 12 inches) thick]. This is from Parsons soil series.

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** High grass canopy and small gaps between plants should reduce raindrop impact and slow overland flow (along with 0-3% slope), providing increased time for infiltration to occur. High root density of shortgrasses (blue grama, buffalograss) can limit infiltration

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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):** No compaction layer characteristic of this site. Compacted layers in rangelands are usually less than 6 inches below the soil surface. It is extremely important to keep in mind increased resistance to a soil probe or penetrometer can be simply due to lower soil moisture or high clay content 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):** The number of dead or decadent to young or mature plants are at proportions expected for the site. Recruitment is occuring. There are a mixture of many age classes of plants relative to site potential and climatic conditions. Only plants native to the site are assessed for plant mortality. Plant mortality may vary considerably depending on natural disturbance events (fire, drought).

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14. **Average percent litter cover (%) and depth (in):** If annual burning is practiced <25% litter and ¼" depth is expected. Burn frequency of 2-4 years expect 25-75% litter cover and ½-1" depth. >5 year burn frequency expect >75% litter cover with >1" depth.

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** 2000-4300 lbs/acre. Representative value is 3,150 lbs/forage/acre. Below normal precipitation during the growing season expect 2,000 lbs/forage/acre and above normal precipitation during the growing season expect 4,300 lbs/forage/acre. If utilization has occured, estimate the annual production removed or expected and include this amount when making the total site production estimate.

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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:** Sericea lespedeza, caucasian bluestem, tall fescue, smooth brome, and Kentucky bluegrass. These species can and will invade rangelands without proactive control measures.

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17. **Perennial plant reproductive capability:** The number and distribution of tillers or rhizomes is assessed relative to the expected production of the perennial warm season tall and midgrasses.
