

# Ecological site R112XY102KS

## Clayey Upland

Last updated: 11/05/2024  
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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 (25 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

National Vegetation Classification System Vegetation Association (NatureServe, 2010):

The reference state for this ecological site is most similar to Schizachyrium scoparium - Sorghastrum nutans - Andropogon ternarius - Coreopsis grandiflora Sandstone - Shale Herbaceous Vegetation (CEGL002212).

Terrestrial Natural Community Type in Missouri (Nelson, 2010):

The reference state for this ecological site is most similar to a Dry-Mesic Sandstone/Shale Prairie.

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 Clayey Upland site is widely distributed in the uplands of MLRA 112.. Soils characteristic of this site are moderately deep (20-40 inches) to very deep (>60 inches) to shale and limestone bedrock. This site is made up of soils with a clay content greater than 40 percent at depths less than 12 inches. This site does not have an abrupt textural change (from silt loam to silty clay or clay) or restrictive layer in the soil profile.

## Associated sites

R112XY101KS	<b>Claypan Upland</b> This Claypan Upland ecological site is upslope from the Clayey Upland ecological site. This site is made up of poorly to moderately well drained soils with a silt loam surface and an abrupt textural change to silty clay or clay at about 10 to 15 inches. It is generally on a slope range of 0 to 3 percent.
R112XY103KS	<b>Loamy Upland</b> This Loamy Upland ecological site is on similar landform positions to those of the Clayey Upland 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.
R112XY104KS	<b>Gravelly Upland</b> This Gravelly Upland site is on similar landform positions to those of the Loamy Upland ecological site. This site is made up of moderately well to well drained soils with silty clay loam surface layers and clayey subsoils that often have moderate to high amounts of limestone or shale fragments. It is generally on a slope range of 2 to 15 percent.

## Similar sites

R112XY101KS	<b>Claypan Upland</b> This Claypan Upland ecological site is similar to the Clayey Upland ecological site because of the clayey subsoils and similar in species composition. However, the Claypan Upland has an E horizon and claypan present below the surface horizon.
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Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified

Herbaceous	(1) <i>Andropogon gerardii</i> (2) <i>Schizachyrium scoparium</i>
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## Physiographic features

The Clayey Upland ecological site is located on upland ridges, hills, interfluves. Slopes range from 1 to 15 percent. This site generates runoff to adjacent, downslope ecological sites. The Clayey Upland site does not flood.

**Table 2. Representative physiographic features**

Landforms	(1) Ridge (2) Hill (3) Interfluve
Runoff class	Very low to high
Flooding frequency	None
Ponding frequency	None
Elevation	149–465 m
Slope	1–15%
Water table depth	15–61 cm
Aspect	Aspect is not a significant factor

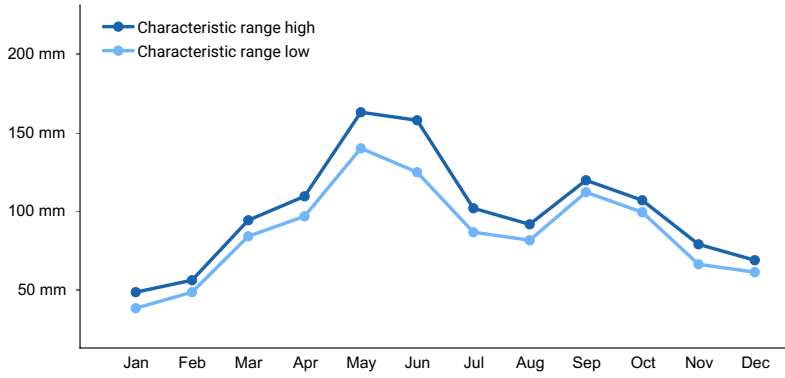
## Climatic features

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 convective 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.

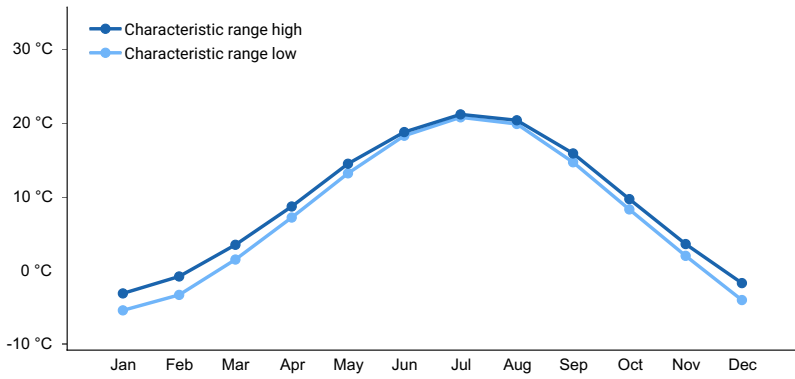
Representative climatic features shown in Table 3 were derived from the climate stations selected for use within the MLRA.

**Table 3. Representative climatic features**

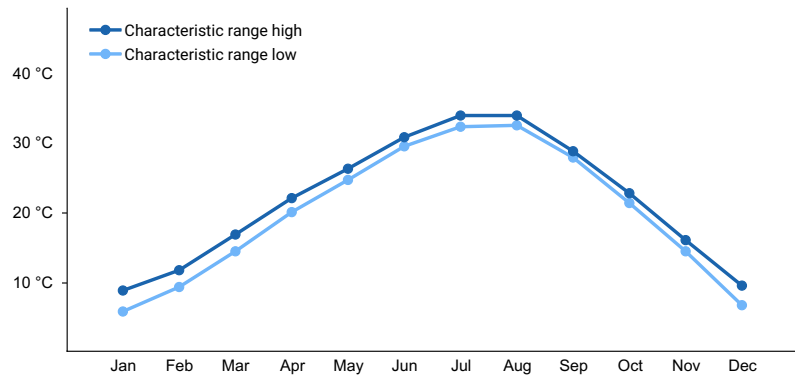
Frost-free period (characteristic range)	177-189 days
Freeze-free period (characteristic range)	201-216 days
Precipitation total (characteristic range)	1,067-1,143 mm
Frost-free period (actual range)	167-196 days
Freeze-free period (actual range)	193-221 days
Precipitation total (actual range)	1,041-1,168 mm
Frost-free period (average)	183 days
Freeze-free period (average)	206 days
Precipitation total (average)	1,118 mm



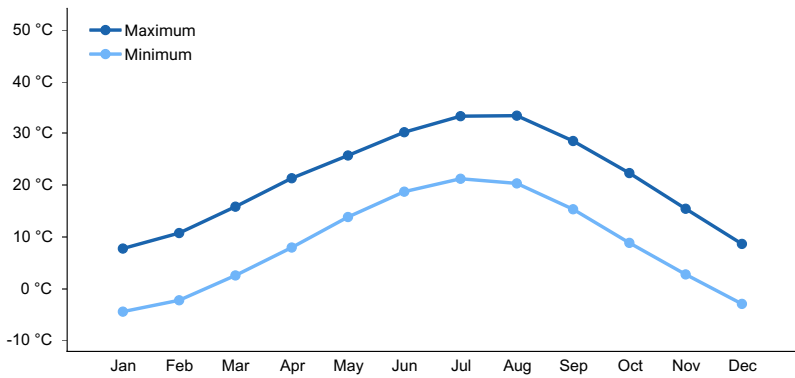
**Figure 1. Monthly precipitation range**



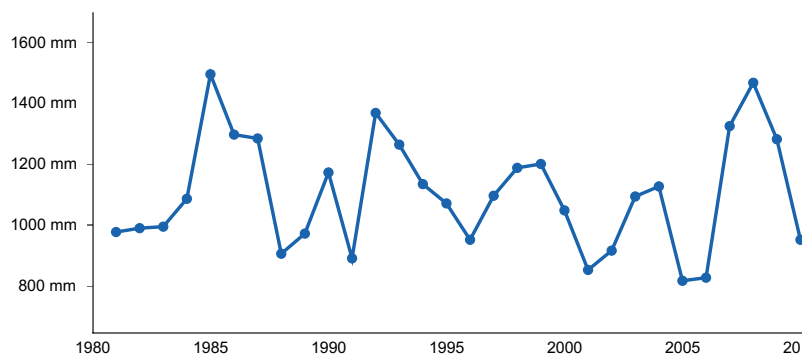
**Figure 2. Monthly minimum temperature range**



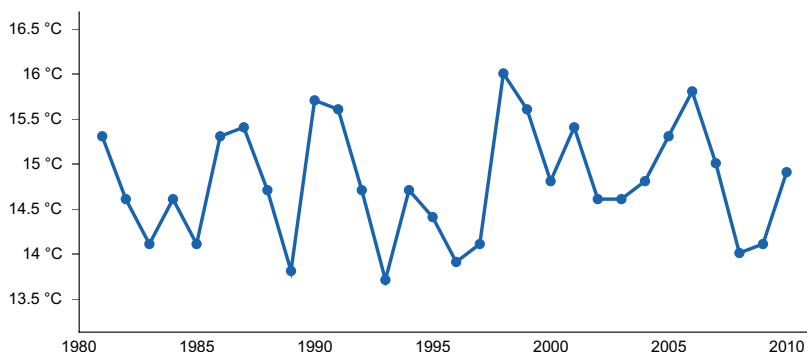
**Figure 3. Monthly maximum temperature range**



**Figure 4. Monthly average minimum and maximum temperature**



**Figure 5. Annual precipitation pattern**



**Figure 6. Annual average temperature pattern**

### **Climate stations used**

- (1) INDEPENDENCE [USC00143954], Independence, KS
- (2) GIRARD [USC00143074], Girard, KS
- (3) CLAREMORE 2 ENE [USC00341828], Claremore, OK
- (4) HOLDENVILLE 2SSE [USC00344235], Holdenville, OK
- (5) TULSA INTL AP [USW00013968], Tulsa, OK
- (6) FREDONIA [USC00142894], Fredonia, KS

### **Influencing water features**

These soils are somewhat poorly to well drained. Water permeability is very slow to slow. Clayey Upland soils can retain large amounts of water which is tightly held by their clay particles. Consequently, water is not available in adequate amounts for plant growth during dry cycle stress periods. This decreases total annual forage production during dry years.

### **Soil features**

These soils are underlain with shale or limestone bedrock at depths of 40 to greater than 60 inches. The soils were formed under prairie vegetation, and have dark, organic-rich surface horizons. The parent material is loess and slope alluvium over residuum derived from shale and limestone and have silt loam to silty clay surface layers, and clayey subsoils. The soils have a clay content of greater than 40% at less than 12 inches in depth. Most of these soils are affected by seasonal wetness. Soil series associated with this site include Apperson, Cherokee, Eram, Kenoma, Mayes, Pharoah, Ringo, Summit, Talihina, Vinita, Woodson, and Zaar.



Figure 7. Zaar series

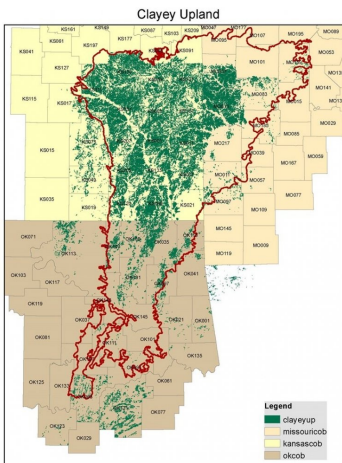


Figure 8. Mapunit locations within the MLRA.

Table 4. Representative soil features

Parent material	(1) Residuum–shale (2) Residuum–limestone
Surface texture	(1) Silty clay (2) Silty clay loam (3) Silt loam
Family particle size	(1) Clayey
Drainage class	Poorly drained to moderately well drained
Permeability class	Very slow to slow
Soil depth	51–203 cm
Surface fragment cover <=3"	0–5%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	12.7–17.78 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)	5.1–7.8

Subsurface fragment volume <=3" (Depth not specified)	0–10%
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 Clayey 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.

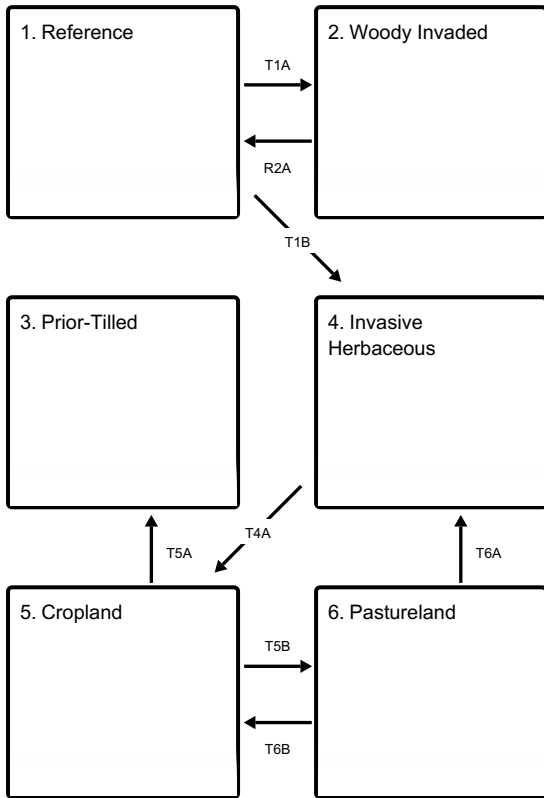
The state and transition model consists of six states and ten community phases. These states and community phases interact based on the timing, intensity, and frequency of prescribe burning and prescribed grazing, introduction of invasive species, and tillage practices. The Reference State (1) typically 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.

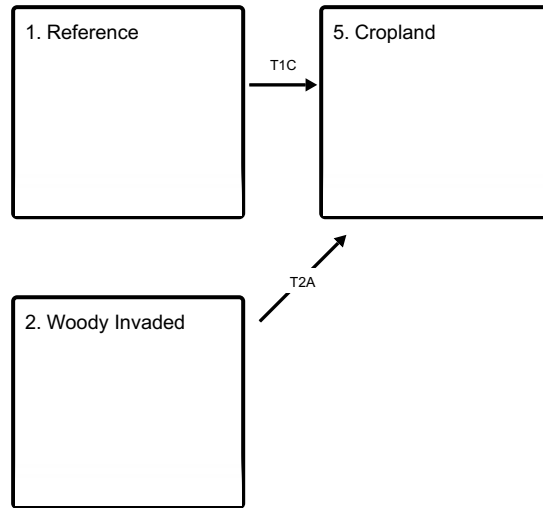
The Woody Invaded State (2) is characterized by a fire frequency and return interval greater than 20 years and a canopy cover percent between 40 and 60 percent. The Prior-Tilled State (3) consists of sites that were allowed to regenerate through natural revegetation or artificially reseeded after tillage 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 reseeded

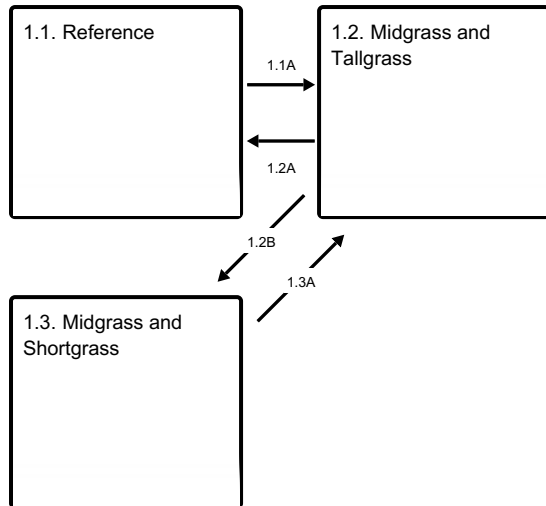
**T5B** - Seeding of grasses and pasture management

**T6A** - Invaded by non-native grasses and forbs.

**T6B** - Tillage and seeding of agricultural crops



### State 1 submodel, plant communities



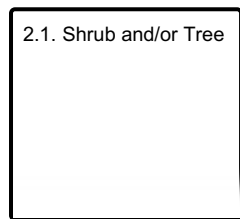
**1.1A** - Heavy, continuous grazing without adequate rest and recovery

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

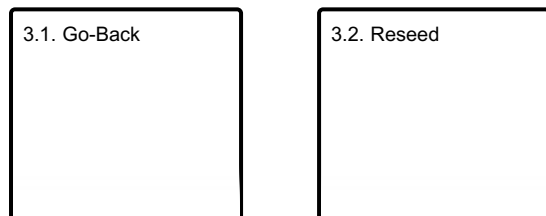
**1.2B** - Long-term (>20 years) continuous grazing with no rest and no recovery

**1.3A** - Long-term prescribed grazing with adequate rest and recovery period during the growing season

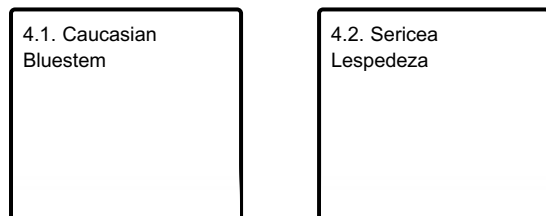
### State 2 submodel, plant communities



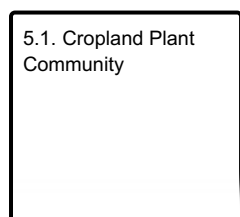
### State 3 submodel, plant communities



### State 4 submodel, plant communities



### State 5 submodel, plant communities



## State 6 submodel, plant communities

6.1. Fescue, Brome,  
Bluegrass

## State 1 Reference



Figure 9. Clayey Upland Reference Community

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 three 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 Encroached 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
- switchgrass (*Panicum virgatum*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- little bluestem (*Schizachyrium scoparium*), grass
- roundhead lespedeza (*Lespedeza capitata*), other herbaceous
- purple prairie clover (*Dalea purpurea*), other herbaceous
- compassplant (*Silphium laciniatum*), other herbaceous
- Nuttall's sensitive-briar (*Mimosa nuttallii*), other herbaceous
- Illinois bundleflower (*Desmanthus illinoensis*), other herbaceous

## Community 1.1 Reference

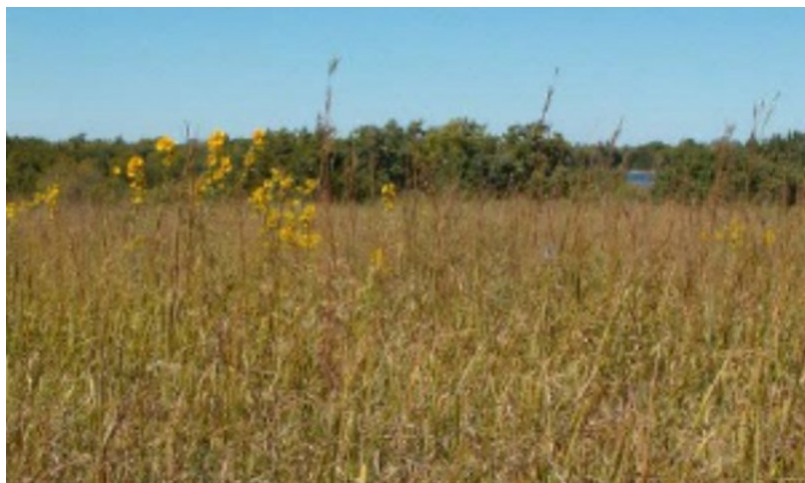


Figure 10. Clayey Upland Reference Plant Community Photo.

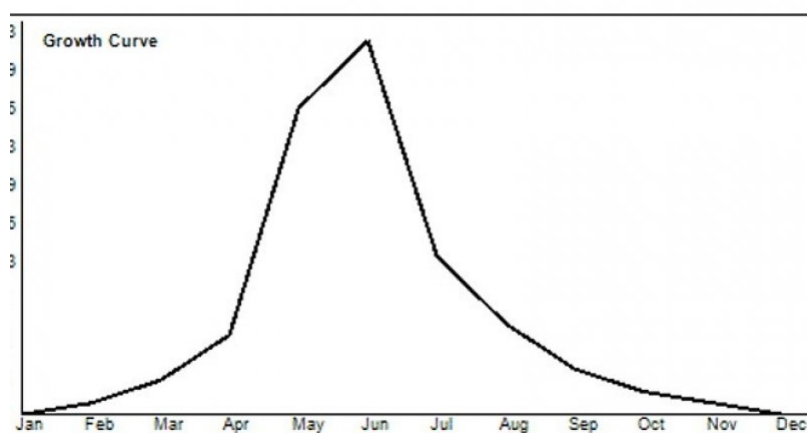


Figure 11. Reference Plant Community Seasonal Growth Curve.

The interpretive plant community for the Clayey 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 75 to 80 percent of vegetation produced annually. Other prevalent midgrasses are sideoats grama, marsh bristlegrass, purple lovegrass, and composite dropseed. Eastern gamagrass and prairie cordgrass sometimes occur where soils are wetter due to underground seepage or run-in from adjacent slopes. Shortgrasses are not a notable component of this community. The site supports a wide variety of native legumes and forbs interspersed throughout the grass sward. The most abundant legumes are Nuttall's sensitive-briar, slimflower scurfpea, violet prairie clover, roundhead lespedeza, and prairie bundleflower. Other prominent forbs include compassplant, Maximilian sunflower, purple pale echinacea, ashy sunflower, upright prairie coneflower, and pitcher sage. 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.

### Dominant plant species

- big bluestem (*Andropogon gerardii*), grass

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

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	1973	3945	6904
Forb	224	448	785
Shrub/Vine	45	90	157
<b>Total</b>	<b>2242</b>	<b>4483</b>	<b>7846</b>

## Community 1.2 Midgrass and Tallgrass



Figure 13. Midgrass-Tallgrass Community

This plant community developed as a result of many years of repeated, heavy grazing. Compared to the Reference Plant Community, there has been a reduction in the more palatable tallgrasses and forbs with an increase in midgrasses and other forbs. Tallgrasses such as big bluestem, Indiangrass, and switchgrass make up less than 40 percent total production of this community. The proportion of midgrasses such as little bluestem, composite dropseed, marsh bristlegrass, purpletop tridens, and sideoats grama has increased and now contributes 30 to 40 percent of the total annual production. 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. Palatable forbs such as Maximilian sunflower, compassplant, wholeleaf rosinweed, Nuttall's sensitive-briar, and prairie bundleflower have decreased and largely been replaced by white heath aster, white sagebrush, Cuman ragweed and Canada goldenrod. Forbs produce 8 to 10 percent of the total annual production. 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 species such as osage orange, honeylocust, and eastern red cedar 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

- leadplant (*Amorpha canescens*), shrub
- New Jersey tea (*Ceanothus americanus*), shrub
- sideoats grama (*Bouteloua curtipendula*), grass

- switchgrass (*Panicum virgatum*), grass
- broomsedge bluestem (*Andropogon virginicus*), grass
- marsh bristlegrass (*Setaria parviflora*), grass
- white heath aster (*Symphotrichum ericoides*), other herbaceous
- white sagebrush (*Artemisia ludoviciana*), other herbaceous
- Canada goldenrod (*Solidago canadensis*), other herbaceous
- Cuman ragweed (*Ambrosia psilostachya*), other herbaceous

### Community 1.3 Midgrass and Shortgrass



Figure 14. Midgrass-Shortgrass Community

The Midgrass-Shortgrass Community is dominated by short-grasses and the less desirable midgrasses. Compared to the Reference Plant Community, the amount of tall-grasses and the more palatable midgrasses is significantly decreased from many years (>20) of overgrazing. Major midgrass species include composite dropseed, purpletop tridens, silver beardgrass, broomsedge bluestem, beaked panicum, sideoats grama, and marsh bristlegrass. Major short-grasses include Kentucky bluegrass, fall witchgrass, thin paspalum, Scribner's rosette grass, buffalograss, tumble windmill grass, hairy grama, and prairie threeawn. Major forbs in the community are Cuman ragweed, tall eupatorium, Canada goldenrod, Missouri goldenrod, white sagebrush, white heath aster, interior ironweed, hoary verbena, lanceleaf ragweed, annual marshelder, and annual ragweed. The most common shrubs include coralberry, wingleaf sumac, blackberry, and roughleaf dogwood. Slippery elm, common hackberry, eastern redcedar, and Osage-orange are the major trees. Shrubs and trees typically do not comprise over 10 to 15 percent of the total production.

#### Dominant plant species

- coralberry (*Symphoricarpos orbiculatus*), shrub
- sumac (*Rhus*), shrub
- roughleaf dogwood (*Cornus drummondii*), shrub
- composite dropseed (*Sporobolus compositus*), grass
- broomsedge bluestem (*Andropogon virginicus*), grass
- purpletop tridens (*Tridens flavus*), grass
- Kentucky bluegrass (*Poa pratensis*), grass
- buffalograss (*Bouteloua dactyloides*), grass
- white sagebrush (*Artemisia ludoviciana*), other herbaceous
- Missouri goldenrod (*Solidago missouriensis*), other herbaceous
- Cuman ragweed (*Ambrosia psilostachya*), other herbaceous

### Pathway 1.1A Community 1.1 to 1.2





Reference



Midgrass and Tallgrass

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



Midgrass and Tallgrass



Reference

The restoration from a Midgrass/Tallgrass Plant Community to a Reference Plant Community requires a shift in management (10-15 years) that includes a forage-animal balance allowing sufficient leaf material to remain on the key tallgrass forage species (big bluestem, switchgrass, Indiangrass, and little bluestem) and palatable legumes within the Reference Plant Community. Adaptive decision-making is required to allow adequate rest and recovery for the key plants and meet a forage-animal balance, especially when drought conditions are encountered. If woody species are present, prescription fires every 6-8 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

### Pathway 1.2B

#### Community 1.2 to 1.3



Midgrass and Tallgrass



Midgrass and Shortgrass

These mechanisms include management controlled by repetitive heavy use, no rest or recovery of the key forage species and no forage and animal balance for many extended grazing seasons. This type of management lasting for

periods greater than 20 years will shift functional and structural plant group dominance towards a Midgrass/Shortgrass Plant Community.

### Pathway 1.3A Community 1.3 to 1.2



Midgrass and Shortgrass



Midgrass and Tallgrass

Causes of plant community shift include management (10-15 years) with adequate rest and recovery of the key forage species (little bluestem, sideoats grama, big bluestem, switchgrass, and Indiangrass) within the Midgrass/Tallgrass Plant Community. If woody species are present, prescription fires every 6-8 years will be necessary for their removal and/or maintenance.

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

#### Conservation practices

Prescribed Burning
Prescribed Grazing

### State 2 Woody Invaded



Figure 15. Woody State

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. This State is dominated by shrubs and trees. Degraded reference sites that have experienced fire suppression for 20 years or more will transition to this woody invaded state. While the woody species such as Osage orange, honey locust, eastern red cedar, and coralberry will increase significantly, native ground cover will decrease. Transitioning back to the Reference State may be possible machine woody removal and prescribed fire.

**Characteristics and indicators.** Hydrologic function in the Woody Invaded 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 Invaded State has not had tillage as a disturbance and could have plants identified in the Pastureland State present on the site.

**Resilience management.** The Woody Invaded 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 Invaded State.

### **Dominant plant species**

- eastern redcedar (*Juniperus virginiana*), tree
- Osage-orange (*Maclura pomifera*), tree
- honeylocust (*Gleditsia triacanthos*), tree
- coralberry (*Symphoricarpos orbiculatus*), shrub
- roughleaf dogwood (*Cornus drummondii*), shrub
- smooth sumac (*Rhus glabra*), shrub
- little bluestem (*Schizachyrium scoparium*), grass
- big bluestem (*Andropogon gerardii*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- switchgrass (*Panicum virgatum*), grass
- sedge (*Carex*), grass

### **Community 2.1 Shrub and/or Tree**



**Figure 16. Shrub and/or Tree Plant Community**

The Shrub and/or Tree Plant Community is dominated by trees and shrubs and may account for 40 to 60 percent total vegetation. Major trees such as Osage orange, honeylocust, and eastern redcedar are common invaders that become established in some areas. Abundant are coralberry, roughleaf dogwood, and smooth sumac. Coralberry is generally the most abundant shrub and often forms low, dense thickets throughout the site. The spread of shrubs and trees results from the absence of fire. Periodic burning will prevent establishment of most of these woody species and favor 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 Scribner's rosette grass, Kentucky bluegrass, composite dropseed, purple lovegrass, and sedges. 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, Indiangrass, little bluestem, switchgrass, Canada wildrye, and sedges. Grass production is significantly reduced by



competition from forbs and woody species. Grass yields vary from 30 to 40 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. A prescribed 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 woody species. Use of labeled herbicides as a brush management tool may be necessary to reduce populations of fire-resistant species like Osage orange and honeylocust and accelerate the recovery of desired vegetative cover.

#### **Dominant plant species**

- eastern redcedar (*Juniperus virginiana*), tree
- Osage-orange (*Maclura pomifera*), tree
- honeylocust (*Gleditsia triacanthos*), tree
- coralberry (*Symphoricarpos orbiculatus*), shrub
- roughleaf dogwood (*Cornus drummondii*), shrub
- smooth sumac (*Rhus glabra*), shrub
- little bluestem (*Schizachyrium scoparium*), grass
- big bluestem (*Andropogon gerardii*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- switchgrass (*Panicum virgatum*), grass
- sedge (*Carex*), grass
- Canadian wildrye (*Elymus hirtiflorus*), grass

### **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**

- little bluestem (*Schizachyrium scoparium*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- switchgrass (*Panicum virgatum*), grass
- prairie threeawn (*Aristida oligantha*), grass

- prairie cupgrass (*Eriochloa contracta*), grass
- annual ragweed (*Ambrosia artemisiifolia*), other herbaceous
- common sunflower (*Helianthus annuus*), other herbaceous
- Korean clover (*Kummerowia stipulacea*), other herbaceous
- Illinois bundleflower (*Desmanthus illinoensis*), other herbaceous
- Maximilian sunflower (*Helianthus maximiliani*), 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. Total annual production varies by site. This depends on seasonal precipitation and the stage of plant succession in the plant community.

**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, deferred grazing, prescribed burning, and related management practices described earlier for this ecological site can be beneficial to the rehabilitation.

### Dominant plant species

- prairie threeawn (*Aristida oligantha*), grass
- prairie cupgrass (*Eriochloa contracta*), grass
- buffalobur nightshade (*Solanum rostratum*), grass
- annual ragweed (*Ambrosia artemisiifolia*), other herbaceous
- common sunflower (*Helianthus annuus*), other herbaceous
- Korean clover (*Kummerowia stipulacea*), 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 sand bluestem, Indiangrass, switchgrass, little bluestem, sideoats grama, and Eastern gamagrass. In some locations, seed of legumes and forbs such as prairie bundleflower and Maximilian sunflower were included in the mixture. 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 ranges varies according to the species planted, established plants, and years of establishment. 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. Occasional burning is effective in controlling establishment of 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**

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

This 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 Plant Community**

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
- corn (*Zea mays*), other herbaceous

- soybean (*Glycine max*), 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.

### 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



Reference



Woody Invaded

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.

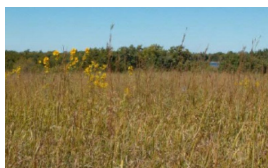
### **Transition T1C State 1 to 5**

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**



Woody Invaded



Reference

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

Table 6. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
<b>Grass/Grasslike</b>					
1	<b>Tallgrasses Dominant 68%</b>			1541–3049	
	big bluestem	ANGE	<i>Andropogon gerardii</i>	897–1401	–
	Indiangrass	SONU2	<i>Sorghastrum nutans</i>	280–594	–
	switchgrass	PAVI2	<i>Panicum virgatum</i>	280–594	–
	eastern gamagrass	TRDA3	<i>Tripsacum dactyloides</i>	0–392	–
	composite dropseed	SPCOC2	<i>Sporobolus compositus var. compositus</i>	84–224	–
2	<b>Midgrasses Subdominant 18%</b>			448–807	
	little bluestem	SCSC	<i>Schizachyrium scoparium</i>	448–701	–
	sideoats grama	BOCU	<i>Bouteloua curtipendula</i>	2–28	–
	Florida paspalum	PAFL4	<i>Paspalum floridanum</i>	2–28	–
	purple lovegrass	ERSP	<i>Eragrostis spectabilis</i>	2–28	–
	marsh bristlegrass	SEPA10	<i>Setaria parviflora</i>	2–28	–
3	<b>Cool Season grasses Trace 2%</b>			11–90	
	Canada wildrye	ELCA4	<i>Elymus canadensis</i>	2–28	–
	Virginia wildrye	ELVI3	<i>Elymus virginicus</i>	2–28	–
	Scribner's rosette grass	DIOLS	<i>Dichantherium oligosanthes var. scribnerianum</i>	2–28	–
	sedge	CAREX	<i>Carex</i>	2–28	–
	prairie Junegrass	KOMA	<i>Koeleria macrantha</i>	2–28	–
<b>Forb</b>					
4	<b>Forb Minor 10%</b>			146–448	
	slimflower scurfpea	PSTE5	<i>Psoralidium tenuiflorum</i>	6–17	–
	Nuttall's sensitive-briar	MINU6	<i>Mimosa nuttallii</i>	6–17	–
	blue wild indigo	BAAUM	<i>Baptisia australis var. minor</i>	6–17	–
	longbract wild indigo	BABR2	<i>Baptisia bracteata</i>	6–17	–
	prairie acacia	ACAN	<i>Acacia angustissima</i>	6–17	–
	purple prairie clover	DAPUP	<i>Dalea purpurea var. purpurea</i>	6–17	–
	Illinois bundleflower	DEIL	<i>Desmanthus illinoensis</i>	6–17	–

	sessileleaf ticktrefoil	DESE	<i>Desmodium sessilifolium</i>	6–17	–
	American licorice	GLLE3	<i>Glycyrrhiza lepidota</i>	6–17	–
	roundhead lespedeza	LECA8	<i>Lespedeza capitata</i>	6–17	–
	groundplum milkvetch	ASCR2	<i>Astragalus crassicaucus</i>	6–17	–
	Maximilian sunflower	HEMA2	<i>Helianthus maximiliani</i>	6–17	–
	compassplant	SILA3	<i>Silphium laciniatum</i>	6–17	–
	pitcher sage	SAAZG	<i>Salvia azurea var. grandiflora</i>	6–17	–
	ashy sunflower	HEMO2	<i>Helianthus mollis</i>	6–17	–
	Baldwin's ironweed	VEBA	<i>Vernonia baldwinii</i>	6–17	–
	Missouri goldenrod	SOMI2	<i>Solidago missouriensis</i>	6–17	–
	white heath aster	SYER	<i>Symphotrichum ericoides</i>	6–17	–
	button eryngo	ERYU	<i>Eryngium yuccifolium</i>	6–17	–
	stiff goldenrod	OLRI	<i>Oligoneuron rigidum</i>	6–17	–
	prairie spiderwort	TROC	<i>Tradescantia occidentalis</i>	6–17	–
	narrowleaf mountainmint	PYTE	<i>Pycnanthemum tenuifolium</i>	6–17	–
	fringeleaf wild petunia	RUHU	<i>Ruellia humilis</i>	6–17	–
	aromatic aster	SYOB	<i>Symphotrichum oblongifolium</i>	6–17	–
	white wild indigo	BAAL	<i>Baptisia alba</i>	6–17	–
	Cuman ragweed	AMPS	<i>Ambrosia psilostachya</i>	6–17	–
	dotted blazing star	LIPU	<i>Liatris punctata</i>	0–11	–
	upright prairie coneflower	RACO3	<i>Ratibida columnifera</i>	0–11	–
	white sagebrush	ARLU	<i>Artemisia ludoviciana</i>	0–11	–
	green antelopehorn	ASVI2	<i>Asclepias viridis</i>	0–11	–
	hoary verbena	VEST	<i>Verbena stricta</i>	0–11	–
	tall blazing star	LIAS	<i>Liatris aspera</i>	0–11	–
	blackeyed Susan	RUHI2	<i>Rudbeckia hirta</i>	0–11	–
	prairie groundsel	PAPL12	<i>Packera plattensis</i>	0–11	–
	common yarrow	ACMI2	<i>Achillea millefolium</i>	0–11	–
	Carolina larkspur	DECAV2	<i>Delphinium carolinianum ssp. virescens</i>	0–11	–
	Indianhemp	APCA	<i>Apocynum cannabinum</i>	0–11	–
<b>Shrub/Vine</b>					
5	<b>Shrub Trace 2%</b>			0–90	
	leadplant	AMCA6	<i>Amorpha canescens</i>	0–45	–
	prairie rose	ROAR3	<i>Rosa arkansana</i>	0–45	–

## Animal community

### Wildlife\*

Game species that utilize this ecological site include:

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

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



Turkey will utilize this ecological site for food (seeds, green browse, soft mast, insects) and nesting and brood-rearing cover. Turkey poult 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 circumlocata*); Ornate Box Turtle (*Terrapene ornata ornata*), Western Slender Glass Lizard (*Ophisaurus attenuatus attenuatus*), Prairie Ring-necked Snake (*Diadophis punctatus amnyi*), 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*), Ottoo Skipper butterfly (*Hesperia ottoe*), Arogos Skipper butterfly (*Atrytone arogos iowa*), Golden Byssus butterfly (*Problema byssus kumskaka*), Delaware Skipper butterfly (*Atrytone logan logan*), and Crossline Skipper butterfly (*Polites origenes*). The larvae of the moth *Eucosma bipunctella* bore into compass plant (*Silphium laciniatum*) roots and feed and the larvae of the moth *Eucosma giganteana* bore into a number of *Silphium* species roots and feed. Native bees, important pollinators, that may be associated with this ecological site's reference condition include: *Colletes brevicornis*, *Andrena beameri*, *A. helianthiformis*, *Protandrena rudbeckiae*, *Halictus parallelus*, *Lasioglossum albipennis*, *L. coreopsis*, *L. disparilis*, *L. nymphaeum*, *Ashmeadiella buconis*, *Megachile addenda*, *Anthidium psoraleae*, *Eucera hamata*, *Melissodes coloradensis*, *M. coreopsis*, and *M. vernoniae*. The Short-winged Katydid (*Amblycorypha parvipennis*), 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**

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## **Approval**

Suzanne Mayne-Kinney, 11/05/2024

## **Acknowledgments**

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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 from February, 2006: David Kraft, John Henry, Doug Spencer, and Dwayne Rice. All were KS NRCS employees.  Corrected/Update version author: Chris Tecklenburg, Ecological Site Specialist, Soil Survey Region 5.
Contact for lead author	Doug Spencer, State Grazing Specialist for Kansas
Date	07/21/2020
Approved by	Suzanne Mayne-Kinney
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

## Indicators

1. **Number and extent of rills:** No natural rill formation common or part of the Clayey Upland ecological site.  

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2. **Presence of water flow patterns:** There are no water flow patterns evidenced by litter, soil, or gravel redistribution, or pedestalling of vegetation or stones that break the flow of water as a result of overland flow.  

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3. **Number and height of erosional pedestals or terracettes:** There is no evidence of pedestals or terracettes that would indicate the movement of soil by water and/or by wind on this site.  

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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% bare ground is found on this site. It 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:** No evidence of accelerated water flow resulting in downcutting of the soil.  

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6. **Extent of wind scoured, blowouts and/or depositional areas:** No wind-scoured or blowout areas where the finer particles of the topsoil have blown away, sometimes leaving residual gravel, rock, or exposed roots on the soil surface. Also, there are no areas of redeposited soil onto this site from another site due to the wind, i.e., depositional areas.  

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7. **Amount of litter movement (describe size and distance expected to travel):** No evidence of litter movement (i.e., dead plant material that is in contact with the soil surface).  

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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):** Soil surfaces may be stabilized by soil organic matter which has been fully incorporated into aggregates at the soil surface, adhesion of decomposing organic matter to the soil surface, and biological crusts. A soil stability kit will score a 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):** Zaar series description.:

Ap--0 to 20 cm (0 to 8 inches); black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; weak fine and medium granular structure; hard, firm; slightly acid; clear smooth boundary.

A--20 to 41 cm (8 to 16 inches); black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; weak coarse subangular blocky structure parting to moderate fine and medium blocky; very hard, very firm; few shiny faces on peds; slightly acid; gradual wavy boundary. [Combined thickness of the A horizon is 25 to 66 cm (10 to 26 inches).]

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Functional and structural groups are that of the Reference Plant Community (see indicator #12 or functional and structural group worksheet). Note changes to plant communities if different than that of the functional and structural group worksheet.
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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):** There is no evidence of a compacted soil layer less than 6 inches from the soil surface. Soil structure is similar to that described in Indicator 9. Compacted physical features will include platy, blocky, dense soil structure over less dense soil layers, horizontal root growth, and increase bulk density (measured by weighing a known volume of oven-dry soil).
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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: Group 1 Tallgrasses Dominant 68%, 1375-2720 lbs/acre. big bluestem 800-1250, Indiangrass 250-530, switchgrass 250-530, eastern gamagrass 0-350, composite dropseed 75-200

Sub-dominant: Group 2 Midgrasses Subdominant 18%, 400-720 lbs/acre, little bluestem 400-625, sideoats grama 2-25, Florida paspalum 2-25, purple lovegrass 2-25, marsh bristlegrass 2-25

Other: Group 3 Cool season grasses Trace 2%, 10-80 lbs/acre, Canada wildrye and all other species 2-25, Virginia wildrye, Scribner's rosette grass, sedge, prairie Junegrass

Group 4 Forbs Minor 10% 130-400 lbs per acre. See ESD for full list of species

Additional: Group 5 Shrubs Trace 2% 0-80 Lbs/acre, leadplant 0-40, prairie rose 0-40

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Recruitment of plants is occurring and there is a mixture of many age classes of plants. The majority of the plants are alive and vigorous. Some mortality and decadence is expected for the site, due to drought, unexpected wildfire, or a combination of the two events. This would be expected for both dominant and subdominant groups.
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14. **Average percent litter cover (%) and depth ( in):** Plant litter is distributed evenly throughout the site. There is no restriction to plant regeneration due to depth of litter. When prescribed burning is practiced, there will be little litter the first half of the growing season.
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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** All species (e.g., native, seeded, and weeds) alive in the year of the evaluation, are included in the determination of total above ground production. Site potential (total annual production) ranges from 2,000 lbs in a below-average rainfall year and 7,000 lbs in an above average rainfall year. The representative value for this site is 4,000 lbs production per year.
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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:** There are no noxious weeds present. Invasive plants make up a small percentage of plant community, and invasive brush species are < 5% canopy.
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17. **Perennial plant reproductive capability:** Plants on site exhibit the required vigor and growth to be able to reproduce vegetatively or by seed. Current management activities do not adversely effect the capability of plants to reproduce.
-