USDA Natural Resources Conservation Service

Ecological site HX076XY113
Loamy Lowland

Last updated: 8/12/2019
Accessed: 05/21/2024

General information

Approved. An approved ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model, enough information to identify the ecological site, and full documentation for all ecosystem states contained in the state and transition model.

MLRA notes

Major Land Resource Area (MLRA): 076X–Bluestem Hills

MLRA 76, is located in Kansas (84 percent) and Oklahoma (16 percent). It makes up about 7,555 square miles (19,585 square kilometers). The towns of Manhattan and El Dorado, Kansas, and Pawhuska, Oklahoma, are in this MLRA. The part of this area in Oklahoma lies between the towns of Ponca City and Bartlesville. Interstates 35 and 70 cross the part of the area in Kansas. The western edge of the Potawatomi Indian Reservation and the Fort Riley Military Base are in the part of the area in Kansas. Most of the Osage Indian Reservation in Oklahoma is in this area. The area is known as the “Flint Hills” in Kansas and the “Osage Hills” in Oklahoma.

Following are the various kinds of land use in this MLRA: Cropland— private, 18 percent; Grassland—private, 69 percent; Federal, 3 percent; Forest—private, 4 percent; Urban development—private, 3 percent; Water —private, 2 percent; Other —private, 1 percent.

Nearly all of this area is in farms or ranches. Nearly three fourths of the area supports native grasses grazed by beef cattle. Nearly one-fifth of the area is in cropland. These cropland areas are located on the deeper soils in valleys and on some of the uplands. The major crops grown include winter wheat, grain sorghum, alfalfa, and hay. These crops are also grown in small irrigated areas along the Arkansas River.

The major soil resource concerns are water erosion, surface compaction, moisture conservation, and maintenance of the content of organic matter in the soils. Maintenance of plant health and vigor and control of noxious and invading plants are the major management concerns on grassland. Conservation practices on cropland generally include terraces, grassed waterways, grade-control structures, conservation tillage, and nutrient and pest management. Conservation practices on rangeland generally include brush management, control of noxious weeds, nutrient management, prescribed burning, and prescribed grazing.

Classification relationships

Land Resource Region H. Central Great Plains winter wheat and range region. Major Land Resource Area (MLRA) 76 Bluestem Hills.

Ecological site concept

The Loamy Lowland ecological site was formerly known as Loamy Lowland (R076XY013KS). This site is made up of alluvial soils which occur on the stream terraces, alluvial fans, or floodplains of drainageways or river valleys. The Loamy Lowland site has very deep soils with loamy to silty surface and subsurfaces. This site is has a flooding frequency that ranges from none to frequently.

Associated sites

HX076XY115	**Loamy Hills** The Loamy Hills ecological site sits adjacent to and in conjunction with the Loamy Lowland ecological site. This site is made up of moderately deep to deep, moderately well to well drained upland soils. This site has a fine-silty and loamy surface texture and is noncalcareous to the surface. Generally, the Loamy Hills ecological site is located on uplands with a slope range of 0 to 16 percent.

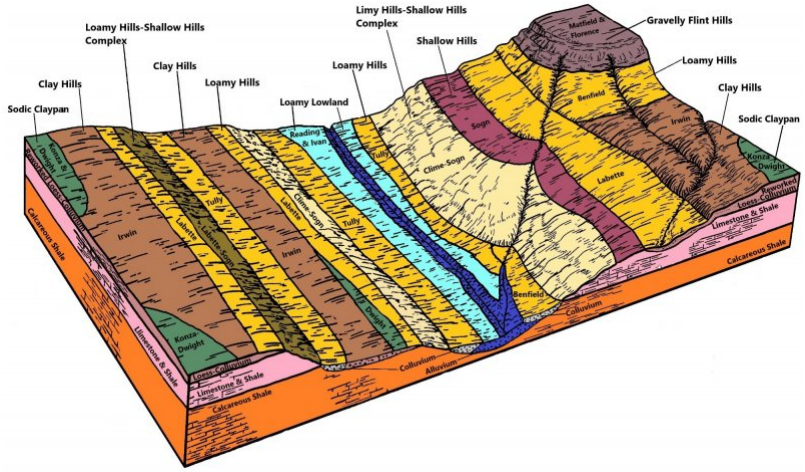


Figure 1. MLRA 76 ESD block diagram.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Andropogon gerardii* (2) *Tripsacum dactyloides*

Legacy ID

R076XY113KS

Physiographic features

Most of MLRA 76 is in the Osage Plains Section of the Central Lowland Province of the Interior Plains. The northern end of the area is in the Dissected Till Plains Section of the same province and division. The landscape consists of rolling hills and cuestas formed in dissected uplands that typically have narrow divides and narrow, steep-sided valleys where Pennsylvanian limestone bedrock is dominant. Stream valleys are less boxlike (broader) where the dominant bedrock is shale. Significant flood plains occur only along a few large streams. Elevation ranges from 980 to 1,650 feet (300 to 505 meters). Local relief is generally 10 to 25 feet (3 to 8 meters), but it can be 100 to 165 feet (30 to 50 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Neosho-Verdigris (1107),33 percent; Kansas (1027), 29 percent; Middle Arkansas (1103), 18 percent; Arkansas- Keystone (1106), 18 percent; and Republican (1025), 2 percent. The area has two large rivers. The Kansas River crosses the northern part of the area, and the Arkansas River runs along the southwestern edge. The smaller rivers that cross the area include the Vermillion, Mill, Neosho, Cottonwood, Fall, Verdigris, Grouse, Elk, Caney, and Bird Rivers.

The Loamy Lowland ecological site occurs in floodplains on nearly level lands that are sometimes subject to flooding. This site is characteristic of deep alluvial soils with loamy to silty surfaces and subsoils.

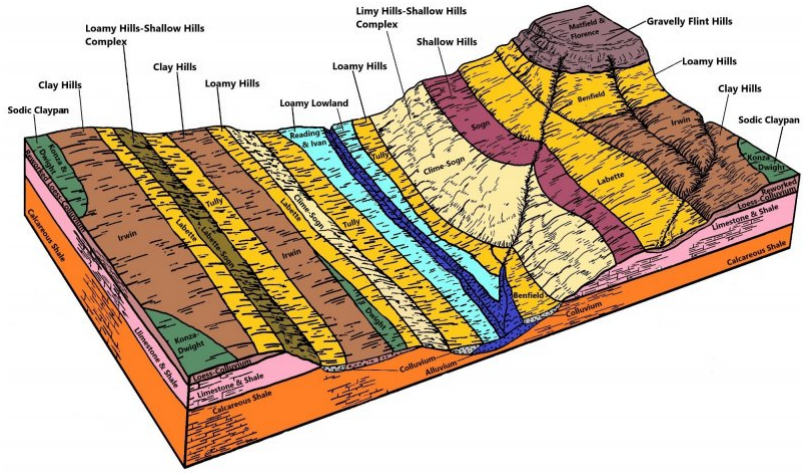


Figure 2. MLRA 76 ESD block diagram.

Table 2. Representative physiographic features

Landforms	(1) River valley > Flood plain (2) River valley > Drainageway (3) River valley > Stream terrace (4) River valley > Alluvial fan
Runoff class	Low to medium
Flooding duration	Brief (2 to 7 days)
Flooding frequency	None to frequent
Ponding frequency	None
Elevation	302–503 m
Slope	0–12%
Water table depth	112 cm
Aspect	Aspect is not a significant factor

Climatic features

The climate of this area is typically continental, being in the interior of a large landmass at mid latitudes. Large daily and annual variations in temperature are common. Winters are cold because of frequent polar air masses moving into the area from the north from December into March. Summer temperatures are warm and usually prevail for about six months of the year. June typically has the most rainfall, and January is the driest. Most of the rainfall occurs as high-intensity, convective thunderstorms. The annual snowfall averages 14 to 20 inches (355 to 510 millimeters). Drought occurs on an average of 3 times in a 30-year period (1981-2010) in MLRA 76.

The climate data listed in the following tables represent minimum and maximum averages and ranges for the climate stations located throughout MLRA 76. The dates referenced are from 1981-2010 (latest 30 year average). Average annual precipitation for this MLRA ranges from 32 to 40 inches (810 to 1020 millimeters). All weather data is supported by the National Oceanic and Atmospheric Administration (NOAA) 1981-2010 Climate Normals. For the average annual precipitation of individual climate station locations and additional climate data, access the National Water and Climate Center at http://www.wcc.nrcs.usda.gov

Table 3. Representative climatic features

Frost-free period (characteristic range)	144-162 days
Freeze-free period (characteristic range)	177-192 days
Precipitation total (characteristic range)	864-991 mm
Frost-free period (actual range)	140-171 days

Freeze-free period (actual range)	167-194 days
Precipitation total (actual range)	838-1,016 mm
Frost-free period (average)	154 days
Freeze-free period (average)	185 days
Precipitation total (average)	914 mm

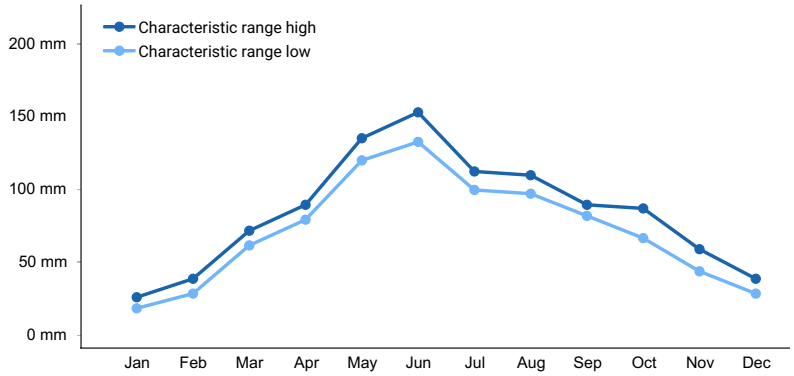


Figure 3. Monthly precipitation range

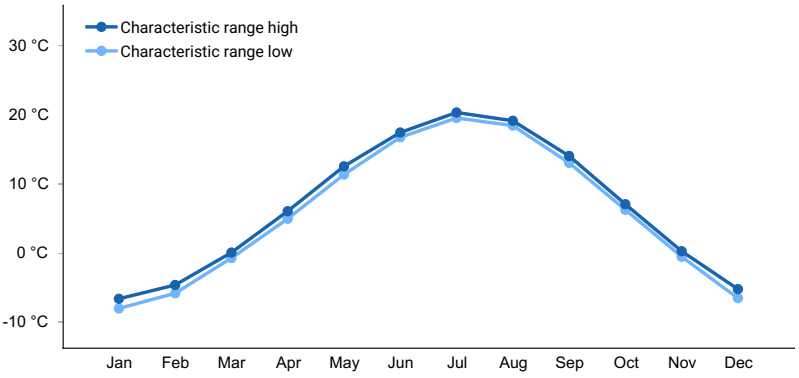


Figure 4. Monthly minimum temperature range

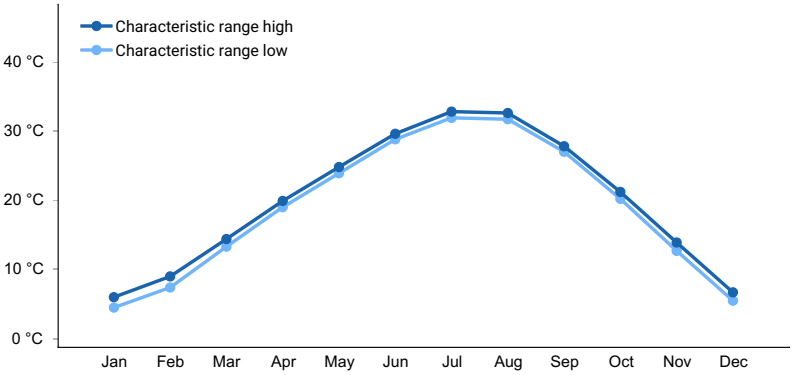


Figure 5. Monthly maximum temperature range

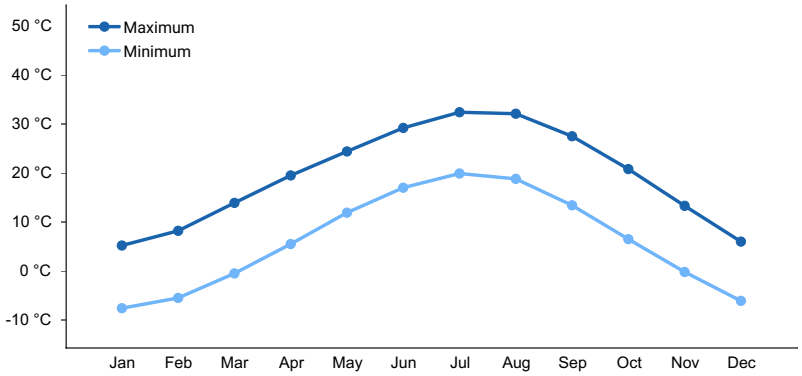


Figure 6. Monthly average minimum and maximum temperature

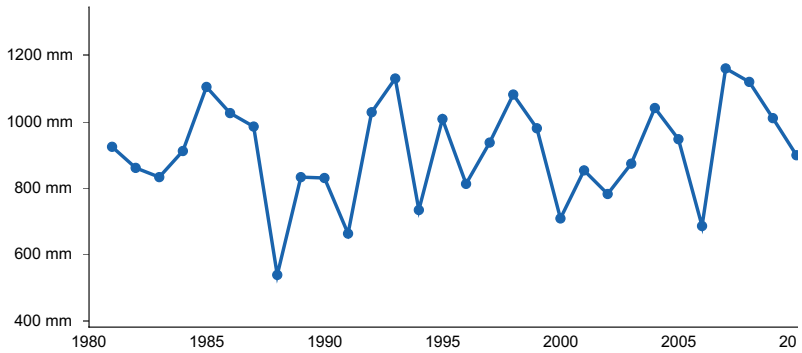


Figure 7. Annual precipitation pattern

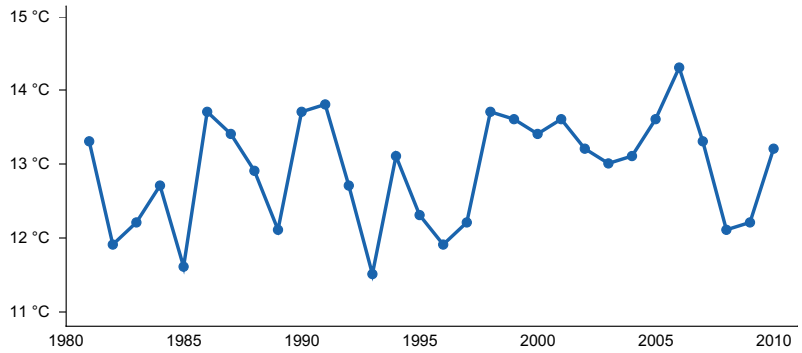


Figure 8. Annual average temperature pattern

Climate stations used

- (1) TUTTLE CREEK LAKE [USC00148259], Manhattan, KS
- (2) MANHATTAN [USC00144972], Manhattan, KS
- (3) WAMEGO 4 W [USC00148563], Wamego, KS
- (4) MANHATTAN MUNI AP [USW00003936], Manhattan, KS
- (5) MANHATTAN 6 SSW [USW00053974], Manhattan, KS
- (6) COUNCIL GROVE LAKE [USC00141867], Council Grove, KS
- (7) TALLGRASS PRAIRIE NP [USC00148061], Strong City, KS
- (8) COTTONWOOD FALLS [USC00141858], Cottonwood Falls, KS
- (9) FLORENCE [USC00142773], Florence, KS
- (10) CASSODAY 2SW [USC00141351], Cassoday, KS
- (11) EL DORADO [USC00142401], El Dorado, KS
- (12) EUREKA 1E [USC00142622], Eureka, KS
- (13) SMILEYBERG 1N [USC00147534], Douglass, KS
- (14) WINFIELD 3NE [USC00148964], Winfield, KS
- (15) HOWARD 1W [USC00143822], Howard, KS

Influencing water features

All soils representing the Loamy Lowland ecological site are sometimes subject to flooding and also receive runoff from adjacent slopes. Water tables may reach into the root zone during wetter periods, but this is usually not the dominant factor controlling plant growth unless it remains wet for an extended period of time. The soils are typically moderately well drained to well drained, permeability ranges from slow to moderate, and available water capacity is high.

The hydrologic group ranges from B or C for the soil types characteristic of the Loamy Lowland ecological site.

Wetland description

Hydric soils (wetlands) are frequently found as inclusions.

Stream Types:

(Rosgen System) C6, F6, and E6 are potential stream types found on this site. The C6 stream type is slightly entrenched, meandering, silt-clay dominated, riffle-pool channel with a well developed floodplain. The C6 stream type can be found in low relief basins typical of interior lowlands such as the Great Plains area. F6 stream types are entrenched, meandering, gentle gradient streams deeply incised in cohesive sediments of silt and clay. Characteristics of F6 streams include very high width/depth ratios, moderate sinuosity, and low to moderate meander width ratios. E6 stream types have channels with low to moderate sinuosity, gentle to moderately steep gradients, and very low width/depth ratios. E6 stream systems are very stable. Streambank disturbance through abuse or other disturbances within the watershed can lead to stream degradation
and an eventual change in the stream type to a less stable system.

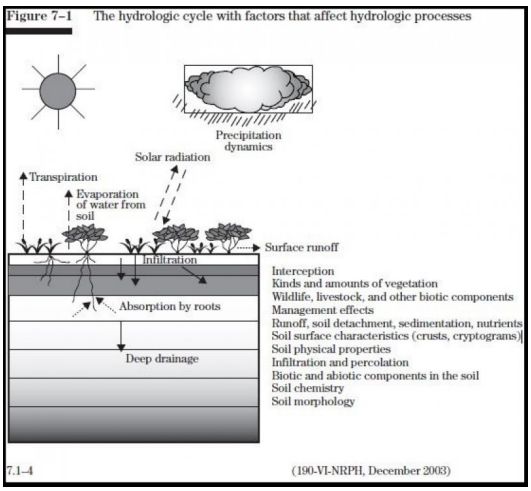


Figure 9. Fig. 7-1 from the National Range and Pasture Handbook.

Soil features

The major soils overlying the Loamy Lowland ecological site are Ivan and Reading. These are alluvial soils that occur on alluvial fans, stream terraces, and floodplains. They are characterized as deep soils with loamy to silty surfaces and subsoils, moderately well to well drained, and a permeability that varies from slow to moderate. The available water capacity is high. Locally, water tables may rise into the root zone during wetter periods.

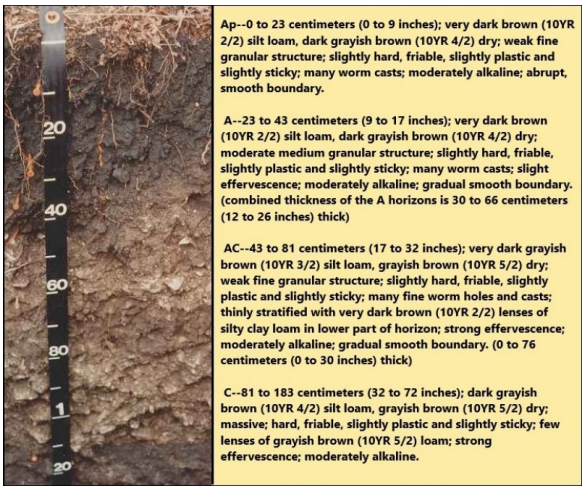


Figure 10. MLRA 76 Ivan soil series profile and description.

Table 4. Representative soil features

Parent material	(1) Alluvium
Surface texture	(1) Silt loam (2) Silty clay loam
Family particle size	(1) Fine
Drainage class	Poorly drained to well drained
Permeability class	Slow to moderate
Soil depth	203 cm
Available water capacity (0-101.6cm)	19.05–22.61 cm
Calcium carbonate equivalent (0-101.6cm)	0–10%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Soil reaction (1:1 water) (0-101.6cm)	5.6–8.4

Ecological dynamics

The Loamy Lowland ecological site in MLRA 76 consist of dynamic plant communities due to the complex interaction of many ecological factors and processes. The vegetation evolved on deep fertile soils on lowlands that were rarely to frequently flooded, exposed to a diverse and fluctuating climate. Plants were historically grazed by herds of large herbivores and periodically subjected to intense wildfires.

The deep, fertile soils representative of this site have loamy surfaces and often receive extra moisture from from adjacent slopes. Some locations have water tables that are within reach of the deep-rooted tallgrasses while other areas have seasonal water tables that only benefit plant growth during portions of the year. The major soils that make up this site generally occur on broad and level bottomlands that are usually adjacent to rivers or streams which include the Cottonwood, Neosho, Fall, Big Blue, Kansas, and Walnut Rivers and tributaries. The site may also occur along narrow upland drainageways.

Rare to frequent flooding and siltation may occur in some locations from stream overflow. Siltation from the flooding often carries additional calcium and phosphorous which may be available for plant growth. The soil and plant moisture relationship is mutually exclusive and the site is potentially very productive.

The original plant community developed with fires of various intensities and frequencies during different seasons of the year playing an important part in ecological processes. Historically, wildfires started by lightning often occurred in spring and early summer months when thunderstorms were prevalent, but also in late summer and fall during dry

weather periods. It is also recognized that early Native Americans often used fire to attract herds of migratory herbivores, especially bison.

The dominant tallgrasses were rhizomatous, enabling them to survive the ravages of even intense wildfires and, thus, gain a competitive advantage in the plant community. Trees and shrubs were suppressed by fire over most of the site. However, trees historically occurred in varying amounts on protected areas, generally along stream and river banks and in oxbows.

Grazing history had a major impact on the dynamics of the site. The vegetative community developed under a grazing regime that consisted primarily of periodic grazing by large herds of bison. As the herds moved through an area, grazing was probably intense. When herds moved to adjacent areas, grazing vegetation was afforded an extended period of rest and recovery during the growing season. This grazing regime, however, was altered during extended drought periods. Because of its proximity to streams, grazing animals were attracted to the site and utilized it more intensely than during normal periods. Other grazing and feeding animals such as elk, deer, rabbits, rodents, and insects had secondary influences on plant community development.

Variations in climate, especially a pattern of annual late summer drought and long-term drought cycles spanning several years, also had a major impact upon plant community development. Species composition fluctuated according to the duration and severity of long-term droughts. During prolonged dry cycles, many of the weaker, shallow-rooted plants died and production of deeper-rooted plants was diminished. When sufficient rainfall occurred following an extended dry period, annual forbs and annual grasses would temporarily occur in abundance. When precipitation returned to normal or above normal, the deeper-rooted grasses and forbs responded and returned to their production potentials.

Flooding that resulted from intense thunderstorms could last up to three to five days, occasionally longer on the major rivers. Effects on the major plants from inundation were usually temporary because they had rhizomes which facilitated their recovery from occasional siltation deposited during flood events.

As European settlers began utilizing the site for production of domestic livestock within fenced pastures in place of roaming bison herds, its ecological dynamics and physical aspects were altered and the plant community shifted from its original composition. These changes were usually in proportion to the season and intensity of use by livestock and were accelerated by a combination of drought and overgrazing. Taller grasses and forbs more palatable to bison were similarly selected and consumed by cattle and horses. Those palatable species were repeatedly grazed throughout the growing season, thus weakening them. Over time, they were gradually replaced by the increase and spread of less palatable species. Where the history of overuse by domestic livestock was more intense, even the plants which initially increased were often replaced by less desirable and lower-producing plants. In some instances, production and plant diversity was reduced to a mixture of mid- and short-grasses, annual grasses, and unpalatable forbs.

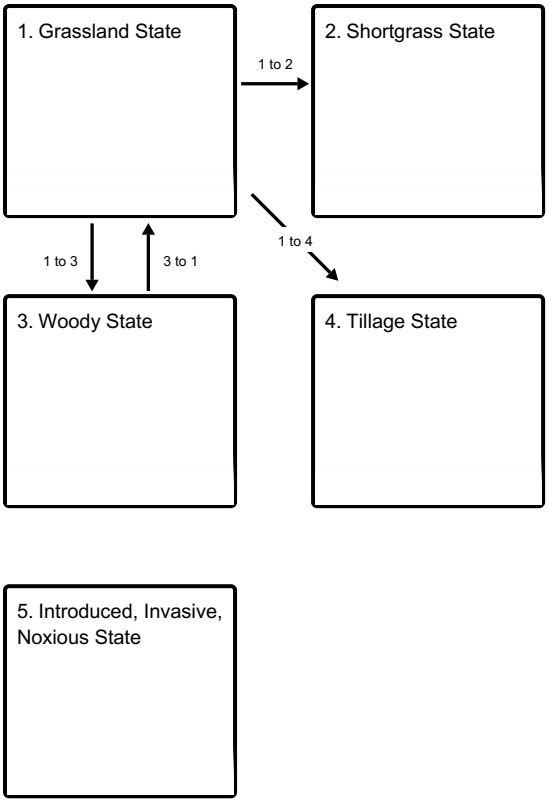
The frequency and role that fires played in maintaining the plant community was reduced with the advent of roads, cultivated fields, and fire suppression techniques developed by European settlers. Use of prescribed fire as a management tool has also diminished in some localities, especially surrounding population centers. In the absence of periodic, intense fire, there has often been a gradual increase in woody species. In some areas, shrubs and trees have encroached to the point of being the dominant influence in the plant community.

The gently rolling topography of this ecological site was attractive to European settlers who sought to create agrarian lifestyles. Some areas of this site were brought under cultivation and used to grow wheat, corn, sorghum, and other crops. Tillage and crop production caused the total destruction of the original native plant community and often major degradation of the inherent structure and fertility of the surface soil layer. Many acres that were formerly used for cultivated crops have been reseeded or allowed to re-vegetate through natural succession.

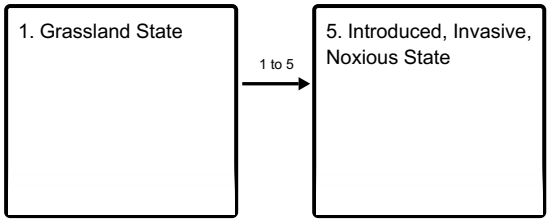
The following diagram illustrates some of the pathways that the vegetation on this site may take from the Reference Plant Community as influencing ecological factors change. There may be other states or plant communities not shown on the diagram, as well as noticeable variations within those illustrated.

State and transition model

Ecosystem states



States 1 and 5 (additional transitions)



1 to 2 - Long-term, heavy, continuous overgrazing, no rest and recovery

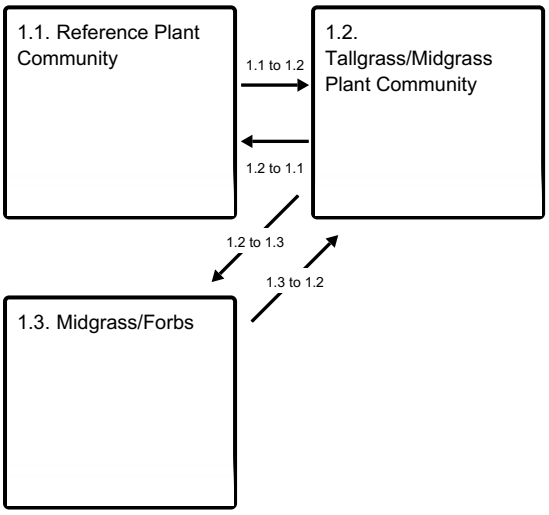
1 to 3 - Lack of fire and brush control

1 to 4 - Tillage by machinery

1 to 5 - Introduction of non-native species

3 to 1 - Prescribed grazing, brush management, and prescribed burning

State 1 submodel, plant communities



1.1 to 1.2 - Heavy, continuous grazing without adequate rest and recovery

1.2 to 1.1 - Prescribed grazing that incorporates periods of deferment during the growing season

1.2 to 1.3 - Long-term (>20 years) continuous grazing with no rest and no recovery

1.3 to 1.2 - Prescribed grazing with adequate rest and recovery period during the growing season

State 2 submodel, plant communities

2.1. Shortgrass Plant Community

State 3 submodel, plant communities

3.1. Shrub and/or Tree Community

State 4 submodel, plant communities

4.1. Reseed Plant Community

4.2. Go-back Plant Community

State 5 submodel, plant communities

5.1. Caucasian Bluestem Community

5.2. Sericea Lespedeza Community

5.3. Fescue, Brome, Bluegrass Community

State 1
Grassland State

The Grassland State defines the ecological potential and natural range of variability resulting from the natural disturbance regime of the Loamy Lowland ecological site. This state is supported by empirical data, historical data, local expertise, and photographs. It is defined by a suite of native plant communities that are a result of periodic fire, drought, and grazing by bison. These events are part of the natural disturbance regime and climatic process. The soil dynamic properties that can influence community phase and state changes are organic matter content, biological activity, aggregate stability, infiltration, soil fertility, and soil reaction. Other grazing and feeding animals such as elk, pronghorns, deer, rabbits, insects, and numerous burrowing rodents had secondary influences on plant community development. Today, cattle are the primary grazers on this ecological site. Within the grassland state, the woody vegetation will generally be less than 15 percent canopy cover per acre. If introduced, invasive or noxious plants are present, they should not exceed 15 percent of the total pounds of vegetation produced per acre in order to avoid crossing a threshold. Plant communities within this state function similarly in their capacity to limit soil loss, cycle water, and produce vegetative biomass. The plant community phases can vary through changes in grazing management or fluctuating climatic conditions. The variables that control the resilience of this grassland state are long-term grazing management and frequency of fire.

Characteristics and indicators. Tallgrasses and Migrasses are dominant in the Grassland State.

Resilience management. Management strategies that will sustain this state include monitoring key forage species and providing a forage and animal balance.

Community 1.1
Reference Plant Community

Figure 11. MLRA 76 Reference Plant Community.

Figure 12. MLRA 76 Woodland in Greenwood County, Kansas.

The interpretive plant community for the Loamy Lowland ecological site is the Reference Plant Community which represents the original plant community that existed prior to European settlement. The site is characterized as grassland with only occasional trees and large shrubs. It is dominated by tall-, warm-season grasses including big bluestem, Indiangrass, switchgrass, eastern gamagrass, and prairie cordgrass. All of these grasses and most of the dominant forbs are strongly rhizomatous. These underground stems often form a dense, intertwined mass throughout the upper four or five inches of the soil profile. Combined, these tallgrasses will account for 70 to 80 percent of the total vegetation produced annually. Little bluestem is the major midgrass. Other prevalent midgrasses and grasslike plants are Canada wildrye, Virginia wildrye, western wheatgrass, marsh bristlegrass, composite dropseed, and several species of sedges and rushes. A number of forbs are found interspersed throughout the grass sward and include Maximilian sunflower, compassplant, wholeleaf rosinweed, Nuttall's sensitive-briar, and prairie bundleflower. Other important forbs are Canada goldenrod, white heath aster, tall blazing star, white sagebrush, American licorice, roundhead lespedeza, and white prairie clover. Desert false indigo and common buttonbush are shrubs that commonly occur, especially along upland drainages. Common hackberry, green ash, black walnut and bur oak are the major trees in the broad bottomlands and are generally located along stream banks. Although the major portion of the site was dominated by herbaceous plants, isolated areas supported groves of trees. Protected by streams and rivers, some areas historically escaped the intensity of wildfires. These areas often developed a savannah plant community with an overstory of hardwood trees that may include bur oak, green ash, black walnut, American elm, black willow, and significant amounts of eastern cottonwood. The understory in these situations usually supports shade tolerant cool season plants such as Canada wildrye, Virginia wildrye, Texas

bluegrass, and sedges. This is a stable, resilient and very productive plant community when adequately managed. A prescribed grazing program that incorporates periods of rest and recovery during the growing season perpetuates the more palatable tallgrasses and forb species. In a number of locations this plant community is managed exclusively for hay production. Mowing tends to reduce the amount of switchgrass and prairie cordgrass plants and favor big bluestem, Indiangrass, and eastern gamagrass.

Resilience management. This is a stable plant community when grazing and fire are adquately managed. A prescribed grazing program that incorporates periods of grazing rest and recovery of key forage species during the growing season benefits the tallgrasses and even the more palatable forb species. Early management programs involving transient steers shipped into the area were effective in maintaining a plant composition closely resembling the reference plant community. Pastures were burned in the spring and grazed from green-up until mid to late July when steers were transported to market. The vegetation was then rested the remainder of the growing season permitting full recovery of most plants.

Dominant plant species

- big bluestem (*Andropogon gerardii*), grass
- eastern gamagrass (*Tripsacum dactyloides*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- prairie cordgrass (*Spartina pectinata*), grass
- switchgrass (*Panicum virgatum*), grass

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	5716	7622	9527
Forb	673	897	1121
Tree	202	269	336
Shrub/Vine	135	179	224
Total	**6726**	**8967**	**11208**

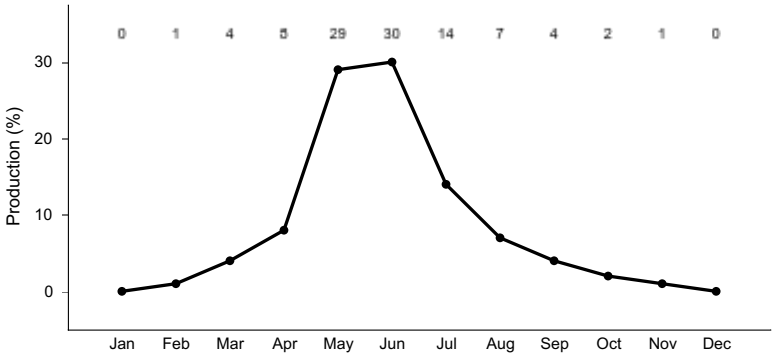


Figure 14. Plant community growth curve (percent production by month). KS7613, Loamy Floodplain. Growth of warm season grasses on this site typically begins during the period of May 1 to May 15 and continues until mid-September. Cool season grasses, sedges and rushes generally have two primary growth periods, one in the fall (September and October) and again in the spring (April, May and June). Some growth may occur in winter months during periods of unseasonably warm temperatures (Indian summers). As a general rule, 75 percent of total production is completed by mid-July. This varies only slightly from year to year depending on temperature and precipitation patterns..

Community 1.2
Tallgrass/Midgrass Plant Community

Figure 15. MLRA 76 Tallgrass/Midgrass Plant Community.

The composition of this plant community is dominated by a mixture of tallgrasses and midgrasses. There has been a decrease in the more palatable tallgrasses and a subsequent increase in midgrasses. Although reduced by overgrazing, tallgrasses such as big bluestem, Indiangrass, and switchgrass remain dominant. The proportion of midgrasses, sedges, and rushes in the overall production of the site has increased. These include composite dropseed, little bluestem, western wheatgrass, marsh bristle grass, and sideoats grama. Other secondary grasses that have increased are Texas bluegrass, Kentucky bluegrass, vine mesquite, and sedges. Combined, these secondary plants now comprise 30 to 40 percent of the total herbage produced annually. Forbs such as Maximilian sunflower, wholeleaf rosinweed, compassplant, Nuttall's sensitive-briar, and prairie bundleflower have decreased and largely been replaced by white heath aster, white sagebrush, great ragweed, Cuman ragweed, interior ironweed, and Canada goldenrod. Forbs produce 8 to 10 percent of the total herbage. In some locations the site supports an increasing amount of shrubs and trees. The most abundant shrubs are desert false indigo, common buttonbush, roughleaf dogwood, smooth sumac, and coralberry. Common hackberry, green ash, bur oak, black walnut, and American elm are the major trees found on the site. Shrubs and trees may comprise 5 to 10 percent of the total production.

Resilience management. Periods of rest and recovery from grazing are essential in maintaining the production of some of the major grasses found in this plant community. Eastern gamagrass and big bluestem are especially preferred and selectively grazed by cattle. When the site is grazed continuously throughout the growing season, these grasses are usually overgrazed and thus maintained in a lower state of plant vigor. When continued for many years, overgrazing results in a gradual reduction in the abundance of these grasses. However, prescribed grazing that incorporates periods of rest and recovery during the growing season will improve the vigor and gradual recovery of the more palatable tallgrasses and forbs. Prescribed burning is often necessary to maintain a grassland dominant community.

Dominant plant species

- big bluestem (*Andropogon gerardii*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- switchgrass (*Panicum virgatum*), grass
- composite dropseed (*Sporobolus compositus var. compositus*), grass
- little bluestem (*Schizachyrium scoparium*), grass
- western wheatgrass (*Pascopyrum smithii*), grass
- marsh bristlegrass (*Setaria parviflora*), grass
- sedge (*Carex*), grass
- rush (*Juncus*), grass

Community 1.3
Midgrass/Forbs

Figure 16. MLRA 76 Midgrass Plant Community.

This plant community is dominated by a mixture of midgrasses and forbs. It occurs following many years of continuous overgrazing. Pastures are usually small and associated with farming enterprises. In the past they were often used as holding areas in anticipation of seasonal wheat pasture or other cropland forages. Dominant grasses are buffalograss, Carolina crabgrass, thin paspalum, sideoats grama, composite dropseed, silver beardgrass, western wheatgrass, and vine mesquite. Annual grasses including sixweeks fescue, field brome (*Bromus arvensis*), cheatgrass (*Bromus tectorum*), little barley (*Hordeum pusillum*), tumblegrass, prairie threeawn, purple threeawn, and fall panicgrass are common during seasons of normal or above normal precipitation. Major forbs are Cuman ragweed, great ragweed, Missouri goldenrod, crested prickly poppy, hoary verbena, annual marshelder, prairie broomweed, interior ironweed, and white sagebrush. A number of thistles both native and introduced are common in this plant community and may include wavyleaf thistle, yellowspine thistle, tall thistle, Canada thistle (*Cirsium arvense*), bull thistle (*Cirsium vulgare*), and nodding plumeless thistle (*Carduus nutans*). The most common shrub is coralberry. Areas where sediment has been deposited during recent flood events will generally support a large number of annual forbs. These may include snow on the mountain (*Euphorbia marginata*), cocklebur (*Xanthium strumarium*), annual ragweed, great ragweed, common sunflower (*Helianthus annuus*), and poison hemlock (*Conium maculatum*). In some locations the site supports an increasing amount of shrubs and trees. The most common shrubs along upland drainways are desert false indigo, common buttonbush, roughleaf dogwood, and coralberry. Common hackberry, green ash, bur oak, black walnut, American elm, eastern redcedar (*Juniperus virginiana*), and osage orange (*Maclura pomifera*) are the major trees found on the site. Shrubs and trees usually will not comprise over ten percent of the total production. Although productivity is significantly reduced when compared to Reference Plant Community, this plant community can be managed as a stable community. Remnant plants of big bluestem, Indiangrass, switchgrass, prairie cordgrass, eastern gamagrass, and Maximilian sunflower are often found scattered throughout the site. These plants are usually grazed repeatedly and maintained in a low state of vigor. These remnants respond favorably to periods of rest and recovery from grazing during the growing season and often regain vigor in a few years.

Resilience management. Recovery of the tallgrasses, midgrasses, and associated forbs characteristic of the Reference Plant Community will require many years of careful management that includes prescribed grazing and extended periods of rest and recovery during the growing season. If remnant stands of the desired species are not present or located nearby as seed sources for reestablishment, interseeding measures may be needed to create pioneer colonies for seed dispersal throughout the community. Prescribed burning can be a useful tool if used strategically to benefit the desired species, especially in the later stages of the recovery process that may take more than a decade.

Dominant plant species

- common hackberry (*Celtis occidentalis*), tree
- green ash (*Fraxinus pennsylvanica*), tree
- bur oak (*Quercus macrocarpa*), tree
- black walnut (*Juglans nigra*), tree
- American elm (*Ulmus americana*), tree
- eastern redcedar (*Juniperus virginiana*), tree
- Osage-orange (*Maclura pomifera*), tree
- false indigo bush (*Amorpha fruticosa*), shrub

- common buttonbush (*Cephalanthus occidentalis*), shrub
- roughleaf dogwood (*Cornus drummondii*), shrub
- coralberry (*Symphoricarpos orbiculatus*), shrub
- composite dropseed (*Sporobolus compositus var. compositus*), grass
- sand dropseed (*Sporobolus cryptandrus*), grass
- silver beardgrass (*Bothriochloa laguroides ssp. laguroides*), grass
- purpletop tridens (*Tridens flavus*), grass
- sideoats grama (*Bouteloua curtipendula*), grass
- western wheatgrass (*Pascopyrum smithii*), grass
- marsh bristlegrass (*Setaria parviflora*), grass
- Cuman ragweed (*Ambrosia psilostachya*), grass
- great ragweed (*Ambrosia trifida*), grass

Pathway 1.1 to 1.2
Community 1.1 to 1.2

Reference Plant Community

Tallgrass/Midgrass Plant Community

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 10 years will shift functional and structural plant group dominance towards a Tallgrass/Midgrass Plant Community. Annual burning or a fire frequency occurrence <2 years will cause a shift in community phases. The frequency of late spring annual burning in combination with late season rest may result in a shift in species diversity as well as fluctuations in productivity. Herbicide use every 1-3 years will remove legumes and forbs and become a grass dominated community. Drought conditions that persist >3 years with below average rainfall during the first half of the growing season in addition to inadequate rest provided for plant recovery will result in productivity changes.

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

Pathway 1.2 to 1.1
Community 1.2 to 1.1

Tallgrass/Midgrass Plant Community

Reference Plant Community

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

Conservation practices

Prescribed Burning
Prescribed Grazing

Pathway 1.2 to 1.3
Community 1.2 to 1.3

Tallgrass/Midgrass Plant Community

Midgrass/Forbs

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/Forbs/Shortgrass Plant Community.

Pathway 1.3 to 1.2
Community 1.3 to 1.2

Midgrass/Forbs

Tallgrass/Midgrass Plant Community

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.

Conservation practices

Prescribed Burning
Prescribed Grazing

State 2
Shortgrass State

With heavy, continuous grazing, blue grama and buffalograss will become the dominant species and have a sod-bound appearance. Unable to withstand the grazing pressure, only a remnant population of western wheatgrass remains.

Characteristics and indicators. The Shortgrass State is characterized with specific dynamic soil property changes. Changes between the Grassland State and the Shortgrass State has been documented. As plant community cover decreases from bunchgrasses to more of the sod grasses there is a decrease in infiltration and interception and an increase in surface runoff (Thurow T., 2003).

Resilience management. This is a resistant and resilient state. Grazing management practice should include a forage and animal balance.

Community 2.1
Shortgrass Plant Community

This plant community presents a distinctive shortgrass aspect on the landscape. It is dominated by blue grama and buffalograss with notable amounts of western wheatgrass and sideoats grama present. Other grasses include annual bromes, composite dropseed, Kentucky bluegrass, prairie threeawn, and tumble windmill grass. These species commonly account for 60 to 70 percent of the annual forage production. Like the desirable grasses, palatable legumes and other forbs have been reduced by continuous grazing and competition over many years. Prevalent broadleaf species in this situation include prairie broomweed, annual ragweed, white sagebrush, Cuman ragweed, interior ironweed, wavyleaf thistle, and curlycup gumweed. Forbs may comprise 15 to 25 percent of the total vegetation. This plant community often contains 15 to 20 percent woody species as a result of fewer fires and

more opportunities for their encroachment. Eastern redcedar, smooth and/or fragrant sumac, roughleaf dogwood, and coralberry are representative trees and shrubs which occur on this site. Leadplant and Jersey tea may still be found, but are generally much reduced from their prominence in the Reference Plant Community.

Resilience management. This plant community can be managed as a stable shortgrass plant community. If recovery of the tallgrasses, midgrasses, and associated forbs characteristic of the Reference Plant Community is desired, however, many years of careful management that includes prescribed grazing and extended periods of rest during the growing season will be required. More study is necessary in order to document restoration processes to the Grassland State. This site may recover faster than adjoining ones as remnant plants may be somewhat protected by the steeper slopes and occasional surface rocks. Where remnant stands of the desired species are not available on or near the site, reseeding may be necessary to advance recovery. However, seeding or interseeding may be severely limited by the steepness of slope and occasional surface rocks.

State 3
Woody State

This state is dominated by a shrub and/or tree plant community. The increase and spread of shrubs and trees results from an absence of fire. 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, it should be pointed out that not all unburned areas have a woody plant invasion. Birds, small mammals, and livestock are instrumental in the distribution of seed and accelerating the spread of most trees and shrubs common to this site. The speed of encroachment varies considerably and can occur on both grazed and non-grazed pastures. Many species of wildlife, especially bobwhite quail, turkey, and white-tailed deer benefit from the growth of trees and shrubs for both food and cover. When management for specific wildlife populations is desirable, these options should be considered in any brush management plan.

Characteristics and indicators. Hydrologic function is affected by the amount of vegetative cover. 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.

Resilience management. 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. In some locations the use of chemicals as a brush management tool may be desirable to initiate and accelerate this transition.

Community 3.1
Shrub and/or Tree Community

This plant community is dominated by shrubs consisting primarily of coralberry, roughleaf dogwood, and smooth sumac. Trees including osage orange, honeylocust, elms, 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 of 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 and the presence of birds and small mammals that distribute seeds over the site. Longtime, continuous overgrazing can also lead to encroachment. In these situations the associated grasses will usually consist of composite dropseed, purple lovegrass, Kentucky bluegrass, 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. Many species of wildlife, especially bobwhite quail, turkey, and white-tailed deer, benefit from woody growth for both food and cover. Conversely, the presence of trees is considered detrimental to populations of greater prairie chickens. When management for specific wildlife populations is desirable, these options should be considered in any brush management plan. Trees and shrubs dominate this plant community and may produce 40 to 50 percent of the total vegetation. Major trees include eastern cottonwood, black willow, peachleaf willow, American elm, Siberian elm (*Ulmus pumila*), common hackberry, osage orange, eastern redcedar, and honeylocust (*Gleditsia triacanthos*). More abundant shrubs are roughleaf dogwood, coralberry, smooth sumac, desert false indigo, and common buttonbush. These woody plants may spread in the absence of fire and occur on the site regardless of grazing management. However, not all unburned areas have a woody plant problem. Encroachment may occur on areas that have been overgrazed for years as well as on areas where both grazing and fire have been excluded. The speed and method of encroachment varies considerably but, under favorable conditions, can happen in a period as short as 20 to 30 years. Cottonwood and willow produce an abundance of seed that is distributed by the wind for long distances. Common hackberry and eastern redcedar are spread by birds. Periodic burning tends to hinder the establishment of most of these woody species and favor forb and grass species. Where woody plants have invaded overgrazed areas, understory vegetation is generally dominated by plants such as Texas bluegrass, Kentucky bluegrass, composite dropseed, purpletop tridens, marsh bristlegrass, sedges, white sagebrush, interior ironweed, and white heath aster. Where woody plants have encroached onto areas essentially ungrazed for many years, the understory consists largely of big bluestem, Indiangrass, little bluestem, Virginia wildrye, Canada wildrye, sedges, prairie bundleflower, Canada goldenrod, and Maximilian sunflower. Herbage production is significantly reduced because of the tree and shrub competition for light and moisture. Grass yields vary from 30 to 40 percent of the total vegetative production. Forbs generally produce 5 to 10 percent of the total. Usually a prescribed burning program, accompanied with a plan of prescribed grazing, will return the plant community to one dominated by 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 additional brush management tools such as chemicals or mechanical methods may be necessary to initiate and accelerate this transition in some locations.

Resilience management. 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 woody species. Use of labeled herbicides as a brush management tool will usually be necessary to reduce populations of fireresistant 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.

State 4
Tillage State

Extensive areas of the historic Loamy Lowland plant communities were plowed and converted to production of cultivated crops by the early European settlers and subsequent generations. In addition to destroying the original plant community, repeated tillage commonly 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, were common on these sites. The extent of these changes depended upon duration of cropping as well as crops grown and other management practices. The Tillage State consists of abandoned cropland that has been naturally revegetated (go-back) or planted/seeded to grassland. Many reseeded plant communities were planted with a local seeding mix under the Conservation Reserve Program (CRP) or were planted to a monoculture of sideoats grama. Go-back communities are difficult to define due to the variability of plant communities that can exist. Many of these communities are represented by the genus Aristida (threeawns).

Characteristics and indicators. This is an alternative state since the energy, hydrologic, and nutrient cycles are altered to that of the Reference State in its natural disturbance regime. 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. This state is a result of a land use management decision.

Community 4.1
Reseed Plant Community

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, blue grama, and western wheatgrass. 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, 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 Siberian elm, common hackberry, eastern redcedar, eastern cottonwood, black willow, and roughleaf dogwood. Occasional burning is effective in controlling the 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, deferred grazing, prescribed burning, and related management practices described earlier for this ecological site can be beneficial to the rehabilitation.

Community 4.2
Go-back Plant Community

This plant community also 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, slender snakecotton, Canadian horseweed, prairie sunflower, common sunflower, Mexican fireweed, camphorweed, and annual buckwheat. Gradually these are replaced by annual grasses including prairie threeawn, mat sandbur, tumblegrass, 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, thin paspalum, purple lovegrass, red lovegrass, Scribner’s rosette grass, Carolina crabgrass, silver beardgrass, and tumble windmillgrass. Common forbs are Cuman ragweed, white sagebrush, Carruth’s sagewort, white heath aster, Missouri goldenrod, and sand milkweed. Combinations of these plants can form a stable community. In time with prescribed grazing management, other perennial grasses and forbs common in the Reference Plant Community return to the site. Blue grama is a shortgrass that is very common to the native plant communities on this site. However, it seldom occurs in go-back communities, even after 40 to 50 years of plant succession. Some go-back areas are invaded by trees and shrubs. The more common include elm, common hackberry, eastern redcedar, eastern cottonwood, and roughleaf dogwood. 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.

State 5
Introduced, Invasive, Noxious State

This state includes three community phases which are characterized by the composition of plant species and soil functions that govern the ecological processes. These three plant communities occur and function independent of one another. Species that define this state include sericea lespedeza, caucasian bluestem, tall fescue, smooth brome, and Kentucky bluegrass. These species can and will invade rangelands without proactive control measures. 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.

Characteristics and indicators. Ecological processes within this state that are affected and differ from the grassland state are hydrologic cycle and nutrient cycle. Water content and infiltration rates are affected by the species.

Resilience management. The plant communities that make up this state are sustained by fertilizing species and managing as pastureland or by a lack of treatment measures for individual species control, maintenance, and/or eradication.

Community 5.1
Caucasian Bluestem Community

Caucasian bluestem is the dominant species that govern the ecological processes and uses of this community. This species can and will invade rangelands without proactive control measures.

Resilience management. Caucasian bluestem survives all control measures. There is no way of killing the Caucasian bluestem without killing the native rangeland. There have been cases where the native taller grasses appear to shade and out compete the Caucasian bluestem but there are ungrazed places on the Konza Prairie Research and biological station where it was introduced from feeding livestock contaminated hay and where it now is crowding out the native grass as its spreads. Caucasian bluestem might be the most serious threat and most aggressive of the introduced, invasive, and noxious species of this time. Soil dynamic property changes include infiltration, biological activity, and soil fertility.

Dominant plant species

- Caucasian bluestem (*Bothriochloa bladhii*), grass

Community 5.2
Sericea Lespedeza Community

Sericea lespedeza (*Lespedeza cuneata*) is the dominant species that govern the ecological processes and uses of this community. Sericea lespedeza is invasive and a statewide noxious weed in Kansas. This species will quickly invade rangelands without proactive control measures. It competes with the native grass community with sunlight, water, and nutrients. It also produces allelopathic compounds (toxic chemicals that negatively impact the germination and/or growth of other plants).

Resilience management. Control measures for sericea lespedeza involve herbicide application. Follow recommended rates and chemical use according to Kansas State University Chemical Weed Control book. Conventional management practices such as prescribed grazing and 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 burning followed by intensive early stocking with stocker cattle. Goats will provide some control as they do eat it much more readily than cattle.

Dominant plant species

- sericea lespedeza (*Lespedeza cuneata*), shrub

Community 5.3
Fescue, Brome, Bluegrass Community

Tall fescue, smooth brome, and Kentucky bluegrass are the dominant species that govern the ecological processes and uses of this community. Any one or combination of these species can be considered an invaded community at levels of >40% by total weight annual production. Once these levels are reached management choices can change to favor these grasses and as a result land use is transitioned from rangeland to pastureland.

Resilience management. Inputs and energy in order to return species to a grassland state are greater than what is considered to be natural. Control measures for tall fescue, smooth brome, and Kentucky bluegrass might involve

herbicide application and/or consecutive prescribed burns. Follow recommended rates and chemical use according to State extension guidelines such as Kansas State University Chemical Weed Control publication. Soil dynamic property changes include biological activity and soil fertility.

Dominant plant species

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

Transition 1 to 2
State 1 to 2

Long-term management (approximately 30 years) without a forage and animal balance and heavy, continuous grazing without adequate recovery periods between grazing events will convert the Grassland State to a Shortgrass State made up of blue grama and buffalograss sod. Drought in combination with this type of management will quicken the rate at which this transition occurs.

Constraints to recovery. The ecological processes affected are the hydrologic and nutrient cycles. There is an increase in evaporation rate, runoff, and in bulk density. There is a decrease in infiltration, a change in plant composition, and the functional and structural groups have changed dominance. These are all examples of the soil and vegetation properties that have compromised the resilience of the Grassland State and therefore transitioned to a Shortgrass State.

Transition 1 to 3
State 1 to 3

Changes from a Grassland State to a Woody State lead to changes in hydrologic function, forage production, dominant functional and structural groups, and wildlife habitat. Understory plants may be negatively affected by trees and shrubs by reductions in light, soil moisture, and soil nutrients. Increases in tree and shrub density and size have the effects of reducing understory plant cover and productivity, and desirable forage grasses often are most severely reduced (Eddleman, 1983). As vegetation cover changes from grasses to trees, a greater proportion of precipitation is lost throughout interception and evaporation; therefore, less precipitation is available for producing herbaceous forage or for deep drainage or runoff (Thurow and Hester, 1997).

Constraints to recovery. Recovery is possible through management.

Transition 1 to 4
State 1 to 4

This transition is triggered by a management action as opposed to a natural event. Tillage, or breaking the ground with machinery for crop production, will move the Grassland State to a Tillage State.

Constraints to recovery. The resilience of the Reference State has been compromised by the fracturing and blending of the native virgin sod. The energy, hydrologic, and nutrient cycles are altered and vary from that of the Grassland State.

Transition 1 to 5
State 1 to 5

Changes from a Grassland State to an introduced, invasive and/or noxious state can lead to changes in hydrology/erosion, forage production, wildlife habitat, and soil dynamic properties. These changes will vary depending on dominance of species. This transition is usually triggered by an introduction of non-native species. The source from which the species originated from (i.e. adjacent crop field) can usually but not always be detected. A threshold is crossed once the species (sericea lespedeza and Caucasian bluestem) is established and increases to levels of greater than 15% total annual production per acre. For cool season grasses such as tall fescue and smooth brome that level is >40% total annual production per acre. Changes in species diversity reflect changes in soil biota activity. The introduced, invasive and noxious species are not selected and grazed and as a result

become increasingly dominant. Hydrology changes begin to occur with the buildup of litter and interception rates increase as canopy increases.

Constraints to recovery. Need further research to document recovery processes.

Restoration pathway 3 to 1
State 3 to 1

Restoration efforts will be costly, labor-intensive, and can take many years, if not decades, to return to a Grassland State. Once canopy levels reach greater than 20 percent, estimated cost to remove trees is very expensive and includes high energy inputs. The technologies needed in order to go from an invaded Woody State to a Grassland State include but are not limited to: prescribed burning— the use of fire as a tool to achieve a management objective on a predetermined area under conditions where the intensity and extent of the fire are controlled; brush management— manipulating woody plant cover to obtain desired quantities and types of woody cover and/or to reduce competition with herbaceous understory vegetation, in accordance with overall resource management objectives; and prescribed grazing—the controlled harvest of vegetation with grazing or browsing animals managed with the intent to achieve a specified objective. In addition, to grazing at an intensity that will maintain enough cover to protect the soil and maintain or improve the quantity and quality of desirable vegetation. When a juniper tree is cut and removed, the soil structure and the associated high infiltration rate may be maintained for over a decade (Hester, 1996). This explains why the area near the dripline usually has substantially greater forage production for many years after the tree has been cut. It also explains why runoff will not necessarily dramatically increase once juniper is removed. Rather, the water continues to infiltrate at high rates into soils previously ameliorated by junipers, thereby increasing deep drainage potential. In rangeland, deep drainage amounts can be 16 percent of the total rainfall amount per year (Thurow and Hester, 1997).

Conservation practices

Brush Management
Prescribed Burning
Prescribed Grazing

Additional community tables

Table 6. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Tallgrasses**			3419–6546	
	big bluestem	ANGE	*Andropogon gerardii*	1681–3363	–
	eastern gamagrass	TRDA3	*Tripsacum dactyloides*	560–1345	–
	Indiangrass	SONU2	*Sorghastrum nutans*	673–1121	–
	prairie cordgrass	SPPE	*Spartina pectinata*	168–673	–
	switchgrass	PAVI2	*Panicum virgatum*	336–673	–
	composite dropseed	SPCOC2	*Sporobolus compositus var. compositus*	0–56	–
	Florida paspalum	PAFL4	*Paspalum floridanum*	0–56	–
2	**Midgrasses**			168–448	
	little bluestem	SCSC	*Schizachyrium scoparium*	168–336	–
	sideoats grama	BOCU	*Bouteloua curtipendula*	0–112	–
3	**Cool-season grasses**			224–448	
	Scribner's rosette grass	DIOLS	*Dichanthelium oligosanthes var. scribnerianum*	17–84	–
	sedge	CAREX	*Carex*	17–84	–

	common spikerush	ELPA3	*Eleocharis palustris*	6–56	–
	Virginia wildrye	ELVI3	*Elymus virginicus*	6–56	–
	western wheatgrass	PASM	*Pascopyrum smithii*	6–56	–
	Canada wildrye	ELCA4	*Elymus canadensis*	6–56	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	6–56	–
4	**Shortgrasses**			0–179	
	blue grama	BOGR2	*Bouteloua gracilis*	0–90	–
	buffalograss	BODA2	*Bouteloua dactyloides*	0–90	–
Forb					
5	**Forbs**			560–897	
	compassplant	SILA3	*Silphium laciniatum*	45–112	–
	Illinois bundleflower	DEIL	*Desmanthus illinoensis*	45–112	–
	Maximilian sunflower	HEMA2	*Helianthus maximiliani*	45–112	–
	wholeleaf rosinweed	SIINL	*Silphium integrifolium var. laeve*	45–112	–
	sawtooth sunflower	HEGR4	*Helianthus grosseserratus*	34–90	–
	Nuttall's sensitive-briar	MINU6	*Mimosa nuttallii*	34–84	–
	roundhead lespedeza	LECA8	*Lespedeza capitata*	28–56	–
	sessileleaf ticktrefoil	DESE	*Desmodium sessilifolium*	28–56	–
	prairie acacia	ACAN	*Acacia angustissima*	28–56	–
	white prairie clover	DACA7	*Dalea candida*	28–56	–
	American licorice	GLLE3	*Glycyrrhiza lepidota*	28–56	–
	cup plant	SIPE2	*Silphium perfoliatum*	6–28	–
	Jerusalem artichoke	HETU	*Helianthus tuberosus*	6–28	–
	butterfly milkweed	ASTU	*Asclepias tuberosa*	6–28	–
	purple prairie clover	DAPU5	*Dalea purpurea*	6–28	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	6–28	–
	tall blazing star	LIAS	*Liatris aspera*	6–28	–
	green antelopehorn	ASVI2	*Asclepias viridis*	6–28	–
	Missouri goldenrod	SOMI2	*Solidago missouriensis*	6–28	–
	prairie blazing star	LIPY	*Liatris pycnostachya*	0–17	–
	narrowleaf four o'clock	MILI3	*Mirabilis linearis*	0–17	–
	downy phlox	PHPI	*Phlox pilosa*	0–17	–
	white crownbeard	VEVI3	*Verbesina virginica*	0–17	–
	wingstem	VEAL	*Verbesina alternifolia*	0–17	–
	Indianhemp	APCA	*Apocynum cannabinum*	0–17	–
	largeleaf wild indigo	BAALM	*Baptisia alba var. macrophylla*	0–17	–
	Baldwin's ironweed	VEBA	*Vernonia baldwinii*	0–11	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	0–11	–
	common yarrow	ACMI2	*Achillea millefolium*	0–11	–
Shrub/Vine					
6	**Shrubs**			0–179	
	leadplant	AMCA6	*Amorpha canescens*	0–45	–

	false indigo bush	AMFR	*Amorpha fruticosa*	0–45	–
	roughleaf dogwood	CODR	*Cornus drummondii*	0–45	–
	American plum	PRAM	*Prunus americana*	0–45	–
	coralberry	SYOR	*Symphoricarpos orbiculatus*	0–45	–
	prairie rose	ROAR3	*Rosa arkansana*	0–45	–
Tree					
7	**Trees**			112–269	
	eastern cottonwood	PODE3	*Populus deltoides*	0–112	–
	bur oak	QUMA2	*Quercus macrocarpa*	0–112	–
	black walnut	JUNI	*Juglans nigra*	0–84	–
	American elm	ULAM	*Ulmus americana*	0–56	–
	common hackberry	CEOC	*Celtis occidentalis*	0–56	–

Animal community

Grazing by domestic livestock is the major income-producing industry in the Flint Hills. There are approximately 1,000,000 beef cattle supported by the tallgrass of the Flint Hills each year. Rangeland in this area may provide year-long forage for cattle or horses. Much of this site is used for summer grazing of livestock.

This site is excellent wildlife habitat because of the great variety of forbs and grasses and its location in riparian areas. The site is preferred habitat for white-tailed deer, wild turkey, quail, pheasant, squirrel, cottontail rabbit, and migrant waterfowl and mourning dove as well. Furbearers such as mink, raccoon, skunk, and opossum are common as are coyotes and red fox. Bobcats are not often seen but are commonly present, using the adjacent rock ledges for dens and hunting the low areas. The encroachment of woody species can make this site even more attractive to a wide variety of wildlife species.

Songbirds are common to the site and include eastern and western kingbirds, brown thrasher, eastern bluebird, and redwinged blackbird. Hawks and owls commonly use this habitat and bald eagles will occasionally utilize it as well.

Some animals are important because of their threatened and endangered status and require special consideration. Please check the Kansas Department of Wildlife and Parks and Tourism (KDWP&T) website at www.ksoutdoors.com for the most current listing for your county.

Grazing Interpretations

Calculating Safe Stocking Rates: Proper stocking rates should be incorporated into a grazing management strategy that protects the resource, maintains or improves rangeland health, and is consistent with management objectives. In addition to usable forage, safe stocking rates should consider ecological condition, trend of the site, past grazing use history, season of use, stock density, kind and class of livestock, forage digestibility, forage nutritional value, variation of harvest efficiency based on preference of plant species, and/or grazing system, and site grazeability factors (such as steep slopes, site inaccessibility, or distance to drinking water).

Often the current plant community does not entirely match any particular Community Phase as described in this Ecological Site Description. Because of this, a resource inventory is necessary to document plant composition and production. Proper interpretation of inventory data will permit theestablishment of a safe initial stocking rate.

No two years have exactly the same weather conditions. For this reason, year-to-year and season-to-season fluctuations in forage production are to be expected on grazing lands. Livestock producers must make timely adjustments in the numbers of animals or in the length of grazing periods to avoid overuse of forage plants when production is unfavorable, and to make advantageous adjustments when forage supplies are above average.

Initial stocking rates should be improved through the use of vegetation monitoring and actual use records that include number and type of livestock, the timing and duration of grazing, and utilization levels. Actual use records over time will assist in making stocking rate adjustments based on the variability factors. Average annual production

must be measured or estimated to properly assess useable forage production and stocking rates.

Hydrological functions

Following are the estimated withdrawals of freshwater by use in MLRA 76: Public supply—surface water, 12.9%; ground water, 10.2% Livestock— surface water, 15.8%; ground water, 4.5% Irrigation—surface water, 53.9%; ground water, 2.7% Other—surface water, 0.0%; ground water, 0.0%.

The total withdrawals average 35 million gallons per day (130 million liters per day). About 17 percent is from ground water sources, and 83 percent is from surface water sources. The moderate precipitation provides water for pastures and crops. Much of the water for livestock is stored in small reservoirs and ponds. A small area is irrigated with water from the Arkansas River in Oklahoma. The surface water is generally of good quality and is suitable for most uses.

These are deep soils with loamy to silty surfaces and subsoils. They are somewhat poorly to well drained and have slow to moderate permeability. Please refer to the NRCS National Engineering Handbook Section 4 (NEH-4) for runoff quantities and hydrologic curves when making hydrology determinations.

Recreational uses

This site is often used for outdoor recreational pursuits because of its plant and wildlife diversity. White-tailed deer and wild turkey are abundant and commonly hunted on this site along with a wide variety of small game such as pheasant, quail, rabbits, squirrels, and raccoons. In addition, this site provides opportunities for bird watching, hiking, outdoor/wildlife photography, and a variety of other outdoor activities. There are a wide variety of plants in bloom throughout the growing season that provide much aesthetic appeal to the landscape. Recurrent flooding and sediment deposition are a site hazard.

Wood products

In some locations there have been commercial harvests of eastern cottonwood, black walnut and bur oak. Some hardwoods are cut for firewood.

Other products

None

Other information

Site Development and Testing Plan

This site went through the approval process.

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.

NRCS contracted the development of MLRA 79 ESDs in 2005. Extensive review and improvements were made to those foundational ESDs in 2017-2018 which provided an approved product.

Range Condition Guides and Technical Range Site Descriptions for Kansas, Loamy Lowland, USDA, Soil Conservation Service, March, 1967.

Range Site Description for Kansas, Loamy Lowland, USDA-Soil Conservation Service, September, 1985.

Ecological Site Description for Kansas, Loamy Lowland (R076XY013KS) located in Ecological Site Information

System (ESIS), 2007

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. Jornal of Range Management 56:114–126.

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

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.

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.

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.

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..

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-station-data/find-station.

Natural Resources Conservation Service. . National Ecological Site Handbook.

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

SSS NRCS OSD and . 2018 (Date accessed). Official Soil Series Descriptions. https://soilseries.sc.egov.usda.gov/osdname.aspx.

United States Department of Agriculture, . 2022. Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin.

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

Other references

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

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

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.

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.

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.

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

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

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.

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

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.

Contributors

Chris Tecklenburg

Approval

David Kraft, 8/12/2019

Acknowledgments

The ecological site development process is a collaborative effort, conceptual in nature, dynamic, and is never considered complete. I thank all those who set the foundational work in the mid-2000s in regard to this ESD. I thank all those who contributed to the development of this site. In advance, I thank those who would provide insight,

comments, and questions about this ESD in the future.

Non-discrimination Statement In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at How to File a Program Discrimination Complaint and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by:

(1) mail: U.S. Department of Agriculture Office of the Assistant Secretary for
Civil Rights 1400 Independence Avenue, SW Washington, D.C. 20250-9410;

(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.

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)	Chris Tecklenburg/Revision 2-05-2019 David Kraft, John Henry, Doug Spencer and Dwayne Rice/original authors 1-15-2005.
Contact for lead author	State Rangeland Management Specialist for Kansas.
Date	02/05/2019
Approved by	
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 Loamy Lowland ecological site.

---

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.

---

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.

---

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).

---

5. **Number of gullies and erosion associated with gullies:** No evidence of accelerated water flow resulting in downcutting of the soil.

---

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.

---

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).

---

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.

---

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

   Ap--0 to 23 centimeters (0 to 9 inches); very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable, slightly plastic and slightly sticky; many worm casts; moderately alkaline; abrupt, smooth boundary.

   A--23 to 43 centimeters (9 to 17 inches); very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, friable, slightly plastic and slightly sticky; many worm casts; slight effervescence; moderately alkaline; gradual smooth boundary. (combined thickness of the A horizons is 30 to 66 centimeters (12 to 26 inches) thick)

   AC--43 to 81 centimeters (17 to 32 inches); very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable, slightly plastic and slightly sticky; many fine worm holes and casts; thinly stratified with very dark brown (10YR 2/2) lenses of silty clay loam in lower part of horizon; strong effervescence; moderately alkaline; gradual smooth boundary. (0 to 76 centimeters (0 to 30 inches) thick)

---

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 functional and structural group worksheet). Note changes to plant communities if different than that of the functional and structural group worksheet.

---

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).

---

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 Tallgrass dominant 73% 5840 lbs. big bluestem 1500-3000, Indiangrass 600-1000, eastern gamagrass 500-1200, switchgrass 300-600, prairie cordgrass 150-600, composite dropseed 0-50.

    Sub-dominant: None

    Other: Group 2 Midgrass Minor 5% 400 lbs. Little bluestem 150-300, sideoats grama 0-100
    Group 3 Cool-season grasses Minor 5% 400 lbs. Scribner's rosette grass, Virginia wildrye, western wheatgrass, Canada wildrye, Prairie junegrass, sedge, common spikerush

    Additional: Group 4 Shortgrasses Trace 2% 160 lbs. blue grama 0-80, buffalograss 0-80.
    Group 5 Forbs Minor 10% 800 lbs. see Reference Plant Community for complete list
    Group 6 shrub Trace 2% 160 lbs. see Reference Plant Community for complete list
    Group 7 Trees Minor 3% 240 lbs. see Reference Plant Community for complete list

---

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.

---

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.

---

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 6,000 lbs in a below-average rainfall year and 10,000 lbs in an above-average rainfall year. The representative value for this site is 8,000 lbs production per year.

---

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.

---

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.
