USDA Natural Resources Conservation Service

# Ecological site HX076XY128
# Shallow Hills

Last updated: 1/30/2024
Accessed: 05/19/2024

## 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 Shallow Hills ecological site was formerly known as Shallow Limy (R076XY028KS). This ecological site is characterized by soils that are less than 20 inches to a limestone or shale layer. This site generally occurs in narrow bands or shoulders on hillslopes. Limestone at the surface is almost always present on this site. The soil series Sogn and Kipson are correlated to this site. Slope ranges from 0 to 20 percent.

## Associated sites

| | |
|---|---|
| HX076XY107 | **Clay Hills**<br>The Clay Hills ecological site sits adjacent to and in conjunction with the Shallow Hills site. This site occurs on summit and shoulder positions with a clay content >35 percent at depths >14 inches. The Clay Hills site has moderately deep to very deep soils with a clay loam to silty clay surface (7 to 14 inches) over clayey subsoil. Although this site can retain large amounts of water, it is tightly held and therefore is not available in adequate amounts for the vegetation during stress periods. |
| HX076XY115 | **Loamy Hills**<br>The Loamy Hills ecological site sits adjacent to and in conjunction with the Shallow Hills site. This site occurs on summit, shoulder positions, and footslopes (Tully soil). The Loamy Hills soils are well drained that formed from colluvium and in residuum from interbedded limestone and clayey shale. The Loamy Hills site has moderately deep to very deep soils with a silt loam to silty clay surface (7 to 14 inches). |
| HX076XY112 | **Limy Hills**<br>The Limy Hills ecological site sits adjacent to and in conjunction with the Shallow Hills site. This site is characterized by one soil series named Clime. This is a moderately deep, well drained soil that formed in residuum from shale. This site occurs on side slopes on uplands with slopes ranging from 1 to 60 percent. The Limy Hills ecological site is usually calcareous to the surface and always strongly calcareous within 10 inches of the soil surface. |

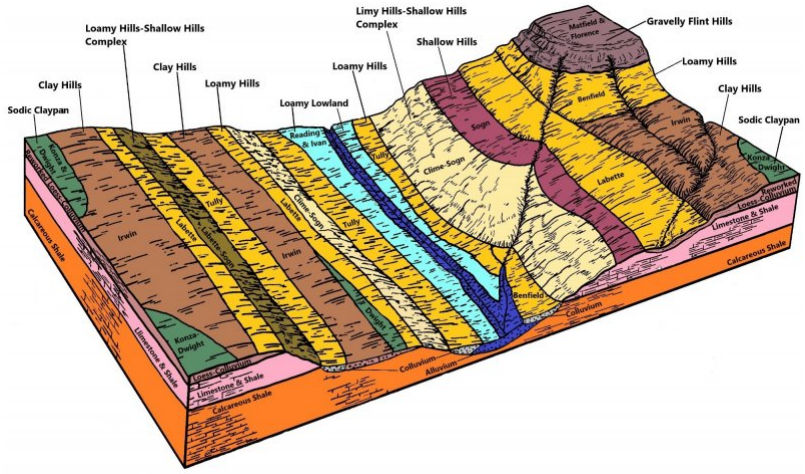



**Figure 1. MLRA 76 ESD block diagram.**

**Table 1. Dominant plant species**

| | |
|---|---|
| Tree | Not specified |
| Shrub | Not specified |
| Herbaceous | (1) *Andropogon gerardii*<br>(2) *Schizachyrium scoparium* |

## Legacy ID

R076XY128KS

## 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 Shallow Hills Ecological Site occurs on nearly level to moderately steep sloping areas on interfluves and hillslopes (summits and shoulders) of uplands. The soil is somewhat excessively drained and formed in residuum weathered from limestone or shale of Permian age. Slope ranges from 0 to 20 percent. This site usually generates runoff. Elevation ranges from 980 to 1,650 feet. T

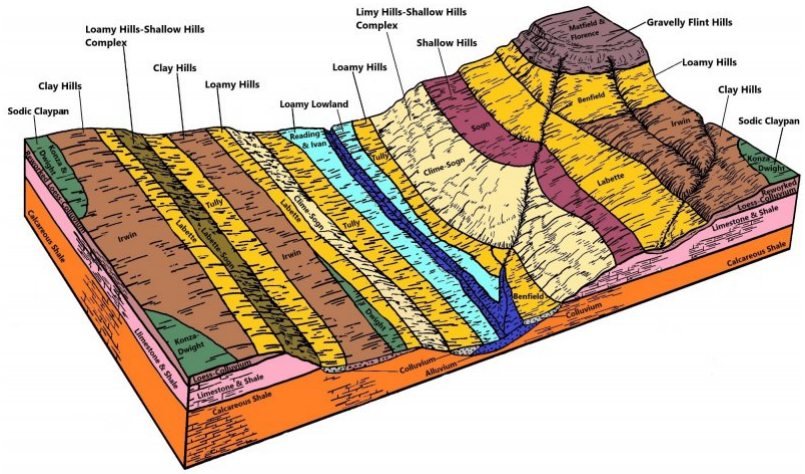



**Figure 2. MLRA 76 ESD block diagram.**

**Table 2. Representative physiographic features**

| | |
|---|---|
| Hillslope profile | (1) Summit<br>(2) Shoulder |
| Landforms | (1) Hills > Interfluve<br>(2) Hills > Hillslope |
| Runoff class | High to very high |
| Flooding frequency | None |
| Ponding frequency | None |
| Elevation | 299–503 m |
| Slope | 0–20% |
| 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 |

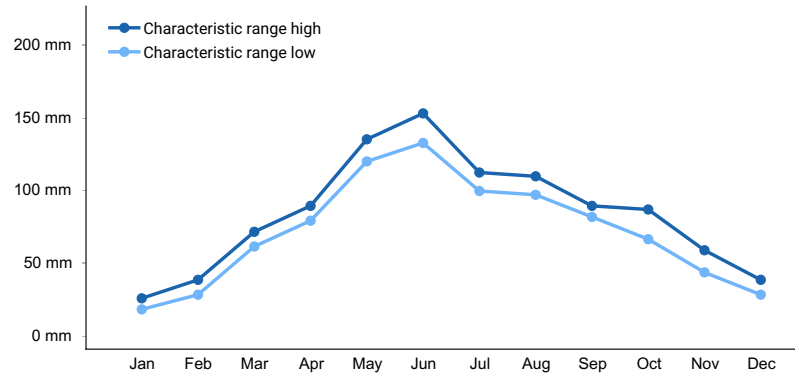



**Figure 3. Monthly precipitation range**

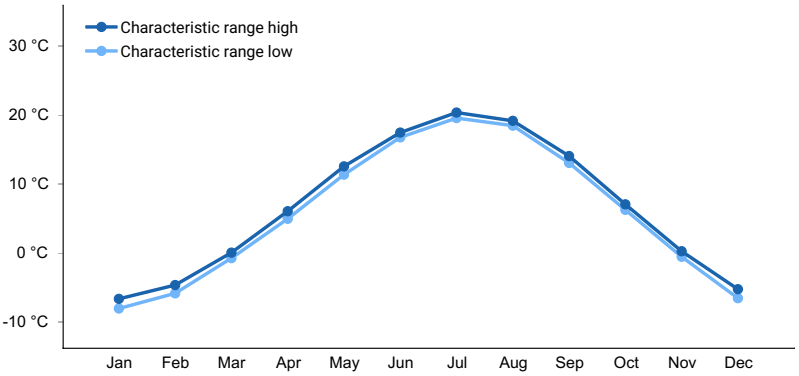



**Figure 4. Monthly minimum temperature range**

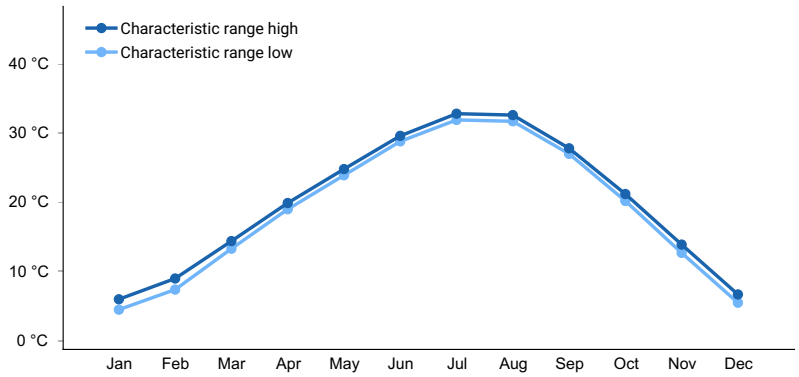



**Figure 5. Monthly maximum temperature range**

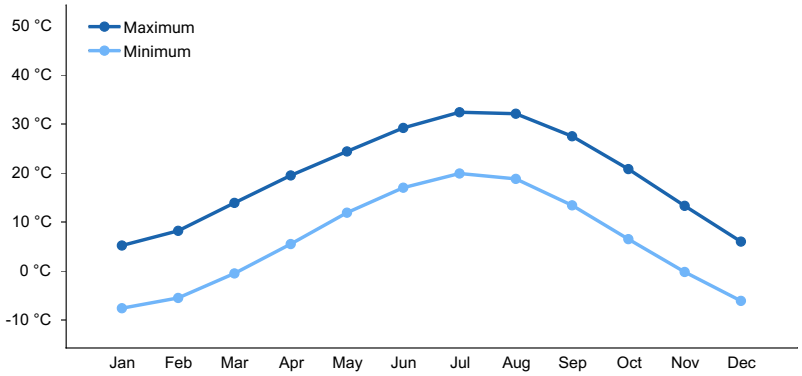



**Figure 6. Monthly average minimum and maximum temperature**

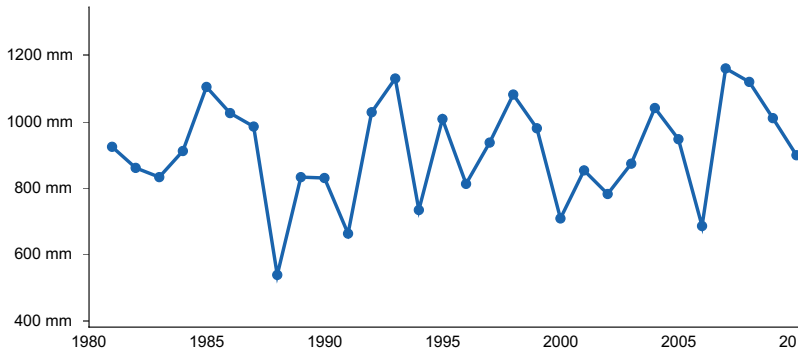



**Figure 7. Annual precipitation pattern**

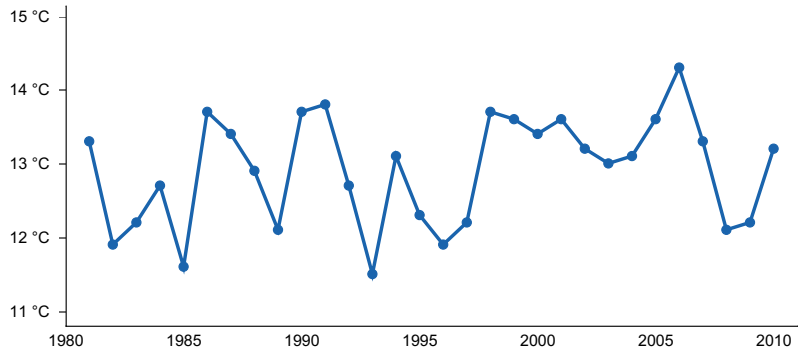



**Figure 8. Annual average temperature pattern**

## 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

The Shallow Hills are sites on nearly level to moderately steep slopes. Runoff is high to very high. Water moves downslope into drainageways. If inadequate vegetative cover is present, sheet erosion becomes excessive.

The soils on this ecological site have moderate permeability. Water holding capacity is very low, and somewhat excessively drained above the bedrock. Total plant production is limited due to the water availability. The availability of water and nutrients is limited due to the shallow to very shallow soil depths to bedrock.

The Sogn and Kipson series are classified as hydrologic soil group D. For more information on hydrologic groups, refer to the NRCS National Engineering Handbook Part 630 chapter 7.

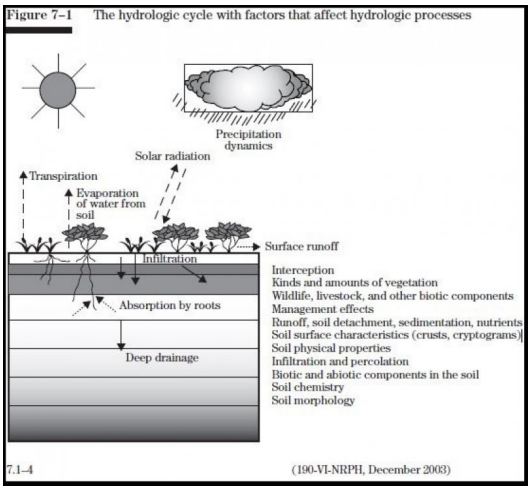



**Figure 9. Fig. 7-1 from the National Range and Pasture Handbook.**

## Soil features

The soils that charaterize the Shallow Hills ecological site are shallow to very shallow. These soils are excessively drained above the bedrock that formed in residuum weathered from limestone and shale. Limestone fragments can be found on the surface and usually throughout the profile. Sogn and Kipson is usually calcareous to the surface. These soils can be highly erosive with sheet erosion being a severe hazard. As much as 10 percent of the surface area of this site may consist of exposed limestone rock, which strongly limits root development and plant growth. The available water capacity is very low for the Shallow Hills site.

The slope varies from nearly level to moderately steep. Runoff is very high on steeper slopes and high on gentle slopes.

The major soils that characterize this site are Sogn and Kipson.

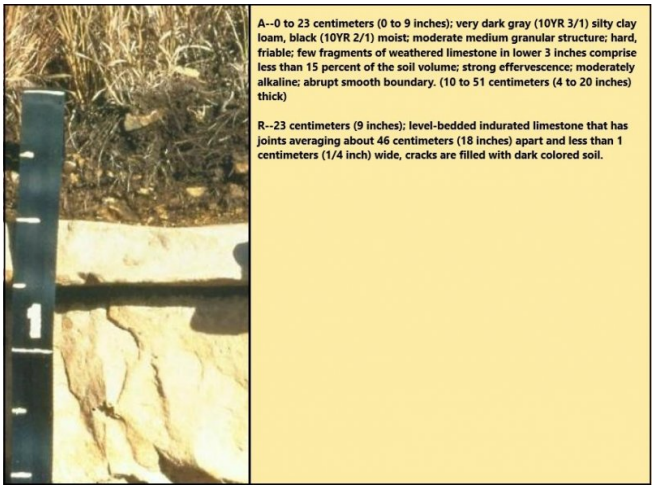



**Figure 10. MLRA 76 Sogn soil series profile and description.**

**Table 4. Representative soil features**

| | |
|---|---|
| Parent material | (1) Residuum–limestone and shale |
| Surface texture | (1) Silty clay loam<br>(2) Silt loam<br>(3) Gravelly silt loam |
| Family particle size | (1) Loamy |
| Drainage class | Somewhat excessively drained |
| Permeability class | Moderate |
| Depth to restrictive layer | 10–51 cm |
| Soil depth | 10–51 cm |
| Surface fragment cover <=3" | 0–10% |
| Surface fragment cover >3" | 0–10% |
| Available water capacity (0-101.6cm) | 2.29–9.65 cm |
| Calcium carbonate equivalent (0-101.6cm) | 0–60% |
| Electrical conductivity (0-101.6cm) | 0–2 mmhos/cm |
| Sodium adsorption ratio (0-101.6cm) | 0 |
| Soil reaction (1:1 water) (0-101.6cm) | 6.1–8.4 |
| Subsurface fragment volume <=3" (Depth not specified) | 0–55% |
| Subsurface fragment volume >3" (Depth not specified) | 0–15% |

## Ecological dynamics

Th Shallow Hills ecological site is a dynamic plant community resulting from the complex interaction of many ecological processes resulting from the complex interaction of many ecological factors and processes. The vegetation developed on shallow (<20 inches or <50 centimeters) to very shallow (<10 inches or <25 centimeters) soils under a diverse and fluctuating climate. Plants were historically grazed by herds of large herbivores and periodically subjected to intense wildfires.

The site’s potential vegetation is diverse and the total annual production is limited due to the shallow to very shallow soil depth. Grasses and grasslike plants make up about 80 percent of the potential vegetation.

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. Low fuel loads on this shallow site often reduced the intensity of fires and minimized the effects of fire compared to adjoining sites. Growth of forbs, especially legumes and annuals, usually was enhanced following a fire event. In the case of the latter, however, this increase generally was temporary, perhaps lasting for one to two years. Shrubs and trees, except for occasional leadplant, sumac, Jersey tea, and cacti, rarely persist in the Reference Plant Community.

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 could be intense. When herds moved to adjacent areas, grazed vegetation was afforded an extended

period of rest and recovery during the growing season. Other grazing and feeding animals such as elk, pronghorns, deer, rabbits, insects, and numerous burrowing rodents 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.

Summer drought also had noticeable impacts on the vegetation, especially on the site's very shallow portions. When soil moisture was depleted during extended summer droughts, plant growth of perennial grasses was stressed and many annual plants perished.

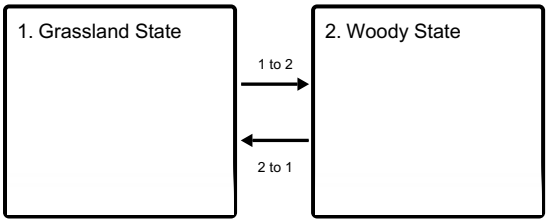
As European settlers began utilizing the site for production of domestic livestock within fenced pastures in place of roaming bison herds, its ecological dynamics and physical aspects were altered and the plant community shifted from its original composition. These changes were usually in proportion 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 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

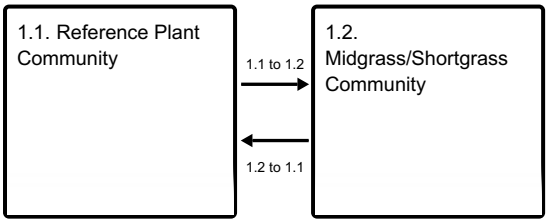
**Ecosystem states**




**1 to 2** - Lack of fire and brush control

**2 to 1** - Prescribed grazing, brush management, and prescribed burning

**State 1 submodel, plant communities**



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

**1.2 to 1.1** - Prescribed grazing with adequate rest and recovery period during the growing season

**State 2 submodel, plant communities**

2.1. Shrub and/or Tree 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 Shallow Hills 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 Midgrasses 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.**

The interpretive plant community for the Shallow Hills ecological site is the Reference Plant Community, and represents the original plant community that existed prior to European settlement. The site is characterized as a grassland essentially free of trees and large shrubs. This site may contain 10 percent or more of exposed limestone rock. These areas generally occur just above or below the outer rim of large hills where a limestone cap or limestone layers are exposed. The site may also occur on broad ridgetops. This site is dominated by tall- and mid-

warm-season grasses including big bluestem, little bluestem, switchgrass, sideoats grama, and Indiangrass. The major midgrass is little bluestem. Combined these five grasses will account for 70 to 80 percent of vegetation produced annually. Other prevalent grasses are purpletop tridens, composite dropseed, buffalograss, blue grama, and hairy grama. The Reference Plant Community supports a variety of legume species which are interspersed throughout the grass sward. Compassplant, Nuttall's sensitive-briar, blacksamson, dotted blazing star, pitcher sage, Maximilian sunflower, and Cuman ragweed are important forbs found on this site. Numerous smaller forbs such as diamondflowers, flowering spurge, branched noseburn, small skullcap, and wooly plantain are also common to the site. Leadplant and Jersey tea are low-growing, fire-tolerant shrubs that occur on this site. Sumac species generally are associated with this site and other shrubs such as coralberry and roughleaf dogwood may occur in small amounts in areas protected from fire. Missouri foxtail cactus, spinystar, and pricklypear—although not abundant—may be found scattered over the site.

**Resilience management.** When adequately managed, this is a stable plant community (with temporary fluctuations due to drought). A prescribed grazing program that incorporates periods of rest and rotation during the growing season benefits the dominant tall- and midgrasses and even the more palatable forbs. Nearly level areas are readily grazed, while moderately sloping ones with exposed limestone rock are less intensively grazed. Excessive grazing and foot or hoof traffic can impact the soil stability on this site and lead to sheet erosion. Gully erosion generally is limited by a rock cap or layers of limestone outcrops, but may occur on the site where water enters from larger associated sites and cascades over the rims of the large hills.

### Dominant plant species

- big bluestem (*Andropogon gerardii*), grass
- little bluestem (*Schizachyrium scoparium*), grass
- sideoats grama (*Bouteloua curtipendula*), grass
- switchgrass (*Panicum virgatum*), 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 | 1345 | 2253 | 3138 |
| Forb | 252 | 415 | 588 |
| Shrub/Vine | 84 | 135 | 196 |
| **Total** | **1681** | **2803** | **3922** |

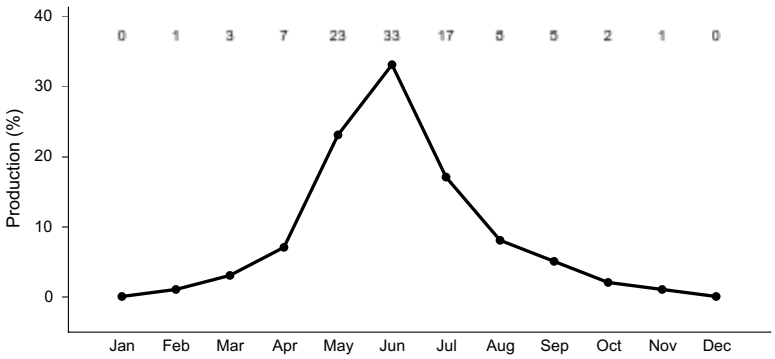



**Figure 13. Plant community growth curve (percent production by month). KS7628, Shallow Hills. Growth of warm-season grasses on this site typically begins in April and continues until mid-September. Cool-season grasses, sedges and rushes generally have two primary growth periods, one in the fall (September and October) and again in the spring (April, May, and June). Some growth may occur in winter months during periods of unseasonably warm temperatures (commonly called "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 upon temperature and precipitation patterns..**

## Community 1.2

## Midgrass/Shortgrass Community


**Figure 14. MLRA 76 Midgrass/Shortgrass Plant Community.**

This plant community results from many years of overgrazing. The Midgrass/Shortgrass plant community is stable. The amount of tallgrasses and the more palatable midgrasses have decreased significantly and the site is dominated by shortgrasses and less desirable midgrasses. Relative to the Reference Community, there has been a reduction in the more-palatable tallgrasses and forbs. Prescribed fire is non-existent or is applied at frequencies greater than 9 years. Grazing at times is more intense and frequent than what the dynamics of the grassland state prescribes. There is no forage-animal balance. This community phase will include several kinds of plant communities. We can expect hydrologic changes, with an increase in shrubs there will be more interception, less infiltration and higher soil surface temperatures in the summer. As the shortgrass community increases, the site will have less infiltration and produce more runoff. Due to the characteristics (exposed limestone and slope) of this site and location on the landscape (narrow bands), this community phase is relatively stable.

**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

- little bluestem (*Schizachyrium scoparium*), grass
- blue grama (*Bouteloua gracilis*), grass

## Pathway 1.1 to 1.2
## Community 1.1 to 1.2

**Reference Plant Community**

**Midgrass/Shortgrass Community**

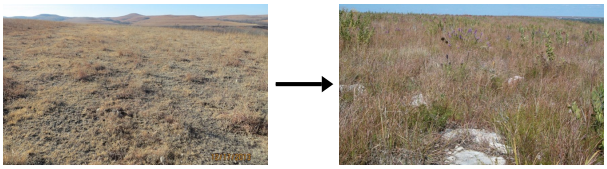
These mechanisms include management controlled by repetitive heavy use, no rest or recovery of the key forage species and no forage and animal balance for many extended grazing seasons. This type of management lasting for periods greater than 20 years will shift functional and structural plant group dominance towards a Midgrass/Shortgrass Plant Community.

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

**Conservation practices**

| |
|---|
| Prescribed Grazing |

### Pathway 1.2 to 1.1
### Community 1.2 to 1.1



**Midgrass/Shortgrass 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, little bluestem, sideoats grama, switchgrass, and Indiangrass) within the Midgrass/Shortgrass Plant Community . If woody species are present, prescription fires every 2-5 years will be necessary for their removal and/or maintenance.

**Conservation practices**

| |
|---|
| Prescribed Burning |
| Prescribed Grazing |

### State 2
### 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.

**Dominant plant species**

- eastern redcedar (*Juniperus virginiana*), tree
- chinquapin oak (*Quercus muehlenbergii*), tree
- common hackberry (*Celtis occidentalis*), tree
- smooth sumac (*Rhus glabra*), shrub
- fragrant sumac (*Rhus aromatica*), shrub

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

This plant community is dominated by shrubs consisting primarily of aromatic sumac, coralberry, roughleaf dogwood, and/or smooth sumac. Trees including osage orange, honeylocust, hackberry, elms, chinkapin oak, and eastern redcedar can invade and 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.

**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 fire resistant species like osage orange and honeylocust and accelerate the recovery of desired vegetative cover. Recently, some landowners have relied on the browsing habits of goats to suppress the woody growth.

#### Dominant plant species

- dwarf chinquapin oak (*Quercus prinoides*), tree
- eastern redcedar (*Juniperus virginiana*), tree
- coralberry (*Symphoricarpos orbiculatus*), shrub

### Transition 1 to 2
### State 1 to 2

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.

### Restoration pathway 2 to 1
### State 2 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 predeterminedarea 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** | | | 448–1076 | |
| | big bluestem | ANGE | *Andropogon gerardii* | 336–588 | – |
| | Indiangrass | SONU2 | *Sorghastrum nutans* | 168–297 | – |
| | switchgrass | PAVI2 | *Panicum virgatum* | 112–196 | – |
| | composite dropseed | SPCOC2 | *Sporobolus compositus var. compositus* | 0–34 | – |
| 2 | **Midgrasses** | | | 560–885 | |
| | little bluestem | SCSC | *Schizachyrium scoparium* | 280–493 | – |
| | sideoats grama | BOCU | *Bouteloua curtipendula* | 224–392 | – |
| | purpletop tridens | TRFL2 | *Tridens flavus* | 0–34 | – |
| 3 | **Shortgrasses** | | | 56–140 | |
| | blue grama | BOGR2 | *Bouteloua gracilis* | 22–112 | – |
| | hairy grama | BOHI2 | *Bouteloua hirsuta* | 22–112 | – |
| | buffalograss | BODA2 | *Bouteloua dactyloides* | 11–67 | – |
| 4 | **Cool-season grasses** | | | 11–140 | |
| | sedge | CAREX | *Carex* | 11–45 | – |
| | Scribner's rosette grass | DIOLS | *Dichanthelium oligosanthes var. scribnerianum* | 11–45 | – |
| | rock muhly | MUSO | *Muhlenbergia sobolifera* | 11–34 | – |
| **Forb** | | | | | |
| 5 | **Forbs** | | | 168–420 | |
| | Nuttall's sensitive-briar | MINU6 | *Mimosa nuttallii* | 6–28 | – |
| | purple prairie clover | DAPU5 | *Dalea purpurea* | 6–22 | – |
| | Cuman ragweed | AMPS | *Ambrosia psilostachya* | 6–22 | – |

| | | | | | |
|---|---|---|---|---|---|
| | blacksamson echinacea | ECAN2 | *Echinacea angustifolia* | 6–22 | – |
| | rose mock vervain | GLCA2 | *Glandularia canadensis* | 6–22 | – |
| | Maximilian sunflower | HEMA2 | *Helianthus maximiliani* | 6–22 | – |
| | willowleaf sunflower | HESA2 | *Helianthus salicifolius* | 6–22 | – |
| | compassplant | SILA3 | *Silphium laciniatum* | 6–22 | – |
| | western silver aster | SYSE2 | *Symphyotrichum sericeum* | 6–22 | – |
| | Missouri goldenrod | SOMI2 | *Solidago missouriensis* | 0–17 | – |
| | white heath aster | SYERE | *Symphyotrichum ericoides var. ericoides* | 0–17 | – |
| | dotted blazing star | LIPU | *Liatris punctata* | 0–17 | – |
| | white prairie clover | DACA7 | *Dalea candida* | 0–17 | – |
| | common yarrow | ACMI2 | *Achillea millefolium* | 0–17 | – |
| | white sagebrush | ARLU | *Artemisia ludoviciana* | 0–17 | – |
| | upright prairie coneflower | RACO3 | *Ratibida columnifera* | 0–17 | – |
| | Leavenworth's eryngo | ERLE11 | *Eryngium leavenworthii* | 0–11 | – |
| | field pussytoes | ANNE | *Antennaria neglecta* | 0–11 | – |
| | stiff goldenrod | OLRIR | *Oligoneuron rigidum var. rigidum* | 0–11 | – |
| | aromatic aster | SYOB | *Symphyotrichum oblongifolium* | 0–11 | – |
| | nettleleaf noseburn | TRUR2 | *Tragia urticifolia* | 0–11 | – |
| **Shrub/Vine** | | | | | |
| 6 | **Shrubs** | | | 0–140 | |
| | leadplant | AMCA6 | *Amorpha canescens* | 0–34 | – |
| | New Jersey tea | CEAM | *Ceanothus americanus* | 0–34 | – |
| | twistspine pricklypear | OPMA2 | *Opuntia macrorhiza* | 0–34 | – |
| | fragrant sumac | RHAR4 | *Rhus aromatica* | 0–34 | – |
| | smooth sumac | RHGL | *Rhus glabra* | 0–34 | – |
| | coralberry | SYOR | *Symphoricarpos orbiculatus* | 0–34 | – |

## 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.

Because of the great variety of forbs and grasses found on this ecological site, it provides excellent habitat for ground nesting birds including both the eastern and western meadowlark as well as the upland sandpiper. The greater prairie chicken often uses this site for booming grounds or “leks” where the males carry out their courtship displays, a unique “flint hills” spring ritual.

Small rodents such as the deer mice and prairie voles and other small furbearers forage on the diverse plant foods available along with numerous insects that are attracted to plants during the growing season. Reptiles including various snakes, lizards and the box turtle are commonly found on this site. Hawks and owls, along with furbearers such as coyotes and badgers, are common predators on this site.

Historically, this site was a preferred grazing location for bison, deer, elk, and pronghorn. Today’s big game would include the white-tailed deer and turkey along with some pronghorn. Upland game including bobwhite quail, greater prairie chicken, and the eastern cottontail are found on this site as well.

The rocky, open areas of the site also are preferred by lizards and snakes which sometimes take advantage of the warmth from solar radiation and feed on insects. Two popular species of lizards in Kansas are found here—the collared lizard and the Texas horned lizard—and commonly can be seen foraging for insects in this rocky terrain. Many songbirds, small rodents, and other small mammals frequently feed here 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.

Grassland State 1: Soils on this site are shallow and very shallow, somewhat excessively drained, and have a moderately high saturated hydraulic conductivity (moderate permeability). The water cycle is most functional when the site is dominated by warm-season tall and mid-grasses. Changes in infiltration and runoff from Reference Community to the mid-shortgrass community can occur. As a result of grazing pressure and fire frequency the mid-shortgrass community can have less infiltration and more runoff due to the composition of species.

Soils that make up this site are hydrologic group D soil. 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 provides opportunities for a variety of outdoor activities which might include bird watching, hiking, outdoor/wildlife photography and filming, and hunting. A wide variety of plants bloom throughout the growing season which, especially in those years with average and above average rainfall, provides much aesthetic appeal to the

landscape.

## Wood products

This site normally produces no wood products.

## Other products

None.

## Other information

Site Development and Testing Plan

This site went through the approval process.

Major Land Resource Area (MLRA) 76 Bluestem Hills and often referred to as the Flint Hills is named for the abundant flint (chert) eroded from the bedrock that lies near or at the surface. This area supports tall prairie grasses. Big bluestem, Indiangrass, switchgrass, and little bluestem are the dominant species. The Flint Hills is designated as a distinct region because it has the most dense coverage of intact tallgrass prairie in North America. Very little of this area has been cultivated because of the abundance of cherty limestone near and on the surface. It is a focal area for the preservation of this ecosystem. Some of the major wildlife species in this area are whitetailed deer, coyote, fox, badger, beaver, raccoon, skunk, civet, opossum, muskrat, mink, great blue heron, prairie chicken, and bobwhite quail. The species of fish in the area include bass, walleye, catfish, bullhead, and carp.

## 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.

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## Contributors

Chris Tecklenburg

## Approval

Suzanne Mayne-Kinney, 1/30/2024

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This ESD was approved for publication by David Kraft, Senior Regional Ecologist on 2/13/2020.

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## Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

| | |
|---|---|
| Author(s)/participant(s) | Chris Tecklenburg/Revision 1-25-2019<br>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 | 01/25/2019 |
| 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 Shallow Hills 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.

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):** Sogn OSD:

   A--0 to 23 centimeters (0 to 9 inches); very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; moderate medium granular structure; hard, friable; few fragments of weathered limestone in lower 3 inches comprise less than 15 percent of the soil volume; strong effervescence; moderately alkaline; abrupt smooth boundary. (10 to 51 centimeters (4 to 20 inches) thick)

   R--23 centimeters (9 inches); level-bedded indurated limestone that has joints averaging about 46 centimeters (18 inches) apart and less than 1 centimeters (1/4 inch) wide, cracks are filled with dark colored soil.

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 38% 960 lbs. big bluestem 300-525, Indiangrass 150-265, switchgrass 100-175, composite dropseed 0-30.

    Sub-dominant: Group 2 Midgrass subdominant 32% 790 lbs. little bluestem 250-440, sideoats grama 200-350, purpletop 0-30.

Other: Group 3 Shortgrass minor 5% 125 lbs. buffalograss 10-60, blue grama 20-100, hairy grama 20-100.
Group 4 Cool-season grass minor 5% 125 lbs. Sedge 10-40, Scribner's rosette grass 10-40, rock muhly 10-30.

Additional: Group 5 forbs subdominant 15% 375 lbs. see Reference Plant community for entire list
Group 6 shrub minor 5% 125 lbs. All 0-30 lbs: leadplant, New Jersey tea, twistspine pricklypear, fragrant sumac, smooth sumac, coralberry.

---

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 1,500 lbs in a below-average rainfall year and 2,500 lbs in an above-average rainfall year. The representative value for this site is 3,500 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.

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