USDA Natural Resources
Conservation Service

Ecological site R086AY013TX
Clayey Bottomland

Last updated: 9/21/2023
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General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

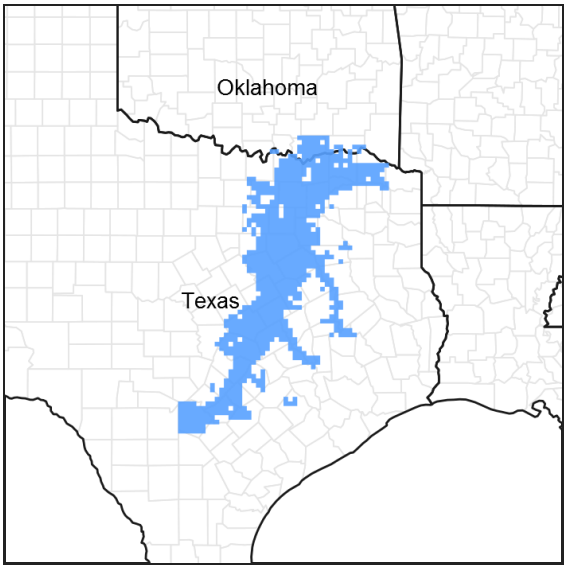


Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

MLRA notes

Major Land Resource Area (MLRA): 086A–Texas Blackland Prairie, Northern Part

MLRA 86A, The Northern Part of Texas Blackland Prairie is entirely in Texas. It makes up about 15,110 square miles (39,150 square kilometers). The cities of Austin, Dallas, San Antonio, San Marcos, Temple, and Waco are located within the boundaries. Interstate 35, a MLRA from San Antonio to Dallas. The area supports tall and mid-grass prairies, but improved pasture, croplands, and urban development account for the majority of the acreage.

Classification relationships

USDA-Natural Resources Conservation Service, 2006.
-Major Land Resource Area (MLRA) 86A

Ecological site concept

The Clayey Bottomland is a tallgrass savannah. The site is unique because it has a hardwood overstory component with the tallgrasses. The soils are very deep clays and are associated with flooding regimes. Their heavy textured soils cause water to drain slowly and may stay for over a month.

Associated sites

R086AY011TX	**Southern Blackland** The Southern Blackland site is often upslope from the Clayey Bottomland site. It differs from the Clayey Bottomland site by its position on uplands, lack of high shrink-swell and hydric soil properties, and having clay soils and higher runoff.
R086AY003TX	**Northern Claypan Prairie** The Northern Claypan site is often adjacent to the Clayey Bottomland site. It differs from the Clayey Bottomland site by forming on stream terraces and having a sandy loam surface soil layer and lower production potential due to low to moderate soil fertility.
R086AY008TX	**Northern Eroded Blackland** The Clayey Bottomland site is frequently adjacent to the site. It differs from the site by its occurrence on floodplains, intact A horizon, and high shrink-swell properties.
R086AY009TX	**Southern Eroded Blackland** The Clayey Bottomland site is frequently adjacent to the site. It differs from the site by its occurrence on floodplains, intact A horizon, and high shrink-swell properties.
R086AY004TX	**Southern Claypan Prairie** The Southern Claypan site is often adjacent to the Clayey Bottomland site. It differs from the Clayey Bottomland site by forming on stream terraces and having a sandy loam surface soil layer and lower production potential due to low to moderate soil fertility.
R086AY006TX	**Northern Clay Loam** The Northern Clay Loam site is often upslope from the Clayey Bottomland site. It differs from the Clayey Bottomland site by occurring in uplands, plains, and terraces and lacking thin stratas of varying textured soils in the soil profile from flooding events.
R086AY007TX	**Southern Clay Loam** The Southern Clay Loam site is often upslope from the Clayey Bottomland site. It differs from the Clayey Bottomland site by occurring in uplands, plains, and terraces and lacking thin stratas of varying textured soils in the soil profile from flooding events.
R086AY010TX	**Northern Blackland** The Northern Blackland site is often upslope from the Clayey Bottomland site. It differs from the Clayey Bottomland site by its position on uplands, lack of high shrink-swell and hydric soil properties, and having clay soils and higher runoff.

Similar sites

R086AY012TX	**Loamy Bottomland** The Loamy Bottomland site is similar to the Clayey Bottomland site by occurring on floodplains and having similar production potential. It differs from the Clayey Bottomland site by forming in recent loamy alluvium and having higher permeability and no shrink-swell soil characteristics.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Elymus virginicus* (2) *Elymus canadensis*

Physiographic features

These are on nearly level slopes and occurs along major rivers and their tributaries on floodplains. Slopes are dominantly 1 to 5 percent, but range from 0 to 10 percent. The sites can flood briefly (two to seven days) to very long (greater than one month) and pond as well. The runoff class is high to very high.

Table 2. Representative physiographic features

Landforms	(1) Plains > Flood plain

Runoff class	High to very high
Flooding duration	Brief (2 to 7 days) to very long (more than 30 days)
Flooding frequency	Rare to frequent
Ponding duration	Brief (2 to 7 days) to long (7 to 30 days)
Ponding frequency	Rare to occasional
Elevation	30–168 m
Slope	1–5%
Ponding depth	0–15 cm
Water table depth	0–183 cm
Aspect	Aspect is not a significant factor

Table 3. Representative physiographic features (actual ranges)

Runoff class	Not specified
Flooding duration	Not specified
Flooding frequency	Not specified
Ponding duration	Not specified
Ponding frequency	Not specified
Elevation	Not specified
Slope	1–10%
Ponding depth	Not specified
Water table depth	Not specified

Climatic features

The climate for MLRA 86A is humid subtropical and is characterized by hot summers, especially in July and August, and relatively mild winters. Tropical maritime air controls the climate during spring, summer and fall. In winter and early spring, frequent surges of Polar Canadian air cause sudden drops in temperatures and add considerable variety to the daily weather. When these cold air masses stagnate and are overrun by moist air from the south, several days of cold, cloudy, and rainy weather follow. Generally, these occasional cold spells are of short duration with rapid clearing following cold frontal passages. The summer months have little variation in day-to-day weather except for occasional thunderstorms that dissipate the afternoon heat. The moderate temperatures in spring and fall are characterized by long periods of sunny skies, mild days, and cool nights. The average relative humidity in mid-afternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 75 percent of the time during the summer and 50 percent in winter. The prevailing wind direction is from the south and highest wind speeds occur during the spring months. Rainfall during the spring and summer months generally falls during thunderstorms, and fairly large amounts of rain may fall in a short time. High-intensity rains of short duration are likely to produce rapid runoff almost anytime during the year. The predominantly anticyclonic atmospheric circulation over Texas in summer and the exclusion of cold fronts from North Central Texas result in a decrease in rainfall during midsummer. The amount of rain that falls varies considerably from month-to-month and from year-to-year.

Table 4. Representative climatic features

Frost-free period (average)	237 days
Freeze-free period (average)	265 days
Precipitation total (average)	991 mm

Climate stations used

- (1) CEDAR CREEK 5 S [USC00411541], Cedar Creek, TX
- (2) TAYLOR 1NW [USC00418862], Taylor, TX
- (3) HILLSBORO [USC00414182], Hillsboro, TX
- (4) TEMPLE [USC00418910], Temple, TX
- (5) GREENVILLE KGVL RADIO [USC00413734], Greenville, TX
- (6) NEW BRAUNFELS [USC00416276], New Braunfels, TX
- (7) SAN MARCOS [USC00417983], San Marcos, TX
- (8) SHERMAN [USC00418274], Denison, TX
- (9) JOE POOL LAKE [USC00414597], Dallas, TX
- (10) KAUFMAN 3 SE [USC00414705], Kaufman, TX
- (11) MCKINNEY [USC00415766], McKinney, TX
- (12) SAN ANTONIO 8NNE [USC00417947], San Antonio, TX
- (13) WAXAHACHIE [USC00419522], Waxahachie, TX
- (14) AUSTIN BERGSTROM AP [USW00013904], Austin, TX

Influencing water features

This site is located in floodplains. It receives water from overflow from watercourses and runoff from higher adjacent sites.

Wetland description

Most of the soils within this site are classified as hydric and may be wetlands. Onsite delineations are required to determine if the site is officially classified as a wetland.

Soil features

The site consists of very deep, moderately well to very poorly drained, slow to impermeable soils. The floodplain soils were formed in alkaline residuum derived from shales and clays. In a representative profile, the surface layer is very dark gray clay. The subsoils are very dark gray to olive clay. Having high shrink-swell characteristics, the soils crack when dry. In this condition, they take in water rapidly. When the soils become wet and the cracks close. The soils are very fertile and hold large amounts of water for plant use. They also have a high wilting point which reduces forage yields in extremely dry years.

The associated soil series are: Aufco, Elbon, Gladewater, Kaufman, Ovan, Redlake, Roetex, Seagoville, Ships, Tinn, Trinity, and Zilaboy.

Table 5. Representative soil features

Parent material	(1) Alluvium–mudstone
Surface texture	(1) Clay (2) Silty clay
Family particle size	(1) Clayey
Drainage class	Moderately well drained to very poorly drained
Permeability class	Slow
Soil depth	203 cm
Surface fragment cover <=3"	0–1%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	12.7–17.78 cm
Calcium carbonate equivalent (0-101.6cm)	1–35%
Electrical conductivity (0-101.6cm)	0–24 mmhos/cm

Sodium adsorption ratio (0-101.6cm)	0–24
Soil reaction (1:1 water) (0-101.6cm)	7.4–8.4
Subsurface fragment volume <=3" (Depth not specified)	0–3%
Subsurface fragment volume >3" (Depth not specified)	0%

Ecological dynamics

Introduction – The Northern Blackland Prairies are a temperate grassland ecoregion contained wholly in Texas, running from the Red River in North Texas to San Antonio in the south. The region was historically a true tallgrass prairie named after the rich dark soils it was formed in. Other vegetation included deciduous bottomland woodlands along rivers and creeks.

Background – Natural vegetation on the uplands is predominantly tall warm-season perennial bunchgrasses with lesser amounts of midgrasses. This tallgrass prairie was historically dominated by big bluestem (*Andropogon gerardii*), Indiangrass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), eastern gamagrass (*Tripsacum dactyloides*), and little bluestem (*Schizachyrium scoparium*). Midgrasses such as sideoats grama (*Bouteloua curtipendula*), Virginia wildrye (*Elymus virginicus*), Florida paspalum (*Paspalum floridanum*), Texas wintergrass (*Nassella leucotricha*), hairy grama (*Bouteloua hirsuta*), and dropseeds (Sporobolus spp.) are also abundant in the region. A wide variety of forbs add to the diverse native plant community. Mottes of live oak (*Quercus virginiana*) and hackberry (Celtis spp.) trees are also native to the region. In some areas, cedar elm (*Ulmus crassifolia*), eastern red cedar (*Juniperus virginiana*), and honey locust (*Gleditsia triacanthos*) are abundant. In the Northern Blackland Prairie oaks (Quercus spp.) are common increasers, but in the Southern Blackland Prairie oaks are less prevalent. Junipers are common invaders, particularly in the northern part of the region.

During the first half of the nineteenth century, row crop agriculture lead to over 80 percent of the original vegetation lost. During the second half, urban development has caused even an even greater decline in the remaining prairie. Today, less than one percent of the original tallgrass prairie remains. The known remaining blocks of intact prairie range from 10 to 2,400 acres. Some areas are public, but many are privately owned and have conservation easements.

Current State – Much of the area is classified as prime farmland and has been converted to cropland. Most areas where native prairie remains have histories of long-term management as native hay pastures. Tallgrasses remain dominant when haying of warm-season grasses is done during the dormant season or before growing points are elevated, meadows are not cut more than once, and the cut area is deferred from grazing until frost.

Due to the current-widespread farming, the Northern Blackland Prairie is still relatively free from the invasion of brush that has occurred in other parts of Texas. In contrast, many of the more sloping have experienced heavy brush encroachment, and the continued increase of brush encroachment is a concern. The shrink-swell and soil cracking characteristics of the soils favor brush species with tolerance for soil movement.

Current Management – Rangeland and pastureland are grazed primarily by beef cattle. Horse numbers are increasing rapidly in the region, and in recent years goat numbers have increased significantly. There are some areas where dairy cattle, poultry, goats, and sheep are locally important. Whitetail deer, wild turkey, bobwhite quail, and dove are the major wildlife species, and hunting leases are a major source of income for many landowners in this area.

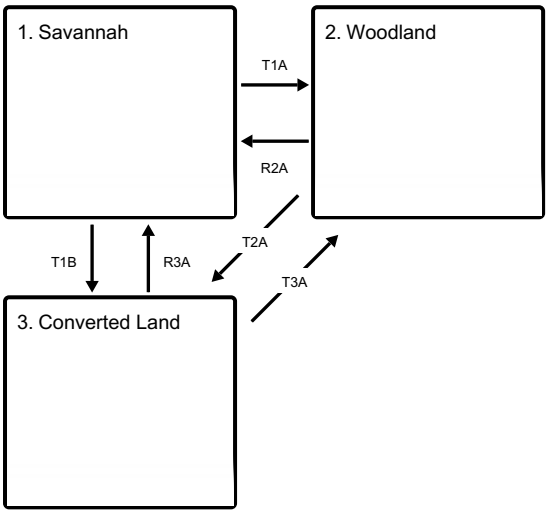
Introduced pasture has been established on many acres of old cropland and in areas with deeper soils. Coastal bermudagrass (*Cynodon dactylon*) and kleingrass (*Panicum coloratum*) are by far the most frequently used introduced grasses for forage and hay. Hay has also been harvested from a majority of the prairie remnants, where long-term mowing at the same time of year has possibly changed the relationships of the native species. Cropland is found in the valleys, bottomlands, and deeper upland soils. Wheat (Triticum spp.), oats (Avena spp.), forage and grain sorghum (Sorghum spp.), cotton (Gossypium spp.), and corn (*Zea mays*) are the major crops in the region.

Fire Regimes – The prairies were a disturbance-maintained system. Prior to European settlement (pre-1825), fire and infrequent, but intense, short-duration grazing by large herbivores (mainly bison and to a lesser extent pronghorn antelope) were important natural landscape-scale disturbances that suppressed woody species and invigorated herbaceous species (Eidson and Smeins 1999). The herbaceous prairie species adapted to fire and grazing disturbances by maintaining below-ground penetrating tissues. Wright and Bailey (1982) report that there are no reliable records of fire frequency occurring in the Great Plains grasslands because there are no trees to carry fire scars from which to estimate fire frequency. Because prairie grassland is typically of level or rolling topography, a natural fire frequency of 5 to 10 years seems reasonable.

Disturbance Regimes - Precipitation patterns are highly variable. Long-term droughts, occurring three to four times per century, cause shifts in species composition by causing die-off of seedlings, less drought-tolerant species, and some woody species. Droughts also reduce biomass production and create open space, which is colonized by opportunistic species when precipitation increases. Wet periods allow tallgrasses to increase in dominance. These natural disturbances cause shifts in the states and communities of the ecological sites.

State and transition model

Ecosystem states



T1A - No fire, no brush management, improper grazing management, drought

T1B - Brush management, crop cultivation, pasture planting, nutrient management, pest management

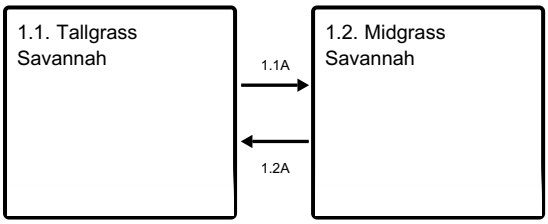
R2A - Fire, brush management, proper grazing, range planting

T2A - Brush management, crop cultivation, pasture planting, nutrient management, pest management

R3A - Fire, brush management, proper grazing, range planting

T3A - No fire, no brush management, heavy continuous grazing, no pest management

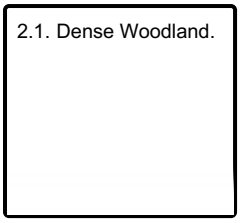
State 1 submodel, plant communities



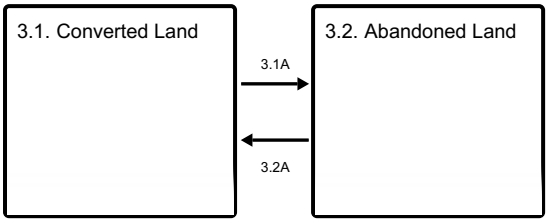
1.1A - No fire, no brush management, improper grazing management, drought

1.2A - Fire, brush management, proper grazing

State 2 submodel, plant communities



State 3 submodel, plant communities



3.1A - No fire, no brush management, heavy continuous grazing, no pest management

3.2A - Fire, brush management, proper grazing, pest management

State 1
Savannah

Two communities exist in the Savannah State: the 1.1 Tallgrass Savannah Community and the 1.2 Midgrass Savannah Community. Community 1.1 is characterized by tallgrasses dominating the understory with woody species creating less than 20 perecent of the canopy cover. Community 1.2 is characterized by midgrasses dominating the understory and woody species making up 20 to 50 perecent of the overstory canopy cover.

Community 1.1
Tallgrass Savannah

The Tallgrass Savannah Community (1.1) is the reference community and is characterized as a hardwood savannah with up to 20 percent tree and shrub canopy cover. Historic records in the 1700's do, however, indicate that early settlers and explorers found portions of this site to be heavily wooded. The Woodland Community (2.1) occurred as a stable community on portions of this ecological site. Other reports (Mann 2004) discuss the importance of human caused fire as an important factor in keeping open grasslands prior to European settlement. It is assumed the Tallgrass Savannah Community (1.1) occurred over the majority of this ecological site in a dynamically shifting mosaic over time with the other community in the Savannah State. Canopy cover drives the transitions between plant communities and states because of the influence of shade and interception of rainfall. Sedges, Virginia wildrye, and rustyseed paspalum (*Paspalum langei*) dominate the herbaceous plant community in shaded and wet areas. The herbaceous community in the drier, open areas is dominated by beaked panicum (*Panicum anceps*), switchgrass, Indiangrass, big bluestem, little bluestem, eastern gamagrass, vine mesquite (*Panicum obtusum*), and Florida paspalum. The balance of warm and cool season tallgrasses will be driven by the

amount of canopy cover from large trees, particularly the amount and size of stands with closed canopy. When the site is open and tree cover is less than 10 percent, warm season tallgrasses will approach 30 percent species composition by weight, while the cool season grasses will approach 10 percent. As tree cover approaches the upper limit of the reference community (20 percent), cool season grasses and grasslikes will approach 30 percent and warm season tallgrasses will approach 10 percent species composition by weight. Oak, elm, hackberry, cottonwood (Populus deltoids), ash (Fraxinus spp.), black willow (*Salix nigra*), pecan (Carya illinoensis), and other large trees create 20 percent canopy cover. The overstory canopy is densest adjacent to watercourses. Woody understory species include hawthorn (Crataegus spp.), greenbriar (Smilax spp.), peppervine (Ampelopsis arborea), grape (Vitis spp.), trumpet creeper (Parthenocissus spp.) and honeysuckle (Symphoricarpos spp.). Continuous, year-long grazing for a succession of years will tend to move the reference herbaceous plant community towards a herbaceous community of common Bermudagrass, dallisgrass (*Paspalum dilatatum*), carpetgrass (Axonopus affinis), giant ragweed (*Ambrosia trifida*), and annual sumpweed (*Iva annua*). The reference Savannah community will shift to the Midgrass Savannah Community (1.2) under the stresses of improper grazing. The first species to decrease in dominance will be the most palatable and/or least grazing tolerant grasses and forbs (namely, eastern gamagrass, Indiangrass, big bluestem). This will initially result in an increase in composition of little bluestem and paspalums. If improper grazing continues, little bluestem will decrease and midgrasses such as bushy bluestem (*Andropogon glomeratus*) and Vaseygrass (*Paspalum urvillei*) will increase in composition. Less palatable forbs will also increase at this stage. Without fire and/or brush control, woody species on the site will increase and the site will transition to the Woodland State. This can occur with or without the understory transitioning to the midgrass community. This transition can occur without degradation of the herbaceous community from dominance by tallgrasses to dominance by midgrasses. Unless some form of brush control takes place, woody species will increase to the 50 percent canopy cover level that indicates a state change. This is a continual process that is always in effect. Managers need to detect the increase in woody species when canopy is less than 50 percent and take management action before the state change occurs. Continuous, year-long grazing with no weed or brush management, or abandoning the site for several years, will allow shrub saplings to establish. There is not a 10-year window before shrubs begin to increase followed by a rapid transition to the Woodland State. The drivers of the transition (lack of fire and lack of brush control) constantly pressure the system towards the Woodland State. The soils of this site are deep clays. The site receives additional water from outside the site as overflow or as runoff from adjacent sites. The soils have high shrink-swell characteristics. They crack when dry and the cracks take in water rapidly. Once wet, the cracks close and permeability becomes very slow. Soils are highly fertile and hold large amounts of soil moisture. However, the soils have a high wilting point, which reduces plant production in very dry years. In very wet years the site is subject to flooding, which reduces plant production and desirability of the site for grazing. This is a very productive site with high yields of palatable, high-quality forage. There is essentially no bare ground in this community. Plant basal cover and litter comprise all of the ground cover. Multiple layer canopy cover approaches 100 percent.

Table 6. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	3363	5044	6305
Shrub/Vine	897	1345	1681
Forb	224	336	420
Total	**4484**	**6725**	**8406**

Community 1.2
Midgrass Savannah

The Midgrass Savannah Community (1.2) typically results from improper cattle grazing management over a long period of time combined with a lack of brush control. It can also be the result of abandoned cropland. Indigenous or invading woody species increase on the site. Growing season stress, usually from overgrazing, causes reduction in vigor and survival of tallgrasses, which allows midgrasses and less palatable forbs to increase in the herbaceous community. When the Midgrass Savannah Community (1.2) is continually overgrazed and fire is excluded, the community crosses a threshold to a state that is dominated by woody plants, the Dense Woodland Community (2.1). Prescribed burning is not a viable option for maintaining or returning this community to a Savannah due to the moisture content and lack of quantity of the herbaceous fine fuel. Mechanical or chemical brush control as well as prescribed grazing must be applied to move this vegetative state back towards the Tallgrass Savannah Community. Remnants of Virginia wildrye and eastern gamagrass may still occur but the herbaceous component of the community becomes dominated by lesser producing grasses and forbs. Shade tolerant species such as broadleaf woodoats (*Chasmanthium latifolium*), longleaf woodoats (*Chasmanthium sessiliflorum*), Cherokee sedge (*Carex cherokeensis*), ironweed (*Vernonia baldwinii*), buttercup (Oenothera spp.), and goldenrod (Solidago spp.) are the most abundant species as canopy cover increases. Trees and shrubs begin to replace the grassland component of the Savannah Community. In addition to the naturally occurring woody species (cedar elm, water oak (*Quercus nigra*), hackberry, pecan, cottonwood, and green ash), honey locust, Chinese tallow (Sapium sebiferum), and eastern persimmon (*Diospyros virginiana*) increase in density and canopy coverage (30 to 50 percent). Species whose seeds are windblown (elm, cottonwood, and ash) or animal dispersed (persimmon, pecan, and Chinese tallow) are the first to colonize and dominate the site. Numerous shrub and tree species will encroach because overgrazing by livestock has reduced grass cover, exposed more soil, and reduced grass fuel for fire. Typically, trees such as oaks and ash will increase in size, while other tree and shrub species such as bumelia (Sideroxylon spp.), sumacs (Rhus spp.), honey locust, winged elm (*Ulmus alata*), and osage orange (*Maclura pomifera*) will increase in density. Once the tallgrasses have been reduced on the site, woody species cover exceeds 50 percent canopy cover, and the woody plants within the grassland portion of the Savannah reach fire-resistant size (over three feet in height), the site crosses a threshold into the Dense Woodland Community (2.1) in the Woodland State (2). Brown and Archer (1999) concluded that even with a healthy and dense stand of grasses, woody species will populate the site and eventually dominate the community. Heavy continuous grazing will reduce plant cover, litter, and mulch. Bare ground will increase and expose the soil to erosion. Litter and mulch will move off-site as plant cover declines. Until the Midgrass Savannah Community (1.2) crosses the threshold into the Dense Woodland Community (2.1), this community can be managed back toward the Tallgrass Savannah Community (1.1) through the use of prescribed grazing and strategic brush control. It may take several years to achieve this state, depending upon the climate and the aggressiveness of the treatment. Once invasive woody species begin to establish, returning fully to the native community is difficult, but it is possible to return to a similar plant community. Potential exists for soils to erode to the point that irreversible damage may occur. If soil-holding herbaceous cover decreases to the point that soils are no longer stable, the shrub overstory will not prevent erosion of the A and B soil horizons. This is a critical shift in the ecology of the site. Once the A horizon has eroded, the hydrology, soil chemistry, soil microorganisms, and soil physics are altered to the point where intensive restoration is required to restore the site to another state or community. Simply changing management (improving grazing management or controlling brush) cannot create sufficient change to restore the site within a reasonable time frame.

Table 7. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	1681	2690	3363
Shrub/Vine	841	1345	1681
Forb	280	448	560
Total	**2802**	**4483**	**5604**

Pathway 1.1A
Community 1.1 to 1.2

Tallgrass Savannah **Midgrass Savannah**

The Tallgrass Savannah Community requires fire and/or brush control to maintain woody species cover below 20 percent. This community will shift to the Midgrass Savannah Community when there is continued growing-season stress on tallgrasses. These stresses include improper grazing management that creates insufficient critical growing-season deferment, excess intensity of defoliation, repeated, long-term growing-season defoliation, and long-term drought. Increaser species (midgrasses and woody species) are generally endemic species released by disturbance. Woody species canopy exceeding 20 percent and/or dominance of tallgrasses falling below 50 percent of species composition indicate a transition to the Midgrass Savannah Community. The Tallgrass Savannah Community can be maintained through the implementation of brush management combined with properly managed grazing that provides adequate growing-season deferment to allow establishment of tallgrass propagules and/or the recovery of stressed plants. Regardless of grazing management, without some form of brush control, the Tallgrass Savannah Community will transition to the Woodland State even if the understory component does not shift to dominance by midgrasses. The driver for community shift 1.1A for the herbaceous component is improper grazing management, while the driver for the woody component is lack of fire and/or brush control.

Pathway 1.2A
Community 1.2 to 1.1

Midgrass Savannah **Tallgrass Savannah**

The Midgrass Savannah Community will return to the Tallgrass Savannah Community with brush control and proper grazing management that provides sufficient critical growing season deferment in combination with proper grazing intensity. Favorable moisture conditions will facilitate or accelerate this transition. The understory component may return to dominance by tallgrasses in the absence of fire (at least until shrub canopy cover reaches 50 percent). Reduction of the woody component will require inputs of fire and/or brush control. The understory and overstory components can act independently when canopy cover is less than 50 percent, meaning, an increase in shrub canopy cover can occur while proper grazing management creates an increase in desirable herbaceous species. The driver for community shift 1.2A for the herbaceous component is proper grazing management, while the driver for the woody component is fire and/or brush control.

State 2
Woodland

Only one community is in the Woodland State, the 2.1 Dense Woodland Community. Community 2.1 is characterized by cool-season grasses and shade-tolerate dominating in the understory. Woody species occupy greater than 50 percent of the overstory.

Community 2.1
Dense Woodland.

The Dense Woodland Community (2.1) has over 50 percent woody plant canopy, dominated by hardwoods such as pecan and oaks. The community loses its savannah appearance with native shrubs beginning to fill the open grassland portion of the savannah. Shade from overstory is the driving factor. Lack of effective brush control creates this community. Annual herbage production decreases due to a decline in soil structure and organic matter. Production of the overstory canopy has increased by a similar amount to the decrease in herbaceous production. All unpalatable woody species have increased in size and density. This plant community is a closed overstory (50 to 80 percent) woodland dominated by green ash, cedar elm, overcup oak (*Quercus lyrata*), water oak, willow oak (*Quercus phellos*), pecan, cottonwood, sycamore (Plantanus occidentalis), and black willow. Understory shrubs and sub-shrubs include yaupon (*Ilex vomitoria*), farkleberry (*Vaccinium arboreum*), possumhaw (*Ilex decidua*), American beautyberry (*Callicarpa americana*), and hawthorn. Woody vines also occur and include rattan (*Berchemia scandens*), poison ivy (*Toxicodendron radicans*), grape, greenbrier, trumpet creeper, Virginia creeper (*Parthenocissus quinquefolia*), and peppervine. A herbaceous understory is almost nonexistent but shade tolerant species including longleaf uniola, broadleaf woodoats, sedges, ironweed, ice plant (*Verbesina lindheimeri*), switchcane (*Arundinaria gigantea*n), eastern gamagrass, and goldenrod may occur in small amounts. Plant vigor and productivity of grass species is reduced due to shade. Shade is a driving factor for the understory plant community. Without brush control, tree canopy will continue to increase until canopy cover approaches 100 percent. Prescribed fire is not a viable treatment option for conversion of this site back to a semblance of the wildrye-sedge Savannah. Chemical brush control on a large scale is not a treatment option; however, individual plant treatment with herbicides on small acreages may be a viable option. Mechanical treatment of this site, along with seeding, is the most viable treatment option although it is probably not economical.

Table 8. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	2242	4147	5604
Grass/Grasslike	280	448	560
Forb	280	448	560
Total	**2802**	**5043**	**6724**

State 3
Converted Land

Two communities exist in the Converted State: 3.1 Converted Land Community and the 3.2 Abandoned Land Community. The 3.1 Community is characterized by agricultural production. The site may be planted to improved pasture for hay or grazing. The site may otherwise be planted to row crops. The 3.2 community represents an agricultural state that has not been managed. The land is colonized by first successional species.

Community 3.1

Converted Land

The Converted Land Community (3.1) occurs when the site, either the Savannah State (1) or Woodland State (2), is cleared and plowed for planting to cropland, hayland, native grasses, tame pasture, or use as non-agricultural land. The Converted State includes cropland, tame pasture, hayland, rangeland, and go-back land. Agronomic practices are used with non-native forages in the Converted State and to make changes between the communities in the Converted State. The native component of the prairie is usually lost when seeding non-natives. Even when reseeding with natives, the ecological processes defining the past states of the site can be permanently changed. The Clayey Bottomland site is frequently converted to cropland or tame pasture sites because of its deep fertile soils, favorable soil/water/plant relationship, and level terrain. Hundreds of thousands of acres have been plowed up and converted to cropland, pastureland, or hayland. Small grains are the principal crop, and Bermudagrass is the primary introduced pasture species. The Clayey Bottomland site can be an extremely productive forage producing site with the application of optimum amounts of fertilizer. Cropland, pastureland, and hayland are intensively managed with annual cultivation and/or frequent use of herbicides, pesticides, and commercial fertilizers to increase production. Both crop and pasturelands require weed and shrub control because seeds remain present on the site, either by remaining in the soil or being transported to the site. Converted sites require continual fertilization for crops or tame pasture (particularly Bermudagrass) to perform well. Common introduced species include coastal Bermudagrass, kleingrass, and Old World bluestems (Bothriochloa spp.) which are used in hayland and tame pastures. Wheat, oats, forage sorghum, grain sorghum, cotton, and corn are the major crop species. Cropland and tame pasture require repeated and continual inputs of fertilizer and weed control to maintain the Converted State. Without agronomic inputs, the site will eventually return to either the Savannah or Woodland state. The site is considered go-back land during the period between active management for pasture or cropland and the return to a native state.

Community 3.2
Abandoned Land

The Abandoned Land Community (3.2) occurs when the Converted Land Community (3.1) abandoned or mismanaged. Mismanagement can include poor crop or haying management. Pastureland can transition to the Abandoned Land Community when subjected to improper grazing management (typically long-term overgrazing). Heavily disturbed soils allowed to “go-back” return to the Woodland State. These sites may become an eastern red cedar break over time. Long-term cropping can create changes in soil chemistry and structure that make restoration to the reference state very difficult and/or expensive. Return to native prairie communities in the Savannah State is more likely to be successful if soil chemistry, microorganisms, and structure are not heavily disturbed. Preservation of favorable soil microbes increases the likelihood of a return to reference (or near reference) conditions. Restoration to native prairie will require seedbed preparation and seeding of native species. Protocols and plant materials for restoring prairie communities is a developing portion of restoration science. Sites can be restored to the Savannah State in the short-term by seeding mixtures of commercially-available native grasses. With proper management (prescribed grazing, weed control, brush control) these sites can come close to the diversity and complexity of Tallgrass Savannah Community (1.1). It is unlikely that abandoned farmland will return to the Savannah State without active brush management because the rate of shrub increase will exceed the rate of recovery by desirable grass species. Without active restoration the site is not likely to return to reference conditions due to the introduction of introduced forbs and grasses. The native component of the prairie is usually lost when seeding non-natives. Even when reseeding with natives, the ecological processes defining the past states of the site can be permanently changed.

Pathway 3.1A
Community 3.1 to 3.2

The Converted Land Community (3.1) will transition to the Abandoned Land Community (3.2) if improperly managed as cropland, hayland, or pastureland. Each of these types of converted land is unstable and requires constant management input for maintenance or improvement. This community requires inputs of tillage, weed management, brush control, fertilizer, and reseeding of annual crops. The driver of this transition is the lack of management inputs necessary to maintain cropland, hayland, or pastureland.

Pathway 3.2A
Community 3.2 to 3.1

The Abandoned Land Community (3.2) will transition to the Converted Land Community (3.1) with proper management inputs. The drivers for this transition are weed control, brush control, tillage, proper grazing management, and range or pasture planting.

Transition T1A
State 1 to 2

Shrubs and trees make up a portion of the plant community in the Savannah State, hence woody propagules are present. Therefore, the Savannah State is always at risk for shrub dominance and the transition to the Woodland State in the absence of fire. The driver for Transition T1A is lack of fire and/or brush control. The mean fire return interval in the Savannah State is two to five years. Most fires will burn only the understory. Even with proper grazing and favorable climate conditions, lack of fire for 8 to 15 years will allow trees and shrubs to increase in canopy to reach the 50 percent threshold level. The introduction of aggressive woody invader species increases the risk and accelerates the rate at which this transition state is likely to occur. This transition can occur from any community within the Savannah State, it is not dependent on degradation of the herbaceous community, but on the lack of some form of brush control. Improper grazing, prolonged drought, and a warming climate will provide a competitive advantage to shrubs which will accelerate this process. Tallgrasses will decrease to less than five percent species composition.

Transition T1B
State 1 to 3

The transition to the Converted State from either the Savannah State is plowed for planting to cropland or hayland. The size and density of brush will require heavy equipment and energy-intensive practices (i.e. rootplowing, raking, rollerchopping, or heavy disking) to prepare a seedbed. The threshold for this transition is the plowing of the prairie soil and removal of the prairie plant community. The Converted State includes cropland, tame pasture, and go-back land. The site is considered “go-back land” during the period between cessation of active cropping, fertilization, and weed control and the return to the “native” states. Agronomic practices are used to convert rangeland to the Converted State and to make changes between the communities in the Converted State. The driver for these transitions is management’s decision to farm the site.

Restoration pathway R2A
State 2 to 1

Restoration of the Woodland State to the Savannah State requires substantial energy input. Mechanical or herbicidal brush control treatments can be used to remove woody species. A long-term prescribed fire program is unlikely to sufficiently reduce brush density to a level below the threshold of the Savannah State if not accompanied by some form of mechanical or chemical brush control. Brush control in combination with prescribed fire, proper grazing, and favorable growing conditions may be the most economical means of creating and maintaining the desired plant community. If remnant populations of tallgrasses, midgrasses, and desirable forbs are not present at sufficient levels, range planting will be necessary to restore the reference plant community. The driver for Restoration Pathway R2A is fire and/or brush control combined with natural restoration of the herbaceous community or active management of the herbaceous restoration process (range seeding). Restoration may require aggressive treatment of invader species.

Transition T2A
State 2 to 3

The transition to the Converted State from the Woodland State (T2A) occurs when the Savannah is plowed for planting to cropland or hayland. The size and density of brush in the Woodland State will require heavy equipment and energy-intensive practices (i.e. rootplowing, raking, rollerchopping, or heavy disking) to prepare a seedbed. The threshold for this transition is the plowing of the prairie soil and removal of the prairie plant community. The Converted State includes cropland, tame pasture, and go-back land. The site is considered “go-back land” during the period between cessation of active cropping, fertilization, and weed control and the return to the “native” states. Agronomic practices are used to convert rangeland to the Converted State and to make changes between the communities in the Converted State. The driver for these transitions is management’s decision to farm the site.

Restoration pathway R3A
State 3 to 1

Restoration from the Converted State can occur in the short-term through active restoration or over the long-term due to cessation of agronomic practices. Cropland and tame pasture require repeated and continual inputs of fertilizer and weed control to maintain the Converted State. If the soil chemistry and structure have not been overly disturbed (which is most likely to occur with tame pasture) the site can be restored to the Savannah State. Heavily disturbed soils are more likely to return to the Woodland State. Without continued disturbance from agriculture the site can eventually return to either the Savannah or Woodland state. The level of disturbance while in the converted state determines whether the site restoration pathway is likely to be R3A (a return to the Savannah State) or R3B (a return to the Woodland State). Return to native communities in the Savannah State is more likely to be successful if soil chemistry and structure are not heavily disturbed. Preservation of favorable soil microbes increases the likelihood of a return to reference (or near reference) conditions. Converted sites can be returned to the Savannah State through active restoration, including seedbed preparation and seeding of native grass and forb species. Protocols and plant materials for restoring prairie communities is a developing part of restoration science. The driver for both of these restoration pathways is the cessation of agricultural disturbances.

Transition T3A
State 3 to 2

Transition to the Woodland State (2) occurs with the cessation of agronomic practices. The site will move from the Abandoned Land Community when woody species begin to invade. After shrubs and trees have established over 50 percent, and reached a height greater than three feet, the threshold has been crossed. The driver for the change is lack of agronomic inputs, improper grazing, no brush management, and no fire.

Additional community tables

Table 9. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Tallgrasses**			1345–2522	
	Virginia wildrye	ELVI3	*Elymus virginicus*	1121–2102	–
	sedge	CAREX	*Carex*	1121–2102	–
	Canada wildrye	ELCA4	*Elymus canadensis*	897–1681	–
	beaked panicgrass	PAAN	*Panicum anceps*	560–1009	–
2	**Tallgrasses**			448–841	
	big bluestem	ANGE	*Andropogon gerardii*	448–841	–
	Florida paspalum	PAFL4	*Paspalum floridanum*	448–841	–
	switchgrass	PAVI2	*Panicum virgatum*	448–841	–
	little bluestem	SCSCS	*Schizachyrium scoparium var. scoparium*	448–841	–
	Indiangrass	SONU2	*Sorghastrum nutans*	448–841	–
	eastern gamagrass	TRDA3	*Tripsacum dactyloides*	448–841	–
3	**Tall/midgrasses**			560–1065	
	rustyseed paspalum	PALA11	*Paspalum langei*	560–1065	–
	white tridens	TRAL2	*Tridens albescens*	560–1065	–
	longspike tridens	TRST2	*Tridens strictus*	560–1065	–
4	**Other grasses**			897–1681	
	panicgrass	PANIC	*Panicum*	673–1261	–
	vine mesquite	PAOB	*Panicum obtusum*	673–1261	–
	marsh bristlegrass	SEPA10	*Setaria parviflora*	673–1261	

	marsh bristlegrass	SEPA10	*Setaria parviflora*	673–1261	–
	gaping grass	STHI3	*Steinchisma hians*	673–1261	–
	purpletop tridens	TRFL2	*Tridens flavus*	673–1261	–
	Indian woodoats	CHLA5	*Chasmanthium latifolium*	224–420	–
	longleaf woodoats	CHSE2	*Chasmanthium sessiliflorum*	224–420	–
	cylinder jointtail grass	COCY	*Coelorachis cylindrica*	224–420	–
	nimblewill	MUSC	*Muhlenbergia schreberi*	224–420	–
	Texas wintergrass	NALE3	*Nassella leucotricha*	224–420	–
Forb					
5	**Forbs**			224–420	
	partridge pea	CHFA2	*Chamaecrista fasciculata*	224–420	–
	ticktrefoil	DESMO	*Desmodium*	224–420	–
	lespedeza	LESPE	*Lespedeza*	224–420	–
	dotted blazing star	LIPU	*Liatris punctata*	224–420	–
	snoutbean	RHYNC2	*Rhynchosia*	224–420	–
	ironweed	VERNO	*Vernonia*	112–224	–
	white crownbeard	VEVI3	*Verbesina virginica*	112–224	–
	Texan great ragweed	AMTRT	*Ambrosia trifida var. texana*	112–224	–
Shrub/Vine					
6	**Shrubs/Vines/Trees**			897–1681	
	eastern cottonwood	PODE3	*Populus deltoides*	673–1261	–
	oak	QUERC	*Quercus*	673–1261	–
	black willow	SANI	*Salix nigra*	673–1261	–
	ash	FRAXI	*Fraxinus*	673–1261	–
	elm	ULMUS	*Ulmus*	673–1261	–
	hackberry	CELTI	*Celtis*	673–1261	–
	hawthorn	CRATA	*Crataegus*	224–420	–
	peppervine	AMPEL3	*Ampelopsis*	224–420	–
	Alabama supplejack	BESC	*Berchemia scandens*	224–420	–
	grape	VITIS	*Vitis*	224–420	–
	honeysuckle	LONIC	*Lonicera*	224–420	–
	saw greenbrier	SMBO2	*Smilax bona-nox*	224–420	–
	pecan	CAIL2	*Carya illinoinensis*	112–224	–

Animal community

This ecological site provides habitat which supports a resident animal community that is inhabited by white-tailed deer, turkey, and squirrels. Migratory waterfowl may use these sites if they are flooded during the late fall and winter. The riparian vegetation provides good cover for wildlife and produces browse, mast, tender grazing, and seeds for a year-round supply.

Hydrological functions

The water cycle on the Clayey Bottomland site functions best under the Tallgrass Savannah Community. When tallgrasses dominate the site infiltration is rapid, soil organic matter is high, soil structure is good, and porosity is high. The site will have high quality surface runoff with low erosion and sedimentation rates. During periods of

heavy rainfall, the high infiltration rates will allow water to transport into the aquifer. The Tallgrass Savannah Community should have no rills and no gullies present. Drainageways should be vegetated and stable. This site is often in a floodplain with occasional out-of-bank flow.

Improper grazing management reduces composition of bunchgrasses and reduces ground cover (resulting in a transition to the Midgrass Savannah Community, 1.2). This decreases the quality of the water cycle: Infiltration declines and runoff increases due to poor ground cover, rainfall splash, soil capping, low organic matter and poor structure. Combining sparse ground cover with intensive rainfall creates conditions that increase the frequency and severity of flooding. The decline in the quality of the understory component and the increase in shrub canopy cover cause soil erosion to accelerate, surface runoff quality to decline, and sedimentation to increase. Streambank stability will decline and erosion of waterways will increase.

In the Woodland State interception of rainfall by tree canopies increases. This reduces the amount of rainfall reaching the surface. Stemflow increases due to the funneling effect of the canopy, which increases soil moisture at tree bases. Trees have increased transpiration compared to grasses, especially evergreen species such as live oak and juniper. The increased transpiration reduces the amount of water available for deep percolation into aquifers. An increase in woody canopy creates a decline in grass cover, which has similar impacts as those described for improper grazing above. The return of the Woodland State to the Tallgrass Savannah Community through brush management and good grazing management can help improve the hydrologic function of the site. Under the dense canopy of a mature woodland, leaf litter builds up. This increases soil organic matter, builds structure, improves infiltration, and reduces surface erosion. These conditions improve the function of the water cycle compared to lower levels of canopy cover.

Site specific information showed that the reference community has no rills or gullies. Water flow patterns are common and follow old stream meanders. Deposition and erosion is uncommon for normal rainfall but may occur during intense rainfall events. Pedestals and terracettes are not common in the reference community. There is generally less than 20 percent bare ground which is randomly distributed throughout the site. The soil surface is resistant to erosion and the soil stability class range is expected to be 5 to 6. Under reference conditions, this Savannah site is dominated by tallgrasses and forbs, having adequate litter and little bare ground which can provide for maximum infiltration and little runoff under normal rainfall events.

When rainfall amounts are high (three to five inches per event) and intense, the site is subject to erosion along adjacent stream banks where adequate herbaceous cover is not maintained. Erosion may also occur on heavy use areas such as roads and livestock trails. Extended periods (60 days) of little to no rainfall during the growing season are common. The site may be periodically inundated from overflow water from adjacent watercourses and may be ponded or saturated for long periods. This site may be a wetland or contain wetland inclusions as oxbows or stream meanders.

Recreational uses

Recreational uses include recreational hunting, hiking, camping, equestrian, and bird watching.

Wood products

Hardwoods are used for posts, firewood, charcoal, and other specialty wood products.

Other products

Jams and jellies are made from many fruit-bearing species, such as wild grape. Seeds are harvested from many reference plants for commercial sale. Many grasses and forbs are harvested by the dried-plant industry for sale in dried flower arrangements. Honeybees are utilized to harvest honey from many flowering plants. Fruit from blackberries, grapes, and plums and nuts from pecans are harvested.

Inventory data references

These site descriptions were developed as part a Provisional Ecological Site project using historic soil survey manuscripts, available site descriptions, and low intensity field traverse sampling. Future work to validate the information is needed. This will include field activities to collect low, medium, and high-intensity sampling, soil

correlations, and analysis of that data. A final field review, peer review, quality control, and quality assurance review of the will be needed to produce the final document.

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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.

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Contact for lead author	817-596-2865
Date	01/17/2008
Approved by	Bryan Christensen
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** None.

2. **Presence of water flow patterns:** Water flow patterns are common and follow old stream meanders. Deposition or erosion is uncommon for normal rainfall but may occur during intense rainfall events.

3. **Number and height of erosional pedestals or terracettes:** Pedestals or terracettes are uncommon for this site.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Essentially none. Site has litter filling interspaces between plant bases.

5. **Number of gullies and erosion associated with gullies:** Some gullies may be present on side drains into perennial and intermittent streams. Drainageways should be vegetated and stable.

6. **Extent of wind scoured, blowouts and/or depositional areas:** None.

7. **Amount of litter movement (describe size and distance expected to travel):** This is a floodplain with an occasional out-of-bank flow. Under normal rainfall, little litter movement should be expected.

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil surface is resistant to erosion. Stability class range is expected to be 5 to 6.

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil is 0 t 53 inches thick with colors from dark reddish brown clay to very dark gray clay with generally weak very fine subangular blocky structure. SOM is approximately 1 to 6 percent. See soil survey for specific soils.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** This bottomland site is dominated by tallgrasses and forbs. Having adequate litter and little bare ground can provide for maximum infiltration and little runoff under normal rainfall events.

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** None.

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: Cool-season grasses >

    Sub-dominant: Warm-season tallgrasses >> Warm-season midgrasses > Warm-season shortgrasses > Trees >

    Other: Forbs > Shrubs/Vines

    Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** There should be little mortality or decadence for any functional groups in reference community.

14. **Average percent litter cover (%) and depth (in):** Litter is primarily herbaceous.

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** 4,000 pounds per acre for below average moisture years to 7,500 pounds per acre for above average moisture years.

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:** Potential invasives include yellow bluestems, Bermudagrass, mesquite, elm, huisache, eastern red cedar, osage orange, and Chinese tallow.

17. **Perennial plant reproductive capability:** All perennial plants should be capable of reproducing, except during periods

of prolonged drought conditions, heavy natural herbivory, prolonged flooding, and intense wildfires.