Ecological site R086AY006TX
Northern Clay Loam

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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 Clay Loam ecological site is a true tallgrass prairie, dominated by little bluestem. The soils are shallow to deep and characterized by their clay loam texture.

Associated sites

R086AY001TX	**Northern Chalky Ridge** The Chalky Ridge site is often upslope from the Clay Loam site. It differs from the Clay Loam site by having shallow soils and low soil fertility.
R086AY003TX	**Northern Claypan Prairie** The Claypan Prairie site is often adjacent to the Clay Loam site. It differs from the Clay Loam site by only occurring along major rivers and their tributaries and having a fine sandy loam soil surface layer.
R086AY012TX	**Loamy Bottomland** The Northern Clay Loam site is often upslope from the Loamy Bottomland site. It differs from the Loamy Bottomland site by occurring in uplands, plains, and terraces and lacking thin stratas of varying textured soils in the soil profile from flooding events.
R086AY013TX	**Clayey Bottomland** 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.

Similar sites

R086AY005TX	**Sandy Loam** Sites have lighter textured soils.
R086BY003TX	**Clay Loam** Similar but different MLRA.
R086AY007TX	**Southern Clay Loam** The Southern Clay Loam site is similar to the Northern Clay Loam site by having similar physiographic features and representative soil features. It differs from the Southern Clay Loam site by receiving more effective precipitation.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Schizachyrium scoparium* (2) *Sorghastrum nutans*

Physiographic features

The site consists of nearly level to moderately sloping soils with very low to medium runoff, with slopes ranging from 0 to 9 percent. The Clay Loam can be found on fluvial terraces and piedmont alluvial plains below limestone hills. The soils formed in alluvium high in calcium carbonate.

Table 2. Representative physiographic features

Landforms	(1) Plains > Terrace
Runoff class	Very low to medium
Flooding frequency	None
Ponding frequency	None
Elevation	131–579 m
Slope	0–9%
Aspect	Aspect is not a significant factor

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 3. Representative climatic features

Frost-free period (average)	231 days
Freeze-free period (average)	257 days
Precipitation total (average)	1,092 mm

Climate stations used

- (1) CORSICANA [USC00412019], Corsicana, TX
- (2) GREENVILLE KGVL RADIO [USC00413734], Greenville, TX
- (3) NAVARRO MILLS DAM [USC00416210], Frost, TX
- (4) HILLSBORO [USC00414182], Hillsboro, TX
- (5) SULPHUR SPRINGS [USC00418743], Sulphur Springs, TX
- (6) LAKE TAWAKONI [USC00414980], Point, TX
- (7) RICHARDSON [USC00417588], Plano, TX
- (8) DALLAS FT WORTH AP [USW00003927], Dallas, TX
- (9) JOE POOL LAKE [USC00414597], Dallas, TX
- (10) KAUFMAN 3 SE [USC00414705], Kaufman, TX
- (11) LAVON DAM [USC00415094], Wylie, TX
- (12) MCKINNEY [USC00415766], McKinney, TX
- (13) WAXAHACHIE [USC00419522], Waxahachie, TX
- (14) WILLS POINT [USC00419800], Wills Point, TX

Influencing water features

This site is not influenced by water from streams.

Wetland description

Wetlands are not associated with this site.

Soil features

The soils are shallow to very deep, well drained soils that have moderate to slow permeability. The the parent material is calcareous alluvium weathered from limestone hills. In a representative profile, the surface layer is dark grayish-brown, calcareous clay loam about 10 to 18 inches thick over a brown calcareous clay loam subsoil. Depth to bedrock ranges from 22 to more than 60 inches below the surface. The available water capacity is low to moderate.

The following dominant soil series are: Altoga, Austin, Engle, Lamar, and Lewisville.

Table 4. Representative soil features

Parent material	(1) Alluvium (2) Residuum–chalk
Surface texture	(1) Clay loam (2) Silty clay
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Moderate to slow
Soil depth	51–203 cm
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-101.6cm)	3.05–7.62 cm
Calcium carbonate equivalent (0-101.6cm)	0–68%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	6.6–8.4
Subsurface fragment volume <=3" (Depth not specified)	2–20%
Subsurface fragment volume >3" (Depth not specified)	0–11%

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.

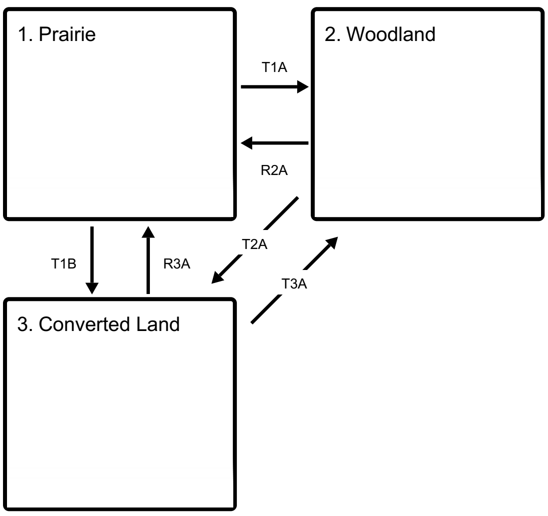
Introduced pasture has been established on many acres of old cropland and in areas with deeper soils. Coastal bermudagrass (*Cynodon dactylon*) and kleingrass (*Panicum coloratum*) are by far the most frequently used introduced grasses for forage and hay. Hay has also been harvested from a majority of 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

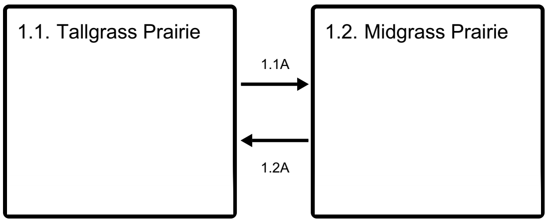
R2A - Fire, brush management, proper grazing, range planting

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

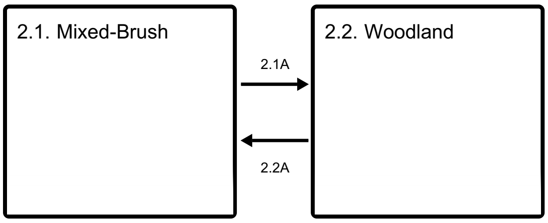
State 1 submodel, plant communities



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

1.2A - Fire, brush management, proper grazing

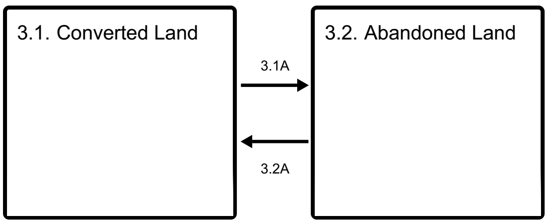
State 2 submodel, plant communities



2.1A - No fire, no brush management, improper grazing management, drought

2.2A - Fire, brush management, proper grazing

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
Prairie

Two communities exist in the Prairie State: the 1.1 Tallgrass Prairie Community and the 1.2 Midgrass Prairie Community. Community 1.1 is characterized by tallgrasses comprising more than 50 percent of the composition. The site is colonized by less than 10 percent woody plants and ranges from 4,000 to 6,500 pounds per acre of biomass. Community 1.2 is characterized by a decrease in tallgrass abundance and an increase in midgrasses. The woody canopy cover has increased from 10 to 20 percent, with some attaining heights of three feet.

Community 1.1
Tallgrass Prairie

The Tallgrass Prairie Community (1.1) reference community is a true prairie with a few large post oak (*Quercus stellata*), elm (Ulmus spp.), and hackberry trees along the draws and in occasional mottes. It is characterized by deeper soils dominated by warm-season, perennial tallgrasses, with warm-season, perennial midgrasses filling most of the remaining species composition. The warm-season, perennial forb component varies between 5 and 15 percent depending on climatic patterns and local precipitation. Woody species make up a minor component of the community, 5 percent by weight, even in the short-term absence of fire (two to five years). Little bluestem (up to 50 percent of production), Indiangrass and big bluestem (up to 30 percent) dominate the site. Other important grasses include switchgrass, eastern gamagrass, Canada wildrye (*Elymus canadensis*), sideoats grama, silver bluestem (*Bothriochloa laguroides*), Texas wintergrass, and Florida paspalum. Forbs commonly found on the site include Engelmann's daisy (*Engelmannia peristenia*), Maximilian sunflower, blacksamson (*Echinacea angustifolia*), halfshrub sundrop (*Calylophus serrulatus*), sensitive-briar (Mimosa spp.), and yellow neptunia (*Neptunia lutea*). Typical, but infrequent, shrub and tree species found in the reference community (1.1) include species of oak, hackberry, pecan (*Carya illinoinensis*), and elm, along with bumelia (Sideroxylon spp.) and coralberry (*Symphoricarpos orbiculatus*). The reference prairie community will transition to a midgrass-dominated community under the stresses of improper grazing management. The first species to decrease in dominance will be the most palatable and/or least grazing tolerant grasses and forbs (i.e. eastern gamagrass, switchgrass, Indiangrass, big bluestem, and Engelmann's daisy). This will initially result in an increase in composition of little bluestem and sideoats grama. If improper grazing management continues, little bluestem and Florida paspalum will decrease and midgrasses such as silver bluestem and Texas wintergrass will increase in composition. Less palatable forbs will increase at this stage. Because the woody species that dominate in the Woodland State are native species that occur as part of the Prairie State, the transition to the Woodland State is a linear process with shrubs and trees starting to increase soon after fire or brush control. Unless some form of brush control takes place, woody species will increase to greater than 20 percent canopy cover, which indicates a state change. This is a continual process that is always in effect. Managers need to detect the increase in woody species when there is less than 20 percent of canopy cover, so they can take appropriate management actions before the state-change occurs. 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. Canopy stem diameter drives the transitions between community and states because of the influence of shade and interception of rainfall. Species composition by weight remains an important descriptor of the herbaceous community and of the community as a whole. This plant community has very little bare ground. Plant basal cover and litter make up almost 100-percent ground cover. Soils are fertile with good permeability and produce abundant high quality palatable forage.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	4035	5548	6557
Forb	224	308	364
Shrub/Vine	224	308	364
Total	**4483**	**6164**	**7285**

Community 1.2
Midgrass Prairie

The Midgrass Prairie Community (1.2) is the result of long-term improper cattle grazing management. Tallgrasses in the reference community decrease in vigor and production, allowing midgrasses and forbs to increase to the point that they make up more than 50 percent of species composition. Indigenous or invading woody species may increase on the site depending on fire and brush control methods. In the Tallgrass Prairie Community (1.1), repeated fires and competition from a vigorous grass component keep woody canopy cover low. When the Midgrass Prairie 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 Mixed-Brush Community (2.1). Important grasses include little bluestem, sideoats grama, silver bluestem, Texas wintergrass, and low panicums. Some of the reference community perennial forbs persist, but less palatable forbs will increase. There might be 10 to 20 percent woody canopy cover depending on the type of grazing animal, fire interval, brush control, and/or availability of increaser shrub species. 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 oak, mesquite (*Prosopis glandulosa*), elm, and hackberry will increase in size, while other woody species such as bumelia, coralberry, honey locust, elbowbush (*Forestiera pubescens*), and sumac (Rhus spp.) species will increase in density. Aggressive, introduced pasture species may begin to invade the Midgrass Prairie Community, particularly if they have been seeded in nearby pastures. These include introduced paspalums, such as bahiagrass (*Paspalum notatum*), Old World bluestems (Bothriochloa spp.), and Bermudagrass. Heavy continuous grazing will reduce plant cover, litter, and mulch. Bare ground will increase and expose the soil to crusting and erosion. Some mulch and litter movement may occur during rainstorms, but little soil movement occurs due to gentle slopes in this vegetation type. Litter and mulch will move off site as plant cover declines. Increasing woody dominants are oak, mesquite, hackberry, elm, and juniper. Once shrubs reach a height of about three feet, they become more resistant to being killed by fires. When woody species exceed 20 percent canopy the site crosses a threshold (T1A) into the Woodland State (2) and the Mixed-Brush Community (2.1). Until the Midgrass Prairie Community (1.2) crosses the threshold into the Mixed-Brush Community (2.1), this community can be managed back toward the reference community (1.1) through the use of prescribed grazing, prescribed burning, and strategic brush control. It may take several years to achieve this state, depending upon climate and the aggressiveness of management. Once woody species begin to establish, returning fully to reference conditions is difficult, but it is possible to return to a similar plant community. If improper grazing management continues but shrubs and trees are held in check through fire, brush control, browsing, or mowing, the Midgrass Prairie Community will continue to degrade. Tallgrasses will continue to decrease in species composition, and midgrasses will begin to decrease. Grazing-resistant shortgrasses, annuals, and forbs will represent more of species composition. These species may increase in relative composition due to the loss of tall and midgrasses. The site will have reduced production and poor ecological processes. Brush control in this community will be more cost effective than after the transition has been made to the Woodland State.

Table 6. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	2746	3531	4511
Shrub/Vine	785	1009	1289
Forb	392	504	644
Total	**3923**	**5044**	**6444**

Pathway 1.1A
Community 1.1 to 1.2

The Tallgrass Prairie Community (1.1) will shift to the Midgrass Prairie Community (1.2) when there is continued growing season stress on reference grass species. These stresses include improper grazing management that creates insufficient critical growing season deferment, excess intensity of defoliation, repeated, long-term growing season defoliation, long-term drought, and/or other repeated critical growing season stress. Increaser species (midgrasses and woody species) are generally endemic species released by disturbance. Woody canopy cover increasing to greater than 10 percent indicates a transition to the Midgrass Prairie Community. The reference community can be maintained through 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 vigor of stressed plants. 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

The Midgrass Prairie Community (1.2) will return to the Tallgrass Prairie Community (1.1) with a combination of brush control and 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 or brush control. However, reduction of the woody component to less than 10 percent canopy will require inputs of fire or brush control. The understory and overstory components can act independently when there is less than 10 percent canopy cover 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

The Woodland State has two communities: 2.1 Mixed-Brush Community and 2.2 Woodland Community. The 2.1 community has a woody species overstory canopy of 20 to 40 percent and the 2.2 community over 40 percent. As tree and brush canopy increases, the herbaceous understory production decreases due to lack of light availability.

Community 2.1
Mixed-Brush

The Mixed-Brush Community (2.1) presents 20 to 40 percent canopy cover of oak, mesquite, hackberry, elm, or juniper as dominant woody species. This community can occur as a result of continuous improper grazing management combined with lack of fire or brush control. It can also occur where there has been proper grazing management without brush control or fire. Improper grazing management speeds the process. Although it is rarely found, it is possible for the herbaceous component to include substantial production from tallgrasses. Palatable woody species tend to decrease and unpalatable woody species tend to increase, particularly where there is heavy browsing from deer or goats. Honey mesquite is an early invader throughout the MLRA, particularly where there is heavy browsing from deer or goats. Ashe juniper (*Juniperus ashei*) invaded from the south, and eastern redcedar is found more frequently in the northern portion of the MLRA. Many of the Tallgrass Community shrubs are still present. Sideoats grama and other reference (1.1) midgrasses decrease, but still remain the dominant component of composition, while shortgrasses such as buffalograss (*Bouteloua dactyloides*) increase. Remnants of reference grasses and forbs along with unpalatable invaders occupy the interspaces between shrubs. Cool-season species such as Texas wintergrass and sedges (Carex spp.), plus other grazing-resistant reference species, can be found under and around woody plants. Plant vigor and productivity of the grassland component is reduced due to grazing pressure and competition for sunlight, nutrients, and water from woody plants. Common herbaceous species include threeawns (Aristida spp.), dropseeds, and dotted gayfeather (*Liatris punctata*). Tumblegrass (*Schedonnardus paniculatus*), Texas grama (*Bouteloua rigidiseta*), western ragweed (*Ambrosia psilostachya*), broomweed (*Amphiachyris dracunculoides*), nightshades (Solanum spp.), curlycup gumweed (*Grindelia squarrosa*), and annual species are persistent increasers until shrub density reaches maximum canopy. This community can be dominated by a mix of forbs and shrubs when there is continued growing season stress on reference and midgrass species. This transition usually results from heavy, long-term continuous grazing and is often associated with farm lots and horse pastures. Invasive species often dominate the site, including invasive forbs, shrubs, and grasses. As the grassland vegetation declines, more soil is exposed, leading to crusting and erosion. In this vegetation type, erosion can be severe. Higher rainfall interception losses by the increasing woody canopy combined with evaporation and runoff can reduce the effectiveness of rainfall. Soil organic matter and soil structure decline within the interspaces, but soil conditions improve under the woody plant cover. Some soil loss can occur during rainfall events. In this plant community, annual production is balanced between herbaceous plants and woody species, with herbaceous production still the dominant component of annual production. Browsing animals such as goats and deer can find fair food value if browse plants have not been grazed excessively. Forage quantity and quality for cattle is low. Unless brush management and good grazing management are applied at this stage, woody species will exceed 40 percent canopy cover, causing the community to convert to the Woodland Community (2.2). Grazing management alone will not allow the site to move back to the Tallgrass Community. Extensive brush management and range planting may be needed to manage the site towards the Prairie State. Soil erosion may prevent the site from recovering. Brush control and range planting can help restore fuel loads to provide the option of reintroducing prescribed fire into the ecosystem. Without fire, the manager will need to be diligent in the use of individual plant treatment of woody species.

Table 7. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	1401	1961	2522
Grass/Grasslike	841	1177	1513
Forb	560	785	1009
Total	**2802**	**3923**	**5044**

Community 2.2
Woodland

The Woodland Community (2.2) has greater than 40 percent canopy cover and is the result of many years of improper grazing, lack of periodic fires, and/or a lack of proper brush management. Reference woody species or increasers, such as juniper, dominate the Woodland Community (2.2). The site can now have the appearance of a dense woodland. Common understory shrubs are pricklypear (Opuntia spp.) and sumac. Woody shrubs seem to increase more rapidly in the southern portion of the MLRA. Remnant midgrasses and opportunistic shortgrasses, annuals, and perennial forbs occupy the woody plant interspaces. Characteristic grasses are curly-mesquite (*Hilaria belangeri*), buffalograss, and tumblegrass. Texas wintergrass and annuals are found in and around tree/shrub cover. Grasses and forbs make up 50 percent or less of the annual herbage production. Common forbs include dotted gayfeather, halfshrub sundrop, croton (Croton spp.), western ragweed, verbena (Verbena spp.), snow-on-the-prairie, Mexican sagewort (*Artemisia ludoviciana* ssp. mexicana), and sensitive-briar. The shrub canopy acts to intercept rainfall and increase evapotranspiration losses, creating a more xeric microclimate. Soil fauna and organic mulch are reduced, exposing more of the soil surface to erosion in interspaces. The exposed soil crusts readily. However, within the woody canopy, hydrologic processes stabilize and soil organic matter and mulch begin to increase and eventually stabilize under the shrub canopy. The Woodland Community (2.2) can provide good cover habitat for wildlife, but only limited forage or browse is available for livestock or wildlife. At this stage, highly intensive restoration practices are needed to return the Woodland to grassland. Alternatives for restoration include brush control and range planting with proper stocking, prescribed grazing, and prescribed burning following restoration to maintain the desired community.

Table 8. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Shrub/Vine	2186	3026	3867
Grass/Grasslike	897	1261	1569
Forb	560	757	1009
Total	**3643**	**5044**	**6445**

Pathway 2.1A
Community 2.1 to 2.2

Without some form of brush control, woody density and canopy cover will increase in the Mixed-Brush Community (2.1) until it converts into the Woodland Community (2.2). Improper grazing management and/or long-term drought (or other growing season stress) will accelerate this transition. A canopy cover greater than 40 percent indicates this transition. Herbaceous understory will shift to cool-season and/or shade-tolerant species. Improper grazing or other long-term growing season stress can increase the composition of less productive grasses and low-growing (or unpalatable) forbs in the herbaceous component. Even with proper grazing, in the absence of fire the woody component will increase to the point that the herbaceous component will decline in production and shift in composition toward sedges, grasses, and forbs suited to growing in shaded conditions with reduced available soil moisture. The driver for community shift 2.1A is lack of fire and/or brush control.

Pathway 2.2A
Community 2.2 to 2.1

Brush management and/or fire can reduce the woody component of the Woodland Community (2.2) to below the transition level of 40 percent canopy cover. Continued fire and/or brush management will be required to maintain control of the wood species. It may be difficult to shift back to the Mixed-Brush Community (2.1) with fire alone. Once woody species become tall enough to not be killed by understory fires, fire is likely to only remove small woody plants. This will increase the savannah effect and leave the site in the Woodland Community. It will be dominated by large trees over an herbaceous understory. This is amplified if the understory transitions to cool-season grasses, which reduce opportunity for prescribed fire. If the woody component has been invaded by juniper, fire remains an option to create transition 2.2A. If the herbaceous component has transitioned to shortgrasses and low forbs, proper grazing management (combined with favorable moisture conditions and adequate seed source) will be necessary to facilitate the shift of the understory component in the Mixed-Brush Plant Community (2.2) to the midgrass-dominated Mixed-Brush Plant Community (2.1). Transition 2.2A is difficult to create with management. Due to the large size of trees present, brush control may require selective removal of large trees along with brush. Range planting may accelerate the transition of the herbaceous community, particularly when combined with favorable growing conditions. Range planting is more commonly associated with restoration efforts associated with Restoration Pathway R2A. The driver for community shift 2.2A is fire and/or brush control.

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 Prairie State (1) or Shrubland 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 Clay Loam 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 on loamy soils in this area. The Clay Loam 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 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 Prairie or Shrubland 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 left alone will eventually “go-back” to the Shrubland State. These sites may become an eastern red cedar brake 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 Clay Loam 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 conditions. Restoration to native prairie will require seedbed preparation and seeding of native species. Protocols and plant materials for restoring prairie communities are a developing portion of restoration science. Sites can be restored to the Prairie 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 Prairie Community (1.1). It is unlikely that abandoned farmland will return to the Prairie 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 make up a portion of the plant community in the Prairie State, hence woody propagules are present. Therefore, the Prairie State is always at risk for shrub dominance and the transition to the Shrubland State in the absence of fire. The driver for Transition T1A is lack of fire and/or brush control. Maintenance of the Prairie State will require prescribed fire every three to five years. Even with proper grazing and favorable climate conditions, lack of fire or brush control for 10 to 15 years will allow woody species to increase in canopy to reach the 35 percent threshold level. Improper grazing management, prolonged drought, and a warming climate will provide disturbance conditions which will accelerate this process. Introduction of aggressive woody invader species (i.e. juniper) also increase the risk and accelerate the rate at which this transition state is likely to occur. This transition can occur from any of the Prairie State Communities.

Transition T1B
State 1 to 3

The transition to the Converted State from the Grassland State occurs when the prairie is plowed for planting to cropland or hayland. 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 States 1 or 2. 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 Shrubland State to the Prairie State requires substantial energy input. Mechanical or herbicidal brush control treatments can be used to remove woody species. A long-term prescribed fire program may sufficiently reduce brush density to a level below the threshold of the Prairie State, particularly if the woody component is dominated by species that are not re-sprouters following top removal. However, fire may not be sufficient to remove mature trees. A mixed program consisting of mechanical, chemical, and fire measures may be used. Brush control in combination with prescribed fire, proper grazing management, and favorable growing conditions may be the most economical means of creating and maintaining the desired plant community. Proper grazing management will be required to promote recovery of the understory towards a tallgrass community. If remnant populations of tallgrasses, midgrasses, and desirable forbs are not present at sufficient levels, range planting will be necessary to restore the prairie plant community. Depending on the understory community and inputs of seed, the restoration pathway can result in return to any of the Prairie State Communities.

Transition T2A
State 2 to 3

The transition to the Converted State from either the Grassland State (T1B) or Shrubland State (T2A) occurs when the prairie is plowed for planting to cropland or hayland. The size and density of brush in the Shrubland State will require heavy equipment and energy-intensive practices (e.g. 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 Prairie 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 Prairie 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 Prairie State) or T3A (a return to the Woodland State). Return to native prairie communities in the Prairie 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 conditions. Converted sites can be returned to the Prairie State through active restoration, including seedbed preparation and seeding of native grass and forb species. Protocols and plant materials for restoring prairie communities are 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 20 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**			2018–3278	
	little bluestem	SCSCS	*Schizachyrium scoparium var. scoparium*	2018–3278	–
2	**Tallgrasses**			1121–1821	
	Indiangrass	SONU2	*Sorghastrum nutans*	1121–1821	–
	eastern gamagrass	TRDA3	*Tripsacum dactyloides*	897–1681	–
	big bluestem	ANGE	*Andropogon gerardii*	897–1681	–
	switchgrass	PAVI2	*Panicum virgatum*	448–841	–
3	**Midgrasses**			673–1093	
	sideoats grama	BOCU	*Bouteloua curtipendula*	336–560	–
	Florida paspalum	PAFL4	*Paspalum floridanum*	336–560	–
	Canada wildrye	ELCA4	*Elymus canadensis*	336–560	–
	Texas wintergrass	NALE3	*Nassella leucotricha*	224–448	–
	composite dropseed	SPCOC2	*Sporobolus compositus var. compositus*	224–448	–
	silver beardgrass	BOLAT	*Bothriochloa laguroides ssp. torreyana*	224–448	–
4	**Mid/Shortgrasses**			224–364	
	purpletop tridens	TRFL2	*Tridens flavus*	168–280	–
	longspike tridens	TRST2	*Tridens strictus*	168–280	–
	fall witchgrass	DICO6	*Digitaria cognata*	112–224	–
	mourning lovegrass	ERLU	*Eragrostis lugens*	112–224	–
	buffalograss	BODA2	*Bouteloua dactyloides*	112–224	–
	sedge	CAREX	*Carex*	56–112	–
	panicgrass	PANIC	*Panicum*	56–112	–
Forb					
5	**Forbs**			224–364	
	Engelmann's daisy	ENPE4	*Engelmannia peristenia*	224–364	–
	Maximilian sunflower	HEMA2	*Helianthus maximiliani*	224–364	–
	coastal indigo	INMI	*Indigofera miniata*	112–196	–
	dotted blazing star	LIPU	*Liatris punctata*	112–196	–
	sensitive plant	MIMOS	*Mimosa*	112–196	–
	yellow puff	NELU2	*Neptunia lutea*	112–196	–
	beardtongue	PENST	*Penstemon*	112–196	–
	woolly plantain	PLPA2	*Plantago patagonica*	112–196	–
	prairie parsley	POLYT	*Polytaenia*	112–196	–
	scurfpea	PSORA2	*Psoralidium*	112–196	–
	snoutbean	RHYNC2	*Rhynchosia*	112–196	–
	fuzzybean	STROP	*Strophostyles*	112–196	–
	vetch	VICIA	*Vicia*	112–196	–
	snow on the prairie	EUBI2	*Euphorbia bicolor*	112–196	–

	Cuman ragweed	AMPS	*Ambrosia psilostachya*	112–196	–
	yellow sundrops	CASE12	*Calylophus serrulatus*	112–196	–
	partridge pea	CHFA2	*Chamaecrista fasciculata*	112–196	–
	prairie clover	DALEA	*Dalea*	112–196	–
	bundleflower	DESMA	*Desmanthus*	112–196	–
	ticktrefoil	DESMO	*Desmodium*	112–196	–
	blacksamson echinacea	ECAN2	*Echinacea angustifolia*	112–196	–
Shrub/Vine					
6	**Shrubs/Vines/Trees**			224–364	
	pecan	CAIL2	*Carya illinoinensis*	224–364	–
	hackberry	CELTI	*Celtis*	224–364	–
	oak	QUERC	*Quercus*	224–364	–
	elm	ULMUS	*Ulmus*	224–364	–
	sumac	RHUS	*Rhus*	112–196	–
	bully	SIDER2	*Sideroxylon*	112–196	–
	western snowberry	SYOC	*Symphoricarpos occidentalis*	112–196	–
	stretchberry	FOPU2	*Forestiera pubescens*	112–196	–

Animal community

The animal community differs depending on what state the site is currently in. Northern Bobwhite prefer the reference state. They require dense bunchgrasses for nesting and cover. As the site transitions into State 2, white-tailed deer will become more prevalent. Deer are woodland and edge species, with their primary diet consisting of browse. Mourning dove need open areas with semi-clear ground and forbs with desirable seed sources. Go-back land and communities with shortgrasses and forbs provide the best habitat for dove.

Hydrological functions

Site-specific information showed that this site has no rills and that no gullies are present on side drains into perennial and intermittent streams. Drainageways are vegetated and stable. 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. Pedestals or terracettes are uncommon for this site. Expect no more than 20 percent bare ground randomly distributed throughout. This site has slowly permeable soils. Under normal rainfall, little litter movement should be expected, however, litter of all sizes may move long distances. Soil surface under reference conditions is resistant to erosion. Soil stability class range is expected to be 4 to 5. This prairie site is dominated by tallgrasses, forbs, and trees. Adequate litter and little bare ground can provide for maximum infiltration and little runoff under normal rainfall events.

Recreational uses

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

Wood products

Eastern red cedar and some oak are used for posts, firewood, charcoal, and other specialty wood products.

Other products

Jams and jellies are made from fruit bearing-species. Seeds are harvested from reference community plants for commercial sale. Grasses and forbs are harvested by the dried-plant industry for sale in dried flower arrangements. Honeybees are utilized to harvest honey from flowering plants.

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.

Author(s)/participant(s)	Lem Creswell, RMS, NRCS, Weatherford, Texas
Contact for lead author	817-596-2685
Date	07/23/2008
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 would have been uncommon for this site when occupied by the reference community.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Expect no more than 20 percent bare ground randomly distributed throughout.

5. **Number of gullies and erosion associated with gullies:** No gullies should 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 site has slowly permeable soils. Under normal rainfall, little litter movement should be expected, however, litter of all sizes may move long distances due to obstructions.

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 4 to 5.

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil surface structure is less than 13 inches thick with colors from dark brown clay loam to very dark gray clay loam and generally weak medium subangular blocky structure. SOM is approximately 1 to 3 percent.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** This savannah site is dominated by tallgrasses and forbs and trees 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: Warm-season tallgrasses >>

    Sub-dominant: Warm-season midgrasses > Cool-season grasses >

    Other: Forbs > Trees > 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 the reference community.

14. **Average percent litter cover (%) and depth (in):** Litter is dominantly 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 year to 6,500 pounds per acre for above average moisture year.

16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that**

become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site: Several potential invasive species include yellow bluestems, Bermudagrass, mesquite, elm, huisache, eastern red cedar, osage orange, and Chinese tallow.

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17. **Perennial plant reproductive capability:** All perennial plants should be capable of reproducing except during periods of prolonged drough conditions, heavy natural herbivory and intense wildfire.
