Ecological site R082AY373TX
Sandy Loam 25-32 PZ

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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.

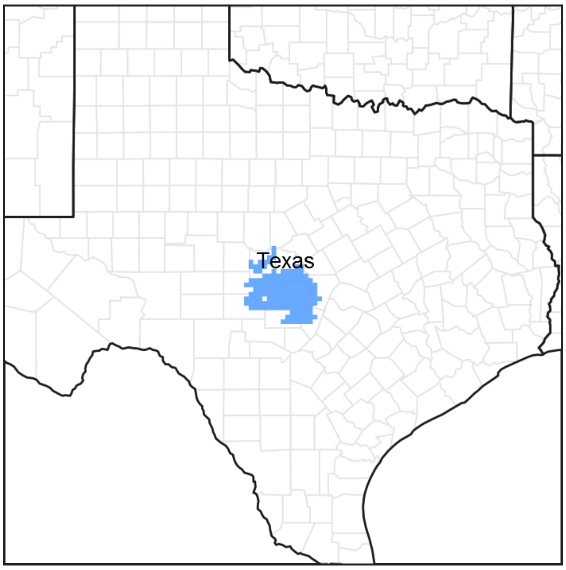


Figure 1. Mapped extent

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): 082A–Texas Central Basin

The 82A MLRA is underlain primarily by igneous, metamorphic, and sedimentary rocks. Igneous and metamorphic outcrops include the Valley Spring Gneiss, Packsaddle Schist, and Town Mountain Granite of Precambrian age. Sedimentary rocks include the Hickory Sandstone and Lion Mountain Sandstone of Cambrian Age and the Hensel Sand of Cretaceous age. Holocene alluvium is on flood plains.

Classification relationships

Major Land Resource Area (MLRA) and Land Resource Unit (LRU) (USDA-Natural Resources Conservation Service, 2006)

Ecological site concept

These soils are on nearly level to gently sloping uplands. Slopes range from 0 to 12 percent. This site consists of very deep, deep, and moderately deep well drained, slowly to moderately permeable soils developed from loamy calcareous materials or clayey mantle over sandstone. This site contains four vegetative States: the Savannah, Shrubland, Converted, and Eroded States. The reference vegetation is a Midgrass Savannah with scattered oak mottes, forbs and shrubs.

Associated sites

R082AY367TX	**Loamy Bottomland 25-32 PZ** The Loamy Bottomland site is lower in the landscape on floodplains.
R082AY371TX	**Sandstone Hill 25-32 PZ** The Sandstone Hill site is typically shallower and has more fragments.
R082AY366TX	**Granite Hill 25-32 PZ** The Granite Hill site is shallow and developed from granite.
R082AY378TX	**Tight Sandy Loam 25-32 PZ** The Tight Sandy Loam site has an argillic that is more dense that restricts water movement and root growth.

Similar sites

R082AY568TX	**Red Savannah 25-32 PZ** Red Savannah exhibits similar vegetative communities and ecological dynamics; it tends to have slightly fewer oaks. The Red Savannah site has moderately deep soils.
R082AY369TX	**Red Sandy Loam 25-32 PZ** The reference plant community has a few more larger trees, liveoak and post oak. The soils are moderately deep.
R082AY372TX	**Sandy 25-32 PZ** The Sandy site has a sandier surface that is 20 to 40 inches thick.
R082AY367TX	**Loamy Bottomland 25-32 PZ** The Loamy Bottomland site has the potential of flooding.
R082AY378TX	**Tight Sandy Loam 25-32 PZ** The Tight Sandy Loam site has an argillic that is more dense that restricts water movement and root growth.

Table 1. Dominant plant species

Tree	(1) *Quercus virginiana* (2) *Quercus stellata*
Shrub	Not specified
Herbaceous	(1) *Schizachyrium scoparium* (2) *Bouteloua curtipendula*

Physiographic features

These soils are on nearly level to gently sloping uplands. Slopes range from 0 to 12 percent. Elevation ranges from 830 to 2,000 feet. Runoff is low to medium.

Table 2. Representative physiographic features

Landforms	(1) Plateau > Ridge (2) Hills > Plain (3) River valley > Stream terrace
Runoff class	Low to medium
Flooding frequency	None
Ponding frequency	None
Elevation	830–2,000 ft
Slope	1–5%
Aspect	Aspect is not a significant factor

Table 3. Representative physiographic features (actual ranges)

Runoff class	Low to high
Flooding frequency	Not specified
Ponding frequency	Not specified
Elevation	Not specified
Slope	0–12%

Climatic features

The climate for MLRA 82A is humid subtropical and is characterized by hot summers and relatively mild winters. The average first frost should occur around November 11 and the last freeze of the season should occur around March 21.

The average relative humidity in mid-afternoon is about 50 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible during the summer and 50 percent in winter. The prevailing wind direction is from the south.

Approximately two-thirds of the annual rainfall occurs during the April to September period. Rainfall during this period generally falls as thunderstorms, and fairly large amounts of rain may fall in localized areas for a short period of time.

Table 4. Representative climatic features

Frost-free period (characteristic range)	210-240 days
Freeze-free period (characteristic range)	240-280 days
Precipitation total (characteristic range)	25-32 in
Frost-free period (actual range)	210-240 days
Freeze-free period (actual range)	240-280 days
Precipitation total (actual range)	25-32 in
Frost-free period (average)	225 days
Freeze-free period (average)	260 days
Precipitation total (average)	28 in

Climate stations used

- (1) LLANO [USC00415272], Llano, TX
- (2) MASON [USC00415650], Mason, TX

Influencing water features

These upland sites may shed some water via runoff during heavy rain events. The presence of good ground cover and deep-rooted grasses can help facilitate infiltration and reduce sediment loss.

Wetland description

N/A

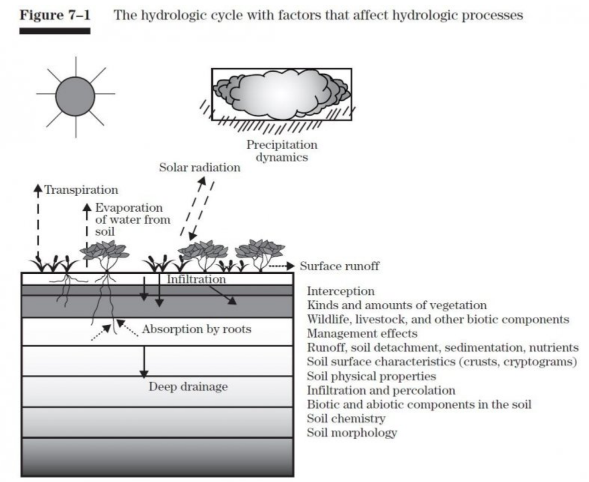


Figure 8.

Soil features

This site consists of very deep, deep, and moderately deep well drained, slowly to moderately permeable soils developed from loamy calcareous materials or clayey mantle over sandstone.

There is little bare soil in this community, with plant basal cover, litter, and rock fragments comprising the ground cover. The site generally does not receive additional water from outside the site. Soils are fertile and hold moderately amounts of soil moisture. This is a productive site with moderately high yields of good quality forage.

Associated soil series for the Sandy Loam site include Acove, Bastrop, Campair, Castell, Hext, Honeycreek, Menard and Pebblepoint.

Table 5. Representative soil features

Parent material	(1) Residuum–sandstone (2) Slope alluvium–gneiss
Surface texture	(1) Sandy loam (2) Fine sandy loam (3) Loam
Family particle size	(1) Fine (2) Fine-loamy (3) Coarse-loamy
Drainage class	Moderately well drained to well drained
Permeability class	Slow to moderate
Depth to restrictive layer	20–80 in
Soil depth	20–80 in
Surface fragment cover <=3"	0–20%
Surface fragment cover >3"	0–5%
Available water capacity (0-40in)	1.6–7.3 in
Calcium carbonate equivalent (0-40in)	0–5%
Electrical conductivity (0-40in)	0–2 mmhos/cm
Sodium adsorption ratio (0-40in)	0–3

Soil reaction (1:1 water) (0-40in)	5.6–7.8
Subsurface fragment volume <=3" (4-40in)	0–18%
Subsurface fragment volume >3" (4-40in)	0–10%

Ecological dynamics

The Sandy Loam 25-32” PZ reference site is a fire-influenced Midgrass Savannah interspersed with perennial forbs, mixed shrubs and hardwood mottes. The site consists of four stable states: Savannah State (1.0), Shrubland State (2.0), Converted State (3.0), and Eroded State (4.0).

The Texas Central Basin (MLRA 82A) is a unique geological region within Texas. It is composed largely of Pre-Cambrian granite, gneiss and schist (Bureau of Economic Geology 1981). Depending upon the parent material and topography, a great variety of soils have developed that vary from shallow, fissured, rocky outcrops with minimal soil development to relatively deep, well-developed soils with textures that vary from fine sandy loams to sands to gravelly clay loams to cobbly clay loams and stony clay loams (Goerdel 2000).

Precipitation patterns are highly variable. Long-term droughts, occurring three to four times per century, cause shifts in species composition by causing a die-off of seedlings, less drought-tolerant species, and some woody species. Droughts also reduce biomass production and create open space that is colonized by opportunistic species when precipitation increases. Wet periods allow little bluestem, sideoats grama, and hardwoods to increase in dominance. The site also tends to have many opportunistic plants such as three-awns (Aristida spp.) and annuals that take advantage of the short flush of available water.

Climatic variation and topographic variability interact to influence vegetation responses to disturbances such as fire and grazing. The vegetation of the region developed under a humid, subtropical climate. Weather variation is great; precipitation is highly variable with seasonal, annual, and multi-year droughts (3-6 years) common as well as seasons and years with well above average precipitation; average conditions rarely exist. Typically the spring and fall are periods of highest precipitation while mid to late summer is usually a hot, droughty period. Winters are moderate with scattered precipitation sometimes in the form of short-lived snow and ice storms (Carr 1969, Bomar 1983).

The herbaceous savannah species adapted to fire and grazing disturbances by maintaining below-ground perennating tissues. Prior to European settlement, fires would likely have been frequent (approximately every 7-12 years) (Scifres and Hamilton 1993, Frost 1998) and burned any time of year as long as there were ample fuels, dry conditions, and an ignition source.

Fire was a major influence on vegetation structure and composition prior to settlement. Lightning and Native Americans were primary ignition sources, and the latter is considered to have increased the frequency and extent of fire as their populations increased. Fires occurred at all seasons but those that occurred during the hot, dry, late-summer season following fine fuel (grass) accumulation in the spring and early summer were perhaps the most intense and had the greatest influence on the character of the vegetation. Fires were frequent, and any area may have burned once within each 7-12 year interval (Scifres and Hamilton 1993, Frost 1998). Fire generally favors the herbaceous component of the community and hinders the establishment and growth of woody species under intense hot, dry conditions. Some individuals of trees (e.g. oak species) and resprouting shrubs (e.g. mesquite) were able to escape fires, and as they matured, they became fire-resistant components of the vegetation except for infrequent stand-replacing crown fires. These woody species became effectively uncoupled from the herbaceous and shrub layer even if the herbaceous species composition was substantially altered by grazing or other factors. If, however, the oaks were killed or removed it is very difficult for them to reestablish into mature single-stemmed trees due to the resprouting nature of the tree, particularly under current land use conditions. While fire had influenced these communities for millennia, as the land was settled with homesteads and crops were established, fires were purposely prevented or stopped. Most of the remaining rangeland was overgrazed, which reduced fuel loads and hence effectively fire-proofed the plant communities from the effect of fires. This was a primary factor in the increase of woody species within the Central Basin.

While shrublands within MRLA 82 have traditionally been viewed as “degraded” relative to livestock production, it is important to recognize that they are not necessarily degraded from the ecological perspective of primary productivity, biomass accumulation, nutrient cycling, and biodiversity. The productivity of shrublands may be equal to or greater than that of the grassland they replaced. In addition, shrubs help modify soils and microclimate to increase levels of organic matter and nutrients in the upper soils horizons (Boutton et al. 2009, Boutton & Liao 2010). This nutrient enhancement by shrubs can offset grazing-induced losses of soil nutrients and contribute to enhance grass production when shrub cover is reduced. While shrub communities may have adverse impacts on grasses and grassland fauna, other plants and animals may benefit (Archer & Smeins 1991, Bestelmeyer et al. 2003). Thus, while ecosystem biodiversity certainly changes, it does not necessarily decrease with a shift from grass to woody dominance on these sites.

Soil and topographic variation interact with weather variation and land use to produce diverse plant communities across the Central Basin and on the Sandy Loam Site. Accounts of earlier explorers and settlers suggest the Central Basin was likely a mosaic of grassland, savannah, and woodlands (Foster 1917). In the historic climax plant community, midgrasses dominated the shortgrasses due to their ability to capture the sunlight and shade as well as being favored by the frequent fires. Plant communities vary from open grassland to savannah/parkland to shrubland/woodland to nearly closed canopy forest. The Historic Climax Community for most of the Central Basin and the Sandy Loam Ecological Site is defined as the historical (ca. 1800) fire-influenced grassland savannah that was widespread at the time of settlement but which did occur in a mosaic of shrublands, woodlands, and forests across much of the Central Basin (Smeins 1980, Weniger 1984). Almost all sites have a two or three-layered structure of over-story trees, mid-story shrubs and a ground layer of grasses and forbs.

Historical photographs suggest the nature of the vegetation structure depending on topography, soil properties, and time since the last major disturbances (such as drought or fire). However, the occurrence of extensive grasslands and grassland fauna (pronghorn, for example) is mentioned in numerous historical accounts.

Grasses that historically dominate Central Basin sites include little bluestem (*Schizachyrium scoparium*), sideoats grama (*Bouteloua curtipendula*), meadow dropseed (*Sporobolus compositus*), plains lovegrass (*Eragrostis intermedia*), plains bristlegrass (*Setaria vulpiseta*), Arizona cottontop (*Digitaria californica*), and sand dropseed (*Sporobolus cryptandrus*). Locally abundant tallgrasses include Indiangrass (*Sorghastrum nutans*) and switchgrass (*Panicum virgatum*). Shortgrasses that occur in the understory of mid- and tallgrasses or on shallow soils or disturbed areas include buffalograss (*Bouteloua dactyloides*), common curly-mesquite (*Hilaria belangeri*), hairy grama (*Bouteloua hirsuta*), and red grama (*B. trifida*) (Whitehouse 1933, Riskind and Diamond 1988). The composition and productivity of grassland communities would have varied with annual rainfall, soil depth, and the extent of argillic horizon development.

Historically, overstory species composition consisted of post oak (*Quercus stellata*), blackjack oak (*Q. marilandica*), live oak (*Q. virginiana*), honey mesquite (*Prosopis glandulosa* var. glandulosa) Texas hickory (*Carya texana*), elm species (Ulmus spp.) and others. The shrub layer was potentially diverse with saplings of the tree layer along with whitebrush (*Aloysia gratissima*), lotebush (*Ziziphus obtusifolia*), algerita (Mahonia trifoliata), Texas persimmon (*Diospyros texana*), prickly pear cactus (Opuntia spp.) and others.

With the exception of Ashe juniper, all native woody species found in the Central Basin \ readily resprout following fire. This trait has frustrated managers and played an important role in driving sites towards the Shrubland State. High numbers of fire sprouting shrubs make shrubland communities very resilient.

An important aspect of this site is the relationship of mature hardwood trees to each of the communities. Mature hardwoods are very resilient and remain constant whether surrounded by reference community grasslands, degraded grasslands, native-dominated shrublands, or invasive-dominated shrublands. Their presence or absence is not driven by grazing management and generally only slightly by prescribed fire. They remain relatively stable over a short management period (5-10 years) unless removed by mechanical or chemical means. Throughout this ecological site, mature oaks can occur in any of the communities if they were not historically removed. They are most likely to occur in mottes and remain relatively constant regardless of what is occurring in the rest of the community, particularly in the understory. Communities will have an absence of hardwoods if the hardwoods were harvested, burned, chained, or sprayed at some point. Once the hardwoods are removed, it is not easy to return to the Savannah State due to the difficulty, expense, and time involved.

Hardwoods were frequently removed from this site during the European settlement period due to their high value for construction and firewood. Additionally, many examples exist where hardwoods were removed as part of a broad scale brush removal program. This was done with chaining, herbicides, rootplowing, and other general means.

Oak mottes on this site formed under different conditions than currently found. This may be due to climate shift or increased competition from aggressive shrub species. However, while reestablishment is slow, there are many examples of second-growth hardwood woodlands on this site. Hardwoods eventually reestablish when there is a lack of fire or tree clearing.

Infection of live oak by oak wilt (Ceratocystis fagacearum) has lead to the death of many individuals and mottes. An increase in tree density and the grafting of roots amongst individuals has facilitated the spread of the pathogen, which is transmitted primarily through root connections (Appel 1995).

Ashe juniper (*Juniperus ashei*), which is very abundant on the surrounding limestone derived soils of the Edwards Plateau, is relatively uncommon in the Central Basin, but it is found scattered across the Central Basin as infrequent individuals or mottes. Observation indicates that it has been increasing in population and extent within the Central Basin during the past two decades (Walter and Wyatt 1982). Juniper has the ability to take over large tracts of land as near monocultures, known as “cedar breaks.”

Even reference sites show the influence of introduced species. King Ranch bluestem (*Bothriochloa ischaemum*) has become almost ubiquitous, occurring on sites where it has not been seeded. It tends to replace little bluestem (*Schizachyrium scoparium*) and can function similarly in the community as far as structure, size and soil-holding capacity. However, unlike little bluestem, King Ranch bluestem acts like an invader and moves to unoccupied areas.

The large ungulate fauna of the region prior to settlement consisted of bison (Bos bison), pronghorn antelope (Antilocarpa americana) and white-tailed deer (Odocoileus virginianus). Bison and pronghorn occasionally occurred in large numbers and may have intensively grazed the rangelands for short periods. However, they were largely migratory and free-roaming, so that when the forage became limited they moved on, often not to return for long periods. Their long-term impacts on the plant communities were considered to be relatively minor and may have had positive influences on production and diversity (Knapp et al. 1999, Fuhlendorf and Engle 2001).

While archeological evidence indicates that bison occurred in the region, there is also evidence of centuries of absence (Dillehay 1974). In addition, their numbers may have varied seasonally as herds migrated. When present, bison may have grazed certain areas heavily and then moved on. The infrequent but intense, short-duration grazing by these species suppressed woody species and invigorated herbaceous species (Eidson and Smeins 1999). After a burn, they would intensely graze the burn until no forages remained. Then, they moved off, probably not returning until the next fire cycle, which could have been five to ten years. This suggests heavy short-term grazing followed by long rest periods. Activities of other native herbivores (termites, cutter ants, soil nematodes, kangaroo rats) also influenced vegetation productivity and dynamics.

Currently, white-tailed deer are the primary native large herbivores. At settlement, large numbers of deer occurred, but as human populations increased (with unregulated harvest) their numbers declined substantially. Eventually, laws and restrictions on deer harvest were put in place which assisted in the recovery of the species. Females were not harvested for several decades following the implementation of hunting laws, which helped create population booms. In addition, suppression of fire favored woody plants which provided additional browse and cover for the deer. Due to their impacts on livestock production, large predators (red wolves (Canis rufus), mountain lions (Felis concolor), black bears (Ursus americanus) and eventually coyotes (Canis latrins)) were reduced in numbers or eliminated (Schmidly 2002).

The screwworm (Cochilomyia hominivorax) was essentially eradicated by the mid-1960s, and while this was immensely helpful to the livestock industry, this removed a significant control on deer populations (Teer, Thomas & Walker 1965, Bushland 1985).

Recent increased management of the deer herd, because of their economic importance through lease hunting, has decreased deer populations with the objectives of improving individual deer quality and improving habitat. High fences, controlled harvest based on numbers, sex ratios, condition and monitoring of habitat quality have been effective in managing the deer herd on individual properties. However, across the Central Basin, excess numbers still exist which may lead to habitat degradation and significant die-offs during stress periods such as extended droughts.

The Central Basin is home to a variety of non-indigenous (exotic) ungulates, mostly introduced for hunting (Schmidly 2002). These animals are important sources of income to some landowners, but as with the white-tailed deer, their populations must be managed to prevent degradation of the habitat for themselves as well as for the diversity of native wildlife in the area. Many other species of medium and small sized mammals, birds, and insects can have significant influences on the plant communities in terms of pollination, herbivory, seed dispersal, and creation of local disturbance patches, all of which contribute to the plant species diversity.

Supplemental feeding of deer and exotics can also contribute to range degradation if it allows survival of excess numbers of animals.

Feral hogs have become well established within the Central Basin. Hogs use all of the ecological sites within MLRA 82. They cause considerable damage to soils and vegetation.

The faunal array of the Central Basin changed radically with the introduction of domestic species. Early on, wild mustangs released from early Spanish settlements roamed in large herds and had significant impacts on the vegetation. Later in the 19th century, cattle, sheep, goats, mules, and hogs were introduced. The pristine rangeland appeared to provide unlimited forage but as the ranges were fenced and overstocked they were degraded. Productivity of the rangeland began to decline, carrying capacity was reduced, and periodic die-offs of livestock occurred. Generally, the mid and taller grasses were replaced by short grasses and perennial grasses, and forbs were replaced by annuals. These changes not only reduced production but also in many instances caused permanent alteration of the ecological sites due to soil erosion, organic matter loss, compaction, moisture regime change, and other factors which altered many soil and hydrologic processes. This often precluded their recovery to pre-European conditions (Smith 1899, Smeins, Fuhlendorf and Taylor 1997). Not only did livestock overgraze the forage, but they also contributed to seed dispersal of some woody plants, particularly honey mesquite, which exacerbated its increase on the rangelands.

Historical accounts prior to the 1800s also identify grazing by herds of wild horses, followed by heavy grazing by sheep and cattle as settlement progressed. Grazing on early ranches changed natural graze-rest cycles to continuous grazing and stocking rates exceeded the carrying capacity. By the early 1800s cattle, sheep, and goat numbers appear to have been quite high in the Central Basin, resulting in heavy, year-round grazing (Lehman 1969). Sheep numbers peaked at 10.8 million head in 1943 and stood at about 1.2 million in 2000. Goat numbers in Texas around 1900 were around 100,000. They peaked in 1965 at 4.6 million and were 345,000 in 2000 (Texas Online). The Central Basin and Edwards Plateau region, because of its climate and diverse vegetation, was the mainstay of the Texas sheep and goat industry.

Today, beef cattle and horses are the primary grazers in the area. Goats used primarily for meat production are locally important, and their numbers have increased. Sheep remain a minor but still important part of livestock grazing in the Central Basin. White-tailed deer, wild turkey, bobwhite quail, and doves are major commercial wildlife species, and hunting leases are a major source of income for many landowners. While the Central Basin ecological sites have changed in many ways since settlement, opportunities exist to produce products and provide income while conserving and sustaining the long-term stability and productivity of the area.

Homesteads and communities developed along with ranching, and many ecological sites within MLRA 82 were converted to cropland for wheat (Triticum spp.), oats (Avena spp.), forage, and peanuts (*Arachis hypogaea*), and other products needed for local consumption or for cash crops. This conversion effectively eliminated the native plant communities due to land clearing and the harvest of larger trees, used for building construction among other uses.

Over time, as many of the croplands became degraded, and along with the rangeland that had been overused, introduced forages were brought in to assist with soil and water conservation and to increase productivity. Coastal bermudagrass (*Cynodon dactylon*), Kleingrass (*Panicum coloratum*), Wilman lovegrass (*Eragrostis superba*) and King Ranch bluestem were widely planted on many acres of old cropland and in areas with deeper soils. The latter, while effective as a soil stabilizer, has become invasive in many areas where it is unwanted and is difficult to control.

In the 1940s, mechanical and herbicide treatments began to replace fire as a control of increasing density of woody plants on the rangeland. This activity was common practice for several decades until the 1980s, when these treatments became less cost-effective. It was clear that brush management practices were treating symptoms rather than underlying problems in addition to their undesirable environmental and wildlife consequences. Sites cleared of brush regenerated rapidly and often formed thickets that were denser and of lower diversity than the original stands.

This realization coupled with the fact that brush management treatments were typically expensive and short-lived, lead to the development of Integrated Brush Management Systems (Scifres et al. 1985). This approach takes a holistic, large-scale, long-term, socioeconomic, ecosystem-based approach to brush management and recognizes multiple-use options for rangeland resources including alternate classes of livestock, lease hunting, exotic game ranching, carbon credits and ecotourism.

Grazing and fire are two factors that critically influence the relative abundance of grasses and woody plants through time. The resulting reduction in abundance of late seral grasses lead to a decline in soil organic matter, a reduction in fire frequency/intensity (due to lack of fine fuels), and a shift in dominance from midgrasses (little bluestem and sideoats grama) to shortgrasses (hooded windmillgrass (*Chloris cucullata*) and buffalograss) and forbs (Mexican sagewort (*Artemisia ludoviciana* ssp. mexicana) and croton (Croton spp.)). These changes would have favored woody plants, most of which are unpalatable to livestock, and enabled them to establish and maintain dominance.

Mesquite, whitebrush, juniper, lotebush, algerita, persimmon, prickly pear, and lime pricklyash (Zanthoxylum fagar) now dominate much of the Central Basin. These woody plants are not ‘new arrivals’ but rather, are native to the region and have increased in size and abundance within their historic ranges. Factors promoting their increase in abundance since European settlement are the subject of active debate. Such factors may involve an interactive combination of changes in climate, intensification of grazing, follow up brush management and reductions in fire frequency/intensity accompanied by increases in atmospheric CO2 concentrations and nitrogen deposition since the industrial revolution (Archer 1994).

Rangeland Health Reference Worksheets have been posted for this site on the Texas NRCS website (www.tx.nrcs.usda.gov) in Section II of the eFOTG under (F) Ecological Site Descriptions (ESD’s).

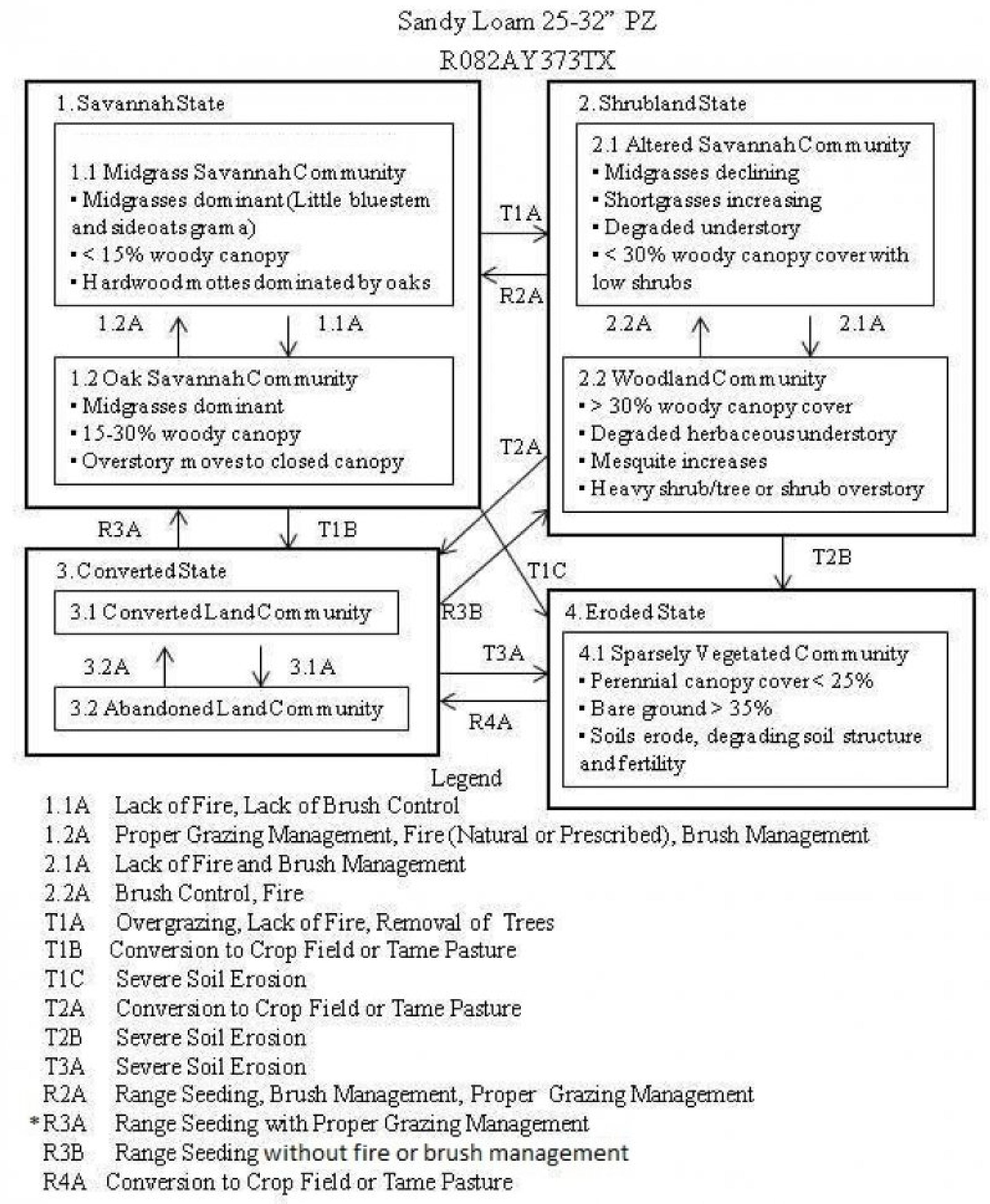
State and Transition Model:
A State and Transition Model for the Sandy Loam Ecological Site (R082AY373TX) is depicted in Figure 1. Thorough descriptions of each state, transition, plant community, and pathway follow the model. Experts base this model on available experimental research, field observations, professional consensus, and interpretations. It is likely to change as knowledge increases.

Plant communities will differ across the MLRA due to the naturally occurring variability in weather, soils, and aspect. The Savannah State is the reference state for this site. It is not necessarily the management goal but can be. Other vegetative states may be desired plant communities as long as the Range Health assessments are in the moderate and above category. The biological processes on this site are complex. Therefore, representative values are presented in a land management context. The species lists are representative and are not botanical descriptions of all species occurring, or potentially occurring, on this site. They are not intended to cover every situation or the full range of conditions, species, and responses for the site.

Both percent species composition by weight and percent canopy cover are used in this ESD. Most observers find it easier to visualize or estimate percent canopy for woody species (trees and shrubs). Canopy cover drives the transitions between communities and states because of the influence of shade and interception of rainfall. Species composition by dry weight is used for describing the herbaceous community and the community as a whole. Woody species are included in species composition for the site. Calculating similarity index requires the use of species composition by dry weight.

The following diagram suggests some pathways that the vegetation on this site might take. There may be other states not shown in the diagram. This information is intended to show what might happen in a given set of circumstances; it does not mean that this would happen the same way in every instance. Local professional guidance should always be sought before pursuing a treatment scenario.

State and transition model



State 1
Savannah State

There are two communities in the Savannah State: the Midgrass Savannah Community (1.1) and the Oak Savannah Community (1.2). Prior to settlement, Sandy Loam sites had a savannah appearance with open areas dominated by midgrasses (little bluestem and sideoats grama) interspersed with scattered mottes dominated by oaks. The Midgrass Savannah (1.1) may have up to 15 percent canopy cover while the Oak Savannah may have a woody canopy that approaches a closed canopy. Relatively frequent fires (7-12 year mean fire return interval) (Frost

1998) maintained the open areas by minimizing shrub cover that was not yet to a fire resistant height. Mature single stemmed hardwoods found in the mottes were long-lived and resistant to ground fires. Fires were natural or human-induced. When fires were frequent on the savannah, most fires burned only the understory, leaving mottes of trees. Even with proper grazing and favorable climate conditions, lack of fire for 7-12 years will allow trees and shrubs to increase in the canopy to reach the 20 percent level that indicates the shift to the Oak Savannah Community. This transition is not dependent on the degradation of the herbaceous community, but on the lack of some form of brush control. Shrub species would increase within the grassland portion of the savannah and within the understory of the mottes following fire. Fine fuels were continuous and of sufficient quantity to allow fire minimizing cover of young brush and trees but not of sufficient quantity to create crown fires that would single stemmed mature trees. Therefore, the savannah would be relatively open for a short period following a fire, shrubs would begin to reestablish reducing the savannah appearance, fire would return in 10 years or less. Occasionally a site would not burn for a period long enough for trees to grow to a fire resistant stage within the grassland portion of the savannah. As these trees matured, the fine fuel understory would decrease, reducing the ability of fires to grow large enough (and hot enough) to harm mature trees. This long-term lack of fire (25 - 50 years) would allow large trees to fill in open areas shifting the site to a woodland appearance. Once the site had dense tree cover, the site would be resistant to fires and a very resilient woodland community would develop. In the absence of fire, the Oak Savannah Community (1.2) dominates the site with up to 30 percent woody canopy cover. The two communities in the Savannah State shifted between one another depending on the frequency and intensity of fire, grazing, and drought. The primary influence on the understory is grazing management and the primary influence on the overstory is fire. This allows the understory and overstory to react independently, i.e., trees can increase to the point where they dominate a site even if the understory component remains vigorous and intact. Grazing management alone cannot maintain the site in the Midgrass Savannah Community (1.1). It was rare that a dense woodland community would shift to a grassland or savannah community. In order to do so, something would have to cause widespread die-off of mature trees. This could occur due to disease or to a very hot fire that spread to the tree, events that typically only occur every 300 to 1,000 years. Following a severe fire, the site would have a grassland appearance for a few years as shrubs and trees resprouted or grew from seed. Shrubs and trees comprise a portion of both plant communities in the Savannah State (1.0), hence woody propagules are present. The Savannah State always has the potential for shrub dominance without fire. Mann (2004) discussed the importance of human-induced fire as an important factor in maintaining open grasslands before European settlement. The relationship between the two communities in the Savannah State remains similar post-settlement. However, examples of these two communities have become difficult to find. In addition, wildfires become less frequent and less widespread as human population density increases. “Cool”, slow-burning natural fires have become basically non-existent, because they are relatively easy to put out using modern firefighting equipment and techniques. Without fire, the reference savannah community becomes less resilient. Unless managers practice some method of brush control, shrub species will increase in the grassland portion of the savannah and in the understory of the oak mottes. Brush control can play the role that natural fires played pre-settlement. However, it is difficult to manage in an ecological and economic matter on a small scale, as this site is rapidly repopulated by shrubs and trees without fire or brush management. Brush control may be prescribed fire, mechanical, chemical or biological control, or targeted grazing (generally by goats, although some instances exist in the Central Basin where exotic wildlife species or overpopulated white-tailed deer reduce woody cover). There are examples of this site being maintained as a savannah with introduced hay meadows and mottes of trees.

Dominant plant species

- oak (*Quercus*), tree
- little bluestem (*Schizachyrium scoparium*), grass
- sideoats grama (*Bouteloua curtipendula*), grass

Community 1.1
Midgrass Savannah Community

Figure 9. 1.1 Midgrass Savannah Community

Figure 10. 1.1 Midgrass Savannah Community (2)

The Midgrass Savannah Community (1.1) reference community is a savannah characterized by expanses of grassland dominated by little bluestem and sideoats grama interspersed with mottes dominated by mature live oak, post oak, and blackjack oak. This community requires relatively frequent fire and/or brush control (every 5 to 10 years) to maintain the savannah appearance. Without fire or some form of long-term brush management, shrubs will begin to dominate the open areas eventually resulting in a nearly closed canopy of shrubs and trees. The Midgrass Savannah Community remains the presumed reference community. It is possible to have a reference community understory with a savannah appearance but the woody portion of the savannah is populated by low-growing shrubs and second-growth non-native hardwoods. Little bluestem, sideoats grama, meadow dropseed, vine mesquite, and sand dropseed dominate the herbaceous component of the site. Forbs commonly found on the site include Mexican sagewort, bundleflower, Engelmann's daisy, western ragweed, orange zexmenia, and sensitive briar. Tree and shrub species found in the Midgrass Savannah Community include species of oaks, whitebrush, pricklypear, and honey mesquite. Shrubs continually increase in the open areas of the savannah and in the understory of the mottes. This pressure to move towards a woodland or shrubland community if further increased when aggressive, invasive shrubs become a part of the community. The Midgrass Savannah Community remains the presumed reference community. It is possible to have a reference community understory with a savannah appearance but the woody portion of the savannah is populated by shrub and tree species other than the native hardwoods. Although large, land-clearing crown fires are relatively rare, similar impacts to the mature hardwoods occur when trees are cleared from the site by logging, chaining, or spraying. If a manager combines woodland removal with proper grazing management and ongoing, maintenance level brush control, a woodland community could shift to a grassland community, mimicking the natural shift that occurred with large land-clearing fires. Maintaining the grassland would require diligent brush control. There are examples where intensive targeted grazing with goats has maintained a grassland or savannah community on this site. The grassland and open savannah communities have proven to be difficult to manage on this site. This is due to the difficulty in combining effective brush management with grazing management that provides for grazing events of proper intensity and sufficient periods of deferment. Due to the difficulty of managing native species in the savannah community, many times this site was seeded with introduced grass species.

Table 6. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	2305	2880	3455
Forb	130	160	190
Tree	100	125	155
Shrub/Vine	25	35	40
Total	**2560**	**3200**	**3840**

Figure 12. Plant community growth curve (percent production by month). TX4410, Mid/Tallgrass Oak Savannah with <5% Woody Canopy. Mid and tallgrasses with oak savannah having less than 5% woody canopy cover..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2	3	5	13	23	15	4	5	15	7	5	3

Community 1.2
Oak Savannah Community

Figure 13. 1.2 Oak Savannah Community

The Oak Savannah Community is presumed to have historically covered a substantial minority of this ecological site. Over time, the oak mottes would expand while mature trees and shrubs increased in canopy cover responding to the fire/grazing/rest dynamics. The understory vegetation in the openings between trees would remain similar in composition to that of the Midgrass Savannah Community (1.1). However, as tree density increased, cool-season grasses and forbs would increase in species composition. Cool-season species increase as the distance to drainages decreases due to increased tree cover and shade near drainages. Dominant species in the Woodland Community are similar to those found in the Midgrass Savannah Community, but species composition shifts to dominance by trees and shrubs. There is also an increase in cool-season grasses and forbs. Texas wintergrass and Canada wildrye increase in production. There also tends to be an increase of shrubs growing in the understory of the hardwoods and in the open areas of the savannah.

Table 7. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	1410	1760	2120
Tree	640	800	960
Forb	255	320	385
Shrub/Vine	255	320	385
Total	**2560**	**3200**	**3850**

Figure 15. Plant community growth curve (percent production by month). TX4411, Midgrass Savannah with Woody Encroachment. Midgrass Savannah with Woody Encroachment..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3	3	5	13	22	15	5	3	15	7	5	4

Pathway 1.1A
Community 1.1 to 1.2

Midgrass Savannah Community

Oak Savannah Community

The driver for community shift 1.1A is lack of fire and/or brush control to maintain the woody component as mottes of mature oak and other hardwoods. Native woody species canopy exceeding 15 percent indicates a shift to the Oak Savannah Community (1.2). The Midgrass Savannah Community requires fire and/or brush control to maintain the savannah appearance with woody species cover below 10 percent. Regardless of the composition and vigor of the herbaceous component, this community will shift to the Oak Savannah Community without effective brush control. This shift can occur even with proper grazing management and if the herbaceous component remains vigorous. Brown and Archer (1999) concluded that even with a healthy and dense stand of grasses, woody species would populate the site and eventually dominate the community.

Pathway 1.2A
Community 1.2 to 1.1

Oak Savannah Community

Midgrass Savannah Community

Fire/brush control and proper grazing management drive community shift 1.2A.The shift from Oak Savannah Community (1.2) to Midgrass Savannah Community (1.1) is thought to have been infrequent historically, as large, crowning fires would be required to remove mature trees found in the Oak Savannah Community. Smaller repeated fires over long periods would result in some bark damage to older oaks and subsequent introduction of disease to the tree, resulting in hollow or dead trees. The Oak Savannah Community can return to the Midgrass Savannah Community with fire and/or brush management combined with 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.

Conservation practices

Brush Management
Prescribed Burning
Prescribed Grazing

State 2
Shrubland State

The Shrubland State is characterized by trees, a significant shrub cover, and a shortgrass understory. There are two communities in the Shrubland State (2.0): the Altered Savannah Community (2.1) and the Woodland Community (2.2). The two communities in the Shrubland State interact in much the same manner as the two communities in the Savannah State. The Altered Savannah Community must be maintained with fire or brush control as it is under constant pressure by woody species to shift to the Woodland Community. The hardwoods that made up a portion of the plant community in the Savannah State (1.0) may or may not be present in the Shrubland State (2.0). The transition to the Shrubland State will not cause a decrease in the number of hardwoods. However, the Shrubland State often occurs on lands that have been cleared of brush and trees at some point in the past. Trees were removed for lumber or firewood, in some cases to clear the land for pasture or farming. Rootplowing had the same effect as tillage, converting the site to a grassland immediately following plowing but leaving the site subject to rapid invasion by fast-growing shrub species. This transition may respond like agricultural conversion and may have been accompanied by shifts in soil chemistry and structure. Rootplowing is likely to shift the community to the Woodland Community (2.2). 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. The understory of the Shrubland State tends to be dominated by shortgrasses and lower-palatability forbs. The communities in the Shrubland State have a degraded herbaceous community when compared to the Savannah State. This is generally a result of long-term improper grazing management. One factor that creates overgrazing on this site is the failure to adjust the stocking rate downward as woody cover increases. Increased woody cover results in fewer grazeable acres and less forage being available. Unless stocking rates are reduced, the stocking pressure on the remaining forage increases, which increases the likelihood of palatable plants being overgrazed, losing vigor, and being grazed out of the community. At the same time, less palatable plants gain a comparative advantage and increase their representation in species composition.

Dominant plant species

- oak (*Quercus*), tree
- pecan (*Carya illinoinensis*), tree
- juniper (*Juniperus*), tree

Community 2.1
Altered Savannah Community

Figure 16. 2.1 Altered Savannah Community

Figure 17. 2.1 Altered Savannah Community (2)

The Altered Savannah Community is characterized by woody canopy cover less than 30 percent. Generally, the shrubs preclude the establishment of remnant historic plants. The Altered Savannah Community supports a lower diversity of uses than the Midgrass Savannah Community (1.1) it replaces. Grazeable acreage is only 30 to 50 percent of the total area. Plants also tend to be less palatable. The Altered Savannah Community requires some form of brush control (fire, mechanical, chemical, or grazing) for maintenance. Without brush control, it will shift to the Woodland Community (2.2) in a relatively short time (5-15 years). The open areas of the Altered Savannah Community will have shrubs sprout every year. As these plants mature, they will fill in the open areas. Once canopy cover of woody species reaches 30 percent, the site has shifted to the Woodland Community. Examples of the Altered Savannah Community within the Central Basin that have remained in this community have frequently been maintained with a combination of fire and goat grazing.

Table 8. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	815	1020	1225
Shrub/Vine	275	340	405
Tree	135	170	205
Forb	135	170	205
Total	**1360**	**1700**	**2040**

Figure 19. Plant community growth curve (percent production by month). TX4417, Altered Savannah Community, 15-30% canopy. Shortgrasses dominate after midgrasses decline. Woody canopy approaches 15-30%..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2	2	5	10	18	15	5	9	15	9	5	5

Community 2.2
Woodland Community

Figure 20. 2.2 Woodland Community

The Woodland Community (2.2) has over 30 percent woody plant canopy, dominated by hardwoods and shrubs. 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. This community results from the lack of effective brush control. Production of the overstory canopy has increased by a similar amount to the decrease in herbaceous production. Unpalatable woody species have increased in size and density. The Woodland Community typically has multiple shrub species: Texas persimmon, mesquite, whitebrush, catclaw, yucca, and/or juniper. Texas wintergrass, three-awns and annuals increase in the shade of the trees. Unpalatable invaders may occupy the interspaces between trees and shrubs. Plant vigor and productivity of grass species is reduced due to shade. Without brush control, tree canopy will continue to increase until canopy cover approaches 80 percent. The Woodland Community (2.2) is a very resilient community and currently the most common community on Sandy sites. Unless managers practice effective, ongoing brush control this community will remain or reestablish. In the absence of fire and brush management, a highly stable and resilient Woodland Community (2.2) develops as woody patches increase in abundance and coalesce with each other. Shrubs mix with oaks to create a canopy cover of greater than 30 percent. Ground cover and herbaceous production beneath shrub canopies is minimal, but soil organic carbon and nitrogen levels are enhanced. A sparsely vegetated community is not stable on this site. Shrubs and invasive grasses and forbs reestablish relatively quickly following disturbance. Because of the availability of invasives with low palatability, this site rarely stays barren. There are examples that are degraded but not dominated by brush but these examples tend to be quickly reinvaded by brush. In this plant community, annual production is dominated by woody species. Goats and deer can find fair food value if browse plants have not been grazed excessively. Forage quantity and quality for cattle is low, and accessibility is severely limited. Intensive treatment is required to affect restoration back to the Savannah State (1.0). Prescribed burning may not be possible until the woody cover is reduced by herbicides or mechanical treatments to the point that grasses (fine fuels) can establish. Brush treatment tends to be short-lived. Observation shows that even effective treatment will require constant maintenance to suppress brush reestablishment. Without maintenance, canopy cover may exceed 30 percent in three to five years.

Table 9. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	880	1100	1320
Shrub/Vine	660	825	990
Tree	330	415	495
Forb	330	410	495
Total	**2200**	**2750**	**3300**

Figure 22. Plant community growth curve (percent production by month). TX4416, Shrubland Community, 30+% Woody Canopy. Shrubs dominate the site with heavy continuous grazing and no brush management. Woody canopy exceeds 30%. Grasses are in further decline..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2	2	5	10	18	15	5	9	15	9	5	5

Pathway 2.1A
Community 2.1 to 2.2


Altered Savannah Community


Woodland Community

Without brush control (including fire), the Altered Savannah Community (2.1) will shift to the Woodland Community (2.2). Shrubs will continue to increase until they reach 30 percent canopy cover. Once shrubs have more than 30 percent canopy cover, management back to the Altered Savannah Community becomes more difficult due to the amount of energy required to remove dense brush.

Pathway 2.2A
Community 2.2 to 2.1


Woodland Community


Altered Savannah Community

Extensive and selective brush management can reduce the woody component of the Woodland Community (2.2) below the community shift level of 30 percent woody canopy cover. It may be difficult to shift back to the Altered Savannah Community (2.1) with fire alone due to the lack of fuel provided by the understory and height of the canopy cover. Fire can reduce seedlings of brush species if the seedling is younger than 2 years or the budding zone has not transitioned below the soil surface (Kramp et al 1999). Fire and/or brush management will be required to maintain woody canopy cover below the 25 percent level. The limitations with fire are amplified if the understory transitions to cool-season grasses. 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 Woodland Community (2.2) to the Altered Savannah Community (2.1).

Conservation practices

Brush Management
Prescribed Burning
Prescribed Grazing
Range Planting

State 3
Converted State

The Converted State (3.0) 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 (3.0). Cropland and tame pasture require repeated and continual inputs of fertilizer and weed control to maintain the Converted State.

Dominant plant species

- kleingrass (*Panicum coloratum*), grass
- Bermudagrass (*Cynodon dactylon*), grass

Community 3.1
Converted Land Community

The Converted Land Community (3.1) occurs when the site, either the Savannah State (1.0) or Shrubland State (2.0), is cleared and plowed for planting to cropland, hayland, native grasses, tame pasture, or use as non-agricultural land. The native component 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. Some Sandy Loam sites were converted to cropland or tame pasture sites because of their fertile soils, favorable soil/water/plant relationship, and gently rolling terrain when producers' objectives were to provide alternative forages during specific times of the year. Small grains are the principal crop, and bermudagrass is the primary introduced pasture species on sandy loam soils in this area. The site can be a productive forage producing site with the application of optimum amounts of fertilizer. Refer to Forage Suitability Group Descriptions for specific management recommendations, estimated production potentials, and species adaptation. Cropland, pastureland, and hayland rely on the use of herbicides, pesticides, and commercial. Both crop and pasturelands require weed and shrub control because their seeds remain on the site or are transported there. Common introduced species include hybrid bermudagrass, kleingrass, Wilman lovegrass, and Old World bluestems (Bothriochloa spp.). Newly seeded stands are prone to invasion by annual and perennial weeds and woody plants, so proper grazing and brush/weed management are required for their maintenance. The rate of woody plant re-establishment will depend on the brush management practice initially used to clear the site, seedbed preparation technique, proximity to undisturbed shrub stands and the rate of livestock and wildlife transporting seeds. Stands seeded to native grasses are also susceptible to invasion by non-native, aggressive pasture grasses such as King Ranch bluestem and seeded bermudagrass. These introduced species, while providing forage and soil stability, may be very difficult to eliminate once established. Fertilized production of these introduced forage grasses may exceed that of non-fertilized native grasses. However, the extent to which introduced grasses provide better forage than native grasses is debatable, especially when their adverse effects on wildlife are taken into account. Conversion of introduced pasture back to native grassland is difficult and typically requires aggressive and costly management intervention. Given the potentially adverse long-term effects of exotic grasses on native grassland flora and fauna, their use should be critically and carefully considered.

Figure 23. Plant community growth curve (percent production by month). TX4400, Cool-season Small Grain. Community planted into cool-season grasses such as wheat and oats..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5	5	10	10	5	0	0	0	20	25	15	5

Figure 24. Plant community growth curve (percent production by month). TX4401, Warm-Season Cropland. Community planted into warm-season crops such as forage sorghum..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	8	20	25	20	10	10	5	2	0	0

Figure 25. Plant community growth curve (percent production by month). TX4402, Pastureland Community. Warm-season native and introduced grass species such as kleingrass, blue pancium, and weeping lovegrass..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2	2	18	23	17	6	4	16	6	3	2

Community 3.2
Abandoned Land Community

Figure 26. 3.2 Abandoned Land Community

The Abandoned Land Community (3.2) occurs when the Converted Land Community (3.1) is abandoned or mismanaged. Mismanagement can include poor crop or haying management and no brush control. 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 Shrubland State (2.0). Abandoned croplands and land seeded with exotic or native grasses are prone to encroachment by woody plants. These areas will revert to shrublands with no fire or brush management. These changes seem to be triggered by recruitment and growth of shrub plants in periods following drought. The shrub ‘seedlings’ that appear in seeded pastures may be true seedlings established from seeds dispersed to the site by wind, water or animals or from seeds which persist in the soil seed bank long after the woody cover has been reduced by brush management practices. Other ‘seedlings’ may actually be sprouts arising from woody plant stems, roots and burls that remain following brush management. These resprout ‘seedlings’ tend to grow faster and have higher establishment rates than true seedlings. Many shrubs on this site have this capability of vegetative regeneration which allows plants to re-establish following brush management. Proper grazing and brush management are required to prevent woody plant ‘seedlings’ from dominating the site. However, once established, grazing alone will not prevent the brush from overtaking. Goats may have some value in maintaining brush but even they may not browse on all brush to the point of control. Long-term cropping can create changes in soil chemistry and structure that make restoration to the reference state very difficult and/or expensive.

Table 10. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Forb	335	420	505
Grass/Grasslike	335	420	505
Shrub/Vine	290	360	430
Tree	0	0	0
Total	**960**	**1200**	**1440**

Figure 28. Plant community growth curve (percent production by month). TX4415, Abandoned Converted Land Community. Warm-season tame pasture with peak biomass production in April, May and June with a lesser peak in September and October..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2	2	18	23	17	6	4	16	6	3	2

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. 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, prescribed burning, and range or pasture planting.

Conservation practices

Brush Management
Prescribed Burning
Forage and Biomass Planting
Prescribed Grazing
Nutrient Management
Integrated Pest Management (IPM)
Planned Grazing System
Residue and Tillage Management, No-Till/Strip Till/Direct Seed

State 4
Eroded State

This state is characterized by a single community, the Sparsely Vegetated Community (4.1). The Eroded State has the potential to be a terminal state. Due to the relatively high risk of severe soil erosion of the sandy loam soils, this site can erode to the point where there is a loss of soil functionality. When this level of erosion occurs, the site loses soil structure, soil fertility, organic matter, and/or soil microflora. There are examples of the loss of the A and B horizons and some with the soil eroded to bedrock. Once the site loses soil horizons or soil functions, it is very difficult or impossible to return the site to one of the other States, resulting in State 4 being an irreversible terminal state.

Community 4.1
Sparsely Vegetated Community

Figure 29. 4.1 Sparsely Vegetated Community

The Sparsely Vegetated Community (4.1) is characterized by a variety of shrubs and a small component of the herbaceous community with few palatable perennial species present. The shrubs may be dense in areas where shrubs can find adequate moisture in the eroded soils. This community occurs only where significant loss of soil depth, function, or fertility has occurred. Due to their aggressive nature, invasive shrubs, grasses, and forbs reestablish relatively quickly following disturbance if there is adequate soil left. This community is frequently associated with significant soil erosion and/or disturbance. Erosion creates a loss of soil structure and fertility and in severe conditions may expose bedrock. Soils may erode to the point that they can no longer be managed back to any of the other states.

Table 11. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Forb	215	270	325
Grass/Grasslike	215	270	325
Shrub/Vine	50	60	70
Tree	0	0	0
Total	**480**	**600**	**720**

Figure 31. Plant community growth curve (percent production by month). TX4414, Sparsely Vegetated Community. Vegetation loss and increase of bare ground..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2	2	5	10	18	15	5	9	15	9	5	5

Transition T1A
State 1 to 2

The driver for Transition T1A is lack of brush management coupled with overgrazing. Overgrazing, lack of fire, and/or improper brush management will result in the site crossing a threshold to the Shrubland State (2.0) characterized by shortgrasses, unpalatable grasses and forbs, annual grasses and forbs, and shrubby species. Bare ground, erosion, and water flow patterns will increase, and forage production will decline. Without regular fire, woody species will increase in size, density, and canopy cover, reducing production from herbaceous species. Woody species composition may vary greatly depending largely on management. Trees will be present if they were not historically removed. More frequently, the woody component is made up of many species of widely scattered shrubs. Overgrazing causes a loss of dominant midgrasses and forbs from the savannah. This transition is indicated by a decrease of little bluestem and sideoats grama to less than 10 percent of species composition of the herbaceous community. Once these species are lost from the community or present only in trace amounts (typically with low vigor), grazing management alone cannot create a shift back to the reference community. At this point, a threshold has been crossed indicating a change in state. Degradation of the herbaceous community combined with the aggressive nature of shrubs creates a loss in the savannah look to the site. The grassland portion is reduced and the trees exist in competition with aggressive shrubs. This competition limits the ability of trees to reproduce and increase. The aggressive nature of shrubs keeps the Savannah State (1.0) at high risk of transition to the Shrubland State (2.0). The possible exception would be the effective use of goats to target and suppress the shrubs. The trigger for this transition comes when shrubs reach reproductive capacity. Overgrazing, prolonged drought, no fire or brush management and a warming climate will provide a competitive advantage to shrubs.

Transition T1B
State 1 to 3

The threshold for this transition is the land clearing to remove the woody plant community. The transition to the Converted State (3.0) from the Savannah State (1.0) occurs when the grassland is cleared and planted to cropland or hayland. The Converted State includes cropland, hayland, 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 of native plants or escaped introduced plants.

Transition T1C
State 1 to 4

This transition occurs when the Sandy Loam site is subject to aggressive brush control, drought, and overgrazing. Broadcast brush control includes chaining, rootplowing, and chemical treatment. Seeding may or may not be done. The effects may be seen as a loss of vegetative cover, loss of soil, and destruction of soil structure or soil health. In some cases, this erosion can be extreme enough to result in the loss of the A (and even B) horizons.

Restoration pathway R2A
State 2 to 1

The driver for Restoration Pathway R2A is fire and/or brush control combined with the restoration of the herbaceous community or active management of the herbaceous restoration process (range seeding). Restoration may require aggressive treatment of invader species. Restoration of the Shrubland State to the Savannah State (R2A) requires substantial energy input. An integrated approach of biological, mechanical and chemical brush control in combination with prescribed fire, proper grazing, and favorable growing conditions is the most economical means of creating and maintaining the desired plant community. A long-term prescribed fire program may sufficiently reduce brush density to a level below the threshold of the Savannah State (1.0). However, the fire program will have to be aggressive because many of the woody species on this site are resprouters following fire and fuel loading is marginal. Establishment of native grasses is difficult and dependent upon natural seeding from remnant patches and seed banks. If remnant populations of midgrasses and desirable forbs are not present at sufficient levels, range planting will be necessary to restore a desirable herbaceous plant community. Proper grazing management and stocking rates maintain the herbaceous layer in this state. With proper grazing management, midgrasses can regain dominance on the site and undesirable trends in soil organic matter, fertility, temperature, and erosion can be arrested and reversed. Re-growth of established woody plants will slow and it will become more difficult for new plants to establish. The extent to which the original Midgrass Savannah Community (1.1) can be re-established will depend on the extent to which soil physical and chemical properties were altered during retrogression (Heitschmidt and Stuth 1991).

Conservation practices

Brush Management
Prescribed Burning
Prescribed Grazing

Transition T2A
State 2 to 3

The Shrubland State (2.0) is a very stable state, and transition to the Converted State (T2A) will require high energy input. The threshold for this transition occurs when the soil is plowed and the woody plant community is removed. The size and density of brush will require heavy equipment and energy-intensive practices (i.e. rootplowing, raking, roller-chopping, or heavy disking) to prepare a seedbed. The Converted State includes cropland, tame pasture, hayland 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, even though the returning vegetation may be introduced plants.

Transition T2B
State 2 to 4

The driver for this transition is non-selective brush control through chaining, rootplowing, or broadcast herbicides. This action removes the trees. Contributing drivers include heavy browsing by wildlife, sheep, and goats and overgrazing by cattle. The resprouting shrubs are generally not palatable forage for cattle. Severe soil degradation can result. A loss of vegetative cover can be followed by a loss of soil. In some cases, this erosion can be extreme enough to result in the loss of the A (and even B) horizons. Mottes of trees may or may not survive this transition.

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 the cessation of agronomic practices. *Restoration to the Savannah State (1.0) is unlikely. Return to native communities in the Savannah State is more likely to be successful if soil chemistry and structure have not been heavily disturbed. Preservation of favorable soil microbes increases the likelihood of a return to reference-like conditions as does remnant seed sources. Converted sites may be returned to a community similar to the Savannah State through active restoration, including seedbed preparation and seeding of native grass and forb species.

Conservation practices

Brush Management
Prescribed Burning
Prescribed Grazing
Grazing Land Mechanical Treatment
Range Planting
Planned Grazing System

Restoration pathway R3B
State 3 to 2

Restoration from the Converted State can occur in the short term through active restoration or over the long-term due to the cessation of agronomic practices. Heavily disturbed or abandoned soils are most likely to return to the Shrubland State (2.0). Return to native communities in the Shrubland State is more likely to be successful if soil chemistry and structure have not been heavily disturbed. Preservation of favorable soil microbes increases the likelihood of a return to Altered Savannah conditions as does remnant seed sources. Converted sites may be returned to the Shrubland State through active restoration, including seedbed preparation and seeding of native grass and forb species.

Conservation practices

Brush Management
Prescribed Burning
Prescribed Grazing
Grazing Land Mechanical Treatment
Range Planting

Planned Grazing System

Transition T3A
State 3 to 4

The driver for this transition is severe soil erosion and loss of soil properties. In some cases, this erosion can be extreme enough to result in the loss of the A (and even B) horizons. Mottes of trees may or may not survive this transition.

Additional community tables

Table 12. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Warm-season Midgrasses**			1920–2875	
	little bluestem	SCSC	*Schizachyrium scoparium*	1400–2200	–
	sideoats grama	BOCU	*Bouteloua curtipendula*	900–1700	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	500–1200	–
	silver beardgrass	BOLAT	*Bothriochloa laguroides ssp. torreyana*	300–1000	–
	plains lovegrass	ERIN	*Eragrostis intermedia*	300–1000	–
	plains bristlegrass	SEVU2	*Setaria vulpiseta*	300–1000	–
	composite dropseed	SPCO16	*Sporobolus compositus*	300–1000	–
	vine mesquite	PAOB	*Panicum obtusum*	300–1000	–
	sand lovegrass	ERTR3	*Eragrostis trichodes*	100–600	–
	green sprangletop	LEDU	*Leptochloa dubia*	200–600	–
	Arizona cottontop	DICA8	*Digitaria californica*	200–600	–
	purpletop tridens	TRFL2	*Tridens flavus*	200–600	–
2	**Warm-season Shortgrasses**			255–375	
	threeawn	ARIST	*Aristida*	200–300	–
	buffalograss	BODA2	*Bouteloua dactyloides*	200–300	–
	curly-mesquite	HIBE	*Hilaria belangeri*	200–300	–
	red grama	BOTR2	*Bouteloua trifida*	200–300	–
	hooded windmill grass	CHCU2	*Chloris cucullata*	200–300	–
	fall witchgrass	DICO6	*Digitaria cognata*	100–200	–
	Hall's panicgrass	PAHA	*Panicum hallii*	100–200	–
	hairy grama	BOHI2	*Bouteloua hirsuta*	100–200	–
3	**Cool-season grasses**			80–105	
	Scribner's rosette grass	DIOLS	*Dichanthelium oligosanthes var. scribnerianum*	50–100	–
	Canada wildrye	ELCA4	*Elymus canadensis*	50–100	–
	Texas wintergrass	NALE3	*Nassella leucotricha*	50–100	–
4	**Grass-likes**			50–70	
	sedge	CAREX	*Carex*	50–70	–
	flatsedge	CYPER	*Cyperus*	50–70	–
5	**Warm-season Tallgrasses**			0–30	

	Indiangrass	SONU2	*Sorghastrum nutans*	0–30	–
Forb					
6	**Forbs**			130–190	
	Forb, annual	2FA	*Forb, annual*	75–160	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	75–160	–
	white sagebrush	ARLUM2	*Artemisia ludoviciana ssp. mexicana*	75–160	–
	croton	CROTO	*Croton*	75–160	–
	bundleflower	DESMA	*Desmanthus*	75–160	–
	Engelmann's daisy	ENPE4	*Engelmannia peristenia*	75–160	–
	sensitive plant	MIMOS	*Mimosa*	75–160	–
	awnless bushsunflower	SICA7	*Simsia calva*	75–160	–
Shrub/Vine					
7	**Shrubs/Vines**			25–40	
	whitebrush	ALGR2	*Aloysia gratissima*	25–40	–
	Texas persimmon	DITE3	*Diospyros texana*	25–40	–
	Texas kidneywood	EYTE	*Eysenhardtia texana*	25–40	–
	algerita	MATR3	*Mahonia trifoliolata*	25–40	–
	pricklypear	OPUNT	*Opuntia*	25–40	–
	Texas almond	PRMI2	*Prunus minutiflora*	25–40	–
	mesquite	PROSO	*Prosopis*	25–40	–
	western soapberry	SASAD	*Sapindus saponaria var. drummondii*	25–40	–
	gum bully	SILAL3	*Sideroxylon lanuginosum ssp. lanuginosum*	25–40	–
Tree					
8	**Trees**			100–160	
	pecan	CAIL2	*Carya illinoinensis*	50–150	–
	blackjack oak	QUMA3	*Quercus marilandica*	50–150	–
	post oak	QUST	*Quercus stellata*	50–150	–
	live oak	QUVI	*Quercus virginiana*	50–150	–
	elm	ULMUS	*Ulmus*	50–150	–
	Nuttall oak	QUTE	*Quercus texana*	50–135	–

Animal community

The Sandy Loam site provides at least a portion of the habitat for many species of reptiles, birds, mammals, and insects. Game birds, songbirds, and birds of prey were indigenous or frequent users, and most are still plentiful. Quail and doves frequent this site depending upon the vegetative community. Small mammals that use the site include armadillos, opossum, raccoons, rodents, jackrabbits, cottontail rabbits, and skunks. Its use by deer is limited by browse and cover in reference conditions. As ecological condition declines and woody plants increase and invade, it becomes more habitable for deer. Deer prefer many of the forbs and legumes that grow on the site.

Feral hogs (Sus scrofa) can be found on most Ecological Sites in Texas. Damage is caused by feral hogs each year including, crop damage by rutting up crops, destroyed fences, livestock watering areas, and predation on native wildlife, domestic livestock (small calves, goats, and sheep) and ground-nesting birds. Feral hogs have no natural predators other than humans, thus allowing their population to grow to high numbers (Cearley 2009 & Mapston 2004). Feral hogs have naturalized to rangelands across the state.

Predators including bobcats, coyotes, foxes, and mountain lions can also be found on the site.

The site is suitable for the production of livestock, including cattle, sheep and goats. In reference condition, the site is very suited to primary grass eaters such as cattle. As retrogression occurs and woody plants invade, the Woodland (1.2) and Altered Savannah (2.1) plant communities become good habitat for sheep, goats, deer and other wildlife because of the desirable browse and cool season grasses. Cattle, sheep and goats should be stocked in proportion to the available grass, forb and browse forage, keeping deer competition for forbs and browse in mind. Deer populations must also be kept within limits of the habitat sustainability even if the site is managed exclusively for deer. If the animal numbers are not kept in balance with herbage and browse production through prescribed grazing management and good wildlife population management, the Woodland Community (2.2) will have little to offer as habitat except cover.

Plant Preference by Animal Kind:
This rating system provides general guidance as to animal forage preference for plant species. It also indicates possible competition between kinds of herbivores for various plants. Grazing preference changes from time to time, especially between seasons, and between animal kinds and classes. Grazing preference does not necessarily reflect the ecological status of the plant within the plant community. For wildlife, plant preferences for food, and plant suitability for cover are rated. Refer to habitat guides for a more complete description of a species habitat needs.

Legend: P=Preferred D=Desirable U=Undesirable N=Not Consumed T=Toxic X=Used, but not degree of utilization unknown
Preferred – Percentage of plant in animal diet is greater than it occurs on the land
Desirable – Percentage of plant in animal diet is similar to the percentage composition on the land
Undesirable – Percentage of plant in animal diet is less than it occurs on the land
Not Consumed – Plant would not be eaten under normal conditions. It is only consumed when other forages not available. This can also include plants that are unavailable during parts of the year.
Toxic – Rare occurrence in diet and, if consumed in any tangible amounts results in death or severe illness in animal (Hart, 2003). (Note: many plants can be good forage but toxic at certain doses or at certain times of the year. Animals in poor condition are most susceptible.)

Hydrological functions

Sandy Loam sites tend to be well vegetated with high levels of canopy cover and low level of bare ground in all communities. Therefore, most examples are functioning hydrologically. Abusive management can create bare soils (particularly in the case of mismanaged brush control or abandoned farming). Bare soils are subject to erosion. Once the organic layer erodes in the A horizon, soils function less well hydrologically and the risk of further erosion increases.

Soils on this site are well drained, making a large percentage of soil water available to plants. Water movement to underground layers is moderately high.

Sandy loam soils have a high risk of erosion (less than sandy soils but more than most other soil textures). The Sandy Loam site can have severe erosion when left bare. There is a risk when treating brush or farming on steeper slopes found on this site.

The Midgrass Savannah (1.1) and Oak Woodland (1.2) Communities tend to retain a highly functioning water cycle. As long as the understory remains intact, bare ground remains very low. Infiltration will be high and runoff low.

A shift to the Altered Savannah Community (2.1) may reduce canopy cover and increase bare ground. If bare ground stays low, the water cycle is expected to function similarly to the Midgrass Savannah Community (1.1). If bare ground increases, infiltration will decrease and runoff will increase due to reduced ground cover, rainfall splash, soil capping, reduced organic matter, and poor structure. With a combination of a sparse ground cover and intensive rainfall, this site can contribute to an increased frequency and severity of flooding within a watershed.

Domination of the site by woody species may degrade the water cycle in the Shrubland Community (2.2). Interception of rainfall by tree canopies increases, which reduces the amount of rainfall reaching the surface and being available to understory plants. Increased stem flow, due to the funneling effect of the canopy, increases soil moisture at the base of trees, especially on mesquite. Evergreen species, such as live oak, create increased transpiration which provides less water for deep percolation. Increases in woody canopy create declines in grass cover, which creates similar causes impacts as those described for overgrazing above. Under the dense canopy of the shrubland, 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.

The hydrological function of the Converted State (3.0) is dependent on the amount of cover on the site during rainfall events and the conservation practices used. If bare soil is left exposed during rainfall events, the site is subject to high runoff, high erosion, and little infiltration. Sandy Loam sites planted to tame pasture tend to have a good hydrological function.

The Eroded State (4.0) tends to have a poor hydrologic function. Runoff is high and infiltration low. This state is caused by the loss of soil. This loss of soil creates conditions (low cover, poor soil structure) that increase the risk of the remaining soil eroding.

Recreational uses

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

Wood products

Honey mesquite and some oak are used for firewood, charcoal, and other specialty wood products.

Other products

Jams and jellies are made from many fruit-bearing species, such as algerita. Seeds are harvested from many 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, such as honey mesquite and whitebrush.

Inventory data references

Information presented was derived from the site's previous Range Site Description, NRCS clipping data, literature, field observations, and personal contacts with range-trained personnel.

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Approval

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Acknowledgments

Site Development and Testing Plan:

Future work, as described in a Project Plan, to validate the information in this Provisional Ecological Site Description is needed. This will include field activities to collect low, medium and high-intensity sampling, soil correlations, and analysis of that data. Annual field reviews should be done by soil scientists and vegetation specialists. A final field review, peer review, quality control, and quality assurance reviews of the ESD will be needed to produce the final document. Annual reviews of the Project Plan are to be conducted by the Ecological Site Technical Team.

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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)	Synergy Resource Solutions, Belgrade, Montana

Contact for lead author	Zone 2 Rangeland Management Specialist, NRCS, San Angelo, Texas 325-944-0147
Date	04/11/2011
Approved by	Bryan Christensen
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

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2. **Presence of water flow patterns:** None, except following extremely high intensity storms when short flow patterns may appear.

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3. **Number and height of erosional pedestals or terracettes:** None.

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** 0 to 5 percent bare ground. Very small (<1 square foot) and non-connected areas.

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5. **Number of gullies and erosion associated with gullies:** None.

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

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7. **Amount of litter movement (describe size and distance expected to travel):** Very little litter movement under normal rainfall intensity. Litter is well distributed and stays in place beneath plant canopies.

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Soil surface is very stable (average soil stability values of > 4.5).

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** 0-28 inches thick, sandy loam, fine sandy loam, loam, brown, weak fine and very fine subangular blocky structure. SOM 0-3%.

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** High canopy, basal cover and density with small interspaces should make rainfall impact negligible. This site has well drained soils, deep with level to gently sloping (0 to 3 percent slopes) which produces negligible runoff and erosion.

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 midgrasses >>

    Sub-dominant: Warm-season shortgrasses >

    Other: Forbs > Cool-season grasses > Trees > Shrubs > Warm-season tallgrasses

    Additional: Forbs make up 5 percent of species composition, shrubs and trees compose up to 5 percent species composition.

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Grasses due to their growth habit will exhibit some mortality and decadence, though very slight. Little mortality evident on woody species.

14. **Average percent litter cover (%) and depth (in):** Loose litter (leaf fall) may be up to 6 inches deep.

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** Representative value for production = 3200 lbs/ac.

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:** Mesquite, huisache and cacti are the primary invaders.

17. **Perennial plant reproductive capability:** All species should be capable of reproducing except for periods of prolonged drought conditions, heavy natural herbivory and fires.