USDA Natural Resources Conservation Service

Ecological site R081CY574TX
Shallow 29-35 PZ

Last updated: 9/19/2023
Accessed: 05/11/2025

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.

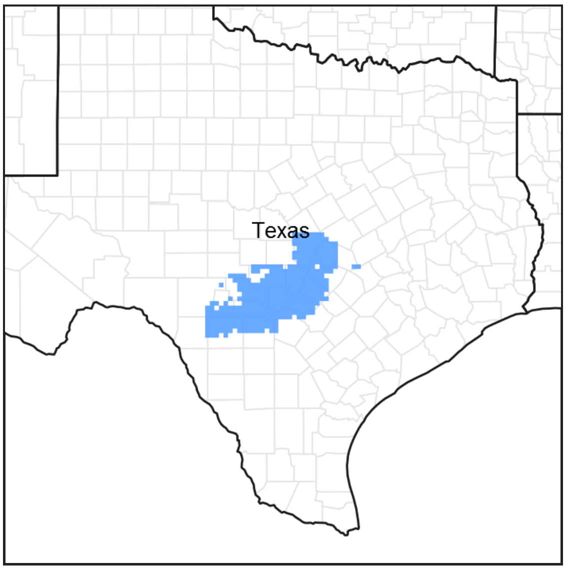


Figure 1. Mapped extent

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): 081C–Edwards Plateau, Eastern Part

This area represents the eastern part of the Edwards Plateau region. Limestone ridges and canyons and nearly level to gently sloping valley floors characterize the area. Elevation is 400 feet (120 meters) at the eastern end of the area and increases westward to 2,400 feet (730 meters) on ridges. This area is underlain primarily by limestones in the Glen Rose, Fort Terrett, and Edwards Formations of Cretaceous age. Quaternary alluvium is in river valleys.

Classification relationships

Major Land Resource Area (MLRA) and Land Resource Unit (LRU) (USDA-Natural Resources Conservation Service, 2006)
National Vegetation Classification/Shrubland & Grassland/2C Temperate & Boreal Shrubland and Grassland/M051 Great Plains Mixedgrass Prairie & Shrubland/ G133 Central Great Plains Mixedgrass Prairie Group.

Ecological site concept

These sites occur on shallow calcareous clays over hard limestone. Reference vegetation includes tall and midgrasses, numerous forbs, and few scattered shrubs. Without periodic fire or other brush management, juniper and other woody species are likely to increase on the site.

Associated sites

R081CY360TX	**Low Stony Hill 29-35 PZ** The Low Stony Hill ecological site has more surface fragments and larger fragments in the soil profile.
R081CY363TX	**Steep Rocky 29-35 PZ** The Steep Rocky ecological site has more fragments on the surface and in the soil profile and has greater slope.
R081CY357TX	**Clay Loam 29-35 PZ** The Clay Loam ecological site is down slope and has deeper soils.

Similar sites

R081CY360TX	**Low Stony Hill 29-35 PZ** The Low Stony Hill ecological site is more diverse and usually has large Texas live oaks occurring in fissures in the rock.
R081CY363TX	**Steep Rocky 29-35 PZ** The Steep Rocky ecological site is much steeper, more woody, with large boulders.

Table 1. Dominant plant species

Tree	(1) *Quercus fusiformis*
Shrub	Not specified
Herbaceous	(1) *Schizachyrium scoparium*

Physiographic features

This site is located in the 81C, Eastern Edwards Plateau Major Land Resource Area (MLRA). It is classified as an upland site. It includes smooth areas of gently sloping topography ranging to moderately sloping areas in a benched landscape. In this “stair-step” position, the Shallow site occurs as narrow contour bands in complex with another site type, such as the Adobe (081CY355TX) site. Slopes are generally 1 to 5 percent, but range up to 8 percent in the benched situation. Elevation ranges from 600 to 2,300 feet.

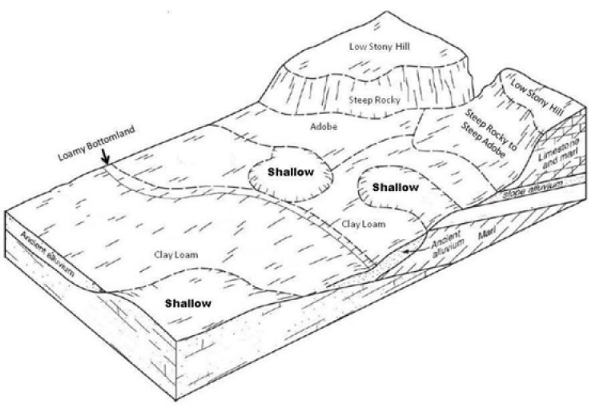


Figure 2. Shallow 081CY574TX

Table 2. Representative physiographic features

Landforms	(1) Plateau > Plain (2) Plateau > Ridge (3) Plateau > Hillslope
Runoff class	Medium to high

Flooding frequency	None
Ponding frequency	None
Elevation	600–2,300 ft
Slope	1–5%
Aspect	Aspect is not a significant factor

Table 3. Representative physiographic features (actual ranges)

Runoff class	Not specified
Flooding frequency	Not specified
Ponding frequency	Not specified
Elevation	Not specified
Slope	1–8%

Climatic features

The climate is humid subtropical and is characterized by hot summers and relatively mild winters. The average first frost should occur around November 15 and the last freeze of the season should occur around March 19.

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 southeast.

Drought is calculated as 75% below average rainfall. It should be noted that timing of rainfall may be more significant than average rainfall.

Approximately two-thirds of annual rainfall occurs during the April to September period. Rainfall during this period generally falls during thunderstorms, and fairly large amount of rain may fall in a short time. Hurricanes provide another source of extremely high rains in a short time. A review of the rainfall records suggest that rainfall is below “normal” at least 60 percent of the time. Therefore, the erratic nature of the rainfall should be considered when developing any land management plans.

The impact of droughts in the Edwards Plateau cannot be under-estimated. Not only are droughts devastating to the land but also to those that manage the land. Droughts occur roughly every 20 years but not always. A severe drought in 2012 coupled with extreme heat resulted in a die off of juniper over millions of acres as well as other native plants.

Table 4. Representative climatic features

Frost-free period (characteristic range)	220-260 days
Freeze-free period (characteristic range)	227-269 days
Precipitation total (characteristic range)	32-37 in
Frost-free period (actual range)	187-260 days
Freeze-free period (actual range)	224-332 days
Precipitation total (actual range)	31-37 in
Frost-free period (average)	235 days
Freeze-free period (average)	257 days
Precipitation total (average)	34 in

Climate stations used

- (1) MEDINA 1NE [USC00415742], Medina, TX
- (2) SAN ANTONIO/SEAWORLD [USC00418169], San Antonio, TX
- (3) KERRVILLE 3 NNE [USC00414782], Kerrville, TX
- (4) BLANCO [USC00410832], Blanco, TX
- (5) CANYON DAM [USC00411429], Canyon Lake, TX
- (6) BURNET MUNI AP [USW00003999], Burnet, TX
- (7) AUSTIN GREAT HILLS [USC00410433], Austin, TX
- (8) GEORGETOWN LAKE [USC00413507], Georgetown, TX
- (9) PRADE RCH [USC00417232], Leakey, TX

Influencing water features

This being an upland site, it is not influenced by water from a wetland or stream. These upland site 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

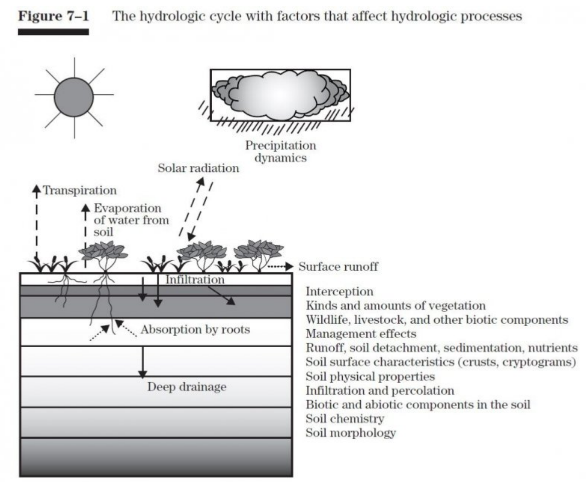


Figure 9.

Soil features

In a representative profile for the Shallow ecological site, the soils are shallow, calcareous clays. The soil material is underlain by hard limestone at a depth of 8 to 20 inches. Limestone fragments are typically less than 15 percent by volume but may range up to 35 percent. These soils take in water readily when they have good cover of mid to tall grasses and plant residue. Surface crusting is common when plant cover and soil conditions deteriorate. Fractures in the limestone bedrock generally contain fine soil particles and store moisture. Plant roots penetrate these cracks and crevices, and thus have access to more moisture and plant nutrients than is apparent in the soil. The plants on this site are relatively unpalatable because of low phosphorus content which occurs because of the limited depth and high lime content.

It should be noted that this site may contain small inclusions of other soils/sites, such as Clay Loam or Low Stony Hill, that were not delineated separately because of mapping intensity. Field investigations and verification should always preclude any inventory efforts.

The following representative soils associated with the Shallow ecological site are Doss and Purves. These are the representative map units associated with the Shallow ecological site:

Doss silty clay, 1 to 5 percent slopes
Doss-Brackett association, undulating
Purves association, undulating

Table 5. Representative soil features

Parent material	(1) Residuum–limestone
Surface texture	(1) Clay (2) Silty clay
Drainage class	Well drained
Permeability class	Moderately slow
Depth to restrictive layer	8–20 in
Soil depth	8–20 in
Surface fragment cover <=3"	0–15%
Surface fragment cover >3"	0–10%
Available water capacity (0-20in)	1–2.2 in
Calcium carbonate equivalent (0-20in)	5–70%
Electrical conductivity (0-20in)	0–2 mmhos/cm
Sodium adsorption ratio (0-20in)	0
Soil reaction (1:1 water) (0-20in)	6.6–8.4
Subsurface fragment volume <=3" (4-20in)	0–15%
Subsurface fragment volume >3" (4-20in)	0–15%

Ecological dynamics

The reference plant community is a tall and midgrass prairie with scattered trees and shrubs. The majority of the reference plant community is a Texas live oak (*Quercus fusiformis*), white shinoak (*Quercus buckleyi*) savannah. Plants such as little bluestem (*Schizachyrium scoparium*), Indiangrass (*Sorghastrum nutans*), and sideoats grama (*Bouteloua curtipendula*) dominate the inner spaces. Also prevalent but in smaller amounts are tall grama (Bouteloua pectinata), slim tridens (*Tridens muticus*), and rough tridens (*Tridens muticus* var. elongates). The historic shrub and tree community comprised as much as a 20 percent canopy consisting of Texas live oak, sumac (Rhus spp.), catclaw (Mimosa spp.), some juniper (*Juniperus ashei*), and other associated species. Numerous forbs such as zexmenia (Wedelia hispida), Dalea (Dalea spp.), sundrop (Calylophus spp.), bundleflower (Desmanthus spp.), and gayfeather (Liatris spp.) frequent the site.

Underlying geology, whether it is non-fractured limestone or fractured limestone determines the woody plant composition. (Fractured limestone favors larger and denser trees, whereas non-fractured limestone features shorter woody species and lower densities.

A study of early photographs of this region reveals that today, these sites are much denser with woody cover and less covered with grasslike vegetation. Early accounts consistently describe this region as a vast expanse of hills covered with "cedar" from San Antonio to Austin. Accounts also describe an abundance of clean, flowing water and abundant wildlife. These accounts seem to describe heavy wooded areas in mosaic patterns occurring along the highs and lows of the landscape. The shallow soils of the site are located on the foot slopes of hills in the area. These adobe soils are laid over soft limestone and are predominated by open prairie grassland species in the historic plant community.

The pre-settlement landscape is different than the landscape seen today. Observations and anecdotal records of early settlers and explorers were usually not site specific but do provide insight as to the general appearance of an area. One example is the Teran expedition in 1691 spoke of “great quantities of buffaloes” in the area. By 1840 the

Bonnell expedition reflected that “buffalo rarely range so far to the south” (Inglis, 1964). In the Helotes, Texas area an early settler, Arnold Gugger who wrote in his journal about the mid to late 1800s, “in those days buffaloes were in droves by the hundreds…..and antelopes were three to four hundred in a bunch….and deer, turkeys at any amount (Massey).”

The plant communities of this site are dynamic and vary in relation to grazing, fire, and rainfall. Studies of the pre-European vegetation of the general area suggested 47 percent of the area was wooded (Wills, 2006).

Many research studies document the interaction of bison grazing and fire (Fuhlendorf, et al., 2008.). Bison would come into an area, graze it down, leave and then not come back for many months or even years. Many times this grazing scheme by buffalo was high impact and followed fire patterns and available natural water. This long deferment period allowed the taller grasses and forbs to recover from the high impact bison grazing. This relationship created a diverse landscape.

Fire was a major influence prior to European settlement. Fire occurred from lightning strikes whenever there were accumulations of fuel load and the grass was dry enough to burn. Fires would burn extensively and unrestrained except when rainfall would put it out or there were topographical changes that served as firebreaks. Native Americans also used fire at their discretion. It is estimated that a fire frequency of 3 to 10 years was possible (Frost, 1998). It is presumed that bison were attracted to the post burned areas, leaving unburned areas relatively ungrazed. Over time, the ungrazed areas would accumulate fuel until a random fire would occur. This usually occurs in a dry year following a period of favorable rainfall. A fire/grazing interaction would result in a mosaic of grass/woody species over the landscape depending upon time since the last burn.

Overgrazing with a corresponding reduction of periodic fire has changed these communities and altered the fire regime. Because of the basic topography, this site is accessible to grazing from animals such as deer, sheep, and goats.

Slope and geologic structure played a major role in the type, formation, and composition of the woody plant community in the general area. On flatter slopes (12 to 20 percent) soils are deeper, grass cover was better and fire occurred more frequently than on steeper and rockier slopes which ranged from 20 to 60 percent. When fires did occur on the steeper slopes, they may have occurred more often on the southern slopes since predominant winds in this area are from the south. The presence of limestone escarpments (benches) running on contour to the slope often slowed or stopped less intensive fires and resulting in mosaic vegetative patterns. Periodic fires set either by Native Americans or by lighting kept oaks (Quercus spp.), Ashe juniper, prairie sumac (*Rhus copallinum*), and other woody species suppressed and confined to protected areas. The structure of the trees was probably somewhat different historically than the contemporary structure as live oak takes on a more thicketized growth form than a tree form under a fire regime.

Ashe juniper will increase regardless of grazing. Goat and probably sheep will eat young juniper and when properly used, are an effective tool to maintain juniper (Taylor, 1997; Anderson, et al., 2013). The main role of excessive grazing relative to juniper is the removal of the fine fuel needed to carry an effective burn. Ashe juniper is a non-resprouting species.

Small areas may exhibit water seepage or spring flow following long periods of rainfall because of small underground water-filled cavities slowly draining through the fractured rock and soil profile from the upper elevation. Some Eastern gamagrass will add to the mosaic pattern of the site.

Heavy continuous grazing by sheep, goats, and deer reduces the palatable forbs and browse plants. Low successional, unpalatable grasses, forbs, and shrubs have taken the place of the more desirable plant species over much of the sites’ range. The diversity of native forbs and grasses for this site are potentially greater than on the more accessible flatter slopes should proper management occur. Because of this plant diversity, no attempt in this document is made to list them all. The major key plants, however, are listed.

The screwworm fly (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, and Walker, 1965; Bushland, 1985).

Currently, due to the reduction in livestock production and a corresponding increase in land ownership for recreational purposes, predator populations are on the increase. This includes feral hogs (Sus scrofa).

Progressive management of the deer herd, because of their economic importance through lease hunting, has the objective of improving individual deer quality and improving habitat. Managed harvest based on numbers, sex ratios, condition, and monitoring of habitat quality has been effective in managing the deer herd on individual properties.

However, across the Edwards Plateau, excess numbers still exist which may lead to habitat degradation and significant die-offs during stress periods such as extended droughts.

The Edwards Plateau 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.

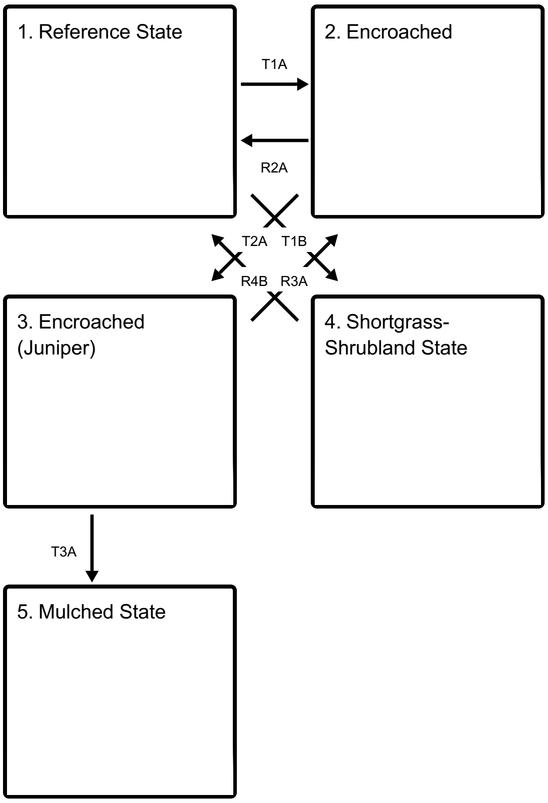
During the settlement period of the late 1800s, the deeper soil portions of the site were often put to the plow for the planting of food, hay, and grazing. Its topsoil in some places is deep enough to support some farming but it is generally not sustainable. Most of these fields today have been planted to a non-native grass such as introduced bluestems (Bothriochloa spp.), Bermuda grass (*Cynodon dactylon*), or kleingrass (*Panicum coloratum*).

The following State-and-Transition model is based 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 because of the naturally occurring variability in weather, soils, and aspect. The Reference Plant Community is not necessarily the management goal; 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 described as are other metrics. Canopy cover can drive 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 the similarity index requires the use of species composition by dry weight.

State and transition model

Ecosystem states



T1A - Absence of wildfire and other disturbance, coupled natural regeneration overtime

T1B - Long-term excessive grazing pressure, likely coupled with drought and/or absence of wildfire

R2A - Mechanical removal of woody canopy coupled with the reintroduction of wildfire

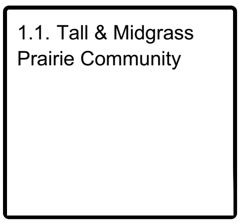
T2A - Absence of wildfire, maybe coupled with excessive grazing pressure

R3A - Mechanical removal of woody canopy

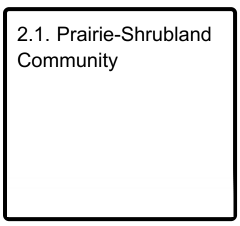
T3A - Removal and mulching of juniper

R4B - Grazing management coupled with reintroduction of wildfire

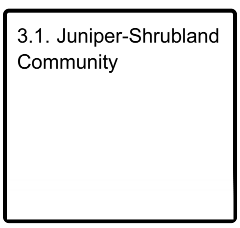
State 1 submodel, plant communities



State 2 submodel, plant communities



State 3 submodel, plant communities



State 4 submodel, plant communities

4.1. Shortgrass-Shrubland Community

State 5 submodel, plant communities

5.1. Mulched Community

State 1
Reference State

The reference state is considered to be representative of the range of variation under pre-Euro settlement conditions. Community phase changes are primarily driven by wildfire, grazing and climatic fluctuations. The plant community is characterized by a tall and midgrass prairie with scattered live oak motts.

Dominant plant species

- Texas live oak (*Quercus fusiformis*), tree
- Texas red oak (*Quercus buckleyi*), tree
- little bluestem (*Schizachyrium scoparium*), grass
- Indiangrass (*Sorghastrum nutans*), grass

Community 1.1
Tall & Midgrass Prairie Community

Figure 10. 1.1 Reference plant community with isolated juniper

Figure 11. Shallow ecological site in foreground of tall and midgrass prairie.

Figure 12. Area resembling a pre-settlement view of a Shallow ecological site.

The reference plant community is a fire managed, tall and midgrass prairie or savannah. Texas live oak trees and mottes are widely scattered, but make up less than 5 percent canopy. Little bluestem is the dominant plant on the site. Big bluestem and Indiangrass occupy favorable micro-sites and can be locally prominent. Also occurring on the site but less frequently or in smaller amounts are sideoats grama (*Bouteloua curtipendula*), tall dropseed (*Sporobolus compositus*), feather bluestem (Bothriochloa spp.), Texas wintergrass (*Nassella leucotricha*), eastern gamagrass (*Tripsacum dactyloides*), and other grasses. Many forbs are endemic to the site adding color to the landscape and providing variety to the diet of the animal community. The mixture of animals using the site will change the plant composition. Overgrazing the plant community with cattle will lead to a reduction in little bluestem, big bluestem, and Indiangrass. If the site is heavily stocked with multiple species such as cattle, sheep, goats, and wildlife the site will shift toward a plant community with very little herbaceous cover and woody trees leaving shrubs with browse lines. Research indicates juniper can establish on both overgrazed and properly grazed rangeland on this site unless goats and probably sheep are utilized (Taylor, 1997; Anderson, et al., 2013). Wildlife species are a vector in spreading the seeds through droppings. Evidence of this is observed along fence lines and under trees. Without fire on a return interval of 3 to 5 years or with managed goat grazing, the site will cross a threshold of 5 to 10 percent canopy to a Prairie Shrubland Community (2.1) in as little as 5 to 8 years. In order to implement prescribed burning, prescribed grazing is essential. This plant community can have approximately 3,800 pounds per acre of fine fuels (1 hour) accumulation with long periods of no grazing because of carryover vegetation.

Table 6. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	800	1500	1900
Tree	250	400	500
Shrub/Vine	50	100	220
Forb	60	100	200
Total	**1160**	**2100**	**2820**

Table 7. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	0%
Grass/grasslike foliar cover	0%
Forb foliar cover	0%
Non-vascular plants	0%
Biological crusts	0%
Litter	50-70%
Surface fragments >0.25" and <=3"	0-15%
Surface fragments >3"	0-15%
Bedrock	5-15%
Water	0%
Bare ground	5-10%

Table 8. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	–	45-60%	3-8%
>0.5 <= 1	–	–	3-10%	3-5%
>1 <= 2	–	–	5-15%	1-5%
>2 <= 4.5	–	1-5%	1-5%	–
>4.5 <= 13	8-15%	–	–	–
>13 <= 40	15-20%	–	–	–
>40 <= 80	–	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Figure 14. Plant community growth curve (percent production by month). TX3775, Tall and Midgrass Prairie Community. Tall and Midgrass Prairie Community.

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

State 2
Encroached

The encroached state is characterized by an increased cover and density of woody species. Herbaceous understory is reduced due to shading and competition from shrub and tree canopy. The plant community is characterized by tall and midgrasses with scattered live oak and increasing juniper.

Dominant plant species

- Texas persimmon (*Diospyros texana*), shrub
- lotebush (*Ziziphus obtusifolia*), shrub
- honey mesquite (*Prosopis glandulosa*), shrub

Community 2.1
Prairie-Shrubland Community

Figure 15. Prairie shrubland community with 5-10% canopy of juniper & 5% canopy of Texas live oak.

Shrubs make up a canopy of 5 to 10 percent. Juniper are over 8 feet tall with a 5 to 10 percent overstory of Texas live oak and other trees. Prescribed fires and selective brush management will kill small juniper species and suppress shrubs keeping them in a low growth form. (Ashe juniper is a non-resprouting plant that is easily killed by fire when less than 6 feet tall if fuel loading is adequate.) If livestock are stocked heavily and continuously, especially with goats and probably sheep, most small brush is removed as is the fine fuel needed for prescribed burning. Wildlife species endemic to the area can also browse on the plant species assisting with the suppression of growth. However, there is usually a browse line on the oak at this point. The loss of fire allows the shrub species to increase both in size and plants per acre in this plant community. Once the shrubs get established, prescribed grazing will not reduce the woody plant component unless goats are used. The main role of prescribed grazing is to retard further seeding establishment and to preserve fine fuel for prescribed burning. Major increasing shrub species usually present are Texas persimmon (*Diospyros texana*), lotebush (*Ziziphus obtusifolia*), algerita (Mahonia trifoliata), mesquite (*Prosopis glandulosa* var. glandulosa), elbowbush (*Forestiera pubescens*), shinoak (*Quercus sinuata* var. breviloba), Texas live oak and Ashe juniper. Herbivory alone was not sufficient to halt the increase in the size and number of invading shrub species. The dominant tallgrass, little bluestem, and sub-dominants, big bluestem and Indiangrass, have been severely reduced from the reference plant community. The following species may also have invaded or increased on the site during this retrogression: pricklypear cactus (*Opuntia macrorhiza*), western ragweed (*Ambrosia psilostachya*), broomweed (Amphiachyris spp.), nightshades (Solanum spp.), milkweeds (Asclepias spp.), gray goldaster (*Heterotheca canescens*), prairie coneflower (*Ratibida columnifera*), snow-on-the-mountain (*Euphorbia marginata*), filaree (Erodium spp.), plantain (Plantago spp.), horehound (*Marrubium vulgare*), evax (Evax spp.), and twinleaf senna (Senna roemariana). Similarly, the following midgrasses have increased: sideoats grama, buffalograss (*Bouteloua dactyloides*), hairy tridens (*Erioneuron pilosum*), slim tridens, hairy grama (*Bouteloua hirsuta*), red grama (*Bouteloua trifida*), Texas grama (*Bouteloua rigidiseta*), tall dropseed (*Sporobolus compositus*), feather bluestem, threeawn (Aristida spp.), and other annual grasses. If the management goal is the reference plant community (1.1), this community can recover with brush management, fire, and prescribed grazing. Unless adequate amounts of historic plants are still available, the seeding of native species may be needed to accelerate the process. The transformation from a Prairie Shrubland (2.1) to a Juniper-Shrubland State (3) occurs when fires are absent and brush management is not done; regardless of grazing treatment. A threshold is crossed when juniper exceeds 10 to 20 feet tall and has a canopy of about 30 percent. This threshold can be crossed in as little as 25 to 30 years from the reference plant community. Unless there is timely intervention, no amount of proper grazing will stop the transition to the Juniper-Shrubland State (3). This plant community, because of its fine fuel and juniper is at risk for wildfires during severe weather conditions.

Table 9. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	600	850	1000
Tree	300	600	900
Shrub/Vine	100	250	350
Forb	20	150	250
Total	**1020**	**1850**	**2500**

Figure 17. Plant community growth curve (percent production by month). TX3776, Prairie Shrubland Community. Prairie Shrubland Community.

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

State 3
Encroached (Juniper)

This state is characterized by the dominance of Ashe juniper. Canopy cover may exceed 30 percent. Understory species are severely reduced due to shading, competition for soil moisture, and accumulation of juniper leaves/litter. Cool-season grasses and sedges dominate understory. Juniper 10-20 feet tall and 30+% woody canopy.

Dominant plant species

- Ashe's juniper (*Juniperus ashei*), tree
- cedar sedge (*Carex planostachys*), grass
- Texas wintergrass (*Nassella leucotricha*), grass

Community 3.1
Juniper-Shrubland Community

Figure 18. Juniper shrubland community with 30% canopy of juniper & 5% canopy of Texas live oak.

The Juniper Shrubland Community (3.1) represents the crossing of a threshold. It can take as little as 25 to 30 years from the reference plant community or less than 10 years from the Prairie-Shrubland unless maintenance brush management is done. Woodies dominate the site in this community with Ashe juniper 10 to 20 feet tall with canopies in excess of 30 percent. Shade tolerant species, such as cedar sedge (*Carex planostachys*) and Texas wintergrass dominate the understories which are void of sunlight. Grass and forb vegetation is significantly reduced because of the severe competition that Ashe juniper and other woody species present regarding sunlight and moisture. Large areas that were once vast grasslands are covered in heavy woody species, such as Ashe juniper, Texas live oak, honey mesquite, algerita, Texas persimmon, elbowbush, and lotebush. The majority of the soil surface on this densely canopied site will have a thick mat of juniper leaves or other shrub leaf material. The open areas between canopies will produce a grass cover primarily composed of lower successional species, such as threeawn, tridens, and dropseeds. Grazing management alone will not restore this community back to the Tall and Midgrass Community (1.1) or the Prairie Shrubland Community (2.1). To transition this site back to the Reference Plant Community (1.1), an integrated therapy of brush management, prescribed burning, possibly range planting, and prescribed grazing will be needed. This plant community is at risk of sustained crown wildfires when severe weather conditions exist.

Table 10. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	600	850	1000
Tree	300	600	900
Shrub/Vine	100	250	350
Forb	20	150	250
Total	**1020**	**1850**	**2500**

Figure 20. Plant community growth curve (percent production by month). TX3763, Oak/Juniper Woodland. Oak/Juniper Woodland.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5	7	8	12	15	10	5	4	12	10	7	5

State 4
Shortgrass-Shrubland State

This state is characterized by the loss of warm-season tall grasses. Infiltration and nutrient cycling are spatially and temporarily truncated. Short grasses, annual forbs understory, overstory of oak 5-10% and Juniper 10-20 feet tall and >10% woody canopy.

Dominant plant species

- Texas live oak (*Quercus fusiformis*), shrub
- Ashe's juniper (*Juniperus ashei*), shrub
- buffalograss (*Bouteloua dactyloides*), grass
- tridens (*Tridens*), grass

Community 4.1
Shortgrass-Shrubland Community

Figure 21. Heavy continuous grazing over long periods of time can even cause juniper to be absent.

This plant community has crossed a threshold driven by the heavy and long term stocking of mixed classes of livestock. Droughts hasten the process. This plant community can probably be derived from any of the prior communities by this same type of grazing and browsing over long periods of time but it is primarily the 1.1 and 2.1 plant communities. There is a 5 to 10 percent overstory of Texas live oak and other trees with little understory. Heavy browsing has removed almost all the plant material the animals can reach except for the most unpalatable shrubs. In this condition, there is not enough fine fuel to carry a prescribed burn. Even though there is a loss of fire, it is still difficult for any shrub to become established as long as heavy browsing pressure remains. Major increasing shrub species usually present are Texas persimmon, lotebush, algerita, mesquite, shinoak and Texas live oak. The dominant, little bluestem, and sub-dominants, big bluestem and Indiangrass are non-existent except where the crevasses in the rocks have offered refuge. The following species may also occur in this plant community: pricklypear cactus, western ragweed, broomweed, nightshades, milkweed, gray goldaster, prairie coneflower, snow-on-the-mountain, filaree, plantain, horehound, evax, twinleaf senna, and mealy cup sage (*Salvia farinacea*). Similarly, the following short grasses exist: sideoats grama (only in protected places), curlymesquite, buffalograss, hairy tridens, slim tridens, hairy grama, red grama, Texas grama, feather bluestem, threeawn, and other annual grasses. The reference plant community (1.1) may no longer be an option for management in a reasonable amount of time. This is because of the loss of key plants and probable loss of topsoil with which to recover. It is possible for some key plants to exist within the protected area of rocks and plant but recovery will be slow and will take prescribed grazing and possibly reseeding although this is a questionable option as well. Soil depth is a limiting factor and the potential for recovery is couched on the amount of topsoil remaining. Soil compaction may also be a limitation. With prescribed grazing, and possibly seeding, the plant communities may begin to respond. The first need is to restore hydrologic function to hold rainfall on the land allowing it to soak into the soil. Once this trend is established the natural functions of freezing, thawing, drying, wetting, and healthy plant roots may begin to restore health and function in the soil. This may take as much as 25 to 30 years under the best of conditions. Once plant cover has been restored, the plant community needs to be monitored to prevent the establishment of secondary plants such as Ashe juniper.

Table 11. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	350	550	750
Tree	300	500	700
Forb	300	450	600
Shrub/Vine	30	50	70
Total	**980**	**1550**	**2120**

Figure 23. Plant community growth curve (percent production by month). TX3776, Prairie Shrubland Community. Prairie Shrubland Community.

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

State 5
Mulched State

Open savannah, 5-15% oak canopy, some grasses, heavy mulch.

Community 5.1
Mulched Community

Figure 24. Mulched juniper shrubland on a Patrick soil in Bexar County.

Figure 25. Mulched juniper shrubland on a Patrick soil in Bexar County.

Figure 26. Heavy equipment is used to convert standing juniper to mulch on a Patrick soil.

This plant community has crossed a threshold from the Juniper/Shrubland Community using heavy equipment. There is a 5 to 15 percent canopy of Texas live oak and other trees with little understory. The structural aspect of this plant community is very similar to the 1.1 Tall and Midgrass Prairie but is missing many of the signature grasses, forbs, and shrubs and usually contains non-native species such as introduced bluestems. Bare ground is less than 1 percent, while the depth of woody chips varies from 0 to 8 inches. The majority of chip coverage is 3 to 4 inches deep. The long-term recovery of this plant community to 1.1 is unknown and relies on several factors. The depth of the mulch, the availability of residual native seeds and the rate of return of the mulch to the soils are factors. In terms of site function, the mulch captures most of the rainfall occurring with little or no runoff or subsequent erosion. Sunlight penetration to the ground to foster the germination of plants is a limiting factor on the thickest areas of mulch. Over time the mulch begins to settle and will be very slow to return to the soil via ecological processes. Those plants that do germinate and protrude above the mulch are very robust because of the conservation of moisture in the rooting zone and the insulation from evaporation. It is anticipated that organisms living in the soil that digest the lignin and cellulose from the mulch will be benefited from an improved micro-habitat. However, on the thicker mulched portions of the site, it is unknown how these micro-organisms will persist, although it is assumed that they will increase as mulch decreases. With time the plant community will change. Juniper will reestablish as will other plants. Plants that are root and crown sprouters will have an advantage over those recovering from seed. The use of prescribed burning will not only accelerate the mineralization of the mulch but can also maintain the openness of this community. The frequency of prescribed burning is unknown on mulched sites as fire intensity will be different than a grassland. To prevent juniper from growing in stature until it is no longer manageable with fire, burning when juniper is less than 4 feet tall is recommended.

Table 12. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	2450	2857	3300
Forb	210	248	285
Tree	120	145	175
Shrub/Vine	40	50	60
Total	**2820**	**3300**	**3820**

Figure 28. Plant community growth curve (percent production by month). TX3776, Prairie Shrubland Community. Prairie Shrubland Community.

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

Transition T1A
State 1 to 2

This transition reflects the crossing of a threshold into a different vegetative state. This transition is driven by a lack of fire, no brush management, and no prescribed grazing. Sunlight energy is increasingly being diverted to woody species such as juniper. The water cycle is also being altered as more and more rainfall is being trapped in the canopy of the woody species.

Transition T1B
State 1 to 4

This transition is driven by a lack of fire and no prescribed grazing that would set up a burn. Excessive long term removal of leaf material from the desirable grasses, forbs, and shrubs results in sunlight energy only being diverted to taller woody species and annual plants. The water cycle is ineffective as there is little vegetation or ground cover to absorb rainfall into the soil to grow herbaceous grasses and forbs. Runoff increases and carries with it sediment.

Restoration pathway R2A
State 2 to 1

The recovery to the Grassland State is driven by significant inputs of energy from equipment such as skid loaders, bulldozers, or other brush management equipment. The removal of unwanted species will restore sun energy more to the herbaceous plants and will remove the canopy that is entrapping rainfall.

Transition T2A
State 2 to 3

This transition is driven by a lack of fire, no brush management, and no prescribed grazing that would set up a burn. No amount of grazing deferment will stop the advance of juniper once it gets to this size. Sunlight energy is increasingly being diverted to woody species such as juniper. The water cycle is also being altered as more and more rainfall is being trapped in the canopy of the woody species and not being absorbed into the soil to grow herbaceous grasses and forbs.

Restoration pathway R3A
State 3 to 2

The recovery to the Prairie Shrubland or the Grassland State is driven by significant inputs of energy from equipment such as skid loaders, bulldozers, or other brush management equipment. The selective removal of unwanted species will restore sun energy more to the herbaceous plants and will remove the canopy that is entrapping rainfall. With time, favorable weather and prescribed grazing, prescribed burning will be once more an option.

Transition T3A
State 3 to 5

Mechanical conversion of primarily juniper canopy to a mulch cover restores the energy flow to the remaining species, usually oak. The hydrologic cycle retains nearly all the rainfall because of the heavy mulch. Little evaporation takes place.

Restoration pathway R4B
State 4 to 1

The recovery to the Prairie Shrubland is achieved by allowing herbaceous grasses to strengthen their root system and restore more solar energy to the herbaceous plants. This will replenish the canopy and ground cover of grass that can entrap rainfall. With time, favorable weather and prescribed grazing, prescribed burning will be once more an option. Erosion will be stabilized although the plant community may never fully recover if past erosion has been severe.

Additional community tables

Table 13. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Tallgrasses**			500–2200	
	little bluestem	SCSC	*Schizachyrium scoparium*	50–500	–
	Indiangrass	SONU2	*Sorghastrum nutans*	50–200	–
	eastern gamagrass	TRDA3	*Tripsacum dactyloides*	0–200	–
	big bluestem	ANGE	*Andropogon gerardii*	50–200	–
	switchgrass	PAVI2	*Panicum virgatum*	0–100	–
2	**Midgrasses**			325–450	
	sideoats grama	BOCU	*Bouteloua curtipendula*	100–250	–
	tall grama	BOHIP	*Bouteloua hirsuta var. pectinata*	100–250	–
	plains lovegrass	ERIN	*Eragrostis intermedia*	100–250	–
	Texas cupgrass	ERSE5	*Eriochloa sericea*	100–250	–
	green sprangletop	LEDU	*Leptochloa dubia*	100–250	–
	Reverchon's bristlegrass	SERE3	*Setaria reverchonii*	100–150	–
3				50–125	
	threeawn	ARIST	*Aristida*	25–75	–
	cane bluestem	BOBA3	*Bothriochloa barbinodis*	25–75	–
	silver beardgrass	BOLAT	*Bothriochloa laguroides ssp. torreyana*	25–75	–
	composite dropseed	SPCO16	*Sporobolus compositus*	25–75	–

	composite dropseed	SPCOC2	*Sporobolus compositus var. compositus*	25–75	–
	slim tridens	TRMU	*Tridens muticus*	25–75	–
	slim tridens	TRMUE	*Tridens muticus var. elongatus*	25–75	–
	fall witchgrass	DICO6	*Digitaria cognata*	10–50	–
	curly-mesquite	HIBE	*Hilaria belangeri*	10–50	–
	buffalograss	BODA2	*Bouteloua dactyloides*	10–50	–
	hairy grama	BOHI2	*Bouteloua hirsuta*	10–50	–
4	**Cool-season Grasses**			70–125	
	cedar sedge	CAPL3	*Carex planostachys*	25–75	–
	Canada wildrye	ELCA4	*Elymus canadensis*	25–75	–
	Virginia wildrye	ELVI3	*Elymus virginicus*	25–75	–
	Texas wintergrass	NALE3	*Nassella leucotricha*	25–75	–
Forb					
5	**Forbs**			50–125	
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	10–40	–
	white sagebrush	ARLUM2	*Artemisia ludoviciana ssp. mexicana*	10–40	–
	aster	ASTER	*Aster*	10–40	–
	yellow sundrops	CASE12	*Calylophus serrulatus*	10–40	–
	croton	CROTO	*Croton*	10–40	–
	prairie clover	DALEA	*Dalea*	10–40	–
	bundleflower	DESMA	*Desmanthus*	10–40	–
	blacksamson echinacea	ECAN2	*Echinacea angustifolia*	10–40	–
	Engelmann's daisy	ENPE4	*Engelmannia peristenia*	10–40	–
	beeblossom	GAURA	*Gaura*	10–40	–
	starviolet	HEDYO2	*Hedyotis*	10–40	–
	Maximilian sunflower	HEMA2	*Helianthus maximiliani*	10–40	–
	trailing krameria	KRLA	*Krameria lanceolata*	10–40	–
	dotted blazing star	LIPU	*Liatris punctata*	10–40	–
	Nuttall's sensitive-briar	MINU6	*Mimosa nuttallii*	10–40	–
	yellow puff	NELU2	*Neptunia lutea*	10–40	–
	narrowleaf Indian breadroot	PELI10	*Pediomelum linearifolium*	10–40	–
	beardtongue	PENST	*Penstemon*	10–40	–
	smartweed leaf-flower	PHPO3	*Phyllanthus polygonoides*	10–40	–
	slimflower scurfpea	PSTE5	*Psoralidium tenuiflorum*	10–40	–
	wild petunia	RUELL	*Ruellia*	10–40	–
	white rosinweed	SIAL	*Silphium albiflorum*	10–40	–
	awnless bushsunflower	SICA7	*Simsia calva*	10–40	–
	fuzzybean	STROP	*Strophostyles*	10–40	–
6	**Annual Forbs**			0	
	prairie broomweed	AMDR	*Amphiachyris dracunculoides*	0	–
Shrub/Vine					
7	**Shrubs/Vines**			20–50	
	Texas persimmon	DITE3	*Diospyros texana*	10–25	–

	Texas kidneywood	EYTE	*Eysenhardtia texana*	10–25	–
	stretchberry	FOPU2	*Forestiera pubescens*	10–25	–
	algerita	MATR3	*Mahonia trifoliolata*	10–25	–
	bastard oak	QUSIB	*Quercus sinuata var. breviloba*	10–25	–
	sumac	RHUS	*Rhus*	10–25	–
	gum bully	SILA20	*Sideroxylon lanuginosum*	10–25	–
	greenbrier	SMILA2	*Smilax*	10–25	–
Tree					
8	**Trees**			50–125	
	Texas live oak	QUFU	*Quercus fusiformis*	0–125	–
	hackberry	CELTI	*Celtis*	0–100	–

Animal community

This site is used for the production of domestic livestock and to provide habitat for native or exotic wildlife species. Cow-calf operations are the primary livestock enterprise although stocker cattle are also grazed. Sheep and goats were formerly raised in large numbers and are still present in reduced numbers. Sustainable stocking rates have declined drastically over the past 100 years because of the deterioration of the reference plant community. An assessment of vegetation useful to the management species is needed to determine correct stocking rates.

A large diversity of wildlife utilizes this site for at least a portion of their habitat needs. Historically, large migrating herds of bison, resident herds of pronghorn, white-tailed deer, and other species were prominent. Prairie chickens (Tympanuchus spp.) were even reported for some areas within the region. With the demise of these species and the changes in the plant community, the variety of wildlife has changed.

With the eradication of the screwworm fly (Cochilomyia hominivorax), the increase in woody vegetation, and insufficient natural predation, white-tailed deer numbers have increased drastically and are often in excess of carrying capacity. Where deer numbers are excessive, overbrowsing and overuse of preferred forbs and browse has caused the deterioration of the plant community. Progressive management of deer populations is needed to keep populations in balance and provide an economically important ranching enterprise. Achieving a balance between woodland and more open plant communities on this site is an important key to deer management. Because of the overlapping diet preferences, competition among deer, sheep, and goats can be an important consideration in livestock and wildlife management. Smaller mammals included many kinds of rodents, jackrabbit, cottontail rabbit, raccoon, skunk, opossum, and armadillo. Mammalian predators include coyote, red fox, gray fox, bobcat, and mountain lion. Many species of snakes and lizards are native to the site.

Many species of birds are found on this site including game birds, songbirds, and birds of prey. The major economically important game birds include the Rio Grande turkey, bobwhite quail, and mourning dove. Turkey prefer plant communities with substantial amounts of shrubs and trees interspersed with grassland. Quail prefer plant communities with a combination of low shrubs, bunchgrass, bare ground, and low successional forbs. The different species of songbirds vary in their habitat preferences. In general, a habitat that provides a large variety of grasses, forbs, shrubs, vines, and trees benefit the most species. This complex ecosystem of grassland, savannah, shrubland, and woodland will support a good variety and abundance of songbirds. Birds of prey are important to keep the numbers of rodents, rabbits, and snakes in balance; therefore, the different plant communities of the site will sustain different species of raptors. These raptors can prey on domestic animals as well.

Various kinds of exotic wildlife have been introduced on the site including aoudad sheep, blackbuck antelope, and axis, sika, fallow, and red deer. Their numbers should be managed in the same manner as livestock and white-tailed deer to prevent damage to the plant community. Feral hogs are present and can cause damage when their numbers are not managed.

Plant Preference by Animal Kind:
This rating system provides general guidance as to animal forage preference for plant species. It also indicates possible competition and diet overlap between kinds of herbivores. Grazing preference changes from time to time,

especially between seasons, and between animal kinds and classes. An animal's preference or avoidance of certain plants is learned over time through grazing experience and maternal learning (http://extension.usu.edu/behave/Grazing). Preference does not necessarily reflect the ecological status of the plant within the plant community. For wildlife, plant preferences for food are rated. Refer to detailed habitat guides for a more complete description of a species habitat needs.

Preferred (P) – Percentage of plant in animal diet is greater than it occurs on the land.
Desirable (D) – Percentage of plant in animal diet is similar to the percentage composition on the land.
Undesirable (U) – Percentage of plant in animal diet is less than it occurs on the land.
Not Consumed (N) – Plant would not be eaten under normal conditions; only consumed when other forages not available.
Used, but Degree of Utilization Unknown (X) – Percentage of plant in animal diet is unknown.
Toxic (T) – Rare occurrence in diet and, if consumed in any tangible amounts, can result in death or severe illness in animal.

Hydrological functions

The existing plant community with representative plant species, current soil conditions (soil health), current management, and climate determine the dynamics of the water cycle. The hydrology of this site is complex and still not fully understood. Plant and litter cover are important factors which protect the site from erosion; however, total production and particularly the types of plant species present have a greater impact on hydrologic dynamics (infiltration capacity, runoff, and soil losses). For example, cover values could be similar among the three plant states (transition diagram), but hydrology (infiltration capacity, water holding capacity, and runoff) will be different. The common denominator is not cover. Furthermore, the most important factors are the types of plants and their relative abundance; in other words, biomass is first and cover is second.

Another important factor is the structure and morphology of the root system associated with the plant species. The items associated with high hydrologic function are organic matter content, non-compacted soil surface (lower bulk density), intact soil structure, high porosity, high aggregate stability and the presence of soil biotic factors, such as earthworms, fungi, blue-green algae, and mosses (when moist).

State 1

With reference to the transitional pathway diagram, the Tall and Midgrass Prairie (reference community) is associated with the maximum hydrologic function. The high degree of hydrologic function in State 1 is because of the dominance of rhizomatous tall and midgrasses. As explained above, when properly managed, these species provide adequate cover. However, one of the keys to high hydrologic function is the structure or morphology of the root system. During high rainfall periods, water will percolate beyond the immediate surface root zone via fractures in the limestone. As this water moves downward, it contributes to the recharge of aquifers if the underlying soils and geology are appropriate.

When conditions are representative of a high composition of tall and midgrass species, little runoff occurs. For example: 50-year average = 35 inches rainfall, Johnson City; 1 inches runoff, 0.26 ton per acres soil loss. The exception is high-intensity thunderstorms. High-intensity storms will produce some runoff; however soil loss will still be less than 1 ton per acre. Rangeland hydrology research and models, such as the Rangeland Hydrology and Erosion Model, reveals that precipitation, runoff, and erosion increases as the storm return period increases with 2-year, 5-year, 10-year, 25-year, or 50-year storms.

Return period analysis based on 50 years of climate:

Storm Return Period Precipitation (in) Runoff (in) Erosion t/ac
Average 50 years 34.1 1.1 0.3
5 years 39.8 1.9 0.5
10 years 43.1 2.5 0.7
25 years 49.7 3.6 0.9
50 years 51.8 7.3 0.9

Based on 50 years of climate data, there is a 96 percent chance there will be a runoff and delivered sediment for these conditions. (Rangeland Hydrology and Erosion Model Predictions—model calibrated from field data).

Return Period Analysis
To help interpret the table, note that a 5-year value will be exceeded, on the average, about once every 5 years, or twice every 10 years. There is a one in five, or 20 percent, chance that a value equal to or greater than the 5-year value will occur in a given year. There is a (100 - 20), or 80 percent, chance that the precipitation, runoff, erosion, or sediment yield will be less than the 5-year value. In the results shown in the table, there is a 20 percent chance that the annual erosion will exceed about 0.5 ton per acre. At best, any predicted runoff or erosion value, by any model, will be within plus or minus 50 percent of the true value. Erosion rates are highly variable.

State 2

Improper grazing management starts the chain reaction causing loss or reduction of the rhizomatous tall and midgrasses. Prolonged improper grazing management, no brush management, no prescribed fire, and the introduction of invasive species results in impaired hydrologic function. During the transition phase from State 1 to State 2: infiltration decreases, runoff increases, and soil loss may begin because of shifts in grass composition from tall and midgrasses species to short species (some bunch and sod formers), higher percentages of bare ground, rainfall splash, soil compaction and capping, loss of organic matter, and deterioration in structure. Hydrologic conditions worsen with continued improper management.

Return period analysis based on 50 years of climate:

Storm Return Period Precipitation (in) Runoff (in) Erosion t/ac
Average 50 years 34.1 3.2 1.7
5 years 39.8 4.3 2.8
10 years 43.1 5.6 3.2
25 years 49.7 7.9 3.5
50 years 51.8 11.6 3.6

Based on 50 years of climate data, there is a 100 percent chance there will be runoff, erosion, and delivered sediment for these conditions. (Rangeland Hydrology and Erosion Model Predictions—model calibrated from field data).

With a combination of increasing bare ground, shorter cover, less leaf area, and high-intensity storms; this site can contribute to an increased frequency and severity of flooding within a watershed.

State 3

This state is representative of the Juniper Shrubland Community dominated by woody plants. Understory species become increasingly sparse because of shading and competition from woody plants. As Ashe juniper becomes mature (10 to 20 feet tall) and density increases, bare ground increases. Research has shown that hydrologic function in the interspace area between shrubs deteriorates. Vegetative ground cover decreases as woody canopy increases.

Return period analysis based on 50 years of climate:

Storm Return Period Precipitation (in) Runoff (in) Erosion t/ac
Average 50 years 34.1 3.8 3.7
5 years 39.8 5.5 5.4
10 years 43.1 6.8 6.7
25 years 49.7 8.3 8.3
50 years 51.8 13.1 8.5

Based on 50 years of climate data, there is a 100 percent chance there will be runoff, erosion, and delivered sediment for these conditions. (Rangeland Hydrology and Erosion Model Predictions—model calibrated from field data).

As the site becomes dominated by woody species, especially oaks and juniper, the water cycle is further altered.

Interception of rainfall by tree canopies is increased which reduces the amount of rainfall reaching the surface. Interception can be as great as 10 to 46 percent. Stem flow is increased by the funneling effect of the canopy resulting in increased soil moisture at the base of the tree.

Juniper litter can be an advantage and a disadvantage Even though litter is water repellent; the litter can store water and conserve moisture in the upper soil horizon. In some cases though, the water repellency can result in an increased runoff in the interspace areas. Excess litter also holds moisture like a sponge and prevents it from moving downward into the soil profile. This impact is worsened when rainfall comes in small amounts. Juniper litter has a decreased decomposition rate and enters the carbon soil pool more slowly.

When evergreen species such as Texas live oak and juniper dominate, their transpiration reduces the chance for deep percolation, especially during a drought situation. Juniper and oak roots are coarser and can reach deeper into soils with stones and crevices than grasses with their finer roots. This gives them access to water for survival at the expense of the grasses and a competitive advantage.

It should be noted that not all sites are recharge sites. Recharge is highly dependent upon porous geology. Some research reveals that the reductions in evapotranspiration from tree and shrub removal are offset by transpiration from the herbaceous plants that replace the shrubs and by evaporation from newly exposed soil. In these cases, it becomes a management decision as to which plants are best suited to use the available soil moisture for the desired use.

Because of the very high shrink-swell clay soil and the formation of surface cracks in dry periods, rainfall infiltration can still occur even when ground cover is poor. 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. Soil erosion is accelerated, quality of surface runoff is poor, and sedimentation increased.

Brush management combined with good grazing management can help restore the natural hydrology of the site. However a threshold may have been crossed, if the soil surface conditions have deteriorated because of excessive overland flow or runoff, loss of organic matter, and excessive erosion. The return to State 1 hydrology depends on the length of time and severity of soil loss in State 3. Therefore, restoration to State 1 hydrology may not be possible or realistic.

If a mature woodland canopy develops, a buildup of leaf litter occurs which increases the organic matter of the soil, builds structure, improves infiltration, and retards erosion. Some values of a properly functioning water cycle are restored on this site when a woodland plant community persists. Unfortunately, not all factors will ever return to the original condition.

Recreational uses

This site has the appeal of the wide open spaces. The abundant tall and mid grasses and scattered oaks produce beautiful fall color variations. The area is also used for hunting, birding and other eco-tourism related enterprises.

Wood products

Honey mesquite and oaks can be used for firewood and the specialty wood industry.

Inventory data references

The data contained in this document is derived from analysis of inventories, clipping studies, and ecological interpretation from field evaluations.

Other references

Anderson, J.R., C.A. Taylor, Jr., C.J. Owens, J.R. Jackson, D.K. Steele, and R. Brantley. 2013. Using experience and supplementation to increase juniper consumption by three different breeds of sheep. Rangeland Ecol. Management. 66:204-208. March.

Archer S. 1994. Woody plant encroachment into southwestern grasslands and savannas: rates, patterns and proximate causes. in: Ecological implications of livestock herbivory in the West, pp.13-68. Edited by M. Vavra, W. Laycock, R. Pieper, Society for Range Management Publication. , Denver, Colorado.

Bestelmeyer, B.T., J.R. Brown, K.M. Havsted, R. Alexander, G. Chavez, and J.E. Hedrick. 2003. Development and use of state-and-transition models for rangelands. Journal of Range Management. 56(2): 114-126.

Bushland, R.C. 1985. Eradication program in the southwestern United States. Symposium on eradication of the screwworm from the United States and Mexico. Misc. Pub. Entomol. Soc. Am., 62:12-15.

Foster, J.H. 1917. The spread of timbered areas in central Texas. Journal of Forestry 15:442-445.

Frost, C. C. 1998. Presettlement fire frequency regimes of the Unites States: a First Approximation. Tall Timbers Fire Ecology Conference Proceedings. No. 20. Tall Timbers Research Station. Tallahassee, FL.

Fuhlendorf, S. D., and Engle D.M., Kerby J., and Hamilton R. 2008. Pyric Herbivory: rewilding Landscapes through the Recoupling of Fire and Grazing. Conservation Biology. Volume 23, No. 3, 588-598.

Hamilton W. and D. Ueckert. 2005. Rangeland Woody Plant Control--Past, Present, and Future. Chapter 1 in: Brush Management-Past, Present, and Future. Texas A & M University Press. Pp.3-16.

Hanselka, W., R. Lyons, and M. Moseley. 2009. Grazing Land Stewardship – A Manual for Texas Landowners. Texas AgriLife Communications, http://agrilifebookstore.org.

Hart, C., R.T. Garland, A.C. Barr, B.B. Carpenter, and J.C. Reagor. 2003. Toxic Plants of Texas. Texas Cooperative Extension Bulletin B-6103 11-03.

Inglis, J. M. 1964. A History of Vegetation on the Rio Grande Plains. Texas Parks and Wildlife Department, Bulletin No. 45. Austin, Texas.

Massey, C.L. 2009. The founding of a town – The Gugger and Benke families. Helotes Echo, July 1, 2009.

Natural Resources Conservation Service. 1994. The Use and Management of Browse in the Edwards Plateau of Texas. Temple, Texas.

Plant symbols, common names, and scientific names according to USDA/NRCS Texas Plant List (Unpublished)

Pyne, S.J. 1982. Fire in America. Princeton University Press, Princeton, NJ.

Roemer, Ferdinand Von. 1983. Roemer's Texas. Eakins Press.

Schmidly, D.J. 2002. Texas natural history: a century of change. Texas Tech University Press, Lubbock.

Scifres, C.J. and W.T. Hamilton. 1993. Prescribed Burning for Brush Management: The South Texas Example. Texas A & M University Press, 245 pp.

Smeins, F., S. Fuhlendorf, and C. Taylor, Jr. 1997. Environmental and Land Use Changes: A Long Term Perspective. Chapter 1 in: Juniper Symposium 1997. Texas Agricultural Experiment Station. Pp 1-21.

Taylor, C.A. (Ed.). 1997. Texas Agriculture Experiment Station Technical Report 97-1 (Proceedings of the 1997 Juniper Symposium), Sonora Texas, pp. 9-22.

Teer, J.G., J.W. Thomas, and E.A. Walker. 1965. Ecology and Management of White-tailed Deer in the Llano Basin of Texas. Wildlife Monographs 10: 1-62.

Thurow, T.O. and J.W. Hester. 1997. 1997 Juniper Symposium. Texas Agricultural Experiment Station, The Texas A&M University System. Tech. Rep. 97-1. January 9-10, 1997. San Angelo, Texas

USDA-NRCS (Formerly Soil Conservation Service) Range Site Description (1972)

Vines, R.A. 1984. Trees of Central Texas. University of Texas Press. Austin, Texas.

Weninger, D. 1984. The Explorer's Texas. Eakin Press; Waco, Texas.

Wilcox. B.P. and T.L. Thurow. 2006. Emerging Issues in Rangeland Ecohydrology: Vegetation Change and the Water Cycle. Rangeland Ecol. Management. 59:220-224, March.

Wilcox, B.P., Y. Huang, and J.W. Walker. 2008. Long-term trends in stream flow from semiarid rangeland: uncovering drivers of change. Global Change Biology 14: 1676-1689, doi:10.1111/j.1365.2486.2008.01578.

Wilcox, B.P., W.A. Dugas, M.K. Owens, D.N Ueckert, and C.R. Hart. 2005. Shrub Control and Water Yield on Texas Rangelands: Current State of Knowledge. Texas Agricultural Experiment Station Research Report 05-1.

Wills, Frederick. 2006. Historic Vegetation of Camp Bullis and Camp Stanley, Southeastern Edwards, Plateau. Texas. Texas Journal of science. 58(3):219-230.

Wright, H.A. and A.W. Bailey. 1982. Fire Ecology: United States and Southern Canada. John Wiley & Sons, Inc.

Wu. B.X., E.J. Redeker, and T.L. Thurow. 2001. Vegetation and Water Yield Dynamics in an Edwards Plateau Watershed. Journal of Range Management. 54:98-105. March 2001.
http://extension.usu.edu/behave/ (Accessed 6/6/2013)

Contributors

Carl Englerth
Dr. Kenneth Spaeth, RMS, NRCS, Fort Worth, Texas
Joe Franklin
Mark Moseley
Edits by Travis Waiser, MLRA Leader, NRCS, Kerrville, TX

Approval

Bryan Christensen, 9/19/2023

Acknowledgments

Reviewers and Contributors:
Joe Franklin, RMS, NRCS, San Angelo, Texas
Ryan McClintock, Biologist, San Angelo, Texas
Bryan Hummel, Natural Resources Technician, Joint Base San Antonio–Camp Bullis, Texas
Mark Moseley, ESS, NRCS, Boerne, Texas
Ann Graham, Editor, NRCS, Temple, Texas
Jessica Jobe, Project Leader, NRCS, Kerrville, Texas
Travis Waiser, Soil Scientist, NRCS, Kerrville, Texas

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.

QC/QA completed by:
Bryan Christensen, SRESS, NRCS, Temple, TX
Erin Hourihan, ESDQS, NRCS, Temple, TX

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)	Zone RMS, San Angelo, Texas
Contact for lead author	325-944-0147
Date	02/14/2012
Approved by	Colin Walden
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:** None, except following extremely high intensity storms where short flow patterns may appear.

---

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

---

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** 0-10% bare ground randomly distributed throughout in small and non-connected areas.

---

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

---

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

---

7. **Amount of litter movement (describe size and distance expected to travel):** Under normal rainfall, little litter movement should be minimal and short (<6").

---

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

---

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil surface is very dark grayish brown silty clay 9 inches thick that contains soft bodies of calcium carbonate. Moderately

alkaline. SOM is 1-3%.

---

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** The savannah of tallgrasses, midgrasses, forbs and trees having adequate litter and little bare ground 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):** No evidence of compaction.

---

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 Trees

    Other: Forbs Cool-season grasses = Forbs = Warm-season shortgrasses Shrubs

    Additional: Forbs make up 4%, Shrubs make up 2% and Trees make up 4%.

---

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Perennial grasses will naturally exhibit a minor amount (less than 5%) of senescence and some mortality every year.

---

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

---

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** 970 to 2,820 pounds per year

---

16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:** Ashe Juniper is dominant, honey mesquite, prickly pear, bermudagrass, Johnsongrass, King Ranch bluestem.

---

17. **Perennial plant reproductive capability:** All perennial species should be capable of reproducing every year unless disrupted by extended drought, overgrazing, wildfire, insect damage, or other events occuring immediately prior to, or during the reproductive phase.
