USDA Natural Resources Conservation Service

Ecological site R081CY361TX
Redland 29-35 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.

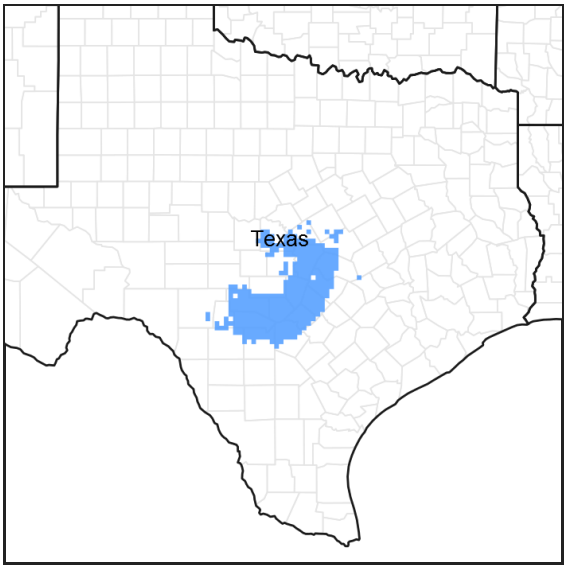


Figure 1. Mapped extent

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): 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. The 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

The Redlands Ecological Site has non-calcareous soils over limestone. The reference vegetation is an oak savannah with mid and tallgrasses, forbs and few shrubs. Without periodic fire or brush management, woody

species will likely increase and dominate the site.

Associated sites

R081CY355TX	**Adobe 29-35 PZ** The Adobe ecological site has sparser woody cover, much less production, more slope, and more caliche type soils of a higher pH with no post oak or blackjack oak.
R081CY360TX	**Low Stony Hill 29-35 PZ** The Low Stony Hill ecological site is generally higher in the landscape and is the plateau above the Redland with no post oak or blackjack oak.

Similar sites

R081CY358TX	**Deep Redland 29-35 PZ** The Deep Redland ecological site has deeper soils and is more productive.
R081CY359TX	**Gravelly Redland 29-35 PZ** The Gravelly Redland ecological site has more fragments in the soil.

Table 1. Dominant plant species

Tree	(1) *Quercus stellata* (2) *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. Soils occur on nearly level to moderately sloping upland plateaus and ridges. Slopes range from 0 to 8 percent. This site was formed in residuum from weathered limestone. These soils consist of shallow, well drained, slowly permeable soils that formed in calcareous clay residuum over indurated limestone bedrock of the Lower Cretaceous and Pennsylvania period. Elevation of this site ranges from 600 to 2400 feet above mean sea level. Runoff from these sites ranges from low to high and is directly correlated to slope percentage. This site will receive runoff from Adobe and Low Stony Hills ecological sites that normally occur along the site's boundary.

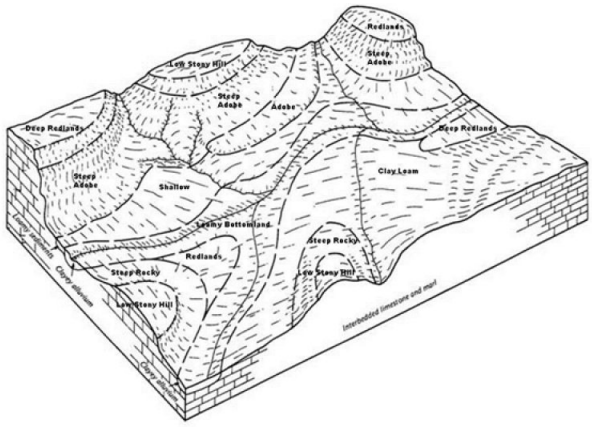


Figure 2. Redland 081CY361TX

Table 2. Representative physiographic features

Landforms	(1) Plateau > Plain (2) Plateau > Ridge (3) Plateau > Hillslope

Runoff class	High to very high
Flooding frequency	None
Ponding frequency	None
Elevation	183–732 m
Slope	0–8%
Aspect	Aspect is not a significant factor

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 3. Representative climatic features

Frost-free period (characteristic range)	210-260 days
Freeze-free period (characteristic range)	227-269 days
Precipitation total (characteristic range)	813-940 mm
Frost-free period (actual range)	187-260 days
Freeze-free period (actual range)	224-332 days
Precipitation total (actual range)	787-940 mm
Frost-free period (average)	235 days
Freeze-free period (average)	257 days
Precipitation total (average)	864 mm

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.

Wetland description

N/A

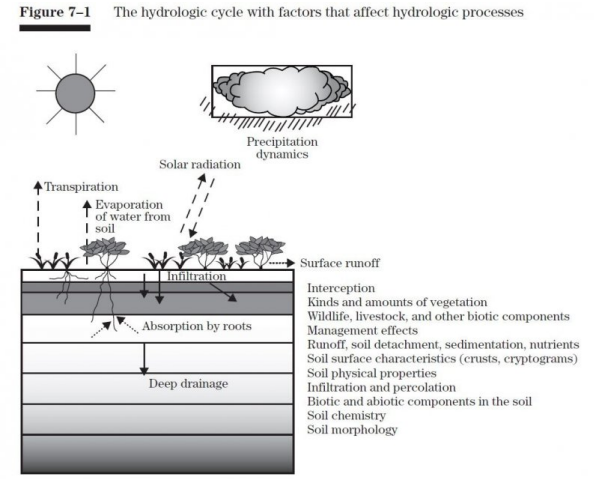


Figure 9.

Soil features

In a representative profile for the Redland ecological site, the soils are shallow, brown or reddish brown, fertile clays, and clay loams. They are underlain by slightly fractured indurated limestone bedrock at depths of 20 inches or less. Plant roots penetrate the crevices, which are usually filled with reddish brown clay. Limestone fragments, cherts, cobbles and stones sometimes occur on the surface and may make up as much as 25 percent of the soil by volume. When dry, the soils crack and take in water rapidly. When wet, the cracks close, and the soils become sticky and plastic and take in water slowly. Light showers are ineffective on the site, which favors the growth of deep-rooted perennial plants. When plant residues are inadequate, soil condition deteriorates and heavy surface crusts develop. In this condition water intake is very slow, runoff is rapid, erosion is a hazard, and grass recovery is slow. The stones on the surface reduce surface evaporation and help protect palatable grasses and forbs from overuse. The mineral content and reaction of these soils enable the site to produce highly nutritious forage. In association with other sites, Redland is usually the preferred grazing area. These sites occur on more stable hillslopes on dissected plateaus.

Due to the scale of mapping, there are inclusions of minor components of other soils within these mapping units. Before performing any inventories, conduct a field evaluation to ensure the soils are correct for the site.

The representative soil series associated with the Redland ecological site are:

Hensley
Tarpley

Table 4. Representative soil features

Parent material	(1) Residuum–limestone
Surface texture	(1) Clay loam (2) Clay (3) Loam (4) Cobbly clay loam

Drainage class	Moderately well drained to well drained
Permeability class	Slow to very slow
Depth to restrictive layer	20–51 cm
Soil depth	20–51 cm
Surface fragment cover <=3"	0–15%
Surface fragment cover >3"	0–2%
Available water capacity (0-50.8cm)	2.79–13.97 cm
Calcium carbonate equivalent (0-50.8cm)	0–5%
Electrical conductivity (0-50.8cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-50.8cm)	0–1
Soil reaction (1:1 water) (0-50.8cm)	6.1–8.4
Subsurface fragment volume <=3" (10.2-50.8cm)	5–20%
Subsurface fragment volume >3" (10.2-50.8cm)	0–15%

Ecological dynamics

The reference plant community is a post oak (*Quercus stellata*) Texas live oak (*Quercus fusiformis*) blackjack oak (*Quercus marilandica*) savannah, including little bluestem, (*Schizachyrium scoparium*) big bluestem (*Andropogon gerardii*), Indiangrass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*) and eastern gamagrass (*Tripsacum dactyloides*). This is a very fertile and productive site. Because of the soil chemistry of this site with its neutral to sometimes slightly acidic pH, it is usually a preferred grazing site.

Natural plant mortality is very low with the major species producing seeds and vegetative structure each year in normal years. Litter cover is 100 percent. Physical soil crust is largely absent.

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 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). Historical records are not specific on the Redland site but do reflect area observations. From the Teran expedition in 1691, “great quantities of buffaloes” were noted in the area. By 1840 the Bonnell expedition reflected that “buffalo rarely range so far to the south” (Inglis, 1964). Another example is an early settler, Arnold Gugger, who wrote in his journal about the mid to late 1800s in the Helotes, Texas area, “in those days buffaloes were in droves by the hundreds…..and antelopes were three to four hundred in a bunch….and deer and turkeys at any amount” (Massey, 2009).

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 usually long deferment period allowed the taller grasses and forbs to recover from the high impact bison grazing. This relationship created a diverse landscape both in structure and composition.

Historical fire frequencies for the region are suggested to be 13 to 25 years (Frost, 1998). When fires did occur, they

were set either by Native Americans or by lighting. Woody plant control would vary in accordance with the intensity and severity of the fire encountered, which resulted in a mosaic of vegetation types within the same site.

Ashe juniper (*Juniperus ashei*) will increase regardless of grazing. Goats and possibly 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, because of its dense low growing foliage, has the ability to retard grass and forb growth. Grass and forb growth can become non-existent under dense juniper canopies. Many times there is a resurgence of the better grasses such as little bluestem when Ashe juniper is controlled and followed by proper grazing management. Seeds and dormant rootstocks of many plant species are contained in the leaf mulch and duff under the junipers.

Currently, cattle, goats, white-tailed deer, sheep and exotic animals are the primary 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 allowed population booms. In addition, suppression of fire favored woody plants which provided additional browse and cover for the deer. Because of their impacts on livestock production, large predators such as 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 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 increased land ownership for recreational purposes and a corresponding reduction in livestock production, 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 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 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.

The plants and topography aided in increasing the infiltration of rainfall into the moderately slowly permeable soil. Any loss of soil organic matter and plant cover has a negative effect on infiltration. More rainfall is directed to overland flow, which causes increased soil erosion and flooding. Soils are also more prone to drought stress since organic matter acts like a sponge aiding in moisture retention for plant growth. Mulch buildup under the Ashe juniper canopy, following brush management and incorporation into the soil, can have a positive effect on increasing infiltration.

This site contains a large diversity of plants and this document does not attempt to cover them all. The intent of this document is to describe ecological processes on representative plants.

European settlement occurred in the mid to late 1800s (Raunick, 2007). This time period also coincided with a stoppage of fire. It was during this time that large-scale fencing was initiated to help the introduction of livestock. Predators were also reduced to protect livestock. In many cases sheep and goats heavily utilized the site. Low successional, unpalatable grasses, forbs and shrubs have taken the place of the more desirable plant species. Non-preferred browse, such as juniper, fared well at the expense of the palatable browse. Juniper is undoubtedly the dominant woody plant over most of the site today.

During the early 1900"s, land managers recognized the soil"s ability to produce annual field crops for added food, forage, and hay. Some of the Redland Sites were put to the plow removing all of the historic species. As land managers decisions changed in the 1970"s thru today, many of the fields were reintroduced with non-native grasses such as bermudagrass (*Cynodon dactylon*), yellow bluestems (Bothriochloa spp.), and kleingrass (*Panicum coloratum*).

Plant Communities and Transitional Pathways (diagram):

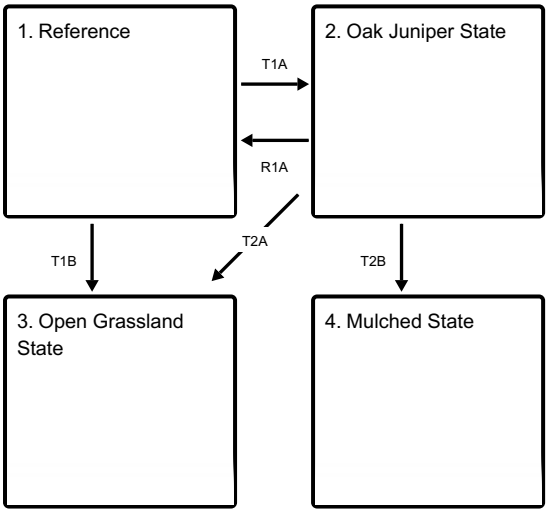
A State and Transition Diagram for the Redland Ecological Site (R081CY361TX) is depicted in this report. Descriptions of each state, transition, plant community, and pathway follow the model. Experts base this model on available experimental research, field observations, professional consensus, and interpretations. It is likely to change as knowledge increases.
Plant communities will differ across the MLRA because of the naturally occurring variability in weather, soils, and aspect. The Reference Plant Community 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 described as are other metrics. Most observers find it easier to visualize or estimate percent canopy for woody species (trees and shrubs). 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 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

Ecosystem states



T1A - Absence of disturbance and natural regeneration overtime

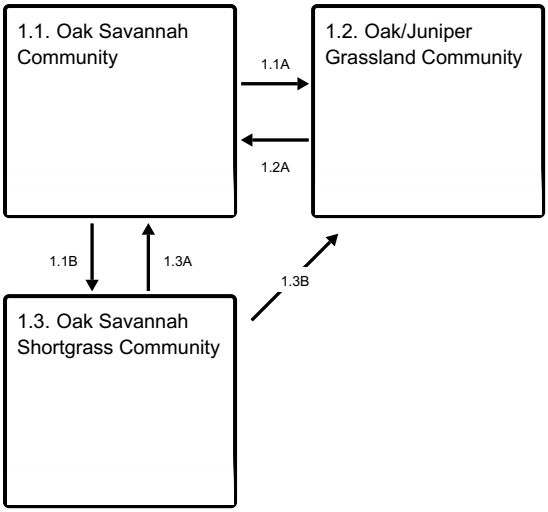
T1B - Clearing of native vegetation, followed by seeding non-native forage species

R1A - Reintroduction of disturbance regimes

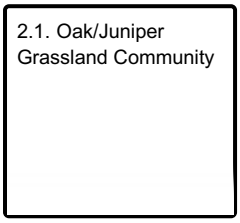
T2A - Clearing native vegetation, followed by seeding non-native forage species

T2B - Mechanical conversion of juniper to mulch

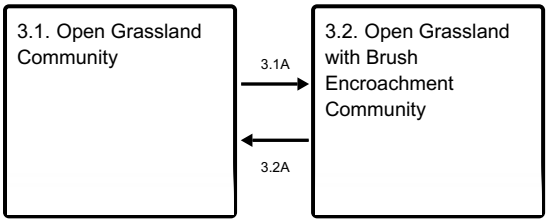
State 1 submodel, plant communities



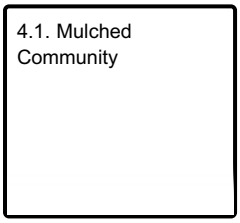
State 2 submodel, plant communities



State 3 submodel, plant communities



State 4 submodel, plant communities



State 1
Reference

The reference state is considered to be representative of the range of variability under pre-Euro settlement conditions. This state is characterized by tallgrasses and scattered post oak savannah. Community phase changes are primarily driven by wildfire, grazing and climatic fluctuations.

Dominant plant species

- post oak (*Quercus stellata*), tree
- blackjack oak (*Quercus marilandica*), tree
- little bluestem (*Schizachyrium scoparium*), grass
- big bluestem (*Andropogon gerardii*), grass

Community 1.1
Oak Savannah Community

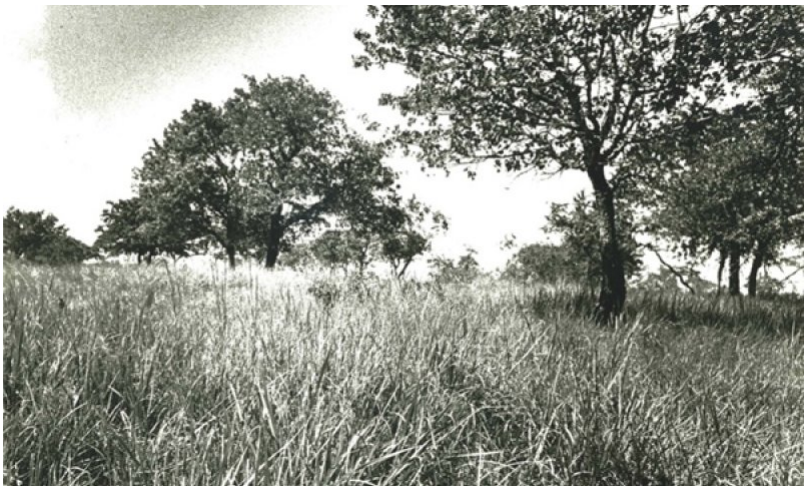


Figure 10. Redlands ecosite in near reference condition. Kendall County, Texas.

Figure 11. A near reference condition location in Blanco County, Texas.

Figure 12. Another near reference condition location in Blanco County, Texas.

The Oak Savannah Community (1.1) is the interpretive plant community. This plant community is a fire/grazing managed savannah composed of tall grasses. The overstory shades around10 percent of the site and consists primarily of post oak, but may include Bigelow oak (*Quercus buckleyi*), Texas red oak (*Quercus texana*), Texas live oak, blackjack oak and several associated species. The post oak and blackjack oak are signature key indicators of the Redland site. Occasionally however there may only be Texas live oak. The role of historic fire and bison grazing was to keep sunlight energy flowing through the deep-rooted trees and grasses, accelerate the mineral and nutrient cycle and to capture the optimum amount of rainfall. The removal or alteration of these ecological disturbances will trigger the plant community to change. The total removal of grazing animals may, in fact, accelerate this change. Juniper is added to the site via droppings from perching birds and small mammals that eat the seeds. Ashe juniper, which is a nonsprouting woody plant easily controlled by fire, and other woody species will increase without fire or some form of brush management. Once Ashe juniper encroachments it can easily be controlled with prescribed fire.

When the juniper exceeds about 6 feet in height, fire options become limited. Without intervention, the Ashe juniper will continue to increase and move towards the Oak/Juniper Grassland plant community (1.2). This may occur in as little as five years.

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	2102	3026	4203
Tree	280	404	560
Forb	280	404	504
Shrub/Vine	140	202	280
Total	**2802**	**4036**	**5547**

Table 6. 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	0-1%
Litter	60-100%
Surface fragments >0.25" and <=3"	0%
Surface fragments >3"	0-1%
Bedrock	0%
Water	0%
Bare ground	0-5%

Table 7. Woody ground cover

Downed wood, fine-small (<0.40" diameter; 1-hour fuels)	–
Downed wood, fine-medium (0.40-0.99" diameter; 10-hour fuels)	–
Downed wood, fine-large (1.00-2.99" diameter; 100-hour fuels)	–
Downed wood, coarse-small (3.00-8.99" diameter; 1,000-hour fuels)	–
Downed wood, coarse-large (>9.00" diameter; 10,000-hour fuels)	–
Tree snags** (hard***)	–
Tree snags** (soft***)	–
Tree snag count** (hard***)	49-86 per hectare
Tree snag count** (hard***)	

*** Decomposition Classes: N - no or little integration with the soil surface; I - partial to nearly full integration with the soil surface.**

**** >10.16cm diameter at 1.3716m above ground and >1.8288m height--if less diameter OR height use applicable down wood type; for pinyon and juniper, use 0.3048m above ground.**

***** Hard - tree is dead with most or all of bark intact; Soft - most of bark has sloughed off.**

Table 8. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	1-3%	0-1%
>0.15 <= 0.3	–	1-3%	3-5%	1-3%
>0.3 <= 0.6	–	5-8%	10-15%	3-10%
>0.6 <= 1.4	–	5-10%	50-60%	–
>1.4 <= 4	–	–	–	–
>4 <= 12	5-20%	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Figure 14. Plant community growth curve (percent production by month). TX3760, Warm Season Native Grasses. Native warm season grasses on rangeland with scattered oaks/junipers..

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

Community 1.2
Oak/Juniper Grassland Community

Figure 15. Young juniper is established. Crossing a threshold is imminent without management.

Figure 16. Young juniper is established mixed with some lower shrubs.

This community still resembles an oak savannah community. However, because of the elimination of fire and/or brush management, woody species begin to invade or increase on the site. This site had a natural variation that

probably included some juniper. However, historic fires precluded it from achieving anything other than an occasional tree. The dominant grass species for this plant community are little bluestem, Indiangrass, and sideoats grama (*Bouteloua curtipendula*). The major species to invade this site is Ashe juniper. Juniper in this plant community is still about 6 feet tall and there are sufficient grasses to provide fine fuel loading for a prescribed burn. By implementing vegetative management such as prescribed burning and prescribed grazing, the land manager can shift the plant community towards the Oak Savannah with minimum labor and expense. The sun's energy being captured by the juniper can then be redirected back to the original plants. Mineral cycling, nutrient cycling, and the water cycle are restored as well. A burn or some type of brush management will be needed on a 5- to 10-year return depending upon the size of the juniper. Juniper will increase on this site regardless of grazing. The best option for using animals to control cedar is the prudent and timely grazing/browsing with goats and/or possibly sheep (Taylor, 1997; Anderson, et al., 2013). If the proper vegetation management decisions are not performed, the site is at risk to transition to the Oak/Juniper Grassland State (2) in 10 to 15 years and a significant, high energy intervention will be needed for restoration.

Table 9. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	1821	2623	3643
Tree	420	605	841
Forb	280	404	560
Shrub/Vine	280	404	560
Total	**2801**	**4036**	**5604**

Figure 18. Plant community growth curve (percent production by month). TX3760, Warm Season Native Grasses. Native warm season grasses on rangeland with scattered oaks/junipers..

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

Community 1.3
Oak Savannah Shortgrass Community

Figure 19. Suppressed tall grasses and a browse line result from long-term heavy grazing by mixed livestock

Figure 20. Suppressed tall grasses result from long-term heavy grazing by mixed livestock classes.

This plant community reflects the combined effects of a drought and severe hot weather. The grazing has been a long term mixture of cattle, sheep and goats. Most of the sunlight energy is being captured by plants such as prickly pear, buffalograss and juniper along with the oak. Some mortality of the grasses can be observed. Soil surface temperatures can easily exceed 100 degrees with the sparse ground cover. There will be very little rainfall capture because of the lack of ground cover, especially if high intensity rains come. To restore the herbaceous plant cover will require a long-term effort combining brush management and grazing management. Prescribed burning is not an option until fuel load is built up. This site will progress through a flush of annuals and short lived grasses depending upon the timing and amount of rainfall. Once this recovery stage is done, which restores the hydrologic cycle, then more stable grasses and forbs establish. Prescribed grazing over time will restore the plant cover needed for a healthy hydrologic cycle and continued recovery. Once that is done, brush management can further accelerate the process. If mechanical brush management is done, then the possibility exists of replanting grasses to accelerate the recovery effort. It will still take several years of careful management and favorable rainfall to return to a diverse productive site. Grazing management alone will not suppress the brush unless goats/possibly sheep are used for targeted grazing.

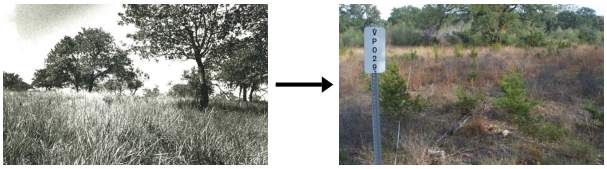
Table 10. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Tree	1009	1345	2018
Grass/Grasslike	420	560	841
Forb	168	224	336
Shrub/Vine	84	112	168
Total	**1681**	**2241**	**3363**

Figure 22. Plant community growth curve (percent production by month). TX3760, Warm Season Native Grasses. Native warm season grasses on rangeland with scattered oaks/junipers..

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



Oak Savannah Community

Oak/Juniper Grassland Community

A shift in the composition of the plant community is primarily driven by the lack of managing woody plants, juniper in particular. Juniper and other woody species are introduced from the site primarily through wildlife fecal deposits. Grazing that removes fuel loading for fire is a contributing factor. However juniper can increase regardless of grazing pressure unless goats and possibly sheep are utilized.

Pathway 1.1B
Community 1.1 to 1.3

Oak Savannah Community

Oak Savannah Shortgrass Community

Heavy continuous stocking rates with sheep, cattle, goats and sometimes deer over many years keep sunlight energy from recharging palatable herbaceous grasses, forbs and shrubs. Drought hastens the process. Little rainfall soaks into the ground because of a lack of cover.

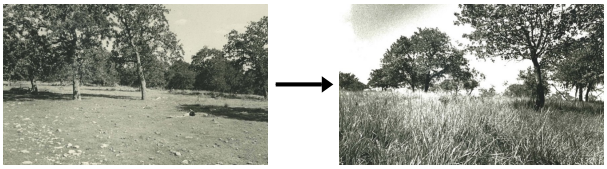
Pathway 1.2A
Community 1.2 to 1.1

Oak/Juniper Grassland Community

Oak Savannah Community

This recovery pathway consist of some method of brush management such as fire, mechanical or hand cutting or targeted grazing with goats and/or possibly sheep. Prescribed grazing is essential.

Pathway 1.3A
Community 1.3 to 1.1

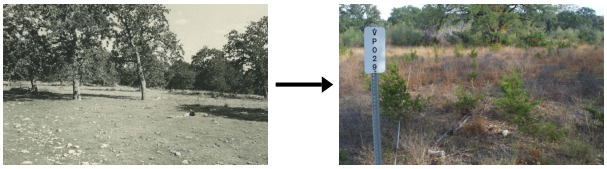


Oak Savannah Shortgrass Community

Oak Savannah Community

Restoring the hydrologic cycle and allowing herbaceous plants to harvest sunlight through prescribed grazing will shift the plant community to something close to the reference plant community. Targeted grazing with goats and/or possibly sheep along with selective brush management and/or prescribed burning will allow expression of the reference plant community.

Pathway 1.3B
Community 1.3 to 1.2



Oak Savannah Shortgrass Community

Oak/Juniper Grassland Community

Restoring the hydrologic cycle and sunlight energy with cattle or just long term deferment without fire or brush

management will in all likelihood result in a recovery of the herbaceous plants but also juniper and other shrubs.

State 2
Oak Juniper State

Ashe juniper > 8-12 feet tall 10-30+% canopy 5-20 years old

Dominant plant species

- Ashe's juniper (*Juniperus ashei*), tree
- honey mesquite (*Prosopis glandulosa*), shrub
- Texas persimmon (*Diospyros texana*), shrub
- composite dropseed (*Sporobolus compositus*), grass

Community 2.1
Oak/Juniper Grassland Community

Figure 23. A mature stand of Ashe juniper exists for the 2.1 plant community on a Tarpley soil.

This community has crossed a threshold from the Oak Savannah State (1). The major woody species to invade is Ashe juniper. Other woody species to commonly invade/increase this site are honey mesquite (*Prosopis glandulosa*), Texas persimmon (*Diospyros texana*), algerita (Mahonia trifoliata), elbowbush (*Forestiera pubescens*), lotebush (*Ziziphus obtusifolia*), Bigelow oak (*Quercus sinuata*), and prickly pear (Opuntia spp.). This site will exhibit Ashe juniper 8 to 12 feet tall with 10 to 30 percent canopies. Foliar cover ranges from 5 to 30 percent. The juniper plants are between 5 and 20 years old. Grasslike vegetation is significantly reduced because of the competition that Ashe juniper and other brush species present regarding sunlight, nutrients and moisture. The dominant grass like species for this plant community are meadow dropseed (*Sporobolus compositus*), silver bluestem (*Bothriochloa saccharoides*), a small amount of sideoats grama, little bluestem, and an occasional Indiangrass. Cool season plant such as Texas wintergrass (*Nassella leucotricha*) and cedar sedge (*Carex planostachys*) occur in the understory. The recovery from an Oak/Juniper Grassland Community (2.1) back to the reference community is still possible but it will involve a considerable investment of time and expense. Implementation of brush management programs involving heavy equipment and/or hand labor makes much higher treatment cost probable. In this state much more sunlight energy is captured in juniper and woody component of the community. There is entrapment of rainfall in the foliage of the juniper which never reaches and enters the soil profile. As much as 20 percent of the annual rainfall is entrapped (Thurow, 1994). The juniper will only get bigger and wider unless intervention is done to prevent it. It is likely that any fires that could burn here under this condition would be wildfires that would also damage the oak community. If left alone for about 20 years, the juniper will attain heights of over 20 feet and crown canopies exceeding 30 percent. At this point the juniper is a threat to the oaks.

Table 11. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Tree	1401	2018	2802
Grass/Grasslike	560	807	1121
Shrub/Vine	560	807	1121
Forb	280	404	560
Total	**2801**	**4036**	**5604**

Figure 25. Plant community growth curve (percent production by month). TX3762, Oak/Juniper Grassland. "Grassland with warm season grasses, oaks, and juniper.".

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3	5	8	13	18	12	5	3	12	10	7	4

State 3
Open Grassland State

This state is characterized by the lost of native vegetation and extensive soil disturbance. Non-native species may be present.

Dominant plant species

- Bermudagrass (*Cynodon dactylon*), grass
- Johnsongrass (*Sorghum halepense*), grass

Community 3.1
Open Grassland Community

Figure 26. This site has been cleared of trees and replanted to introduced bluestems, on a Tarpley soil.

A threshold has been crossed into the Open Grassland State. The Open Grassland Community (3.1) can be former cropland that has been reseeded or be a result of significant chemical or mechanical brush management. The shallow soils precluded long-term success as cropland. Depending upon the management goals, the site can be seeded to native or exotic species or a combination. Exotic grasses invade without seeding being introduced through hay, livestock or wildlife. Much of the species diversity and site integrity has been lost when compared to the reference plant community. The length of plowing and the intensity of the plowing will dictate the magnitude of deterioration of the soil health and structure. Many of the original soil organisms are missing and soil erosion may have taken place. Soil compaction is usually a problem to be dealt with. This fact makes it difficult to restore completely to the reference plant community. Total tree removal from brush management activities will cause a loss of their root system to the soil resource. This may impact infiltration and organic matter content over the long run. Through the re-introduction of fire and prescribed grazing, plus reseeding of native forbs and grasses, this site can

be restored to something resembling the reference plant community as far as the grassland component. It may take many years for natural processes within the soil to restore the oak species. Utilizing native plants in the re-seeding will greatly benefit wildlife species such as deer, turkey, quail, and other birds. This open grassland community may also represent a community of annual and/or perennial seeded species which are non-native and which may occur as monoculture communities. These monoculture type communities may be too dense for gallinaceous wildlife. These communities are typically not very diverse. Seeded or invading grasses include naturalized species such as King Ranch bluestem, bermudagrass, Johnsongrass (*Sorghum halepense*), silky bluestem (*Dichanthium sericeum*), kleingrass and many others. In many cases, hardly any native grasses can be found. There has been a dramatic reduction in the native forb and legume diversity. Total production for this site may be similar to the productive potential of this site in reference condition except the majority of the plant community is grasses. Production can also vary depending upon the amount of purchased fertilizer applied.

Table 12. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	2522	3632	5044
Forb	140	202	560
Shrub/Vine	140	202	280
Tree	–	–	–
Total	**2802**	**4036**	**5884**

Table 13. Ground cover

Tree foliar cover	0%
Shrub/vine/liana foliar cover	0-1%
Grass/grasslike foliar cover	15-20%
Forb foliar cover	1-2%
Non-vascular plants	0%
Biological crusts	0%
Litter	90-100%
Surface fragments >0.25" and <=3"	0%
Surface fragments >3"	0-1%
Bedrock	0%
Water	0%
Bare ground	0-10%

Table 14. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	1-3%	0-1%
>0.15 <= 0.3	–	0-3%	3-5%	1-3%
>0.3 <= 0.6	–	–	20-50%	3-10%
>0.6 <= 1.4	–	–	60-100%	–
>1.4 <= 4	–	–	–	–
>4 <= 12	–	–	–	–
>12 <= 24	–	–	–	–
>24 <= 37	–	–	–	–
>37	–	–	–	–

Figure 28. Plant community growth curve (percent production by month). TX3764, Open Grassland. Warm season grasses with minor cool season influence on open grassland..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1	5	15	25	20	7	5	13	5	2	1

Community 3.2
Open Grassland with Brush Encroachment Community

Figure 29. Juniper, willow baccharis, and other shrubby species invade on this site once abandoned.

This community is reseeded open grassland which has an encroachment of woody species. Grasslike vegetation is significantly reduced because of the severe competition that Ashe juniper and other woody species present regarding sunlight and moisture as the brush thickens. Ashe juniper can be 20 feet tall and taller, with canopies in excess of 30 percent. Other brushy cover consists of species such as willow baccharis (*Baccharis salicina*), honey mesquite (*Prosopis glandulosa*), algerita, Texas persimmon, elbowbush, and lotebush. Willow baccharis can also be a dominant woody plant. As warm season grass-like species are reduced, bare ground increases because of sunlight limitations. Shade tolerant species such as cedar sedge (*Carex planostachys*) and Texas wintergrass species dominate the understory's void of sunlight. The open sites between canopies may provide opportunities for occasional short grasses such as hairy grama (*Bouteloua hirsuta*), Texas grama (*Bouteloua rigidiseta*), meadow dropseed (*Sporobolus compositus*), and threeawns (Aristida spp.). Once juniper becomes the dominant woody plant, the majority of the soil surface will have a thick mat of cedar leaves and other woody tree and shrub leaf material. The total grasslike production potential for this community is severely restricted. The introduction of an integrated therapy of brush management, prescribed burning and prescribed grazing this site will successfully shift back towards the Open Grassland Community and remain productive. If brush management alternatives are not implemented in a timely manner, this site will become infested with woody species. In as little as 20 years, the brush will be utilizing most of the sunlight and moisture stored in the soil. In addition, rainfall entrapment will deteriorate the hydrologic cycle so that less moisture is absorbed into the rooting zone. Forage productivity will decline accordingly as grazeable acreage decreases.

Table 15. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Tree	1401	2018	2802
Grass/Grasslike	1121	1614	2242
Shrub/Vine	140	202	280
Forb	140	202	280
Total	**2802**	**4036**	**5604**

Figure 31. Plant community growth curve (percent production by month). TX3764, Open Grassland. Warm season grasses with minor cool season influence on open grassland..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1	5	15	25	20	7	5	13	5	2	1

Pathway 3.1A
Community 3.1 to 3.2

Open Grassland Community

Open Grassland with Brush Encroachment Community

Over time, without any brush management or fire, juniper and other shrubs will establish and begin to capture increasing amounts of sun energy as well as entrapping and utilizing more soil moisture that could be utilized by herbaceous plants.

Pathway 3.2A
Community 3.2 to 3.1

Open Grassland with Brush Encroachment Community

Open Grassland Community

Prescribed burning or selective brush management will restore the grassland. Targeted grazing with goats and/or possibly sheep may arrest the increase of juniper and other shrubs, but cattle grazing alone probably will not, even if stocked properly.

State 4
Mulched State

Savannah with limited herbaceous plants. Litter cover may be 100% depending on time in treatment.

Dominant plant species

- Ashe's juniper (*Juniperus ashei*), tree
- post oak (*Quercus stellata*), tree

Community 4.1
Mulched Community

Figure 32. Hydro mulched juniper on a Tarpley soil.

The Mulched (4.1) plant community is a result of using mechanical mulching to reduce canopy and structure of dense woody species which is usually juniper. The amounts of mulch on the ground and the orientation of the mulch are dependent upon the amount of woody cover treated and the time since treatment. The mulch tends to settle over time and is very resistant to deterioration. This community can structurally appear very similar to the reference plant community but without the herbaceous cover. The understanding of how this plant community reacts over time is unknown but studies are currently underway to monitor. One result is that the soil is protected for a long time. There will be a need for maintenance to treat juniper and other species as they re-establish.

Table 16. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Tree	1524	1715	3363
Forb	90	101	196
Grass/Grasslike	90	101	196
Shrub/Vine	90	101	196
Total	**1794**	**2018**	**3951**

Transition T1A
State 1 to 2

A transition occurs because of a lack of brush management with mechanical means, fire or targeted goat/possibly sheep grazing. Grazing deferment alone will not halt the increase of woody species. Hydrologic characteristics are altered by increased woody species. Now, energy flows more through woody plants than herbaceous plants.

Transition T1B
State 1 to 3

Land clearing replanting with grasses represents this transition. Similar reduction in oak species will be expressed with herbicidal treatment. Recovery to the Oak Savannah State is very doubtful, especially if herbaceous exotic plants are utilized. Even though the plants are exotic, many times their hydrologic function is similar to the original native plants.

Restoration pathway R1A
State 2 to 1

The restoration pathway includes some form of brush management. Prescribed burning will also help and prescribed grazing will be essential. In some cases of severe long-term overharvesting of the desired plants, replanting may be necessary.

Transition T2A
State 2 to 3

Land clearing replanting with grasses represents this transition. Similar reduction in oak species will be expressed with herbicidal treatment. Recovery to the Oak Savannah State is very doubtful, especially if herbaceous exotic plants are utilized. Even though the plants are exotic, many times their hydrologic function is similar to the original native plants.

Transition T2B
State 2 to 4

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.

Additional community tables

Table 17. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**Tallgrass**			1681–3587	
	little bluestem	SCSC	*Schizachyrium scoparium*	897–1121	–
	Indiangrass	SONU2	*Sorghastrum nutans*	448–897	–
	big bluestem	ANGE	*Andropogon gerardii*	336–673	–
	eastern gamagrass	TRDA3	*Tripsacum dactyloides*	0–448	–
	switchgrass	PAVI2	*Panicum virgatum*	0–224	–
2	**Midgrasses**			336–560	
	sideoats grama	BOCU	*Bouteloua curtipendula*	224–448	–
	plains lovegrass	ERIN	*Eragrostis intermedia*	112–224	–
	Texas cupgrass	ERSE5	*Eriochloa sericea*	112–168	–
	vine mesquite	PAOB	*Panicum obtusum*	112–168	–
	composite dropseed	SPCO16	*Sporobolus compositus*	56–112	–
	purpletop tridens	TRFL2	*Tridens flavus*	0–84	–
	slim tridens	TRMU	*Tridens muticus*	28–84	–
	slim tridens	TRMUE	*Tridens muticus var. elongatus*	28–84	–
3	**Midgrasses**			34–202	
	cane bluestem	BOBA3	*Bothriochloa barbinodis*	56–112	–
	composite dropseed	SPCOC2	*Sporobolus compositus var. compositus*	56–112	–
	silver beardgrass	BOLAT	*Bothriochloa laguroides ssp. torreyana*	28–84	–
4	**Shortgrasses**			34–202	
	buffalograss	BODA2	*Bouteloua dactyloides*	84–112	–
	curly-mesquite	HIBE	*Hilaria belangeri*	84–112	–
	threeawn	ARIST	*Aristida*	28–84	–
	fall witchgrass	DICO6	*Digitaria cognata*	28–56	–
5	**Cool Season Grasses and grasslike**			34–224	
	Texas wintergrass	NALE3	*Nassella leucotricha*	112–168	–
	Canada wildrye	ELCA4	*Elymus canadensis*	56–112	–

	cedar sedge	CAPL3	*Carex planostachys*	56–112	–
	Scribner's rosette grass	DIOLS	*Dichanthelium oligosanthes var. scribnerianum*	28–56	–
Forb					
6	**Annual Forbs**			–	
	prairie broomweed	AMDR	*Amphiachyris dracunculoides*	0–1	–
7	**Forb**			34–224	
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	28–112	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	28–112	–
	yellow sundrops	CASE12	*Calylophus serrulatus*	28–112	–
	prairie clover	DALEA	*Dalea*	28–112	–
	bundleflower	DESMA	*Desmanthus*	28–112	–
	ticktrefoil	DESMO	*Desmodium*	28–112	–
	blacksamson echinacea	ECAN2	*Echinacea angustifolia*	28–112	–
	Maximilian sunflower	HEMA2	*Helianthus maximiliani*	56–112	–
	dotted blazing star	LIPU	*Liatris punctata*	28–112	–
	mallow	MALVA	*Malva*	28–112	–
	smartweed leaf-flower	PHPO3	*Phyllanthus polygonoides*	28–112	–
	scurfpea	PSORA2	*Psoralidium*	28–112	–
	snoutbean	RHYNC2	*Rhynchosia*	28–112	–
	wild petunia	RUELL	*Ruellia*	28–112	–
	annual checkerbloom	SICA	*Sidalcea calycosa*	56–112	–
	fuzzybean	STROP	*Strophostyles*	28–112	–
	vetch	VICIA	*Vicia*	28–112	–
Shrub/Vine					
8	**Shrubs**			22–202	
	eastern redbud	CECA4	*Cercis canadensis*	0–84	–
	snailseed	CODI	*Cocculus diversifolius*	28–84	–
	Texas persimmon	DITE3	*Diospyros texana*	11–84	–
	jointfir	EPHED	*Ephedra*	28–84	–
	Texas kidneywood	EYTE	*Eysenhardtia texana*	28–84	–
	stretchberry	FOPU2	*Forestiera pubescens*	28–84	–
	desert-thorn	LYCIU	*Lycium*	28–84	–
	algerita	MATR3	*Mahonia trifoliolata*	28–84	–
	Virginia creeper	PAQU2	*Parthenocissus quinquefolia*	28–84	–
	fragrant sumac	RHAR4	*Rhus aromatica*	0–84	–
	winged sumac	RHCO	*Rhus copallinum*	28–84	–
	evergreen sumac	RHVI3	*Rhus virens*	0–84	–
	gum bully	SILAO	*Sideroxylon lanuginosum ssp. oblongifolium*	28–84	–
	roundleaf greenbrier	SMRO	*Smilax rotundifolia*	28–84	–
	Eve's necklacepod	STAF4	*Styphnolobium affine*	28–84	–
	grape	VITIS	*Vitis*	28–84	–

	twistleaf yucca	YUPA	*Yucca pallida*	28–84	–
Tree					
9	**Trees**			45–224	
	Nuttall oak	QUTE	*Quercus texana*	112–336	–
	post oak	QUST	*Quercus stellata*	0–280	–
	Texas live oak	QUFU	*Quercus fusiformis*	0–280	–
	blackjack oak	QUMA3	*Quercus marilandica*	0–280	–
	hackberry	CELTI	*Celtis*	56–224	–
	bastard oak	QUSIB	*Quercus sinuata var. breviloba*	28–112	–
	elm	ULMUS	*Ulmus*	28–112	–

Animal community

This site is used for the production of domestic livestock and to provide habitat for native wildlife and certain species of exotic wildlife. 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 historic plant community. Initial starting stocking rates will be determined with the landowner or decision maker. An assessment of vegetation is needed to determine stocking rates. Calculations used to determine an initial starting stocking rate will be based on forage production and on grazeable acres.

A large diversity of wildlife is native to this site. In the historic plant community, large migrating herds of bison, resident herds of pronghorn and large numbers of lesser prairie chickens were the more dominant species. With the demise of these species and the changes in the plant community, the kinds of wildlife have changed.

With the eradication of the screwworm fly, the increase in woody vegetation, and insufficient natural predation, white-tailed deer numbers have increased drastically and are often in excess of natural carrying capacity. Where deer numbers are excessive, overbrowsing and overuse of preferred forbs causes deterioration of the plant community. Progressive management of deer populations through hunting can 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. Competition among deer, sheep and goats can be an important consideration in livestock and wildlife management and can cause damage to preferred native vegetation.

Smaller mammals include many kinds of rodents, jackrabbit, cottontail rabbit, raccoon, skunks, possum 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. Major game birds that are economically important are 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, bunch grass, 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 and a complex 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. The different plant communities of the site will sustain different species of raptors.

Various kinds of exotic wildlife have been introduced on the site including axis, sika, fallow and red deer, aoudad sheep and blackbuck antelope. 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/accessed 8/20/13). 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.

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

The water cycle on this site functions according to the existing plant community and the management of that plant community. The water cycle is most functional when the site is dominated by tall bunchgrass and the oak savannah. Rapid rainfall infiltration, high soil organic matter, good soil structure and good porosity are present with a good cover of bunchgrass. When dry, the soils crack and take water in readily. When wet, the cracks close and the soil becomes sticky and plastic taking water in slowly. Light showers are ineffective to this site. Quality of surface runoff will be high and erosion and sedimentation rates will be low. With high rates of infiltration and periods of heavy rainfall, some water will move below the root zone of grasses into the fractures in the limestone. As this water moves downward it contributes to the recharge of aquifers.

When heavy grazing causes loss or reduction of bunchgrass and ground cover, the water cycle becomes impaired. Infiltration is decreased and runoff is increased because of poor ground cover, rainfall splash, soil capping, low organic matter and poor structure. 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.
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. Stem flow is increased, however, because of the funneling effect of the canopy which increases soil moisture at the base of the tree. Increased transpiration, especially when evergreen species such as Texas live oak and juniper dominate, provides less chance for deep percolation into aquifers. As woody species increase, grass cover declines, which causes some of the same results as heavy grazing. Brush management combined with good grazing management can help restore the natural hydrology of the site.

If a mature woodland canopy develops, a buildup of leaf litter occurs which increases the organic litter on the soil, builds structure and retards erosion. The duff, however, can store some moisture and reduce infiltration. Some, but not all values of a properly functioning water cycle are restored on this site when a woodland plant community persists.
The soils of this site are in hydrologic group D.

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

Information provided here has been derived from limited NRCS clipping data and from field observations of range trained personnel. Information has also been interpreted from scientific articles.

Other references

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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)	San Angelo ZO
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Date	04/08/2013
Approved by	Colin Walden
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:** Some minimal flow patterns may be evident at the juncture of the associated sites.

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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):** None.

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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:** None.

7. **Amount of litter movement (describe size and distance expected to travel):** Little or no litter movement or deposition during normal rainfall events.

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

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** 0 to 3.1 inches; brown dry, loam; moderate fine subangular blocky structure; friable, moderately hard, slightly sticky, slightly plastic; 2 percent limestone fragments; noneffervescent by HCl, 1 normal; clear smooth boundary.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** The tallgrass/midgrass savanna with abundant forbs, adequate litter, and little bare ground provides for maximum infiltration and negligible runoff.

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

12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

    Dominant: Warm-season tallgrasses

    Sub-dominant: Warm-season midgrasses Trees Forbs

    Other: Cool Season Grasses Shrubs Warm Season Short Grasses

    Additional:

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):** >90 percent litter, 0.5 to 3 inch depth.

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** 2500 to 5000 pounds per acre.

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, baccharis, pricklypear, yucca, tasajillo, pricklyash, lotebush, mesquite, King Ranch bluestem, silky bluestem, and annual broomweed.

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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.
