USDA Natural Resources Conservation Service

Ecological site R081CY363TX
Steep Rocky 29-35 PZ

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Accessed: 04/24/2024

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.

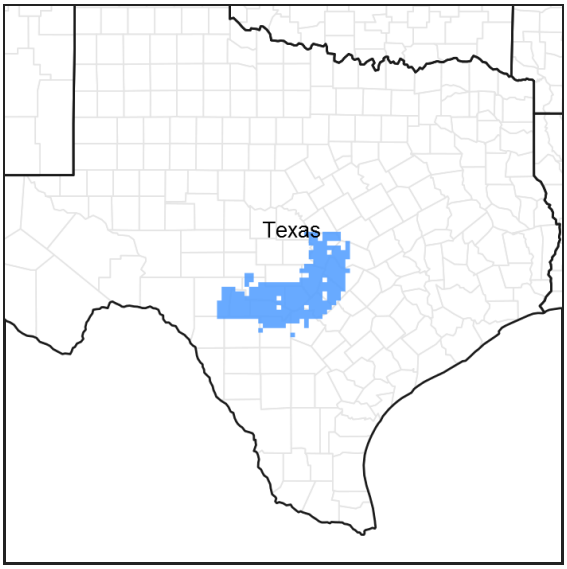


Figure 1. Mapped extent

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 steep, shallow soils with numerous stones and/or boulders present. Reference vegetation includes an oak savannah with mid and tallgrasses, forbs and numerous shrubs. These sites have historically

carried more woody species due to some areas being protected from recurring fires. However, if fire is removed completely, woody species are likely to increase across the site.

Associated sites

R081CY360TX	**Low Stony Hill 29-35 PZ** The Low Stony Hill is generally higher in the landscape and is the plateau above the Steep Rocky.
R081CY362TX	**Steep Adobe 29-35 PZ** The Steep Adobe site has sparser woody cover and more caliche type soils.
R081CY574TX	**Shallow 29-35 PZ** The Shallow ecological site occurs on areas with less slope.

Similar sites

R081CY362TX	**Steep Adobe 29-35 PZ** The Steep Adobe is a more open site with few boulders and more soil. Hence the production is higher in the Steep Adobe.
R081CY574TX	**Shallow 29-35 PZ** The Shallow has shallow soils but has fewer fragments on the surface and in the soil profile.

Table 1. Dominant plant species

Tree	(1) *Quercus fusiformis* (2) *Quercus texana*
Shrub	(1) *Eysenhardtia texana*
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. Slope gradient range from 12 to 65 percent. This site was formed in residuum from weathered limestone. Elevation of this site ranges from 1000 to 2400 feet above mean sea level. Slopes on Steep Rocky sites range from 12 to 65 percent. Generally, because of steep slope and rockiness this site is not accessible to cattle, vehicular traffic, or machinery.

There is an effect observed in the vegetation brought about by landscape position. The southern exposure of the slopes are drier because of directly facing the sun and less rainfall retained on the steep slopes. The northern exposure of the slope is more mesic due to less direct sunlight causing a more moderate temperature range. This allowed for additional vegetation to grow and hold more rainfall on the steeper slopes.

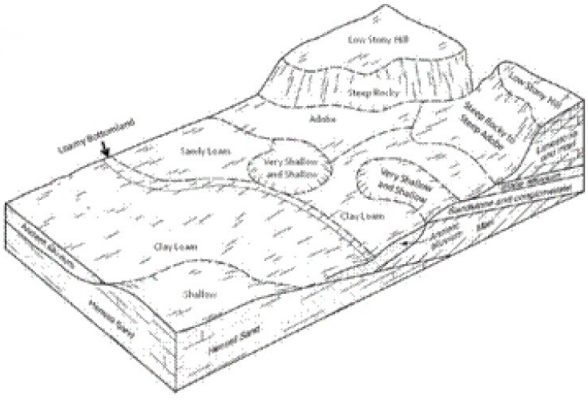


Figure 2. SR Illustration

Table 2. Representative physiographic features

Landforms	(1) Plateau > Ridge
Runoff class	High to very high
Flooding frequency	None
Ponding frequency	None
Elevation	1,000–2,400 ft
Slope	12–65%
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)	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 sites may shed some water via runoff during heavy rain events. The presence of good ground cover and deep rooted grasses can help facilitate infiltration and reduce sediment loss.

Wetland description

N/A

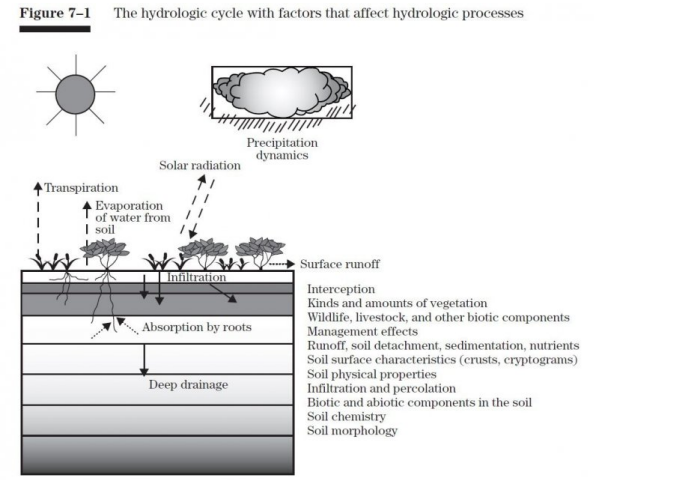


Figure 9.

Soil features

In a representative profile for the Steep Rocky ecological site, these soils are very shallow or shallow to indurated limestone. Depth of bedrock ranges from 4 to 20 inches. The soil is a black clayey soil and is neutral to alkaline. Stones and boulders cover 35 to 65 percent of the soil surface. Ledges of hard limestone outcrop on the contour, giving a banded appearance. The soils are fertile, usually have good structure, and take in water readily. Their fertility and moisture-holding capacity, however, is limited by soil depth and fragment volume. Fractures in the limestone bedrock, on the other hand, generally contain fine soil particles and store some moisture. Plant roots penetrate these cracks and crevices, and thus have access to more moisture and plant nutrients than is apparent in the soil. Forage produced on the site is of good quality. These sites occur on sideslopes of ridges 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 Steep Rocky ecological site is Eckrant.

Table 4. Representative soil features

Parent material	(1) Residuum–limestone
Surface texture	(1) Very cobbly clay (2) Very cobbly silty clay (3) Very stony clay
Drainage class	Well drained
Permeability class	Slow to moderately slow

Depth to restrictive layer	4–20 in
Soil depth	4–20 in
Surface fragment cover <=3"	20–45%
Surface fragment cover >3"	10–35%
Available water capacity (0-20in)	0.1–1.4 in
Calcium carbonate equivalent (0-20in)	2–20%
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)	10–20%
Subsurface fragment volume >3" (4-20in)	25–50%

Ecological dynamics

The reference plant community is a mixture of many woody species along with tall and midgrasses, and forbs, The structure of the woody component is somewhat determined by fire frequency, exposure, and the geologic formation. Many of the woody species, except the Ashe juniper (*Juniperus ashei*), are root sprouters. The large variety of plants that exist on this site precludes mentioning all of them.

The reference plant community for the Steep Rocky ecological site is diverse with Texas live oak (*Quercus fusiformis*), Texas red oak (*Quercus texana*), bigtooth maple (*Acer grandidentatum*), and Ashe juniper trees as well as some elm (Ulmus spp.) and hackberry (Celtis spp.). Grass species include little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardii*), Indiangrass (*Sorghastrum nutans*), and sideoats grama (*Bouteloua curtipendula*). Other important species include green sprangletop (*Leptochloa dubia*), Texas wintergrass (*Nassella leucotricha*), and kidneywood (*Eysenhardtia texana*). Slope and geologic structure play a major role in the type, form, and composition of the plant community.

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 Steep Rocky site are located on the slopes of hills in the area.

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 Steep Rocky 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, 2008. et al.). 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.

The historic plant community for the Steep Rocky ecological site was not greatly influenced by bison grazing but somewhat by fires. Fire, when it did occur, was an important factor in maintaining the mosaic structure of vegetation on these slopes. There were several “refuges” for fire-sensitive plants afforded in the geology. The northern exposure of this site had a denser population of Ashe juniper. Ashe juniper is native to this site but not as abundant as seen today. Wildfire frequency is anticipated to have been less frequent on this site than on adjacent flatter slopes because of the steeper topography and corresponding lower fine fuel loading. 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 will increase regardless of grazing. Juniper will establish with grazing and without unless goats and possibly sheep are utilized. Goats and sometimes sheep will eat young juniper and when properly used, are an effective tool to maintain juniper (Taylor, 1997; Anderson, et al., 2013). Goats and sheep are very adapted to browse the Steep Rocky site with goats being the better of the two. 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 nonexistent 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, 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.

Plant Communities and Transitional Pathways (diagram)

A State and Transition Model for the Steep Rocky Ecological Site (R081CY363TX) 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.

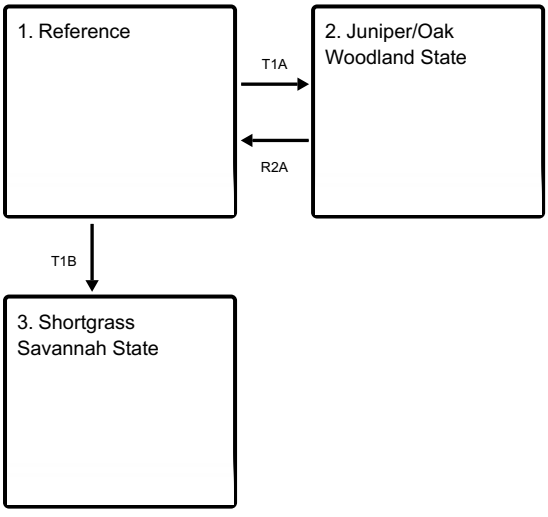
Plant communities will differ across the MLRA because of the naturally occurring variability in weather, soils, and aspect. The Reference Plant Community is not necessarily the management goal; other vegetative states may be desired plant communities as long as the Range Health assessments are in the 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 the 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

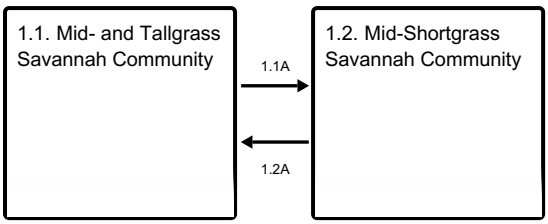


T1A - Absence of wildfire and natural regeneration overtime. Maybe be coupled with prolonged excessive grazing.

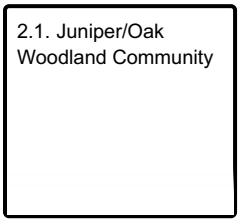
T1B - Absence of wildfire coupled with prolonged excessive grazing pressure

R2A - Reintroduction of disturbance

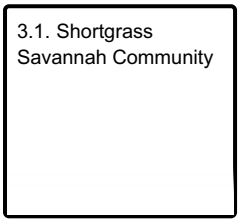
State 1 submodel, plant communities



State 2 submodel, plant communities



State 3 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 a mixture of woody species with an understory of midgrasses and forbs. Community phase changes are primarily driven by wildfire and climatic fluctuations.

Dominant plant species

- Texas live oak (*Quercus fusiformis*), tree
- Texas red oak (*Quercus buckleyi*), tree
- Texas kidneywood (*Eysenhardtia texana*), shrub
- little bluestem (*Schizachyrium scoparium*), grass

Community 1.1
Mid- and Tallgrass Savannah Community

Figure 10. Photo 1: Mid and Tallgrass Savannah Community

Figure 11. Photo 2: Mid and Tallgrass Savannah Community

The Mid- and Tallgrass Savannah Community is the interpretive plant community for this and is a diverse mosaic. The information for this site is derived from vegetation inventories and professional opinion of range trained individuals. It is recognized the north slopes will have denser stands of juniper, however, the south slope is selected as the interpretive or diagnostic plant community as it is more dynamic. The density and frequency of woody vegetation is strongly dependent on the presence or absence of fractured limestone and exposure. Where non-fractured geology exists, canopies will be less dense. Large deep-rooted trees are rare. Northern facing exposures have higher canopy covers and larger trees than southern exposures. This site was referred to as a “cedar brake” by early explorers (Roemer, 1846) because of the juniper dominance in several locations. The absence or presence of juniper was directly related to the fire frequency and intensity but many times was limited by rock outcrops, lack of fuel or escarpments. The overstory canopy ranges from 20-35 percent. Moreover, the canopy varied considerably over the full range of the site. The woody canopy consists primarily of Texas live oak, Texas red oak, Ashe juniper, white shin oak (*Quercus sinuata* var. breviloba), Lacey oak (*Quercus laceyi*), and several associated species. Unique indicator plants such as Lindheimer's silk tassel (*Garrya ovata* var. lindheimeri), Texas madrone (*Arbutus xalapensis*), bigtooth maple, escarpment black cherry (*Prunus serotina*), and walnut species (Juglans spp.) occurred in fractured limestone. Numerous forbs such as zexmenia (Wedelia spp.), Dalea (Dalea spp.), sundrop (Calyophus spp.), bundleflower (Desmanthus spp.), and gayfeather (Liatris spp.) frequent the site. Mid and tallgrasses are dominants of the site although a large portion of these sites often supported a shrub and tree community. The structure of many of the woody plants on this site, such as live oak, can exist either as a tree or as a shrub or thicket because of their resprouting ability following fire or top damage. Juniper is the exception, being a non-sprouter. Not only did periodic fires maintain the reference plant community in a mosaic nature but droughts are known to kill woody plants such as live oak and juniper (Wills, 2006). Retrogression of the site comes mainly from juniper. Juniper functions as an increaser on this site as it is native. Heavy browsing by livestock and wildlife weakens palatable browse and offers juniper an opportunity to increase. When retrogression is cattle induced (on the lower ranges of the slope), little bluestem, green sprangletop, sideoats grama, and the minor species Indiangrass, big bluestem, and palatable forbs are the primary decreasers. Feathery bluestems (Bothriochloa spp.), tall dropseed (*Sporobolus compositus* var. compositus), Texas wintergrass, tridens (Tridens spp.), threeawn (Aristida spp.), and woody species are increasers. Slim tridens (*Tridens muticus*), rough tridens (*Tridens muticus* var. elongatus), and threeawn (Aristida spp.) are the most persistent of the grasses under abusive use. Juniper can increase regardless of browsing. Seeds eaten by birds and deposited in the understory of other woody species will germinate and establish in the absence of fire. Over a period of time, the juniper will eventually dominate its surrogate woody plant. Other wildlife species will also eat the juniper berries then fecally deposit them over the site (Smeins, 1997). This process may take 20 or so years depending upon the rate of introduction and the fire frequency. Once juniper reaches approximately a 30 percent canopy, a threshold is being approached. At this point, the fine fuel necessary for an effective fire is diminished except for severe, catastrophic type fires. Because of the steep nature of this site, only a very few management practices can be used for maintenance. Hand cutting of juniper is an example to keep the canopy open enough to maintain some vegetative cover even though it is labor intensive. Mechanical clipping can be done on the lower slope classes. If selective removal is done, there is usually enough seed source for the site to recover once historic disturbances are returned. It is recognized that fire did not completely burn this site nor is it always feasible to burn because of difficult terrain.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	1210	1650	1925
Tree	440	600	700
Shrub/Vine	330	450	525
Forb	220	300	350
Total	**2200**	**3000**	**3500**

Figure 13. Plant community growth curve (percent production by month). TX3770, Grassland/Oak Hillside Community. Tall and midgrasses with scattered live oak motts..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3	3	7	13	20	15	7	5	10	7	5	5

Community 1.2
Mid-Shortgrass Savannah Community

This community closely resembles the reference plant community of an open grassland with interspersed mottes of oak and other species. The elimination of fire and brush management will allow the invasion and increase of woody plant species. The main woody species to increase on the site is Ashe juniper, usually introduced in wildlife droppings. The major grass species for the site are still little bluestem, Indiangrass, big bluestem, and sideoats grama but in reduced amounts. There is a shift from a little bluestem dominated plant community toward a sideoats grama-Texas wintergrass-Silver bluestem (*Bothriochloa laguroides*) dominated herbaceous plant community. This community with Ashe juniper of 5 feet or less in height presents challenges and a critical decision point for the land resource manager. Applying a prescribed burn or individual plant treatment of Ashe juniper at this time will allow the site to move back towards the mid and tallgrass savannah plant community at a more reasonable cost than waiting until the juniper is too big. The steepness of this site and the rock outcrops renders mechanical treatment to only the flatter more accessible portions. It gets too big for fire when it gets to about 10 feet high, then it takes a harsher fire requiring special precautions. Most of the time terrain vastly increases the complexity of the burn. Applying no control methods at this time will allow the juniper to increase in size and density and puts this community at risk for juniper dominating the site at the expense of a diversity of plants. The community will transition to the Juniper/Oak State (2) if remedial action is not taken soon. To move from this community back toward the Savannah State (1) will take a more considerable investment of resources.

Table 6. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	990	1350	1575
Tree	550	750	875
Shrub/Vine	440	600	700
Forb	220	300	350
Total	**2200**	**3000**	**3500**

Figure 15. Plant community growth curve (percent production by month). TX3769, Open Grassland with Juniper. Open Grassland with Juniper Encroachment having warm season grasses with minor cool season influence..

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 1.1A
Community 1.1 to 1.2

Removal of fire from the landscape and introduction of juniper seeds by wildlife initiates the shift toward the mid-shortgrass savannah. Excessive removal of herbaceous leaves shifts the sunlight energy to favor juniper and non-palatable plants as well as removes grass fuel to burn.

Pathway 1.2A
Community 1.2 to 1.1

The application of fire or individual plant treatment (IPT) of unwanted plants will restore the energy cycle, preserve the water cycle, and move the community back toward the mid-tallgrass savannah.

State 2
Juniper/Oak Woodland State

Dominant plant species

- Ashe's juniper (*Juniperus ashei*), tree
- Texas live oak (*Quercus fusiformis*), tree
- algerita (*Mahonia trifoliolata*), shrub
- Texas persimmon (*Diospyros texana*), shrub

Community 2.1
Juniper/Oak Woodland Community

Figure 16. Photo 3. Rock outcrop Southern and Northern Exp.

Figure 17. Photo 4. Juniper/Oak Woodland Community.

Figure 18. Photo 5. Juniper/Oak Woodland, Southern Exp.

The elimination of fires, lack of prescribed grazing and browsing, plus the lack of brush management allowed Ashe juniper and other woody species to overtake this site. It is a dense woody canopy community where fractured geologic formations exist. Where the geology is non-fractured, the vegetative communities will produce somewhat shorter woody vegetation with lighter densities than the fractured sites. The dominant species is Ashe juniper but there is still usually live oak, Texas madrone, Texas oak, Lacey oak, white shin-oak, black cherry, and walnut species left in some amounts. Shrubs commonly growing in the area are sumac (Rhus spp.), algerita (*Mahonia trifoliolata*), Texas persimmon (*Diospyros texana*), Texas colubrina (*Colubrina texensis*), elbowbush (*Forestiera pubescens*), mountain laurel (*Sophora secundiflora*), and hawthorn (Crataegus spp.) species. This vegetative state will exhibit Ashe juniper 20 to 30 feet tall and taller, with canopies ranging from 30 to 50 percent. This density and structure of juniper is also a potential safety hazard from wildfire for homes or other structures built in this vegetative community. Not only does the terrain and density of trees make it difficult for firefighting equipment to respond, but the slope amplifies wildfire and the rate of spread. Ashe juniper, which originally occurred in varying amounts among the rocky, craggy fire-free outcrops is a dense canopy and suppresses other vegetation. Ashe juniper and other woody species significantly out-compete understory grasses and forbs for sunlight and moisture. Understory is characterized by mid-shortgrasses and perennial forbs. In this vegetative state, cedar sedge (Carex spp.), hairy grama (*Bouteloua hirsuta*), hairy tridens (*Erioneuron pilosum*), Texas grama (*Bouteloua rigidiseta*), red threeawn (Aristida trifida), puffsheath dropseed (*Sporobolus neglectus*), and Evax (Evax spp.) are common in the understory and in the small openings. Grazing/browsing management alone will not shift this community back towards the reference community. Total restoration to the mid-tall grass savannah community may not even be possible if excessive erosion has removed what little soils exist. Implementing selective brush control measures such as individual plant treatments are needed to begin the restoration. Prescribed grazing/browsing is essential to allow the herbaceous plant community to recover. The length of time of reasonable recovery can be many years depending upon past history. Maintenance activities will be needed for juniper every few years as there is a large seed bank both on-site and from adjacent sites. Fire is an ecological driver that can sometimes be used depending upon local settings and conditions.

Table 7. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Tree	1320	1800	2100
Shrub/Vine	660	900	1050
Forb	110	150	175
Grass/Grasslike	110	150	175
Total	**2200**	**3000**	**3500**

State 3
Shortgrass Savannah State

Dominant plant species

- Texas persimmon (*Diospyros texana*), shrub
- lotebush (*Ziziphus obtusifolia*), shrub
- algerita (*Mahonia trifoliolata*), shrub
- buffalograss (*Bouteloua dactyloides*), grass
- tridens (*Tridens*), grass

Community 3.1
Shortgrass Savannah Community

Figure 20. Photo 6. Heavy continuous overgrazing

This plant community has crossed a threshold driven by the heavy and long term stocking of mixed classes of livestock. Droughts hasten the process. There is a 5 to 10 percent overstory of live oak and other trees with little understory. Heavy browsing has removed most 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, shin oak 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 (Opuntia spp.), ragweed (Ambrosia confertifolia), broomweed (*Amphiachyris dracunculoides*), nightshades (Solanum spp.), milkweeds (Asclepias spp.), gray goldaster (Chrysopisis spp.), prairie coneflower (*Ratibida columnifera*), snow-on-the-mountain (Asclepias spp.), filaree (Erodium spp.), plantain (Plantago spp.), horehound (*Marrubium vulgare*), evax, twinleaf senna (*Senna bauhinioides*), and mealy cup sage (*Salvia farinacea*). Similarly, the following short grasses exist: sideoats grama (only in protected places), buffalograss (*Bouteloua dactyloides*), hairy tridens, slim tridens (*Tridens muticus*), hairy grama (*Bouteloua hirsuta*), 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. The ecological processes of the hydrologic cycle, energy flow, mineral cycling, and nutrient cycling have been lost. This is demonstrated by the loss of key plants and 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 reseeding 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 in. Once this trend is established the natural functions of freezing, thawing, drying, and 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 8. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Tree	1100	1500	1750
Grass/Grasslike	550	750	875
Forb	330	450	525
Shrub/Vine	220	300	350
Total	**2200**	**3000**	**3500**

Figure 22. 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

Transition 1A is a scenario with some combination of no fire, heavy browsing by livestock and wildlife, no brush management, and the unmitigated increase of juniper. Wildlife contributes to the spread of seeds through droppings.

Transition T1B
State 1 to 3

This transition is caused by interruption of sunlight energy flowing through the system to only the overstory plants. The hydrologic cycle is severely impeded and the loss of top soil is a degradation of the mineral cycle.

Restoration pathway R2A
State 2 to 1

Recovery 2A represents some combination of juniper removal coupled with prescribed grazing and prescribed burning.

Additional community tables

Table 9. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Tall grasses**			800–1450	
	little bluestem	SCSC	*Schizachyrium scoparium*	600–900	–
	Indiangrass	SONU2	*Sorghastrum nutans*	100–250	–
	big bluestem	ANGE	*Andropogon gerardii*	100–250	–
	eastern gamagrass	TRDA3	*Tripsacum dactyloides*	0–50	–

2	**Midgrasses**			100–150	
	sideoats grama	BOCU	*Bouteloua curtipendula*	100–150	–
3	**Midgrasses**			80–125	
	cane bluestem	BOBA3	*Bothriochloa barbinodis*	25–50	–
	silver beardgrass	BOLAT	*Bothriochloa laguroides ssp. torreyana*	25–50	–
	plains lovegrass	ERIN	*Eragrostis intermedia*	25–50	–
	green sprangletop	LEDU	*Leptochloa dubia*	25–50	–
	composite dropseed	SPCOC2	*Sporobolus compositus var. compositus*	25–50	–
	vine mesquite	PAOB	*Panicum obtusum*	0–25	–
	Texas cupgrass	ERSE5	*Eriochloa sericea*	0–25	–
	tall grama	BOHIP	*Bouteloua hirsuta var. pectinata*	0–25	–
4	**Midgrasses**			80–100	
	Reverchon's bristlegrass	SERE3	*Setaria reverchonii*	25–100	25–50
	slim tridens	TRMU	*Tridens muticus*	25–50	–
	slim tridens	TRMUE	*Tridens muticus var. elongatus*	25–50	–
	threeawn	ARIST	*Aristida*	0–25	–
5	**Cool Season Grasses**			50–100	
	Canada wildrye	ELCA4	*Elymus canadensis*	50–100	–
	Texas wintergrass	NALE3	*Nassella leucotricha*	75–100	–
	cedar sedge	CAPL3	*Carex planostachys*	50–75	–
Forb					
6	**Forbs**			220–350	
	cedar sedge	CAPL3	*Carex planostachys*	50–150	–
	Texas wintergrass	NALE3	*Nassella leucotricha*	50–150	–
	Engelmann's daisy	ENPE4	*Engelmannia peristenia*	50–100	–
	eastern milkpea	GARE2	*Galactia regularis*	50–100	–
	Maximilian sunflower	HEMA2	*Helianthus maximiliani*	50–100	–
	trailing krameria	KRLA	*Krameria lanceolata*	50–100	–
	dotted blazing star	LIPU	*Liatris punctata*	50–100	–
	Nuttall's sensitive-briar	MINU6	*Mimosa nuttallii*	50–100	–
	beardtongue	PENST	*Penstemon*	50–100	–
	snoutbean	RHYNC2	*Rhynchosia*	50–100	–
	awnless bushsunflower	SICA7	*Simsia calva*	50–100	–
	fuzzybean	STROP	*Strophostyles*	50–100	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	50–100	–
	white sagebrush	ARLUM2	*Artemisia ludoviciana ssp. mexicana*	50–100	–
	Berlandier's sundrops	CABE6	*Calylophus berlandieri*	50–100	–
	prairie clover	DALEA	*Dalea*	50–100	–
	zarzabacoa comun	DEIN3	*Desmodium incanum*	50–100	–
	bundleflower	DESMA	*Desmanthus*	50–100	–
	blacksamson echinacea	ECAN2	*Echinacea angustifolia*	0–75	–
	Forb, annual	2FA	*Forb, annual*	0–1	–
Shrub/Vine					

Shrub/Vine					
7	**Shrubs/Vines**			330–525	
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	100–300	–
	white sagebrush	ARLUM2	*Artemisia ludoviciana ssp. mexicana*	100–300	–
	yellow sundrops	CASE12	*Calylophus serrulatus*	100–300	–
	prairie clover	DALEA	*Dalea*	100–300	–
	bundleflower	DESMA	*Desmanthus*	100–300	–
	ticktrefoil	DESMO	*Desmodium*	100–300	–
	blacksamson echinacea	ECAN2	*Echinacea angustifolia*	100–300	–
	Engelmann's daisy	ENPE4	*Engelmannia peristenia*	100–300	–
	Maximilian sunflower	HEMA2	*Helianthus maximiliani*	100–300	–
	dotted blazing star	LIPU	*Liatris punctata*	100–300	–
	Nuttall's sensitive-briar	MINU6	*Mimosa nuttallii*	100–300	–
	scurfpea	PSORA2	*Psoralidium*	100–300	–
	snoutbean	RHYNC2	*Rhynchosia*	100–300	–
	awnless bushsunflower	SICA7	*Simsia calva*	100–300	–
	vetch	VICIA	*Vicia*	100–300	–
	creepingoxeye	WEDEL	*Wedelia*	100–300	–
	mescal bean	SOSE3	*Sophora secundiflora*	100–200	–
	ungnadia	UNGNA	*Ungnadia*	100–150	–
	yucca	YUCCA	*Yucca*	100–150	–
	Texas persimmon	DITE3	*Diospyros texana*	100–150	–
	Texas kidneywood	EYTE	*Eysenhardtia texana*	100–150	–
	stretchberry	FOPU2	*Forestiera pubescens*	100–150	–
	Lindheimer's silktassel	GAOVL	*Garrya ovata ssp. lindheimeri*	50–150	–
	western white honeysuckle	LOAL	*Lonicera albiflora*	50–150	–
	algerita	MATR3	*Mahonia trifoliolata*	100–150	–
	devil's shoestring	NOLI	*Nolina lindheimeriana*	100–150	–
	winged sumac	RHCO	*Rhus copallinum*	100–150	–
	gum bully	SILAO	*Sideroxylon lanuginosum ssp. oblongifolium*	50–150	–
	greenbrier	SMILA2	*Smilax*	100–150	–
Tree					
8	**Trees**			440–700	
	Texas live oak	QUFU	*Quercus fusiformis*	250–600	–
	Ashe's juniper	JUAS	*Juniperus ashei*	100–600	–
	mescal bean	SOSE3	*Sophora secundiflora*	150–350	–
	ungnadia	UNGNA	*Ungnadia*	150–350	–
	yucca	YUCCA	*Yucca*	150–350	–
	eastern redbud	CECA4	*Cercis canadensis*	150–350	–
	Texas persimmon	DITE3	*Diospyros texana*	150–350	–
	Texas kidneywood	EYTE	*Eysenhardtia texana*	150–350	–
	stretchberry	FOPU2	*Forestiera pubescens*	150–350	–
	Lindheimer's silktassel	GAOVL	*Garrya ovata ssp. lindheimeri*	150–350	–

	algerita	MATR3	*Mahonia trifoliolata*	150–350	–
	devil's shoestring	NOLI	*Nolina lindheimeriana*	150–350	–
	fragrant sumac	RHAR4	*Rhus aromatica*	150–350	–
	prairie sumac	RHLA3	*Rhus lanceolata*	150–350	–
	evergreen sumac	RHVI3	*Rhus virens*	150–350	–
	bully	SIDER2	*Sideroxylon*	150–350	–
	greenbrier	SMILA2	*Smilax*	150–350	–
	hackberry	CELTI	*Celtis*	100–250	–
	bastard oak	QUSIB	*Quercus sinuata var. breviloba*	100–250	–
	Nuttall oak	QUTE	*Quercus texana*	100–250	–
	sandpaper oak	QUVA5	*Quercus vaseyana*	100–250	–
	Lacey oak	QULA	*Quercus laceyi*	100–200	–
	bigtooth maple	ACGR3	*Acer grandidentatum*	0–150	–
	littleleaf leadtree	LERE5	*Leucaena retusa*	100–150	–
	black cherry	PRSE2	*Prunus serotina*	0–100	–
	walnut	JUGLA	*Juglans*	0–100	–
	Eve's necklacepod	STAF4	*Styphnolobium affine*	50–100	–
	elm	ULMUS	*Ulmus*	50–100	–

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. The site is somewhat accessible to use by cattle but is more accessible to deer, sheep, Angora goats, and meat goats. Global Positioning Systems studies reveal slopes above 11 percent are generally less accessible to cattle while sheep and goats can utilize slopes up to 45 percent. Also revealed is that cattle will avoid a site once it contains about 30 percent surface rocks. (Hanselka, et al.)

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. Carrying capacity has declined drastically over the past 100 years due to the deterioration of the reference community. A field assessment of vegetation is needed to determine stocking rates based on the forage needs of desired animal species.

Many species, including domestic livestock, use more than one ecological site to meet their habitat needs.

Managing all the grazing and browsing animals is important 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. Competition among deer, sheep, and goats is an important consideration in livestock and wildlife management and can cause damage to preferred vegetation.

Smaller mammals include many kinds of rodents, jackrabbit, cottontail rabbit, raccoon, skunks, opossum, and armadillo. Mammalian predators include coyote, red fox, gray fox, bobcat, and mountain lion. Many species of snakes and lizards utilize the site.

Many species of birds can be 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. Some exotic species, such as axis deer have the ability to shift their diets to alternative plant groups which give them a competitive advantage over the native white-tailed 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.

Hydrological functions

The soils on this site are well drained with very low water holding capacity. Surface runoff is very rapid because of the slope of the site. Water erosion is potentially severe. Soils of the site are in Hydrologic Groups C and D. The water cycle on this site functions according to existing plant community composition and the management of the plant community. The water cycle is at optimum when the site is dominated by tall bunchgrasses. High infiltration capacity organic matter, and good soil structure and porosity are associated with a good bunchgrass cover. Higher organic matter and soil structure optimizes high water quality when runoff occurs and erosion and sedimentation rates will be minimal. Infiltration during periods of heavy rainfall can result in some deep percolation of water. Water will move below the root zone of grasses into the fractures in the limestone. As water percolates and moves downward, it contributes to aquifer recharge and helps provide sustained flow to downstream watersheds.

State 1

Return period analysis based on 50 years of climate

Storm Return
Period Precipitation
(in.) Runoff
(in.) Erosion
(t ac)
Average 50 yr 33.6 1.1 0.8
2.5 year 34.0 1.1 0.8
5 year 39.7 1.9 1.4
10 year 45.6 2.6 2.0
25 year 51.9 3.6 3.1
50 year 53.4 4.9 3.3

Based on 50 years of climate, there is a 98 percent chance there will be runoff, erosion, and sediment delivery (Rangeland Hydrology and Erosion Model Predictions—model calibrated from field data).

Return Period Analysis

To help interpret the table, note that a five-year value will be exceeded, on the average, about once every five years, or twice every ten years. There is a 1/5, or 20 percent, chance that a value equal to or greater than the five-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 1.4 tons per acre. At best, any predicted runoff or erosion value, by any model, will be within only plus or minus 50 percent of the true value. Erosion rates are highly variable.

State 3

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. With a combination of a sparse ground cover, excessive slopes, 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 is increased.

Ashe juniper, Texas persimmon, Mexican buckeye, algerita, and other woody plants, which occurred in small amounts among the rocky, craggy outcrops in State 1, have increased to form a dense canopy. The understory in such conditions may consist of a sparse cover of cedar sedge, hairy tridens, and threeawn. Juniper also has a

heavy duff layer at its base. This layer has been reported to capture and store as much as 33 percent of the annual rainfall at some locations (Thurow, 1994).

Return period analysis based on 50 years of climate

Storm Return
Period Precipitation
(in.) Runoff
(in.) Erosion
(t ac)
Average 50 yr 33.6 1.5 1.6
2.5 year 35.0 1.5 1.5
5 year 39.7 2.5 2.7
10 year 45.5 4.0 4.5
25 year 51.9 5.0 6.1
50 year 53.3 5.2 6.5

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

When conditions have reached a threshold and woody invasion has reached maximum densities and beneficial native understory grasses are absent or at very low densities, a reversion to State 1 hydrology is not likely. Erosion has reduced the capacity of this site to recover.

Recreational uses

This site has potential for recreational use due to the diversity of wildlife which utilizes the site. The tall and mid grasses and scattered oaks produce beautiful fall color variations. The area is used for hunting, hiking, birding and other nature tourism-related enterprises.

Wood products

Oaks and Ashe juniper may be used for firewood, fencing material, and/or in the specialty wood industry. In some areas, the oil of the mature Ashe juniper heartwood is extracted for use in the fragrance industry.

Other products

None

Other information

Brilliant fall colors result from the mix of evergreen and deciduous woody species found on this site. Color changes of Texas oak and flame-leaf sumac blend beautifully with Ashe juniper and live oak. Many native plants, valuable for low-maintenance landscaping may be found on this site.

Inventory data references

Information provided here has been derived from limited NRCS clipping data, and from field observations of range trained personnel.

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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.

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

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

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** 0 to 10 percent bare ground. 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):** Minimal and short.

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

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil surface is very dark gray stony clay 8 inches thick that contains 60 percent by volume of cobbles and stone fragments of limestone. Moderately alkaline. Soil Organic Matter is 1-4 percent.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** High canopy, basal cover and density with small interspaces should make rainfall impact negligible. This site has well drained soils, moderately slow permeability, very low AWC, severe water erosion hazard, fertility is medium, and shallow root zone.

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

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

    Dominant: Warm-season tallgrasses

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

    Other: Forbs Shrubs

    Additional:

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

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

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** 3250# for below average moisture to 5750# for above average moisture.

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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 the primary invader.

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17. **Perennial plant reproductive capability:** All species should be capable of reproduction on the Steep Rocky ecological site except for periods of prolonged drought conditions, heavy natural herbivory, and wildfires.
