USDA Natural Resources Conservation Service

Ecological site R081BY323TX
Clay Flat 19-23 PZ

Last updated: 9/19/2023
Accessed: 11/04/2024

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.

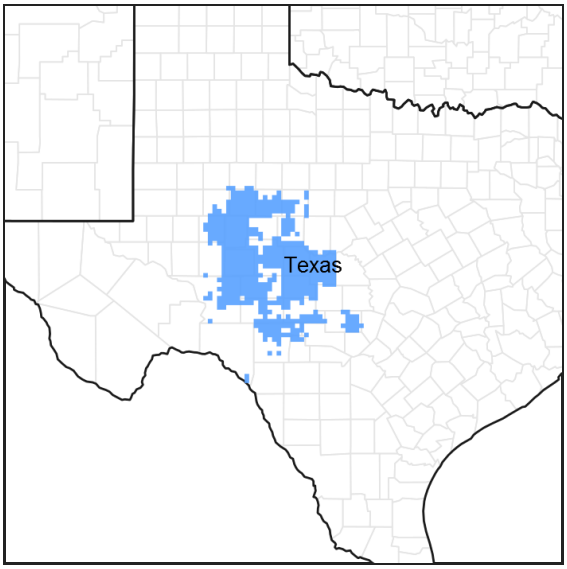


Figure 1. Mapped extent

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): 081B–Edwards Plateau, Central Part

This area is entirely in south-central Texas. It makes up about 11,125 square miles (28,825 square kilometers). The towns of Fredericksburg, Junction, Menard, Rocksprings, and Sonora are in this MLRA. Interstate 10 crosses the middle part of the area. A few State parks and State historic sites are in this MLRA.

Classification relationships

USDA-Natural Resources Conservation Service, 2006.
-Major Land Resource Area (MLRA) 81B

Ecological site concept

The Clay Flat is characterized by heavy clay soils on nearly level slopes. Sites are productive, but can be droughty due to their high clay content and available moisture to plants. The depression areas can be occasionally ponded with excess precipitation for up to a month.

Associated sites

R081BY325TX	**Clay Loam 19-23 PZ** The Clay Loam site may be encountered on adjacent slopes.
R081BY353TX	**Very Shallow 19-23 PZ** The Very Shallow site may be encountered adjacent to this site.

Similar sites

R081BY325TX	**Clay Loam 19-23 PZ** The Clay Loam site is similar in that both sites are located on similar topography but Clay Loam has more diverse plant community.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	(1) *Pleuraphis mutica* (2) *Bouteloua curtipendula*

Physiographic features

The Clay Flat consists of gently sloping to gently undulating soils. They can be found on stream terraces of Piedmont alluvial plains below the limestone hills. The soils formed in alluvium are high in calcium carbonate. The elevation ranges from 1,100 feet to 2,800 feet above sea level. Slope ranges from 0 to 3 percent. The site is used mostly for rangeland while irrigated vegetables, cotton, corn, and grain sorghum are also planted.

Table 2. Representative physiographic features

Landforms	(1) Plateau > Plain (2) Plateau > Depression (3) Plateau > Swale
Runoff class	Negligible to high
Flooding frequency	None
Ponding duration	Long (7 to 30 days)
Ponding frequency	None to occasional
Elevation	1,100–2,800 ft
Slope	0–3%
Ponding depth	0–24 in
Water table depth	80–100 in
Aspect	Aspect is not a significant factor

Climatic features

The climate in the MLRA 81B is subtropical subhumid on the eastern portion and subtropical steppe on the western portion of the MLRA. Winters are dry, and the summers are hot and humid. The precipitation increases from west to east and the temperatures increase from north to south. The area usually receives 65 to 70 percent sunshine each year. The majority of the rainfall occurs during the warm months of April to October. Most precipitation comes from thunderstorms that vary in the amount of water received and the areas covered. Spring is characterized by fluctuating patterns, but mild temperatures prevail. July and August are relatively dry and hot with little weather variability day-to-day. As summer progresses through fall, an increase of precipitation usually occurs in the eastern portions while a decrease of precipitation occurs to the west. Winter temperatures are mild, but polar Canadian air masses bring rapid drops in temperature. These cold spells last 2 or 3 days. Prevailing winds are southerly with March and April the windiest months.

Table 3. Representative climatic features

Frost-free period (characteristic range)	210-240 days
Freeze-free period (characteristic range)	240-280 days
Precipitation total (characteristic range)	19-24 in
Frost-free period (actual range)	210-240 days
Freeze-free period (actual range)	240-280 days
Precipitation total (actual range)	19-25 in
Frost-free period (average)	225 days
Freeze-free period (average)	260 days
Precipitation total (average)	22 in

Climate stations used

- (1) CARTA VALLEY [USC00411492], Rocksprings, TX
- (2) ELDORADO [USC00412809], Eldorado, TX
- (3) SONORA [USC00418449], Sonora, TX
- (4) OZONA [USC00416734], Ozona, TX
- (5) BIG LAKE 2 [USC00410779], Big Lake, TX

Influencing water features

Due to the high clay content and low slope, sites can be ponded. This only occurs occasionally, 1 in 10 years, but can be ponded for 1 month.

Wetland description

Wetland determinations need to be made onsite.

Soil features

The Clay Flat consists of soils that are very deep, well drained, very slowly permeable soils formed in calcareous clayey alluvium derived from limestone. The bedrock, when present, is greater than 60 inches below the surface and it is about 20 inches thick. Internal drainage is well drained and permeability is very slow to slow. The available water capacity is moderate. The following soil series are associated: Irion and Tobosa.

Table 4. Representative soil features

Parent material	(1) Alluvium–limestone
Surface texture	(1) Clay
Family particle size	(1) Fine
Drainage class	Well drained
Permeability class	Very slow
Depth to restrictive layer	60–80 in
Soil depth	60–80 in
Surface fragment cover <=3"	0–2%
Surface fragment cover >3"	0–1%
Available water capacity (0-40in)	4.5–7.1 in

Calcium carbonate equivalent (0-40in)	0–45%
Electrical conductivity (0-40in)	0–2 mmhos/cm
Sodium adsorption ratio (0-40in)	0–15
Soil reaction (1:1 water) (0-40in)	7.4–8.4
Subsurface fragment volume <=3" (4-40in)	0–4%
Subsurface fragment volume >3" (4-40in)	0–1%

Table 5. Representative soil features (actual values)

Drainage class	Not specified
Permeability class	Not specified
Depth to restrictive layer	40–80 in
Soil depth	40–80 in
Surface fragment cover <=3"	Not specified
Surface fragment cover >3"	Not specified
Available water capacity (0-40in)	Not specified
Calcium carbonate equivalent (0-40in)	Not specified
Electrical conductivity (0-40in)	Not specified
Sodium adsorption ratio (0-40in)	Not specified
Soil reaction (1:1 water) (0-40in)	Not specified
Subsurface fragment volume <=3" (4-40in)	Not specified
Subsurface fragment volume >3" (4-40in)	Not specified

Ecological dynamics

The Clay Flat was a fire-induced midgrass prairie with a few scattered shrubs. The reference community evolved under frequent fire and periodic heavy grazing by bison, pronghorn antelope, and deer. The subtropical semiarid climate, with hot summers and convective summer precipitation, is conducive to deep-rooted woody plants and herbs. European settlement during the 1800’s brought animal husbandry, windmills, and fencing to the area. Before their arrival, however, frequent wildfires suppressed woody and forb species at very low levels. Fires were postulated to have occurred every three years. The frequent and intense fires likely were more influential in shaping the open Midgrass Prairie Community (1.1), than the intermittent grazing by bison and pronghorns and periodic droughts.

Tobosa (*Pleuraphis mutica*), sideoats grama (*Bouteloua curtipendula*), feathery bluestems (Bothriochloa spp.), and vine mesquite (*Panicum obtusum*) dominated the Midgrass Prairie Community (1.1) making up approximately 70 percent of the total herbage production. The frequent fires favored grasses, especially tobosa, over woody plants and forbs but there was a wide variety of forbs still present. Ruellia (Ruellia spp.), nightshades (Solanum spp.), globemallow (Sphaeralcea spp.), and verbena (Verbena spp.) were representative forbs. Few scattered mesquite

(Prosopis spp.), pricklypear (Opuntia spp.), and other shrubs were likely present.

The Midgrass Prairie Community (1.1) was relatively stable and resilient until European Settlement. The settlement in the 1800's brought an elimination of the bison herd and a large increase of domestic livestock. The development of the windmill and barbed wire fencing in the 1880's brought about heavy continuous grazing throughout the Edwards Plateau. As heavy grazing continued, there was a reduction of more palatable plants and an increase in tobosa, less palatable forbs, and shortgrasses. When retrogression was cattle induced, sideoats grama, feathery bluestems, vine mesquite and other palatable species decreased. Total herbage production declined as well. There was a concomitant decline in vegetative ground cover, mulch, and soil organic matter. The shift in composition of the plant cover and decline in soil properties favored woody plant encroachment. This, along with the reduction in intensity and frequency of fires, allowed invasion of species from adjacent sites or the increase of more grazing resistant endemic species.

Under the above scenario, the reference community will transition into a Tobosa/Mixed-grass Savannah Community (1.2). In this plant community, tobosa, buffalograss (*Bouteloua dactyloides*), and curlymesquite (*Hilaria belangeri*) increase and become dominant. Grasses, primarily tobosa, dominate primary production and the encroaching woody species also contributed to the total annual production. When the Tobosa/Mixed-grass Savannah Community (1.2) is continually grazed heavily and fire is excluded, ecological succession proceeds toward woody plant dominants and replacement of the more preferred species. Primary increasing woody species are mesquite and pricklypear. Tobosa, buffalograss, and curly mesquite continue to increase and palatable forbs and midgrasses decrease. As grass cover declines, litter and soil organic matter decline while bare ground, erosion, and other desertification processes increase. The microclimate in the grassland areas becomes more arid. When the woody plant component reaches approximately 15 percent canopy, grazing management strategies, such as grazing deferment, generally will not restore the grassland community. A combination of proper grazing and prescribed burning could be successful. Without these management practices, the woody plants will continue to increase in density and size as ecological succession forces drive the plant community toward a woody plant dominance in the absence of fire and competition from herbaceous plants. The next community in the succession is a Tobosa/Shortgrass Mesquite/Mixed-Brush Community (2.1).

Mesquite dominates the Tobosa/Shortgrass Mesquite/Mixed-Brush Community (2.1). Pricklypear, condalia (Condalia spp.), algerita (*Mahonia trifoliolata*), and broom snakeweed (*Gutierrezia sarothrae*) are representative understory shrubs. The grass component is a mixture of midgrasses, shortgrasses, and low-quality forbs, with tobosa characteristically the dominant species. When heavy livestock grazing is continued, tobosa, buffalograss, and curly mesquite are gradually replaced by less palatable species such as three-awns (Aristida spp.) and hairy grama (*Bouteloua hirsuta*). Cool-season grasses such as Texas wintergrass (*Nassella leucotricha*) and annual bromes (Bromus spp.) also increase. During this phase, the process of deterioration can be reversed with relatively inexpensive brush control methods and improved grazing management that provides necessary fine fuel loadings for prescribed burning at six to seven-year intervals.

If heavy grazing continues and brush control practices are not applied, the woody canopy will continue to increase in size and density until a woody plant dominated community develops. Woody plants begin to dominate the plant community at about 35 to 40 percent cover. At this threshold, the grassland component will not produce enough fine fuel for fires to effectively control the woody plants. When this occurs, the site completes the transition into a new state, the Mesquite/Mixed-Brush Shortgrass Community (2.2).

The Mesquite/Mixed-Brush Shortgrass Community (2.2) is dominated by mesquite and mixed-brush to the exclusion of most reference herbaceous species except in the plant interspaces. Once ground cover exceeds 40 to 50 percent understory, forage production is very limited except in wet periods when annuals contribute to the annual forage production. Shortgrasses, cool-season grasses, and forbs are in a weakened condition due to severe shading and competition from the woody plants. Mesquite and understory brush continue to increase in size and density regardless of grazing management. With livestock continuing to graze the site severely, tobosa, buffalograss, and curly mesquite are replaced by less palatable species such as three-awns, low grama species (Bouteloua spp.) and broomweed (Gutierrezia spp.). Cool-season grasses such as Texas wintergrass and annuals also increase. Broom snakeweed, a perennial half-shrub, sometimes dominates the understory which can present toxicity problems for sheep and cattle. The Mesquite/Mixed-Brush Shortgrass Community (2.2) provides undesirable food sources for livestock and low-quality deer habitat providing only cover and low-quality browse. Desertification, including erosion, continues in the interspaces until maximum ground cover by woody species is approached. The microclimate becomes drier as interception losses increase with shrub cover. Once shrub cover

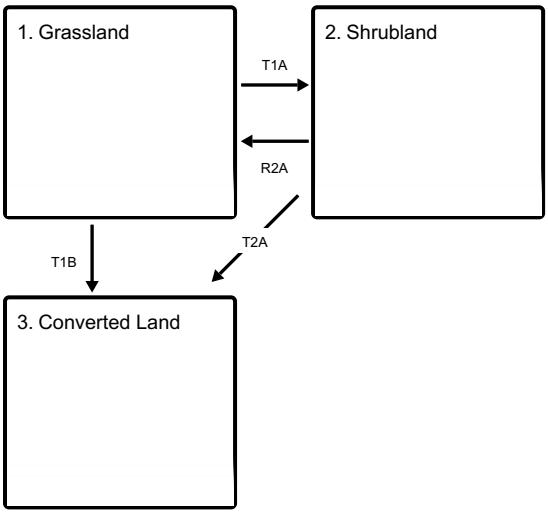
reaches potential, however, the hydrologic processes, energy flow, and nutrient cycling stabilize under the woodland environment.

Major expense and energy are required to restore Mesquite/Mixed-brush Shortgrass Community (2.2) to a midgrass prairie community. Generally, mechanical or herbicidal treatments are used to remove brush. Areas can be dozed or plants treated individually (IPT) with chemicals. Many times, this is followed by range planting to provide native seed back in the soil. Restoration of this site is very difficult to accomplish because of different soil characteristics. The brushy species, namely mesquite, can be very hard to control with herbicides. Mechanical control such as grubbing or root plowing can destroy the perennial grass cover and more often than not, annuals or broom snakeweed can prevail for two or three years, even with reseeding. Eventually, the plants most adapted to the site will return and again become dominant. The restoration process may take several years of repeated treatments. Soil erosion during the restoration process may preclude a complete return to the reference community.

The Clay Flat site is used mainly for range, but some areas are cultivated. Potential for cultivated crops are high with irrigation. Without irrigation, crop agriculture is not sustainable in the semiarid climate. Although some grain and winter cereal crops are planted today, most of the fields in the site are used as rangeland. Some areas originally planted to crops have been abandoned and let “Go Back” to native range. These generally re-establish naturally with species from adjacent acreage, especially brush species. If the woody invaders are not controlled with brush management, woody species will eventually dominate through secondary succession.

State and transition model

Ecosystem states



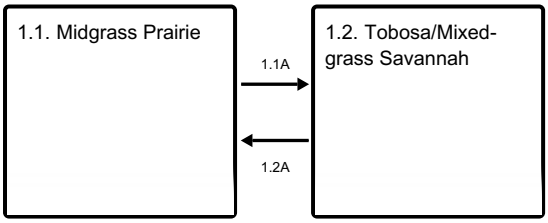
T1A - Absence of disturbance and natural regeneration over time, may be coupled with excessive grazing pressure

T1B - Extensive soil disturbance followed by seeding

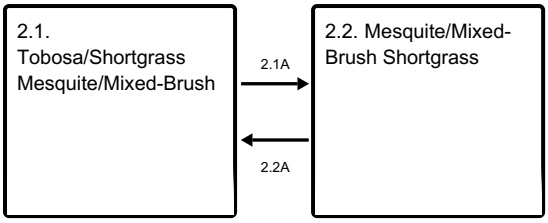
R2A - Reintroduction of historic disturbance return intervals

T2A - Extensive soil disturbance followed by seeding

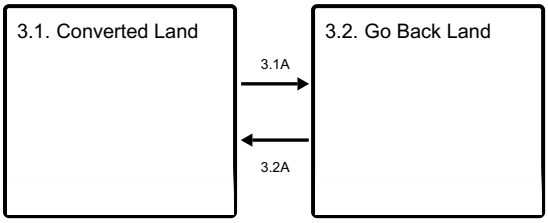
State 1 submodel, plant communities



State 2 submodel, plant communities



State 3 submodel, plant communities



State 1
Grassland

Dominant plant species

- tobosagrass (*Pleuraphis mutica*), grass
- sideoats grama (*Bouteloua curtipendula*), grass

Community 1.1
Midgrass Prairie

Figure 8. 1.1 Midgrass Prairie Community

The reference community for this site is a fire induced midgrass prairie. Woody species make up less than five percent of the total herbage production. Tobosa, being tolerant of repeated fires, made up as much as 20 percent. Sideoats grama, feathery bluestems, vine mesquitegrass, Arizona cottontop (*Digitaria californica*), Texas cupgrass (*Eriochloa sericea*), and plain bristlegrass contribute 30 to 60 percent. Buffalograss and curlymesquite were common shortgrasses. Texas wintergrass (*Nassella leucotricha*), wildrye (Elymus spp.), and western wheatgrass (*Pascopyrum smithii*) were important parts of the cool-season grass component. Forbs include Engelmann's daisy (*Engelmannia peristenia*), ruellia (Ruellia spp.), sida (Sida spp.), verbena, groundcherry (Physalis spp.), and bundleflower (Desmanthus spp.). Shrubs are scarce but include fire-resistant species as sumac (Rhus spp.), pricklypear (Opuntia spp.), and condalia (Condalia spp.). Oaks (Quercus spp.) and mesquite (Prosopis spp.) are also present but are usually scattered multi-stemmed shrubs created by repeated wildfires. The Midgrass Prairie Community (1.1) produce as much as 3,000 pounds in good moisture years and as little as 600 pounds in dry years. Annual yields decline from east to west due to precipitation differences. Grasses and forbs contribute up to 95 percent of the total annual production. The midgrasses aid in the infiltration of rainfall into the moderately permeable soil and reduced runoff. Litter and organic matter buildup is limited by the dry climate. The Midgrass Prairie Community (1.1) furnishes good forage for grass eating type animals such as bison, pronghorn antelope,

horses, and cattle.

Table 6. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	540	1800	2700
Shrub/Vine	30	100	150
Forb	30	100	150
Tree	0	0	4
Total	**600**	**2000**	**3004**

Figure 10. Plant community growth curve (percent production by month). TX3615, Midgrass Dominant with Shortgrass and Scattered Shrubs. Midgrass dominant vegetation with shortgrasses and scattered shrubs..

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

Community 1.2
Tobosa/Mixed-grass Savannah

Figure 11. 1.2 Tobosa/Midgrass Savannah Community

The Tobosa/Mixed-grass Savannah Community (1.2) is a tobosa dominated mixed-grass community being encroached by woody species that have been held at low densities by repeated fires and competition from a vigorous grass component. Brushy species, including pricklypear and mesquite, increase in density because heavy abusive grazing by livestock reduces grass cover, causes reduction of soil cover, and reduces fine fuel necessary to care fires. Due to selective grazing and differential response of plants to defoliation, heavy grazing also causes changes in composition of the reference community. The more palatable midgrasses and forbs are replaced by less palatable, or more grazing resistant, species. The encroaching woody species are generally less than five feet tall and subject to control by prescribed burning. The woody canopy varies between 5 and 15 percent depending on length and severity of overgrazing, frequency and duration of fires, and seed sources by invading species. Typically, mesquite and/or pricklypear are early and persistent increasers. Condalia (Condalia spp.), algerita (*Mahonia trifoliolata*), broom snakeweed, and acacia (Acacia spp.) are also common. The prairie grassland becomes a grassland-shrub savannah being encroached by suppressed woody species. The preferred midgrasses are being replaced by the more grazing resistant tobosa, although sideoats grama, vine mesquite, Texas cupgrass, and feathery bluestems persist in this phase. Most of the perennial forbs found in the reference community remain, although in lesser amounts. Annual primary production is reduced slightly relative to the reference community, ranging from 500 to 2,500 pounds per acre depending on precipitation amounts and the specific soil series. Grasses remain the dominant producers of forage. Heavy abusive grazing reduces plant cover, litter, and mulch, and increases bare ground which exposes the soil to erosion. There could be some mulch and litter movement during rainstorms but due to gentle slopes, little soil movement takes place in this vegetation phase.

Table 7. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	400	1440	2000
Shrub/Vine	75	270	375
Forb	25	90	125
Tree	0	0	4
Total	**500**	**1800**	**2504**

Figure 13. Plant community growth curve (percent production by month). TX3633, Tobosa/Mixed-grass Savannah Community. Warm-season rangeland with peaks in production in May and in September that coincide with peaks in precipitation..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3	3	5	13	20	17	4	4	15	7	5	4

Pathway 1.1A
Community 1.1 to 1.2

Midgrass Prairie **Tobosa/Mixed-grass Savannah**

The reference community can be maintained with prescribed grazing and prescribed burning. Stocking rates must consider the kind of livestock and balance their numbers with current annual forage production while considering competition from other herbivores. With heavy abusive grazing, decrease in intensity and frequency of fires and no brush management, this plant community transitions very quickly to the Tobosa/Mixed-grass Savannah Community (1.2).

Pathway 1.2A
Community 1.2 to 1.1

Tobosa/Mixed-grass Savannah **Midgrass Prairie**

With prescribed grazing, prescribed burning, brush management, and IPT, the Tobosa/Mixed-grass Savannah Community can revert back to the Midgrass Prairie Community.

Conservation practices

Brush Management
Prescribed Burning
Prescribed Grazing

State 2
Shrubland

Dominant plant species

- algerita (*Mahonia trifoliolata*), shrub
- broom snakeweed (*Gutierrezia sarothrae*), shrub

Community 2.1
Tobosa/Shortgrass Mesquite/Mixed-Brush

Figure 14. 2.1 Shortgrass Mesquite/Mixed-Brush Community

The Tobosa/Shortgrass Mesquite/Mixed-Brush Community (2.1) presents a 15 to 35 percent woody canopy cover dominated by mesquite with mixed-brush and a shortgrass understory. This community is the result of selective heavy grazing by livestock, suppression of fire, and the differential response of plants due to defoliation. The diversity of the grassland component declines while woody plants and unpalatable forbs increase. Primary production decreases due to decline in soil structure and organic matter and is primarily from the woody component instead of the grass-like component. All, except the more palatable woody species, have increased in size and density. Mesquite typically dominates the overstory and pricklypear dominates the understory. Algerita, acacia, condalia, and broom snakeweed may also be present in this community. Remnants of reference community may occupy interspaces between trees and shrubs, but more often they are unpalatable invader species. Tobosa remains dominant, but as regression progresses under heavy grazing pressure, tobosa gives way to buffalograss (Buchloe dactyloides), curlymesquite (Hilaria belangeii), and other less palatable shortgrasses. Mexican sagewort (Artemesia ludoviciana), Texas nightshade (Solanum spp.), queen's delight (*Stillingia sylvatica*), prairie coneflower (*Ratibida columnifera*), Texas grama (*Bouteloua rigidiseta* var. rigidiseta), and red grama (*Bouteloua trifida*) are commonly found in this community. Cool-season grasses such as Texas wintergrass can be found under and around woody plants. In wet cycles, bromes (Bromus spp.) and other annual species such as broomweed (Gutierrezia spp.) are abundant. Annual primary production is approximately 500 to 2,000 pounds per acre, depending on precipitation events. Herbage production is balanced between the grassland component and woody species. As the grassland component declines, more soil is exposed to crusting and wind erosion. During the middle and end of this plant community phase, considerable soil becomes exposed further. Water erosion is not a serious problem because of the shallow slopes on the site but wind erosion can be rather high. High interception losses by the increasing woody canopy combined with evaporation losses can reduce the effectiveness of rainfall. Litter, soil organic matter and structure decline in the interspaces reducing water infiltration but hydrologic conditions improve under the woody plant cover.

Table 8. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	250	750	1000
Shrub/Vine	175	525	700
Tree	75	225	300
Forb	50	150	200
Total	**550**	**1650**	**2200**

Figure 16. Plant community growth curve (percent production by month). TX3635, Tobosa/Shortgrass Mesquite/Mixed-Brush Community. Community

is composed of a 15 to 35 percent woody canopy cover dominated by mesquite with tobosa/shortgrass understory..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3	3	5	13	20	17	4	4	15	7	5	4

Community 2.2
Mesquite/Mixed-Brush Shortgrass

Figure 17. 2.2 Mesquite/Mixed-Brush Shortgrass Community

The Mesquite/Mixed-Brush Shortgrass Community (2.2) is dominated by mesquite and shrubs with few shortgrasses present. Remnants of the reference grassland vegetation, mostly shortgrasses and shade tolerant forbs, occupy the shrub interspaces. This community is the result of selective heavy grazing by livestock and wildlife, absence of natural fires and the differential response of plants due to defoliation on the shrubland site. The typical woody canopy is mesquite with pricklypear in the understory. Algerita, acacia, condalia, and snakeweed are also common in this community. Tobosa remains dominant initially; but as regression progresses under heavy grazing pressure, tobosa gives way to buffalograss, curlymesquite, and other less palatable species. Mexican sagewort, Texas nightshade, queen’s delight, prairie coneflower, Texas grama, and red grama become common. Cool-season grasses such as Texas wintergrass can be found under and around woody plants. During wet periods, bromes and other annual species such as broomweed are abundant. Because of grazing pressure and competition for nutrients and water from the woody plants, the grassland component shows a lack of plant vigor and productivity. As the grassland component declines, more soil is exposed to crusting and wind erosion. During the beginning and middle of this plant community phase, considerable soil becomes exposed. Water erosion is not a serious problem because of the shallow slopes, but wind erosion can be rather high. High interception losses by the increasing woody canopy combined with evaporation losses can reduce the effectiveness of rainfall. Litter, soil organic matter and structure decline in the interspaces reducing water infiltration in the interspaces, but hydrologic conditions improve under the woody plant cover. Browsing animals can find fair quality food sources if deer and goat browsing have not been excessive. Forage quantity and quality for cattle in this plant community is low. Livestock stocking decisions should consider the forage species composition, quantity of available forage, and rangeland health conditions to determine the proper annual carrying capacity. Unless brush management and prescribed grazing management are applied, the transition toward dense shrubland will continue. Brush control practices are required to reverse the continuing trend of a brush canopy enclosure. To restore livestock or deer production, brush management is required to remove undesirable brush species, range planting of native species to return vegetation, and establish prescribed grazing and prescribed fire conservation practices to maintain the health of the desired plant community. Caution should be applied in choosing brush control and seeding methods. Broadcast herbicides are often ineffective and mechanical treatments that expose soil leave the site open which can lead infestation of weeds that often can persist for several years.

Table 9. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Shrub/Vine	225	675	900
Tree	125	375	500
Grass/Grasslike	125	375	500
Forb	25	75	100
Total	**500**	**1500**	**2000**

Figure 19. Plant community growth curve (percent production by month). TX3636, Mesquite/Mixed-Brush Shortgrass Community. Mesquite dominated shrubland shortgrass complex. Remnants of the climax grassland vegetation, mostly shortgrasses and shade tolerant forbs, occupy the shrub interspaces..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3	3	5	13	20	17	4	4	15	7	5	4

Pathway 2.1A
Community 2.1 to 2.2

Tobosa/Shortgrass Mesquite/Mixed-Brush

Mesquite/Mixed-Brush Shortgrass

When the shrub canopy cover nears 35 percent and the herbaceous component contributes less than 50 percent of the herbage production, the plant community crosses the threshold and becomes a Mesquite/Mixed-Brush Shortgrass Community (2.2).

Pathway 2.2A
Community 2.2 to 2.1

Mesquite/Mixed-Brush Shortgrass

Tobosa/Shortgrass Mesquite/Mixed-Brush

With the implementation of brush management, prescribed grazing, and prescribed burning, the Mesquite/Mixed-brush Shortgrass Community can revert back to the Tobosa/Shortgrass Mesquite/Mixed-brush Community.

Conservation practices

Brush Management
Prescribed Burning
Prescribed Grazing

State 3
Converted Land

Dominant plant species

- kleingrass (*Panicum coloratum*), grass

Community 3.1
Converted Land

The Clay Flat is used mainly for rangeland production but some areas are still cultivated. Potential for cultivated crops is higher with irrigation than by dryland cropping systems. Without irrigation, crop agriculture is not sustainable in this semiarid climate. Cropping small acreages is practiced in either summer annual forage crops or winter small grain grazing. Many fields, however, have been abandoned and let ‘go back’ to native range or planted to native or introduced grasses for pasture. Cropland areas are seeded to native or introduced species such as Kleingrass (*Panicum coloratum*) or Old World bluestem (Bothriochloa spp.). Production on those seeded to adapted introduced grasses or native grasses can reach peak production within a few years, once a full stand becomes established. In this case, herbage production will equal the reference community if native species are seeded. Adapted introduced species plantings such as Kleingrass may surpass reference community production. The practice of including adapted legumes or other forbs will enhance productivity and usefulness, especially for wildlife. Invasion of the seeded fields by brush, particularly mesquite and pricklypear, is common. Drought and reduced soil cover due to crop cultivation and heavy abusive grazing along with a nearby seed source trigger the brush invasion. The shrubs that appear in seeded or abandoned fields are established by seeds brought in by animals, water, or wind. The invading brush must be controlled with grazing management, prescribed burning, or other appropriate brush management methods, or the woody invaders will dominate.

Figure 21. Plant community growth curve (percent production by month). TX3600, Cool Season Crops. Cool season species are planted in the fall for winter and spring growth. Species include wheat and oats..

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

Figure 22. Plant community growth curve (percent production by month). TX3601, Warm Season Crops. Warm season species are planted in early spring. Their peak growth is in late May with a lesser peak in September. Forage and Grain sorghum that are planted during the warm season months..

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

Figure 23. Plant community growth curve (percent production by month). TX3613, Reclaimed Land. Reclaimed Land seeded with native or introduced species..

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 3.2
Go Back Land

The Go Back Land Community (3.2) is used to describe cropland fields that have been abandoned and are undergoing secondary succession. The Go Back Land Community results from abandoning cropped land and leaving it idle without seeding or brush management. Many cropland areas have been abandoned and are invaded by brush from the adjacent rangeland. The initial composition of abandoned fields is composed of annual, biennial, and weak perennial grasses and forbs. The species depends on the seed source from adjacent areas. The rate of succession depends on grazing management and drought frequency, but the reestablishment of reference community species takes many years. Without grazing management and brush management practices, brush species such as pricklypear, mesquite, and juniper will dominate the site before a grass community can establish. Biomass production will be limited in the early seral stage and increase as the plant community develops. Brush management and grazing management are necessary to allow the field to go back to the reference community.

Table 10. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	300	900	1200
Shrub/Vine	100	300	400
Forb	100	300	400
Total	**500**	**1500**	**2000**

Figure 25. Plant community growth curve (percent production by month). TX3629, Shortgrass-Mixedbrush Community. Shortgrass and mixed-brush summer growth with some cool-season grass growth..

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

Pathway 3.1A
Community 3.1 to 3.2

With abandonment, invasion of brush, no brush management, heavy abusive grazing, no pest management, and no nutrient management, the Converted Land Community will shift to the Go Back Land Community.

Pathway 3.2A
Community 3.2 to 3.1

With crop cultivation, plowing, pasture planting, nutrient management, pest management, and prescribed grazing conservation practices, the Go Back Community can revert back to the Converted Land Community.

Conservation practices

Brush Management
Conservation Crop Rotation
Prescribed Burning
Nutrient Management
Integrated Pest Management (IPM)
Prescribed Grazing
Precision Pest Control Application

Transition T1A
State 1 to 2

The changes in species composition are small initially, but unless proper grazing and prescribed burning are initiated; the invading species continue to increase in size and density. When the canopy of the woody plants becomes dense enough (15 percent) or tall enough (greater than 5 feet) to suppress grass growth and resist fire damage, a threshold in ecological succession is crossed. This threshold can also occur when the fine fuel load provided by grasses is too low to control brush effectively with fire. The Tobosa/Mixed-grass Savannah Community (1.2) then becomes the Tobosa/Shortgrass Mesquite/Mixed-Brush Community (2.1). In this plant community, normal range management practices, such as prescribed grazing, cannot reverse the trend to woody plant dominance.

Transition T1B
State 1 to 3

With crop cultivation, plowing, pasture planting, nutrient management, pest management, and prescribed grazing conservation practices, the Grassland State can be converted into the Converted Land State.

Restoration pathway R2A
State 2 to 1

With the application of various conservation practices such as prescribed grazing, prescribed burning, brush management, IPT, and range planting, the Shrubland State could revert back to the Grassland State.

Conservation practices

Brush Management
Prescribed Burning
Range Planting
Prescribed Grazing

Transition T2A
State 2 to 3

With crop cultivation, plowing, pasture planting, nutrient management, pest management, and prescribed grazing, the Shrubland State shifts to the Converted Land State.

Additional community tables

Table 11. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Midgrass**			160–600	
	tobosagrass	PLMU3	*Pleuraphis mutica*	160–600	–
2	**Midgrasses**			300–1500	
	cane bluestem	BOBA3	*Bothriochloa barbinodis*	300–1500	–
	sideoats grama	BOCU	*Bouteloua curtipendula*	300–1500	–
	blue grama	BOGR2	*Bouteloua gracilis*	300–1500	–
	silver beardgrass	BOLAT	*Bothriochloa laguroides ssp. torreyana*	300–1500	–
	Arizona cottontop	DICA8	*Digitaria californica*	300–1500	–
	Texas cupgrass	ERSE5	*Eriochloa sericea*	300–1500	–
	vine mesquite	PAOB	*Panicum obtusum*	300–1500	–
	large-spike bristlegrass	SEMA5	*Setaria macrostachya*	300–1500	–
	composite dropseed	SPCOC2	*Sporobolus compositus var. compositus*	300–1500	–
3	**Shortgrasses**			60–300	
	buffalograss	BODA2	*Bouteloua dactyloides*	60–300	–
	curly-mesquite	HIBE	*Hilaria belangeri*	60–300	–
4	**Midgrasses**			30–150	
	threeawn	ARIST	*Aristida*	30–150	–
	hairy grama	BOHI2	*Bouteloua hirsuta*	30–150	–
	slim tridens	TRMUE	*Tridens muticus var. elongatus*	30–150	–
5	**Cool-season Grasses**			30–150	
	Canada wildrye	ELCA4	*Elymus canadensis*	30–150	–
	Texas wintergrass	NALE3	*Nassella leucotricha*	30–150	–

	western wheatgrass	PASM	*Pascopyrum smithii*	30–150	–
Forb					
6	**Forbs**			30–150	
	Indian mallow	ABUTI	*Abutilon*	30–150	–
	onion	ALLIU	*Allium*	30–150	–
	white sagebrush	ARLUM2	*Artemisia ludoviciana ssp. mexicana*	30–150	–
	nicker	CAESA	*Caesalpinia*	30–150	–
	yellow sundrops	CASE12	*Calylophus serrulatus*	30–150	–
	leather flower	CLEMA	*Clematis*	30–150	–
	croton	CROTO	*Croton*	30–150	–
	bundleflower	DESMA	*Desmanthus*	30–150	–
	Engelmann's daisy	ENPE4	*Engelmannia peristenia*	30–150	–
	rushpea	HOFFM	*Hoffmannseggia*	30–150	–
	Gregg's tube tongue	JUPI5	*Justicia pilosella*	30–150	–
	rush skeletonplant	LYJU	*Lygodesmia juncea*	30–150	–
	narrowleaf Indian breadroot	PELI10	*Pediomelum linearifolium*	30–150	–
	beardtongue	PENST	*Penstemon*	30–150	–
	leafflower	PHYLL	*Phyllanthus*	30–150	–
	groundcherry	PHYSA	*Physalis*	30–150	–
	wild petunia	RUELL	*Ruellia*	30–150	–
	awnless bushsunflower	SICA7	*Simsia calva*	30–150	–
	fanpetals	SIDA	*Sida*	30–150	–
	Texas nightshade	SOTR2	*Solanum triquetrum*	30–150	–
	globemallow	SPHAE	*Sphaeralcea*	30–150	–
	queen's-delight	STSY	*Stillingia sylvatica*	30–150	–
Shrub/Vine					
7	**Shrubs**			24–120	
	acacia	ACACI	*Acacia*	24–120	–
	snakewood	CONDA	*Condalia*	24–120	–
	desert-thorn	LYCIU	*Lycium*	24–120	–
	algerita	MATR3	*Mahonia trifoliolata*	24–120	–
	pricklypear	OPUNT	*Opuntia*	24–120	–
	sumac	RHUS	*Rhus*	24–120	–
Tree					
8	**Trees**			0–4	
	hackberry	CELTI	*Celtis*	0–4	–
	mesquite	PROSO	*Prosopis*	0–4	–

Animal community

Many types of grassland prairie wildlife use the Clay Flat Ecological Site. Insects, reptiles, birds, and mammals frequent the site, either as their base habitat or from the adjacent sites. Small mammals include many kinds of rodents, rabbits, raccoon, skunk, opossum, and armadillo. Predators include coyote, red fox, gray fox, and bobcat. Many types of birds including game birds, songbirds, and birds of prey are indigenous. Most are still plentiful. Bison and pronghorn antelope, however, are no longer present. White-tailed deer and many species of exotic deer utilize

the Clay Flat site in its various states. Deer, turkey, and quail particularly favor the habitat provided by the Tobosa/Midgrass Savannah Plant Community.

The site is suitable for the production of livestock, including cattle, sheep, and goats. The reference community is very suited to primary grass eaters such as bison and cattle. As retrogression occurs and woody plants invade, it becomes a better habitat for sheep, goats, deer, and other wildlife because of the browse and cool-season grasses. Cattle, sheep, and goats should be stocked in proportion to the available grass, forb, and browse forage, keeping deer competition for forbs and browse in mind. If the animal numbers are not kept in balance with herbage and browse production through grazing management and good wildlife population management, the late Mesquite/Mixed-Brush Shortgrass phase will have little to offer as habitat except cover.

Hydrological functions

The Clay Flat Ecological Site is a well-drained, deep upland with generally flat slopes. It may receive water from surrounding soils and the site may be covered with by water during seasons of high rainfall. Soil moisture holding capacity is high and percolation is moderate. Runoff is slow due to gentle to nearly level depression slopes. The soil crusts readily when exposed leading to high evaporation and possibly wind erosion. It also cracks to great depth when dry, allowing rapid water up-taken when rain occurs on dry soil. The deep soils, with moderate to good water holding capacity, are conducive to high herbage production during above average moisture years.

Under reference conditions, the grassland vegetation intercepts and utilizes much of the incoming rainfall. Litter and soil movement is slight. Standing plant cover, duff, and organic matter decrease as the Midgrass Prairie (1.1) transitions to the Tobosa/Midgrass Savannah Community (1.2). These processes continue in the interstitial spaces in the Tobosa/Shortgrass Mesquite/Mixed-brush Community (2.1) and the Mesquite/Mixed-brush Shortgrass Community (2.2). Once the shrubland matures, the hydrologic and ecological processes, nutrient cycling, and energy flow stabilize within the woody plant canopy. Evaporation and interception losses are higher, however, resulting in less moisture reaching the soil. Essentially no water passes through the soil to underground water.

Recreational uses

The Clay Flat site is well suited for many outdoor recreational uses including hunting, hiking, camping, equestrian, and bird watching. This site, along with adjacent upland sites, provides diverse scenic beauty and many opportunities for recreation.

Wood products

Mesquite is sometimes used for posts and charcoal. It is also used for furniture and specialty products.

Other products

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

Inventory data references

Five records were used from Schleicher County. Information presented has been derived from the revised Clay Flat Range Site, literature, limited NRCS clipping data (417s), field observations, and personal contacts with range-trained personnel. Photos by J. L. Schuster.

Other references

Archer, S. 1994. Woody plant encroachment into southwestern grasslands and savannas: Rates, patterns, and proximate causes. Ecological implications of livestock herbivory in the West, 13-68.

Archer, S. and F. E. Smeins. 1991. Ecosystem-level processes. Grazing Management: An Ecological Perspective. Edited by R.K. Heischmidt and J.W. Stuth. Timber Press, Portland, OR.

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

Bracht, V. 1931. Texas in 1848. German-Texan Heritage Society, Department of Modern Languages, Southwest Texas State University, San Marcos, TX.

Bray, W. L. 1904. The timber of the Edwards Plateau of Texas: Its relations to climate, water supply, and soil. No. 49. US Department of Agriculture, Bureau of Forestry.

Briske, D. D., S. D. Fuhlendorf, and F. E. Smeins. 2005. State-and-transition models, thresholds, and rangeland health: A synthesis of ecological concepts and perspectives. Rangeland Ecology and Management, 58(1):1-10.

Brothers, A., M. E. Ray Jr., and C. McTee. 1998. Producing quality whitetails, revised edition. Texas Wildlife Association, San Antonio, TX.

Brown, J. K. and J. K. Smith. 2000. Wildland fire in ecosystems, effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-vol. 2. Ogden, UT: US Department of Agriculture, Forest Service, Rocky Mountain Research Station, 257:42.

Davis, W. B. 1974. The Mammals of Texas. Texas Parks and Wildlife Department, 41.

Foster, J. H. 1917. The spread of timbered areas in central Texas. Journal of Forestry 15(4):442-445.

Frost, C. C. 1998. Presettlement fire frequency regimes of the United States: A first approximation. Fire in ecosystem management: Shifting the paradigm from suppression to prescription. Tall Timbers Fire Ecology Conference Proceedings, 20:70-81.

Gould, F. W. 1975. The grasses of Texas. The Texas Agricultural Experiment Station, Texas A&M University Press, College Station, TX.

Hatch, S. L. and J. Pluhar. 1993. Texas Range Plants. Texas A&M University Press, College Station, TX.

Hamilton, W. and D. Ueckert. 2005. Rangeland woody plant control--past, present, and future. Texas A&M University Press. College Station, TX.

Hart, C. R., A. McGinty, and B. B. Carpenter. 1998. Toxic plants handbook: Integrated management strategies for West Texas. Texas Agricultural Extension Service, The Texas A&M University, College Station, TX.

Heitschmidt, R. K. and J. W. Stuth. 1991. Grazing management: An ecological perspective. Timberline Press, Portland, OR.

Loughmiller, C. and L. Loughmiller. 1984. Texas wildflowers. University of Texas Press, Austin, TX.

Milchunas, D. G. 2006. Responses of plant communities to grazing in the southwestern United States. Gen. Tech. Rep RMRS-GTR-169. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Research Station, 126:169.

Niehaus, T. F. 1998. A field guide to Southwestern and Texas wildflowers (Vol. 31). Houghton Mifflin Harcourt, Boston, MA.

Ramsey, C. W. 1970. Texotics. Texas Parks and Wildlife Department, Austin, TX.

Roemer, F. translated by O. Mueller. 1995. Roemer’s Texas, 1845 to 1847. Texas Wildlife Association, San Antonio, TX.

Scifres, C. J. and W. T. Hamilton. 1993. Prescribed burning for brushland management: The South Texas example. Texas A&M Press, College Station, TX.

Smeins, F. E., S. Fuhlendorf, and C. Taylor, Jr. 1997. Environmental and land use changes: A long term perspective. Juniper Symposium, 1-21.

Taylor, C. A. and F. E. Smeins. 1994. A history of land use of the Edwards Plateau and its effect on the native vegetation. Juniper Symposium, 94:2.

Thurow, T. L. 1991. Hydrology and erosion. Grazing Management: An Ecological Perspective. Edited by R.K. Heitschmidt and J.W. Stuth. Timber Press, Portland, OR.

Tull, D. and G. O. Miller. 1991. A field guide to wildflowers, trees and shrubs of Texas. Texas Monthly Publishing, Houston, TX.

USDA-NRCS. 1997. National range and pasture handbook. Washington, DC: United States Department of Agriculture. Natural Resources Conservation Service, Grazing Lands Technology Institute.

Weniger, D. 1997. The explorers' Texas: The animals they found. Eakin Press, Austin, TX.

Weniger, D. 1984. The explorers' Texas: The lands and waters. Eakin Press, Austin, TX.

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

Vines, R. A. 1960. Trees, shrubs and vines of the Southwest. University of Texas Press, Austin, TX.

Contributors

Dr. Joseph Schuster, Range & Wildlife Habitat Consultants, LLC, Bryan, TX
Joe McEntire
Mark Moseley, RMS, NRCS, Boerne, TX
Edits by Travis Waiser, MLRA Leader, NRCS, Kerrville, TX

Approval

Bryan Christensen, 9/19/2023

Acknowledgments

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

Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	Joe Franklin, Zone RMS, NRCS, San Angelo, TX
Contact for lead author	325-944-0147
Date	12/01/2005
Approved by	Bryan Christensen
Approval date	

Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

2. **Presence of water flow patterns:** None to slight. Site may receive runoff from adjacent sites.

3. **Number and height of erosional pedestals or terracettes:** None to slight. Minimal pedestals due to erosion. Cracking and shrinking and swelling of the soil profile may give gilgae relief which should not be confused with water erosion patterns and pedestaling.

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Less than 10 percent bare ground. Small and non-connected areas. Cracking and swelling of soil may expose bare soil.

5. **Number of gullies and erosion associated with gullies:** None. Flat concave terrain and vegetative cover precludes gullying.

6. **Extent of wind scoured, blowouts and/or depositional areas:** None to slight. Wind hazard is moderate when soil is exposed.

7. **Amount of litter movement (describe size and distance expected to travel):** Minimal movement of fine litter for short distances.

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Erosion stability values estimated at 5 to 6. Water erosion hazard of bare soil is slight.

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Surface layer of Tobosa soil is dark grayish brown clay. Structure is weak, medium, and moderate angular blocky. There are medium to few roots to 34 inches in depth.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Reference midgrasses with good distribution and cover provided excellent infiltration and slow runoff. Under normal rainfall, runoff is essentially nil, but when rainfall exceeds the sites ability to hold water, the runoff is free of active erosion.

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be**

mistaken for compaction on this site): None.

---

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

    Dominant: Warm-season midgrasses

    Sub-dominant: Warm-season shortgrasses

    Other: Cool-season grasses = forbs shrubs/vines Trees

    Additional: Tobosagrass was about 20 percent in the reference community but became dominant quickly after disturbance.

---

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Minimal. Grasses will almost always show some mortality and decadence, especially under drought conditions.

---

14. **Average percent litter cover (%) and depth (in):** Interspaces between plant canopies essentially covered with various sizes of litter and mulch.

---

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** 600 pounds per acre in years with below average moisture, 2,000 pounds per acre in average moisture, and 3,000 pounds per acre in above average moisture years. Site may receive extra moisture from adjacent sites and be highly productive in wet years.

---

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

---

17. **Perennial plant reproductive capability:** Good. All species should be capable of reproducing except during periods of prolonged drought, heavy natural herbivory or intense fire. Recovery from these disturbances will take 2 to 5 years.
