USDA Natural Resources
Conservation Service

Ecological site R078AY128TX
Very Shallow 25-28" PZ

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General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

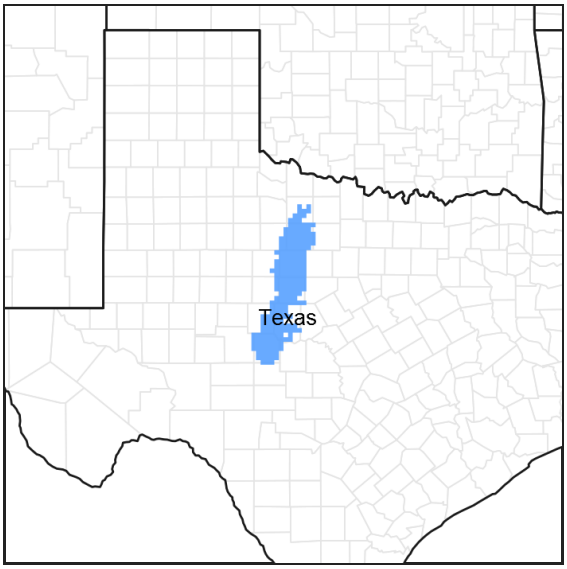


Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

MLRA notes

Major Land Resource Area (MLRA): 078A–Rolling Limestone Prairie

MLRA 78A is characterized by erosional plains with terraces adjacent to perennial and intermittent streams. Loamy and clayey soils range from shallow to deep over limestones and shales of Permian and Pennsylvanian age. Loamy soils are also associated with stream terraces.

LRU notes

NA

Classification relationships

This ecological site is correlated to soil components at the Major Land Resource Area (MLRA) level which is further described in USDA Ag Handbook 296.

Ecological site concept

These sites occur on shallow soils over caliche and limestone. Reference vegetation consists of mid and shortgrasses with forbs and few woody species. Abusive grazing practices can lead to a change in species

composition and an alternate plant community. Without fire or other brush management, woody species may increase across the site.

Associated sites

R078AY126TX	**Shallow Clay 25-28" PZ** The site differs in species composition and productivity. Soils are deep and plant-soil-air-moisture relationships are more favorable.

Similar sites

R078AY125TX	**Shallow 25-28" PZ** The shallow site is closely associated, generally downslope of the very shallow site. It has deeper soils. Plant communities are similar but have higher annual production.

Table 1. Dominant plant species

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

Physiographic features

The Very Shallow Ecological site occurs on nearly level to moderately sloping, outwash plains, stream terraces, alluvial fans, ridgetops and breaks of erosional uplands. The soils were formed in calcareous and loamy sediments several feet thick; either residuum from indurated limestone or loamy calcareous gravelly alluvium. Soils are very shallow and shallow to a petrocalcic horizon, well drained, and moderately permeable. The site generally will not receive runoff from adjacent ecological sites. Slopes are smooth to convex and range from 1 to 30 percent. Elevation of the site ranges from 1200 to 2400 feet above mean sea level.

Table 2. Representative physiographic features

Landforms	(1) Plains > Ridge (2) Plains > Plain (3) Plains > Hillslope
Runoff class	Low to medium
Flooding frequency	None
Ponding frequency	None
Elevation	1,200–2,400 ft
Slope	1–30%
Aspect	Aspect is not a significant factor

Climatic features

The climate of MLRA 78A is subtropical subhumid, with hot, dry summers and mild, dry winters. The Precipitation is similar north to south throughout the area, but decreases slightly from east to west. Temperature is similar east to west, but warmer from north to south. The area is clear to partly cloudy 80 percent of the time during the summer and 60 percent during the winter. Prevailing winds usually occur from a southerly direction and from north to northwest during passage of fall and winter cool fronts. March and April are the windiest months of the year.

Most precipitation occurs during the warmer months from April to October, in the form of rainfall during thunderstorms, often of short duration and high intensity, with considerable variation in amounts of rain and the area covered. Lightening, strong winds and hail frequently accompany the thunderstorms. Occasional tornadoes are not uncommon. Precipitation distribution is bimodal, with peaks occurring in May-June and September-October. The

annual precipitation is about 25 to 28 inches. Timeliness and amount of rainfall are critical to plant growth. Rainfall events of one-fourth inch or less have limited effectiveness. High temperatures and dry winds reduce precipitation effectiveness. Snowfall represents only a small part of the annual precipitation. Snowfall of one inch or more occurs about one in five years, while snowfall of greater than five inches occurs only about one in ten years. Snow cover generally is of short duration (i.e. one to three days). Probability of snowfall is greater in the northern part of MLRA 78A.

Rainfall in the region is highly erratic, usually with more years below than above average. Periodic droughts of both temporary and prolonged duration are common to the area, although not predictable. Some of the more severe droughts of the past century in this region occurred during 1918-1919, early 1930's, early to mid 1950's, and mid to late 1990's. High temperatures and dry winds accentuate the effects of drought. The extremes in climate have greater influence on plant communities than averages. Historic wet and dry cycles of extended duration likely influenced the evolution of drought hardiness and other survival traits in the endemic flora and fauna of the area.

Temperatures range from 31 degrees F in January to 96 degrees F in July, based on the 30-year average from 1971-2000, although considerably lower and higher temperatures for these months, respectively, have been recorded for some years. Periods of excessive heat, exceeding 100 degrees F, are not uncommon during July and August. Temperatures in the winter are generally mild, but abrupt and large drops in temperature can occur when polar air masses plunge southward across the area. The duration of freezing temperatures usually does not last more than three to five days. Temperatures in the spring are mild, both daytime and nighttime. Summer temperatures are hot, with highs generally in the 80's to mid 90's during the daytime, cooling down to the upper 70's during the night. Fall is usually pleasant with mild, sunny days and crisp, cool nights, as cool northers periodically begin moving south this time of year. The area has a frost-free period of approximately 225 to 233 days and a freeze-free period of about 248 to 259 days. The primary growing season for warm-season plants is approximately 233 to 246 days, increasing from north to south. The first frost generally occurs around November 15 and the last frost occurs around March 15. These dates will vary from north to south and from year to year.

The average relative humidity ranges from 35 to 50 percent in mid-afternoon as diurnal air temperature nears maximum. As nighttime air temperature drops, relative humidity rises, averaging 70 to 80 percent by dawn.

Table 3. Representative climatic features

Frost-free period (characteristic range)	197-210 days
Freeze-free period (characteristic range)	222-244 days
Precipitation total (characteristic range)	27-29 in
Frost-free period (actual range)	195-216 days
Freeze-free period (actual range)	221-260 days
Precipitation total (actual range)	27-30 in
Frost-free period (average)	204 days
Freeze-free period (average)	235 days
Precipitation total (average)	28 in

Climate stations used

- (1) CONCHO PK/IVIE RSVR [USC00411934], Millersview, TX
- (2) COLEMAN [USC00411875], Coleman, TX
- (3) PUTNAM [USC00417327], Baird, TX
- (4) ALBANY [USC00410120], Albany, TX
- (5) THROCKMORTON 7NE [USC00419016], Throckmorton, TX

Influencing water features

There are no influences of water features on the Very Shallow site.

Wetland description

NA

Soil features

The soils of the Very Shallow Ecological Site are very shallow loam and clay loam uplands, with solums ranging in thickness from 7 to 20 inches deep over cemented or indurated caliche or limestone. The surface layer is brown, dark brown, grayish brown or dark grayish brown with loan or clay loam soil surface texture. Gravel and channers of caliche make up 5 to 30 percent by volume along with up to 15 percent cobbles and flagstones. Calcium carbonate makes up 40-60 percent of the soil profile. Scattered hard caliche or limestone fragments are present on the surface. Available water capacity is very low and the soils are droughty. Rainfall intake is moderate. Permeability is moderate to slow in surface layers, depending upon depth and amounts of hardened layers beneath the surface. Surface runoff is medium to rapid, depending upon amount of cover and degree of slope. Plant-soil-air-moisture relationships are fair to poor. In healthy condition, rills, ephemeral gullies, wind scoured areas, and pedestals are present in moderate quantities on the site. Shallow depth to cemented pans, large percentage of fragments, high lime content, and very low water capacity are the most limiting features for intensive agricultural uses, such as cropland or tame pasture.

Soil surveys often delineate two or more kinds of soil in a single mapping unit, due to their geographical association in the landscape, intricate patterns, or size, making it is impractical to map them separately at the selected scale for a given soil survey. Such groupings of soils are referred to as either associations or complexes. Ecological sites may or may not correspond to the all soil series contained in the association or complex.

The Very Shallow Ecological Site is associated with the following soil series and/or associations and complexes in MLRA 78A: Cho gravelly loam, Lueders very cobbly clay loam, Pitzer gravelly clay loam, and Talpa stony clay loam.

Table 4. Representative soil features

Parent material	(1) Residuum–limestone
Surface texture	(1) Gravelly loam (2) Stony clay loam (3) Very cobbly silty clay loam
Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Very slow
Soil depth	7–20 in
Surface fragment cover <=3"	5–30%
Surface fragment cover >3"	0–15%
Available water capacity (0-40in)	0.4–2.1 in
Calcium carbonate equivalent (0-40in)	40–65%
Electrical conductivity (0-40in)	0 mmhos/cm
Sodium adsorption ratio (0-40in)	0
Soil reaction (1:1 water) (0-40in)	7.9–8.4
Subsurface fragment volume <=3" (Depth not specified)	5–35%
Subsurface fragment volume >3" (Depth not specified)	2–25%

Ecological dynamics

An ecological site is a distinctive kind of land with specific physical characteristics, which differs from other kinds of land in its ability to produce a distinctive kind and amount of vegetation. A specific site has the potential to produce characteristic plant communities on a recurring basis under the prevailing climate and limitations of the soils supporting such plant communities. Productivity, kind of plants, plant species composition, and kind of soil are the primary criteria used to distinguish ecological sites within the same climatic regime. Natural plant communities of ecological sites are dynamic entities within a more comprehensive ecosystem. Ecological sites were shaped by abiotic (non-living) influences of climate, soils, topography, and fire, as well as biotic factors of flora and fauna, including man. The biotic community evolved through a synergistic relationship among the endemic flora and fauna, including grazing and browsing by large herbivores, as well as rodents and herbivorous insects. The community functions through the capture of energy from the sun through photosynthesis by green plants and the cycling of water, minerals, and nutrients. Plants are the producer organisms, which form the base of the food chain. Consumer organisms at all levels (i.e. herbivores and carnivores) are dependent, directly or indirectly, upon the producers. Decomposer organisms in the soil are essential links to cycling and the flow of energy within the system. The amount of energy captured and the efficiency of energy flow within the system determine the degree of functionality of the system. The Very Shallow Ecological Site functioned accordingly, as a component of such a system.

The ecological site contains numerous micro-sites, such as slight depressions, level areas, shallow areas, outcrops of caliche or rock, shaded areas, and open sunny areas, as well as others. Shady areas with good mulch cover would be cooler and favor growth of cool-season (C-3) grasses, such as Texas wintergrass (*Nassella leucotricha*), while open, sunny areas would be more conducive to the warm-season (C-4) grasses, such as little bluestem (*Schizachyrium scoparium*), sideoats grama (*Bouteloua curtipendula*), and curlymesquite (Hilaria berlangeri). The deeper-rooted mid-grasses, such as cane bluestem (*Bothriochloa barbinodis*), would take advantage of areas with deeper soil, where they would be more competitive with the shallow-rooted shortgrasses. However, all endemic species, or groups of plants with similar functionality, would successfully occupy niches within the overall plant community. Some plant species are either physiologically or morphologically adapted to withstand prolonged drought, extreme temperatures, heavy grazing pressure, fire, and other stresses. Different types of reproductive methods (i.e. seeds, stolons, rhizomes, and tubers) among the species are inherent characteristics, which further aid in perpetuating the plant community.

Fire plays a major role in grassland ecology. However, due to the naturally lower production and sparse nature of herbaceous vegetation on the Very Shallow Ecological Site, fire probably occurred less frequently than other sites, which produced greater fine fuel loads. Periodic fires perpetuated the grassland state of the historic climax plant community by suppressing the increase and invasion of woody plants. Sparsely distributed woody plants and mottes occurred within the grassland, where they had escaped past fires, due to their location near rock outcrops and terrain breaks, or in the protection of woody mottes, or in heavily grazed areas lacking sufficient fine fuel. Lightning started natural wildfires, and Native Americans occasionally used burning as a tool in hunting. Fires, whether started naturally of by man, occurred only when sufficient fine fuel with continuity of cover was available, primarily during years of more abundant rainfall and grazing deferment. In years of low rainfall or heavy grazing, the Very Shallow Ecological Site probably remained unburned or partially burned.

This reference plant community functioned under the influence of multi-species herbivory by endemic herbivores, including bison, elk, pronghorn and white-tailed deer. Just as plants filled niches in the plant community, so did animals. Animal preferences for food and cover determined the degree of use of the Very Shallow Ecological Site in association with other sites. Drastic changes in plant communities would result in changes in patterns and degree of use by the various kinds of animals, as well as degree of competition among animal species for habitat requirements. Grazing and browsing preferences of native herbivores were significant factors in maintaining a healthy, well-balanced plant community. Diets of the different species of animals varied from one-another in plant species, proportions and seasonally.

The bison was the largest herbivore grazing the historic climax plant community. Large herds of bison migrated from the northern and central plains into this area annually, for wintering. Bison probably grazed the Very Shallow Ecological Site intermittently in association with surrounding sites. They selectively grazed specific areas or sites, often heavily, before moving to other areas of more abundant forage. Burned areas were strongly preferred by bison, and such areas were often heavily grazed. Long deferment periods allowed the plant community to recover before the next migration into the area. During the early to mid 1800’s, bison populations were decimated through indiscriminate slaughter, thousands for their hides and tongues alone. Very few bison remained in the area after

1860, and the great migrations ceased.

Large resident populations of pronghorn occupied the area year-round, but others migrated into the area from farther north during severe winters. The historic climax plant community of the Very Shallow Ecological Site was ideal for the pronghorn, due to its openness, position in the landscape, and its large variety of forbs. The pronghorn preferred wide, open spaces, using keen eyesight and fleet-footed running ability instead of woody cover for security. Following European settlement, the pronghorn was extirpated from the immediate region and no longer occurs as a stable, free-roaming population.

White-tailed deer occurred in significant numbers, as more sedentary resident populations. The Very Shallow Ecological Site provided edge-effect and a wide variety of preferred browse and forbs. They were both browsers and grazers on a seasonal basis, using considerable amounts of forbs and cool-season grasses, especially in winter and early spring. Unlike the other larger herbivores, white-tailed deer populations have increased in the region since early settlement.

The gregarious prairie dog often established large towns throughout the region. The prairie dog towns occurred on various sites, especially those with deeper soils and good visibility. The Very Shallow Ecological Site would have been used in conjunction with adjacent sites, especially in areas of deeper soils. The prairie dog effectively suppressed woody plants in the vicinity of their towns, but kept the plant community in a low seral stage. The very short vegetation and large amounts of bare ground created major firebreaks, which may have played a role in reducing the severity and size of prairie fires. Very few active prairie dog towns remain in the region.

Predation was a natural phenomenon in maintaining the balance of biotic communities and the flow of energy in the ecosystem. The Very Shallow Ecological Site provided an abundance of prey species for all of the predators, common to the area. Mammalian predators using the site include gray wolf, coyote, red fox, gray fox, bobcat, ocelot and mountain lion. Since European settlement, the wolf and the ocelot have been totally extirpated from Texas and the mountain lion occurs only as an occasional transient in this region. Smaller carnivores included black-footed ferret, badger and ringtail. The smaller carnivores preyed primarily on small rodents, snakes, lizards and insects. The prairie dog was the main prey of the black-footed ferret. Coinciding with the precipitous decline of the prairie dog population, the black-footed ferret was extirpated from the region and is now near extinction. Loss of major predators from an ecosystem results in population increases of the principal prey species, often primary consumers (herbivores), which in turn increases competition for available resources, adversely impacting the plant community and natural flow of energy in the system.

The Native Americans lived in harmony as a component of the natural ecosystem, which included the endemic flora and fauna. Under that regime the historic climax plant community was perpetuated and functioned as a dynamic entity within the ecosystem. Unfortunately, the historic climax plant community did not fare so well under the influence of Europeans who indiscriminately decimated or displaced endemic animal populations, introduced domestic livestock, and suppressed fire. The European settlers might be likened to an exotic plant species invading a plant community. Invading species are successful in establishing themselves through their ability to outcompete endemic species for space, water and nutrients. So, the Europeans entered (invaded) a naturally functioning ecosystem, eliminated critical components, and displaced the endemic people, through competition for natural resources and warfare with superior technology. These evens were precursors leading to degradation of the historic climax plant community, as a component of the larger ecosystem.

Spanish explorers and missionaries were the first Europeans to influence the plant communities of the Rolling Plains. The early explorers introduced the horse, which was their means of transportation. Some horses escaped and plains Indians captured others. Historical accounts refer to thousands of wild horses roaming the plains and prairies of this region, well before other kinds of domestic livestock were introduced. As early as 1732, Spanish missions were established in the region, and missionaries brought sheep, goats, oxen and burros. The livestock were herded or free-roaming at short distances from primary water sources in close proximity to the mission stockades. Some of these livestock became feral and expanded their ranges from the missions. Horses and sheep probably exerted the earliest livestock grazing pressure on rangeland plant communities in the region. Subsequent European pioneers from the East brought more livestock to graze the open range.

Grazing pressure on the plant community increased during the historic cattle drives of the mid to late 1800s, as large herds of longhorn cattle from South Texas passed through the area en route to northern rail heads in Kansas and other points north. Grazing pressure further intensified as land in this region was privatized, and landowners

began establishing local herds and flocks of cattle, goats, and sheep. Sheep were well established in the region by the late 1800's and exerted tremendous grazing pressure on rangelands, perhaps, greater than that of cattle. The Spanish goat was maintained initially in small herds for local meat production on the ranches. The Angora goat was not brought into the area until the early 1900's, and small herds were raised primarily for mohair. The introduction of fencing, windmills and railroads had tremendous impacts on the condition of rangelands in the region. Fencing and water developments allowed livestock to be confined on the same area of land in a continuous grazing regime, with especially heavy concentration in the vicinity of water. With the coming of the railroad, better marketing capabilities encouraged landowners to increase their herds and flocks for short-term economic gain, resulting in still heavier grazing pressure on plant communities.

The early settlers' knowledge of land management was primarily agronomic-based and in more humid regions. The science and art of rangeland management, based upon ecological principles, had not yet evolved. Therefore, their stewardship of rangeland resources was largely trial and error. By the time the settlers gained knowledge about conservation of natural resource, considerable damage had already occurred in many natural plant communities.

Under abusive grazing, livestock repeatedly graze their preferred species. This reduces the leaf area of plants, thus preventing them from capturing sufficient sunlight for growth and development of new tillers and leaves. Also, overgrazing reduces the plant's ability to replace carbohydrates in the base and stems of the plant. Stored carbohydrates provide energy for respiration during dormancy and to initiate regrowth following winter dormancy, heavy grazing or drought.

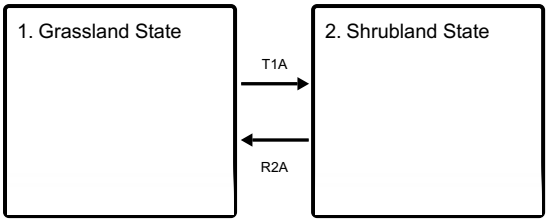
Palatability of species influences their susceptibility to grazing and browsing pressure. Excessive grazing or browsing of the more palatable species over prolonged periods results in loss of plant health and vigor, reduction of root mass, and eventually plant mortality. Under these conditions, other less palatable species within the community tend to increase their dominance. Overgrazing, droughts, extremes in temperature, lack of fires or untimely fires are all factors contributing to further degradation of the plant community. Also, species from other sites or exotics may invade the community and outcompete the endemic species. Increase or invasion of woody plants often replaces grass as the dominant vegetation. Bare ground generally increases under such conditions and annual species become more abundant. In association with vegetation degradation, soils also become degraded, resulting in accelerated erosion, reduction in infiltration, excessive runoff and loss of organic matter. At this point the integrity of the plant community is damaged or lost and may require supplemental energy to shift it back to the original plant community. Maintenance of a functional site or repair of a damaged site requires management focused on soil stability, nutrient cycling, and vegetation enhancement. Site degradation beyond the point of self-repair represents the crossing of a threshold in space and time, which is not reversible on a practical time scale without substantial inputs of energy from outside the community. This energy input may be in the form of reclamation practices, such as chemical or mechanical brush management, prescribed burning, and prescribed grazing.

The vegetative state is a persistent plant community that is recognizable, resistant in its ability to maintain its identity while external conditions change, and resilient in its ability to recover after it has been changed.

The following diagram illustrates some of the more commonly recognized vegetative states and associated plant communities occurring on the Very Shallow Ecological Site. There may be other vegetative states, not shown. Also, in some situations, differences in composition or production may represent only temporary fluctuations, due to the natural dynamics of the community. Such conditions are generally reversible through internal energy adjustments that will bring the plant community back to a similar, recognizable and functional state. Arrows, along with the more likely drivers (i.e. HCG, NF, and NBM), show potential transitional pathways from one vegetative state to another. Likewise, reverse arrows represent possible drivers providing the energy input to move the subsequent plant community back to or toward the previous community. The approximated historic climax plant community is used as the initial reference point in time. Each subsequent vegetative state is given a descriptive name and briefly described in numerical sequence, in relation to the diagram.

State and transition model

Ecosystem states

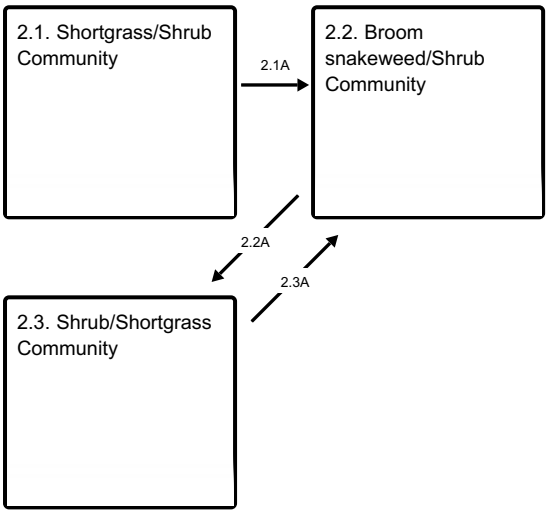


T1A - Absence of disturbance and natural regeneration over time, may be coupled with excessive grazing pressure

R2A - Adequate rest from defoliation, followed by reintroduction of historic disturbance regimes

State 1 submodel, plant communities

State 2 submodel, plant communities



State 1
Grassland State

The Midgrass/Shortgrass Prairie Plant Community is the reference plant community of the Very Shallow Ecological Site. It is a Midgrass/Shortgrass Prairie Community, dominated by grasses, a large variety of perennial forbs, scattered shrubs and a few trees. This is a somewhat open grassland community, with considerable amounts of bare ground, often with caliche or limestone fragments on the surface. Midgrasses include little bluestem, cane bluestem, sideoats grama and plains bristlegrass. Shortgrasses include curlymesquite, buffalograss, slim tridens, hairy tridens and Texas grama. Some of the major forbs are dotted gayfeather, bushsunflower, catclaw sensitivebriar, halfshrub sundrop, and trailing ratany. The site has less than 10% woody canopy, including low shrubs, such as catclaw, littleleaf sumac, skunkbush, and feather dalea. There are also a few scattered trees such as hackberry and juniper. Opportunistic, ephemeral plants, predominately cool-season species, commonly occupied bare areas following significant rainfall.

Dominant plant species

- sideoats grama (*Bouteloua curtipendula*), grass
- buffalograss (*Bouteloua dactyloides*), grass

Community 1.1
Midgrass/Shortgrass Prairie Community

Figure 8. 1.1 Mid/Shortgrass Prairie Community

The Midgrass/Shortgrass Prairie Community is the reference plant community of the Very Shallow Ecological Site. It is a midgrass/shortgrass prairie, dominated by grasses, a large variety of perennial forbs, scattered shrubs and a few trees. This is a somewhat open grassland community, with considerable amounts of bare ground, often with caliche or limestone fragments on the surface. Midgrasses include little bluestem, cane bluestem, sideoats grama and plains bristlegrass (*Setaria vulpiseta*). Shortgrasses included curlymesquite, buffalograss (*Bouteloua dactyloides*), slim tridens (*Tridens muticus*), hairy tridens (*Erioneuron pilosum*) and Texas grama (*Bouteloua rigidiseta*). Some of the major forbs are dotted gayfeather (*Liatris punctata*), bushsunflower (Simsa calva), catclaw sensitivebriar (Mimosa uncinata), halfshrub sundrop (*Calylophus serrulatus*), plains blackfoot (*Melampodium leucanthum*) and trailing ratany (*Krameria lanceolata*). The site has less than 10% woody canopy, including low shrubs, such as catclaw (Acacia greggi), littleleaf sumac (*Rhus microphylla*), skunkbush (*Rhus trilobata*), feather dalea (*Dalea formosa*) and a few scattered trees, such as hackberry (*Celtis laevigata* var. reticulata) and juniper (Juniperus spp.). Opportunistic, ephemeral plants, predominately cool-season species, commonly occupied bare areas following significant rainfall. Productivity of the Very Shallow Ecological Site is limited by its very shallow soils with restrictive layers of hard caliche or limestone, coarse surface fragments, and very low available water capacity. Productivity of the Very Shallow Ecological Site is significantly less than that of the Shallow Ecological Site, which had somewhat deeper soils and higher available capacity. Productivity is the primary vegetative criterion distinguishing the two sites from one another. Plant species composition is quite similar on both sites, with the exception of some tallgrasses on the Shallow Ecological Site. The Very Shallow Ecological Site is naturally hot and droughty. A plant community shift occurs when the plant community when it was exposed to heavy, continuous, grazing over a period of many years. Major shifts occur in species composition as the more palatable species of midgrasses, such as little bluestem, sideoats grama and plains bristlegrass decreased, while less palatable species of shortgrasses, such as slim tridens, threeawns (Aristida spp.), sand dropseed (*Sporobolus cryptandrus*) and red grama (*Bouteloua trifida*), increased. Woody species, including juniper, honey mesquite (*Prosopis glandulosa* var. glandulosa), catclaw and lotebush (*Ziziphus obtusifolia*), and pricklypear (Opuntia spp.) increased or invaded the site. In the absence of fire or brush management to suppress the increase and invasion of woody species, canopy cover would increase to 10-20% canopy. The loss of ground cover in the understory increased soil erosion and deterioration in rangeland health. The time required for these changes to occur would have depended upon prevailing climatic conditions, severity of grazing pressure, and degree of fire suppression. At this point in time, the Midgrass/Shortgrass Prairie Community will have regressed beyond the point of self-repair and could no longer maintain its identity and resistance to change. Under these conditions, the Midgrass/Shortgrass Prairie Community eventually would be pushed across a threshold from the Grassland State to the Shrubland State, resulting in a significantly different plant community, referred to as the Shortgrass/Shrubland Community.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	850	1700	2125
Forb	100	200	250
Shrub/Vine	40	80	100
Tree	10	20	25
Total	**1000**	**2000**	**2500**

Figure 10. Plant community growth curve (percent production by month). TX2514, Midgrass Prairie Community. Midgrass Prairie Community..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2	5	12	25	20	5	5	14	8	2	1

State 2
Shrubland State

The Shortgrass/Shrub Community (2.1) is dominated by shortgrasses, including curlymesquite, buffalograss, slim tridens, and Reverchon bristlegrass. Midgrasses, which dominated the reference plant community, are scarce but remnants will remain, due to their resilience, as well as their presence in soil seed banks. The more palatable forbs, such as bushsunflower, purple prairieclover, Engelmann's daisy, and gaura are replaced by less preferred species, including broom snakeweed, croton, gray coldenia, plains zinnia and silverleaf nightshade. Woody plants with canopy cover of 10-15 % would co-dominate the site. Productivity is much lower than the Grassland State due to loss of the more productive midgrasses and increase of bare ground. The Shortgrass/Shrub Community (2.1) produces only about 800 to 1,000 pounds air-dry biomass per acre. The Broom snakeweed/Shrub Community (2.2) is dominated by dense stands of broom snakeweed and shortgrasses in the lower herbaceous layer, while shrubs would continue to co-dominate the overstory. Broom snakeweed is a highly competitive perennial forb with a thick woody-like base and perenniating stems. It occurred as a minor component in the reference plant community, but continued to increase in density and weight as the site deteriorated and crossed the threshold from the Grassland State to the Shrubland State. Under the dominance of broom snakeweed, even the shortgrasses are greatly suppressed, leaving only weak pioneer perennials, as the major grasses under these degraded conditions. Very few remnants of midgrasses are present, surviving only in the protection of thorny or spiny shrubs. Annual forbs are more abundant during moist periods. Yucca and cacti are also more abundant. Juniper increases on the site, but remain scattered, rather than forming dense closed canopy as seen on some other degraded sites. The Shrub/Shortgrass Community (2.3) does not result from the crossing of a threshold to a new vegetative state, but a significantly improved plant community within the Shrubland State. This community represents a more short-lived plant community, co-dominated by woody shrubs and shortgrasses. Shortgrasses, such as curlymesquite, hooded windmillgrass, Reverchon bristlegrass, slim tridens, Hall's panicum, hairy grama and threeawns species occur in the lower herbaceous layer. Shrubs, such as pricklyash, Texas persimmon, algerita, catclaw acacia, catclaw mimosa, and juniper trees, continue to dominate the overstory, but at reduced densities and canopy cover. Higher production occurs from the shortgrasses and occasional midgrasses, with reduction in competition from broom snakeweed and woody plants. Much of the production is still from shrubs and lower succession grasses and forbs, including annuals. This would represent a management-orientated plant community, so the degree of canopy reduction would vary depending upon resource management objectives.

Community 2.1
Shortgrass/Shrub Community

Figure 11. 2.1 Shortgrass/Shrub Community

The Shortgrass/Shrub Community (2.1) is dominated by shortgrasses, including curlymesquite, buffalograss, slim tridens, Reverchon bristlegrass (*Setaria reverchonii*), Hall's panicum, hairy tridens and red grama. Midgrasses, which dominated the reference plant community, are scarce but remnants will remain, due to their resilience, as well as their presence in soil seed banks. The more palatable forbs, such as bushsunflower (Simsa calva), purple prairieclover (*Dalea purpurea*), Engelmann's daisy (Engelmania pinnatifida), low menodora (*Menodora heterophylla*), hairy tubetongue (Siphonoglossa pilosella) and gaura (Gaura spp.) are replaced by less preferred species, including broom snakeweed (*Gutierrezia sarothrae*), croton (Croton spp.), gray coldenia (Coldenia canescens), plains zinnia (*Zinnia grandiflora*) and silverleaf nightshade (*Solanum elaeagnifolium*). Woody plants with canopy cover of 10-15 % co-dominate the site. Woody plants, including catclaw acacia (Acacia greggi), lotebush (*Ziziphus obtusifolia*), javelinabush (*Condalia ericoides*), pricklyash (*Zanthoxylum hirsutum*), and juniper (Juniperus spp.) increase and honey mesquite (*Prosopis glandulosa* var. glandulosa) invades from nearby sites. Sacahuista (*Nolina texana*), yuccas (Yucca spp.), pricklypear (Opuntia spp.) and tasajillo (*Cylindropuntia leptocaulis*) also increase in this community state. Productivity is much lower than the Mid/Shortgrass Prairie Community (1.1), due to loss of the more productive midgrasses and increase of bare ground. The Shortgrass/Shrub Community (2.1) produces only about 800 to 1,000 pounds air-dry biomass per acre. This site can be rejuvenated through high-level energy inputs, including brush management (BM), using individual plant treatment (IPT), and prescribed grazing (PG). This would reverse the trend in degradation and return the community to the Grassland State and a plant community of somewhat similar composition and production as the Mid/Shortgrass Prairie Community (1.1). However, due to soil degradation and possible loss of some of the species, it likely would not exactly resemble the original refernece plant community. Under prescribed grazing and occasional prescribed burning, the Shortgrass/Shrub Community (2.1) could again function similar to the reference plant community in terms of nutrient cycling and energy flow. On the otherhand, the site could continue to deteriorate under continuous heavy grazing and lack of fire. Even the shortgrasses would begin to give way to broom snakeweed, ratear coldenia, dogweed (Dyssodia spp.), angel trumpet and annual species, while woody overstory would continue to increase. Opportunistic species, such as honey mesquite from outside the community, may also invade the site. Soil degradation would accompany these changes in the vegetative component, contributing to more bare ground, soil erosion and reduction in rangeland health. Although a threshold will not have been crossed, another plant community, referred to as the Broom Snakeweed/Shrub Community (2.2), will have developed within the Shrubland State.

Table 6. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	630	820	1085
Forb	100	125	175
Shrub/Vine	60	95	125
Tree	10	10	15
Total	**800**	**1050**	**1400**

Figure 13. Plant community growth curve (percent production by month).

TX2515, Shortgrass/Shrub Dominant Community. Shortgrasses and Shrubs dominate this plant community..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3	4	10	10	20	20	5	5	10	8	2	3

Community 2.2
Broom snakeweed/Shrub Community

Figure 14. 2.2 Broom snakeweed/Shrub Community

The Broom snakeweed/Shrub Community (2.2) is dominated by dense stands of broom snakeweed and shortgrasses in the lower herbaceous layer, while shrubs continue to co-dominate the overstory. Broom snakeweed is a highly competitive perennial forb with a thick woody-like base and perenniating stems. It occurred as a minor component in the reference plant community, but continued to increase in density and weight as the site deteriorated and crossed the threshold from the Grassland State to the Shrubland State. Under the dominance of broom snakeweed, even the shortgrasses, such as hairy grama (*Bouteloua hirsuta*) curlymesquite, buffalograss, slim tridens and Hall's panicum, would be greatly suppressed, leaving only weak pioneer perennials, such as sand dropseed, tumblegrass (*Schedonnardus paniculatus*), tumble windmillgrass (*Chloris verticillata*), red grama, Texas grama and hairy tridens as the major grasses under these degraded conditions. Very few remnants of midgrasses would be present, surviving only in the protection of thorny or spiny shrubs, such as javelinabush, condalia, and catclaw, or pricklypear and tasajillo. Annual forbs would become more abundant during moist periods. Yucca and cacti also would become more abundant. Feather dalea, skunkbush and littleleaf sumac, preferred browse of deer and goats, would be heavily hedged and probably decrease over time. Catclaw acacia and catclaw mimosa are armored with sharp curved spines, which reduce excessive browsing. Hackberry trees with branches out of reach of browsing animals may remain scattered over the site, but due to its palatability, recruitment of younger age classes would not be successful, except where seedlings were protected within dense canopy of shrubs such as catclaw. Juniper would increase on the site, but remain scattered, rather than forming dense closed canopy as seen on some other degraded sites. Broom snakeweed has low palatability to most livestock and wildlife. It contains a poisonous compound, which can cause abortions in cattle if consumed in sufficient quantities. Although livestock generally do not prefer the plant, they will sometimes consume it on degraded ranges, where desirable forage species are limited, especially during severe drought. Some of the primary browse plants of deer and goats, such as elbowbush (*Forestiera pubescens*), feather dalea, littleleaf sumac and skunkbush, would decrease, while browse plants of secondary preference, such as catclaw, javelinabush, and lotebush would probably increase. This would become a stagnated plant community under the dominance of broom snakeweed, high density and canopy of shrubs and trees (juniper and mesquite), along with severe degradation of soil health. Reclamation to return this vegetative state to the Shortgrass/Shrubland Plant Community (2) or beyond would have limited feasibility from the standpoint of supplemental energy input, especially under higher degrees of soil degradation. Mechanical brush management and artificial revegetation would not be feasible, due to the shallow soils and low productive capacity. However, the Broom snakeweed/Shrub Community (2.2) can be improved, up to a point, through minimal energy inputs of selective brush management, using individual plant treatment (IPT), and broadcast herbicide spraying of broom snakeweed. This would produce the Shrub/Shortgrass Community (2.3).

Table 7. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Forb	350	400	500
Grass/Grasslike	175	200	225
Shrub/Vine	50	75	100
Tree	10	15	25
Total	**585**	**690**	**850**

Figure 16. Plant community growth curve (percent production by month). TX2518, Broom snakeweed/Shrubland Community. Broom Snakeweed and Shrubs dominated community..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2	2	5	10	23	18	5	5	16	10	2	2

Community 2.3
Shrub/Shortgrass Community

Figure 17. 2.3 Shrub/Shortgrass Community

The Shrub/Shortgrass Community (2.3) would not result from the crossing of a threshold to a new vegetative state, but a significantly improved plant community within the Shrubland State. This community would represent a more short-lived plant community, co-dominated by woody shrubs and shortgrasses. Shortgrasses, such as curlymesquite, hooded windmillgrass (*Chloris cucullata*), Reverchon bristlegrass, slim tridens, Hall's panicum, and threeawns species would occur in the lower herbaceous layer. Shrubs, such as pricklyash (*Zanthoxylum hirsutum*), Texas persimmon (*Diospyros texana*), algerita (Mahonia trifolialata),catclaw acacia, catclaw mimosa, (Mimosa biuncifera) and juniper trees, would continue to dominate the overstory, but at reduced densities and canopy cover. Higher production would occur from the shortgrasses and occasional midgrasses, with reduction in competition from broom snakeweed and woody plants. Much of the production still would be from shrubs and lower succession grasses and forbs, including annuals. This would represent a management-orientated plant community, so the degree of canopy reduction would vary depending upon resource management objectives. Minimal energy inputs, including brush management, such as individual plant treatment (IPT), and weed control would result in reduction of woody canopy and broom snakeweed. Such treatments, followed by grazing deferment, will promote development of fine fuel loads for effective prescribed burning. Periodic prescribed burning and prescribed grazing would result in the return of more productive shortgrasses and eventually more midgrasses, such as silver bluestem, cane bluestem, plains bristlegrass and Reverchon bristlegrass. These management practices also would enhance plant vigor, reproduction, and species diversity. Improved ground cover would lower soil temperature, decelerate soil erosion, and reduce shading from shrubs and trees. Grazing deferment following any kind of brush management is essential to achieving improvement in range and soil health. Prescribed grazing, using rotational grazing systems, seasonal grazing, or periodic deferments during the growing season, would aid in maintaining the integrity of this improved plant community. This community may actually have more value for wildlife, such as bobwhite quail, scaled quail, doves, and white-tailed deer, than for domestic livestock. Since the Shrub/Shortgrass Community (2.3) would have a strong tendency to revert back to the Broom snakeweed/Shrub Community (2.2), periodic follow-up

treatments of woody plants and broom snakeweed would be necessary to maintain this plant community and prevent its return to the Broom snakeweed/Shrub Community.

Table 8. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	525	750	950
Forb	150	215	275
Shrub/Vine	50	75	100
Tree	15	20	25
Total	**740**	**1060**	**1350**

Figure 19. Plant community growth curve (percent production by month). TX2519, Shrubland/Shortgrass Community. Shrubland and Shortgrass Dominated community..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2	3	10	10	25	20	5	5	10	5	3	2

Pathway 2.1A
Community 2.1 to 2.2

Shortgrass/Shrub Community

Broom snakeweed/Shrub Community

With heavy continuous grazing, no fires, brush invasion, and no brush management, the Shortgrass/Shrub Community will shift to the Broom snakeweed/Shrub Community.

Pathway 2.2A
Community 2.2 to 2.3

Broom snakeweed/Shrub Community

Shrub/Shortgrass Community

With the implementation of various conservation practices such as Prescribed Grazing, Brush Management (Individual Plant Treatment), and Pest Management, the Broom snakeweed/Shrub Community can shift to the Shrub/Shortgrass Community.

Conservation practices

Brush Management
Prescribed Grazing
Integrated Pest Management (IPM)

Pathway 2.3A
Community 2.3 to 2.2

Shrub/Shortgrass Community

Broom snakeweed/Shrub Community

With heavy continuous grazing, no fires, brush invasion, no brush management, and no pest management, the Shrub/Shortgrass Community will revert back to the Broom snakeweed/Shrub Community.

Transition T1A
State 1 to 2

The time required for these changes to occur would have depended upon prevailing climatic conditions, severity of grazing pressure, and degree of fire suppression. Under these conditions, the Midgrass/Shortgrass Prairie Community eventually would be pushed across a threshold from the Grassland State to the Shrubland State.

Restoration pathway R2A
State 2 to 1

With various conservation practices such as Prescribed Grazing, Brush Management (IPT), and Prescribed Burning applied, the Shrubland State can be restored back to the Grassland State.

Conservation practices

Brush Management
Prescribed Burning
Prescribed Grazing

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	**Midgrasses**			250–625	
	sideoats grama	BOCU	*Bouteloua curtipendula*	250–625	–
	Arizona cottontop	DICA8	*Digitaria californica*	250–625	–
	green sprangletop	LEDU	*Leptochloa dubia*	250–625	–
	plains bristlegrass	SEVU2	*Setaria vulpiseta*	250–625	–
2	**Tallgrass**			100–250	
	little bluestem	SCSC	*Schizachyrium scoparium*	100–250	–
3	**Midgrasses**			80–200	
	cane bluestem	BOBA3	*Bothriochloa barbinodis*	80–200	–
	silver beardgrass	BOLAT	*Bothriochloa laguroides ssp. torreyana*	80–200	–
4	**Shortgrasses**			150–375	
	buffalograss	BODA2	*Bouteloua dactyloides*	150–375	–
	curly-mesquite	HIBE	*Hilaria belangeri*	150–375	–
5	**Shortgrasses**			150–375	
	threeawn	ARIST	*Aristida*	150–375	–
	hairy grama	BOHI2	*Bouteloua hirsuta*	150–375	–

	hooded windmill grass	CHCU2	*Chloris cucullata*	150–375	–
	fall witchgrass	DICO6	*Digitaria cognata*	150–375	–
	Hall's panicgrass	PAHA	*Panicum hallii*	150–375	–
	Reverchon's bristlegrass	SERE3	*Setaria reverchonii*	150–375	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	150–375	–
	slim tridens	TRMU	*Tridens muticus*	150–375	–
	slim tridens	TRMUE	*Tridens muticus var. elongatus*	150–375	–
6	**Shortgrasses**			50–125	
	Texas grama	BORI	*Bouteloua rigidiseta*	50–125	–
	red grama	BOTR2	*Bouteloua trifida*	50–125	–
	Australian windmill grass	CHVE	*Chloris ventricosa*	50–125	–
	hairy woollygrass	ERPI5	*Erioneuron pilosum*	50–125	–
	tumblegrass	SCPA	*Schedonnardus paniculatus*	50–125	–
7	**Cool Season Grass**			50–125	
	Texas wintergrass	NALE3	*Nassella leucotricha*	50–125	–
8	**Annuals**			20–50	
	Grass, annual	2GA	*Grass, annual*	20–50	–
Forb					
9	**Forbs**			80–200	
	Indian mallow	ABUTI	*Abutilon*	80–200	–
	angel's trumpets	ACLO2	*Acleisanthes longiflora*	80–200	–
	dozedaisy	APHAN3	*Aphanostephus*	80–200	–
	white sagebrush	ARLUM2	*Artemisia ludoviciana ssp. mexicana*	80–200	–
	yellow sundrops	CASE12	*Calylophus serrulatus*	80–200	–
	croton	CROTO	*Croton*	80–200	–
	prairie clover	DALEA	*Dalea*	80–200	–
	purple prairie clover	DAPU5	*Dalea purpurea*	80–200	–
	bundleflower	DESMA	*Desmanthus*	80–200	–
	perfumeballs	GASU	*Gaillardia suavis*	80–200	–
	beeblossom	GAURA	*Gaura*	80–200	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	80–200	–
	gumhead	GYGL	*Gymnosperma glutinosum*	80–200	–
	Gregg's tube tongue	JUPI5	*Justicia pilosella*	80–200	–
	trailing krameria	KRLA	*Krameria lanceolata*	80–200	–
	dotted blazing star	LIPU	*Liatris punctata*	80–200	–
	low menodora	MEHE2	*Menodora heterophylla*	80–200	–
	plains blackfoot	MELE2	*Melampodium leucanthum*	80–200	–
	Nuttall's sensitive-briar	MINU6	*Mimosa nuttallii*	80–200	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	80–200	–
	wild petunia	RUELL	*Ruellia*	80–200	–
	twoleaf senna	SERO8	*Senna roemeriana*	80–200	–
	awnless bushsunflower	SICA7	*Simsia calva*	80–200	–

	dwarfless bushsunflower	SIGA	*Simsia calva*	80–200	
	fanpetals	SIDA	*Sida*	80–200	–
	silverleaf nightshade	SOEL	*Solanum elaeagnifolium*	80–200	–
	Texas nightshade	SOTR2	*Solanum triquetrum*	80–200	–
	globemallow	SPHAE	*Sphaeralcea*	80–200	–
	greenthread	THELE	*Thelesperma*	80–200	–
	rue of the mountains	THTE2	*Thamnosma texana*	80–200	–
	bristleleaf pricklyleaf	THTE7	*Thymophylla tenuiloba*	80–200	–
	crinklemat	TIQUI	*Tiquilia*	80–200	–
	noseburn	TRAGI	*Tragia*	80–200	–
	vervain	VERBE	*Verbena*	80–200	–
	creepingoxeye	WEDEL	*Wedelia*	80–200	–
10	**Annual Forbs**			20–50	
	Forb, annual	2FA	*Forb, annual*	20–50	–
Shrub/Vine					
11	**Shrubs/Vines**			30–75	
	catclaw acacia	ACGR	*Acacia greggii*	30–75	–
	javelina bush	COER5	*Condalia ericoides*	30–75	–
	snakewood	CONDA	*Condalia*	30–75	–
	Texas persimmon	DITE3	*Diospyros texana*	30–75	–
	jointfir	EPHED	*Ephedra*	30–75	–
	stretchberry	FOPU2	*Forestiera pubescens*	30–75	–
	desert-thorn	LYCIU	*Lycium*	30–75	–
	algerita	MATR3	*Mahonia trifoliolata*	30–75	–
	catclaw mimosa	MIAC3	*Mimosa aculeaticarpa*	30–75	–
	Texas sacahuista	NOTE	*Nolina texana*	30–75	–
	fragrant sumac	RHAR4	*Rhus aromatica*	30–75	–
	littleleaf sumac	RHMI3	*Rhus microphylla*	30–75	–
	yucca	YUCCA	*Yucca*	30–75	–
	Texas Hercules' club	ZAHI2	*Zanthoxylum hirsutum*	30–75	–
	lotebush	ZIOB	*Ziziphus obtusifolia*	30–75	–
12	**Cacti species**			10–25	
	Christmas cactus	CYLE8	*Cylindropuntia leptocaulis*	10–25	–
	pricklypear	OPUNT	*Opuntia*	10–25	–
Tree					
13	**Trees**			10–25	
	netleaf hackberry	CELAR	*Celtis laevigata var. reticulata*	10–25	–
	juniper	JUNIP	*Juniperus*	10–25	–

Animal community

The animal community, like the plant community, is a component of a larger and more complex ecosystem. The animal community includes the primary consumer organisms, which interface directly with the vegetative component of the ecological site, as well as the secondary and tertiary consumers (carnivores and scavengers). All play a vital role in maintaining the cycling of nutrients and flow of energy in the ecosystem. Some animal species were site-specific, but many species common to the region used various ecological sites in association with one-

another.

The animal community changed dramatically from the mid 1800s to early 1900s, as a result of overexploitation of various wildlife species through unregulated market hunting, trapping, poisoning, and wanton destruction. Some of the most drastic changes in animal communities include the extinction of populations, species, and subspecies, changes in geographical distribution, and the introduction of non-endemic species. In the past century, changes in animal populations have been more related to loss or fragmentation of critical habitat. Loss of habitat is usually the major cause of population declines or even extinction of some species. Cultivation has been the demise of many wildlife species, such as the prairie chicken and certain kinds of waterfowl, while still other species, such as the pronghorn, have been displaced geographically. However, the problem does not always result from total destruction of habitat, but often involves the loss of one or more critical habitat components, such as mating and nesting habitat for certain birds, or in other cases the reduction in area or continuity of desirable habitat.

The major problem affecting many wildlife species of the Very Shallow Ecological Site was and continues to be degradation of the plant community and soils. As the site changed from a midgrass dominant plant community to a shortgrass and shrub dominant plant community, the animal community has also changed. The true grassland animal species decreased their use of the site with loss of the prairie midgrasses and increase of woody cover. The site would have become less desirable for species, such as pronghorn, lesser prairie chicken and certain species of grassland sparrows. Some of the mice and other small rodents migrated into the Shortgrass/Shrubland Plant Community, as well as the Broom Snakeweed Plant Community, because they were more adapted to such brushy habitats. Conversion of the natural plant communities of the Very Shallow Ecological Site to seeded states would result in major habitat destruction and fragmentation. However, the Very Shallow Ecological Site is not arable, so its natural habitat would be less likely to be destroyed by cultivation. Species having limited tolerance to habitat change might abandon certain plant communities for more suitable habitat in another community, or in some cases extirpated from the area.

The reference plant community of the Very Shallow Ecological Site was used by a diversity of indigenous wildlife, which preferred grassland habitat. The larger grazing and browsing herbivores included bison, elk, pronghorn and white-tailed deer. The smaller mammals included prairie dog, black-footed ferret, badger, jackrabbit, cottontail rabbit, skunk, ground squirrel and various other species of small rodents. Transient species, such as bats, occasionally used the site intermittently or incidental to more preferred or associated sites. Carnivores included the wolf, coyote, bobcat, fox and mountain lion. Birds included lesser prairie chicken, wild turkey, bobwhite quail, scaled quail, doves, nighthawk, roadrunner, and numerous species of sparrows, eagles, hawks and vultures. Various snakes and lizards, including the rattlesnake and horned lizard, also occurred in the historic climax plant community.

The migratory bison was the largest herbivore grazing the historic climax plant community. Bison probably grazed the Very Shallow Ecological Site intermittently in association with surrounding sites. They were selective grazers, preferring primarily grasses, while utilizing only a few forbs and very little woody browse. Bison often grazed an area heavily, but it was primarily during winter dormancy of the warm-season prairie grasses, and long deferment periods occurred before the next migration into the area. Unlike bison grazing, earlier domestic livestock grazing was both heavy and continuous. Domestic cattle eventually replaced the endemic bison and became the principal larger grazing herbivore, after 1860.

The elk, another large migratory herbivore, used the Very Shallow Ecological Site on an intermittent basis during the winter. The elk was primarily a grazer, using grasses and forbs in this wintering location, although newer leader growth of some shrubs would have been used. The elk probably did not impact the plant community to the extent of the bison. Like the bison, elk were eventually extirpated from this region, due to over exploitation, competition with domestic livestock, and land use practices after European settlement.

Local populations of pronghorn occupied the area year-round, prior to European settlement. The pronghorn was primarily a grazer, with strong preference for forbs, while using considerably less woody browse and grasses. Pronghorn populations are believed to have decreased in the Rolling Plains, due to extirpation of the larger predators, the increase of brush on the prairies, competition with domestic sheep and the introduction of netwire fencing. The pronghorn has been displaced geographically and no longer inhabits the immediate region. Individuals or small groups of pronghorn may occasionally wander into this region from farther west.

White-tailed deer was another non-migratory herbivore with a considerably smaller home range than the antelope. The white-tailed deer is considered to be primarily a browser but also utilizes large quantities of forbs, including

cool-season annuals, and some cool-season grasses in winter and early spring, while using very limited amounts of warm-season grasses in any season. The Very Shallow Ecological Site provided a wide variety of preferred food items of the white-tailed deer, and scattered woody shrubs and motes provided edge-effect and screening cover. The site was used in association with other sites in the area. Since European settlement, the white-tailed deer population has increased dramatically. The increase in the white-tailed deer population may be attributed to extirpation of the wolf and mountain lion, primary predators of the deer, increase of woody vegetation, eradication of the screwworm fly, and intensive predator control, as well as early regulatory restrictions on harvest of does. During the past three decades (1970-2004), great progress has been made in wildlife management, through habitat improvement, as well as selective population controls (primarily through hunting), including harvest of does and manipulation of buck:doe ratios. The white-tailed deer has become the most popular large game species in the region, and contributes immensely to local economies.

The reference plant community of the Very Shallow Ecological Site was marginally suitable to the javelina. Javelina prefer habitat with dense woody cover and cacti. The site actually became more favorable to the javelina, following retrogression of the plant community, in which woody species and cacti increased in abundance. Prickly pear and mesquite beans are highly preferred dietary items. Interest in the javelina as a game species has grown in recent years, especially among bow hunters.

Smaller herbivores of the Very Shallow Ecological Site include: jackrabbits, cottontail rabbits, black-tailed prairie dogs, Mexican ground squirrels and many species of smaller rodents having diets of herbage, seeds, and mast. Also occurring on the site, usually in association with other sites, were the striped skunk, raccoon, and opossum, which are omnivorous with mixed diets of insects, arthropods, roots, tubers, mast, fish, occasional rodents and carrion. Small carnivores included black-footed ferret, badger and ringtail with diets of rodents and insects. The black-footed ferret, which preyed primarily on the prairie dog when it was abundant, has been extirpated from the region and is near extinction.

The prairie dog was despised by European settlers, leading to large-scale control of the rodent by shooting and poisoning along with natural die-offs from disease. These events led to major reductions in prairie dog populations throughout the region. Very few active prairie dog towns remain in the region. These relict prairie dog towns are small and very sparsely dispersed throughout the region. The vegetative state of the prairie dog towns represented degraded plant communities from higher seral stages. Since abandonment of prairie dog towns, the sites have been undergoing long-term secondary plant succession.

Lesser prairie chickens used the Very Shallow Ecological Site for feeding, nesting and brood rearing as long as the taller midgrasses were plentiful. The vegetative structure was more important than plant species for the life cycle of this species and many other bird species. The taller, standing dry grasses from previous year’s growth are important to nesting success. Openings among the taller bunchgrasses provided ease of movement by young chicks and protection from avian predators. The chicks and juveniles fed primarily on protein-rich insects, which were abundant and easily accessible on recently burned areas. Male prairie chickens used open shortgrass land, bare areas and recently burned areas for leks, where their courtship ritual was performed. Even after loss of midgrass dominance, the prairie chicken continued to use the same historical plant community until rendered undesirable by excessive brush encroachment. The lesser prairie chicken no longer occurs in this immediate region, now relegated to only isolated populations farther north and northwest of the Major Land Resource Area. All prairie chicken species and subspecies were true prairie birds. They have been so strongly affected by loss and fragmentation of grassland habitat that some species are rare or on the brink of extinction.

Many other species of birds still inhabit the Very Shallow Ecological Site in the alternate vegetative states, although plant species composition differs considerably from that found in the reference plant community. The gallinaceous birds, including wild turkey, bobwhite quail, and scaled quail still occur in one or more of the communities, but the lesser prairie chicken has been extirpated. Many species of grassland passeriformes, including songbirds such as larks and sparrows, have been displaced due to increase in woody cover and cacti. The community has become more desirable for other species, such as wrens and thrashers, which prefer habitat with more woody cover. The roadrunner is a unique bird from the past, which thrives in vegetative states with abundance of woody vegetation and cacti such as the Shortgrass/Shrubland Plant Community. It feeds upon a variety of items including lizards, snakes, insects and prickly pear tunas, common to such plant communities. The roadrunner nests in thorny shrubs and sometimes in larger pricklypear plants. Numerous species of hawks, many migratory, still use this site due to the abundance of rodents and rabbits.

Birds of prey associated with the Very Shallow Ecological Site, included eagles, hawks, and falcons. Some of the common hawks include Swainson's hawk, red-tailed hawk and Harris' hawk. The American kestrel, a small falcon, is one of the smaller avian predators occurring in the area. The golden eagle was common and fed mostly on jackrabbits and other small mammal, as well as young lambs and kid goats. After European settlement of the area, the golden eagle population was extirpated from this ecosystem and now only infrequently ventures into this region from farther west. The bald eagle occurred primarily around perennial streams and lakes, since their primary prey was fish. The bald eagle became endangered during the mid-twentieth century. Although still rare, the bald eagle has recovered sufficiently enough to be removed from the endangered species list. Federal law now protects all eagles and hawks.

Both turkey vulture and black vulture were and still are common to the Very Shallow Ecological Site and surrounding sites in the area. They are not site specific. Vultures are scavengers, feeding primarily on dead animals and birds. These tertiary consumers are important in accelerating nutrient cycling and flow of energy in the ecosystem. The vultures are protected by federal law.

Snakes, lizards and tortoise are still important components of the Very Shallow Ecological Site. Many of the reptiles are important prey species of predators and omnivores. The rattlesnake, a remnant from the reference plant community or far beyond, was the only poisonous snake endemic to the site. Occasional rock outcrops on this site provided dens for the rattlesnake and its prey. The unique horned lizard, another remnant species from past eras, also occurred on this site. It preferred bare or sparsely vegetated areas, especially where its primary dietary item, the red harvester ant, was abundant. The horned lizard has become rare during the late twentieth century, due to reduction of major dietary items within its very small home range, increased predation and human activities.

Larger mammalian predators using the Very Shallow Ecological Site include the gray wolf, coyote, red fox, gray fox, ocelot, bobcat and occasional mountain lion. Wolves and ocelot were common to the area before European settlement, but declined rapidly thereafter and no longer occur in the area. All of these species did not coexist in harmony, but from time to time each found a survival niche in the community. The wolf and mountain lion preyed primarily on deer and antelope, but also took some of the smaller mammals, including other predators. After ranching was begun in the area, all of the larger predators preyed upon domestic livestock. The gray fox population tends to increase as the coyote population declines and visa versa. The Very Shallow Ecological Site was used for denning by coyote and fox, but not simultaneously at the same location. The wolf and ocelot have been extirpated the entire state, and the mountain lion now is only as an occasional transient in this region. Viable populations of coyote, gray fox, and bobcat still exist in the area, while the red fox occurs occasionally. Coyote and bobcat predation on domestic livestock can be a problem, especially where sheep and goats are raised.

The animal component of the plant community has changed drastically since settlement and the introduction of domestic livestock, including cattle, sheep, and goats. All current vegetative states of the Very Shallow Ecological Site are now used for the production of domestic livestock, as well as native wildlife. Domestic livestock have largely replaced the endemic large herbivores, with the exception of white-tailed deer. Cattle have replaced bison as the principal grazers, utilizing approximately 85 % grass, 10 % forbs and 5 % woody plants. Sheep have replaced the pronghorn, with their strong preference for forbs, approximately 85 % while using only about 10 % grasses and 5% browse. There is strong competition between sheep and deer for forbs, especially during late winter and spring. Spanish goats are heavy browsers with diets consisting of approximately 80% woody plants, 10% forbs and 10 % grasses. This places them in strong competition with white-tailed deer for woody browse. Angora goats and Borer goats utilize considerably less browse than the Spanish goat, with the balance of their diets consisting of about equal proportions of forbs and grass. Both Spanish and Angora goats have been used for biological control of certain woody species, especially in conjunction with mechanical brush management and prescribed burning. Tables of plant preferences for the major kinds of animals are provided following this section.

The Very Shallow Ecological Site is one of the lower producing sites with considerable amounts of woody plants, especially in the Shrubland State. Plant communities in this vegetative state would be less desirable for cattle, but highly desirable for Spanish goats and white-tailed deer, since both are strong browsers. The abundance of pricklypear in these communities provides large amounts of pricklypear tunas, which deer and other animals utilize in large amounts when available from late summer to winter. The wide variety of forbs preferred by deer would be desirable during winter and early spring, thus placing deer and sheep in strong competition. Areas with large amounts of catclaw and catclaw mimosa are undesirable for Angora goats, and to a lesser degree for sheep, due to snagging of mohair and wool. Kid goats sometimes become entangled in these shrubs and die from overexposure to heat or cold, starvation, or predation. The site also provides cover for white-tailed deer, in conjunction with other

sites.

Numerous exotic herbivores have been introduced to this region, primarily from Africa and Asia. They now graze and browse the Very Shallow Ecological Site, in association with other sites, usually confined by high fences. Some of the more common exotic animals include axis deer, blackbuck antelope, gazelle, red deer, fallow deer, ibex and eland. Some of the exotics compete directly with the native white-tailed deer, as well as domestic livestock. The feral hog is an exotic, invader species sometimes associated with this site. It often is destructive to rangeland, due to its feeding habits, which cause major soil disturbance and damage to perennial vegetation. The feral hog is considered to be omnivorous and sometimes preys on young lambs and kid goats, as well as ground nests of birds.

Recreational hunting is a decimating factor of wildlife species, considered to be game animals. Game hunting substitutes for natural predation of earlier times. Hunting can be a useful management tool when based upon sound ecological principles. On the contrary, it can be detrimental to wildlife populations, if not based upon sound principles. Hunting can be used for population control, to manipulate sex ratios, and to enhance quality of certain attributes within a population. State game laws regulate seasons and bag limits of non-migratory species while federal game laws take precedent over state laws in regulating the harvest of migratory species. Most exotic wildlife species using this site are hunted as an economic enterprise and are not regulated by law as to seasons or bag limits. White-tailed deer, a non-migratory species, is the only native big game animal hunted in association with the Very Shallow Ecological Site. Non-migratory game birds of this site are the Rio Grande wild turkey, bobwhite quail and scaled quail. Migratory game birds using this site include the mourning dove, and more recently the white-winged dove. Wildlife management takes the form of habitat conservation and habit manipulation, as well as balancing populations with available habitat. It requires knowledge of the natural history of individual species and their specific habitat requirements. Brief statements follow, regarding some of the preferences and habitat requirements for principle native game species using the Very Shallow Ecological Site.

White-tailed deer prefer edge-effect, but will readily adapt to other vegetation types or plant community states. They require cover for protection from predators (including hunters), bedding areas, travel corridors, and thermoregulation. White-tailed deer are strong browsers, utilizing large amounts of certain woody plants on a seasonal basis. White-tailed deer also utilize large amounts of forbs and some cool-season grasses, especially during late fall, winter, and early spring. Some perennial forbs also are used during the summer and fall. White-tailed deer are, however, very selective as to species preference (see table of preference ratings).

The Rio Grande turkey prefers to locate in the vicinity of roost trees, but they range over large areas while feeding. They would use this site in conjunction with others for feeding and cover. The wild turkey feeds on seeds and mast of many plants occurring on the Very Shallow Ecological Site. They also use large amounts of herbaceous plant material, including lush green grass, especially Texas wintergrass, during fall, winter, and spring. Turkeys would nest among the taller midgrasses of this site when it is in a higher stage of plant succession. Structure is the key vegetation attribute for most ground nesting birds, with the exception of the nighthawk and killdeer.

Bobwhite quail prefer edge-effect and scattered shrubs with underspace, such as lotebush and littleleaf sumac, which provide loafing areas and cover from raptors. Combinations of bunchgrasses and low shrubs provide good nesting cover. The Very Shallow Ecological Site supports many plants, especially the leguminous forbs and shrubs, which produce hard seeds preferred by quail. Quail diets also include many of the annual forbs produced on this site. The scaled (blue) quail prefers the more regressed plant communities of this site to higher seral stages of dense grass cover. It prefers openness in the understory, bare ground, and shortgrasses, which facilitates their running nature and their preference or tolerance for more woody cover and cacti. They use many of the same foods as bobwhites, in addition to fruits of the tasajillo and pricklypear. Both species of quail also use considerable amounts of leafy herbage in their diets.

Additional information on both game and non-game species is available from local offices of Natural Resources Conservation Service, Texas Agricultural Extension Service, Texas Parks and Wildlife Department, or range, wildlife, and biology departments of various universities.

Hydrological functions

The reference plant community of the Very Shallow Ecological Site, with its abundance of deep-rooted bunchgrasses, good surface mulch, moderately high soil organic matter, and limited erosion, contributed to optimum hydrologic functions, within limitations of the prevailing climate, geology, and soils. Infiltration and

percolation of water to plant root zones was moderate. Permeability was moderate to slow in surface layers, depending on depth and amounts of hardened layers beneath the surface. The soils are well drained, but have very low available water capacity and medium to rapid runoff, causing this to be a droughty site. Precipitation effectiveness is low, so more frequent rainfall is required to maintain adequate moisture for plant growth. Light showers are ineffective in benefiting the deeper-rooted midgrasses, although the short grasses and annuals may have short-term benefits. Deep percolation beyond the root zone is limited, due to low annual precipitation and hardened subsurface layers of caliche or limestone. However, where limestone is fractured, some water would reach greater depths during higher rainfall events, provided adequate surface cover is available to reduce runoff. The Very Shallow Ecological Site is probably less significant in recharging underground aquifers or water tables, than most other sites with deeper soils, lacking restrictive subsurface layers and having better infiltration rates and less runoff. The Very Shallow Ecological Site supports various woody shrubs, having limited effect on deep percolation, and supports very few deep-rooted trees, which could channel water to greater depths.

Loss of vegetative cover, especially the larger bunchgrasses, as well as mulch and soil organic matter, reduces infiltration and increases runoff. This occurs under heavy continuous grazing, prolonged drought, or untimely fire. As the deep-rooted midgrasses, such as little bluestem, sideoats grama, and cane bluestem, decrease, the shortgrasses, such as buffalograss, curlymesquite, and slim tridens, tend to increase. The shallow-rooted, sod-forming grasses, such as buffalograss and curlymesquite, are less effective than bunchgrasses in promoting good water infiltration and reducing runoff. Under these conditions woody plants, such as catclaw, lotebush, and juniper, also increase in density and canopy cover. Increased runoff results in less water for plants and accelerates soil erosion. Under intensive rainfall, the degraded site can contribute to down slope flooding, sedimentation, and poor water quality in streams and rivers. Regression of the plant community to stages 2 and 3 farther accentuates these conditions. Degradation of the plant community and soils disrupts the normal water dynamics of the site, consequently impairing the water cycle.

Brush management and prescribed grazing will help improve hydrologic function over a period of several years, through increase of deep-rooted midgrasses and surface cover, which will improve water infiltration and percolation to the root zone; also reduce raindrop splash and soil erosion. Woody plants use larger amounts of water than grasses per unit of biomass produced and usually outcompete grasses for available water. Reduction of woody plants through chemical versus mechanical methods will give grasses a competitive advantage for limited moisture. Reduction of woody canopy will reduce evaporation of precipitation intercepted by woody canopies, thus allowing more water to reach the soil surface and infiltrate. Although, hydrologic functions can be improved, along with improvement in the plant community, it would not return to that of the reference plant community if excessive soil loss has occurred in associated with site degradation leading to the crossing of ecological thresholds.

Soil Surveys of Concho County (1988) and Tom Green County (1976) placed the principal soils of the Very Shallow Ecological Site in Hydrologic Groups C and D.

Recreational uses

The Very Shallow Ecological Site generally occupies a higher position in the landscape, providing opportunity to enjoy panoramic vistas of surrounding landscapes, as well as plant and animal life. In some locations the site contains artifacts and other historical evidence of past civilizations. The site provides aesthetic appeal from colorful wildflowers, produced in the spring. This site is used for hunting, birding, hiking, camping, and horseback riding.

Wood products

Most woody species of the Very Shallow Ecological Site are shrubs, having limited value for wood products. Blueberry juniper is used for fence posts and stays but redberry juniper is less desirable.

Other products

The Very Shallow Ecological Site contains large amounts of caliche, which is mined for roadfill and construction of ranch roads. Occasional boulders and flagstone occurring on the site are used in landscaping. The site may be used for honey production from some of the woody shrubs, such as catclaw, which produces blooms favored by honeybees.

Other information

None.

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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.

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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Date	08/11/2004
Approved by	Bryan Christensen
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

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2. **Presence of water flow patterns:** None. This site rarely has water flow patterns due to shallow soil depth and surface rocks.

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3. **Number and height of erosional pedestals or terracettes:** None. Some very minor pedestalling may occur in the shallow, lower production portions of site.

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** 5 to 10 percent. Small and non-connected areas.

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

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

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

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Stability class is 4-6 for both canopy and interspaces.

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Grayish brown (10YR 5/2) gravelly loam, moderate, fine, granular structure and moderate fine subangular blocky; hard; firm; many roots; 25 percent hard caliche fragments and siliceous pebbles; 40 % surface fragments; calcareous; moderately alkaline.

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** High canopy, basal cover and density with small interspaces should make rainfall impact negligible. The stones in the profile capture moisture and enter through soil profile. This site has well drained soils, shallow with 0 to 5 percent slopes which are less susceptible to high runoff and erosion rates.

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

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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 > Forbs > Warm-season tallgrasses >

    Other: Trees > Shrubs/Vines > Cool-season midgrasses

    Additional: Forbs make up 10 percent of species composition, shrubs and trees compose up to 5 percent species composition.

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

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

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** 1000 to 2500 pounds per acre.

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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:** Mesquite and Saccahuista are the primary invaders.

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17. **Perennial plant reproductive capability:** All species should be capable of reproduction except during prolonged periods of drought, heavy natural herbivory or intense wildfires.
