Evaluation of Ecological Site Classes and Community Classes for Regional Scale Modeling of Conservation Effects on Grazing Lands: MLRA 77C

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Introduction

The Grazing Lands Component of the Conservation Effects Assessment Project is evaluating the development and use of general Ecological Site Classes and Community Classes within Major Land Resource Areas for regional and national scale modeling of conservation effects. National Resources Inventory (NRI) data was correlated to the identified to provide data for the Agricultural Policy/Environmental eXtender (APEX) model and other models. The Rangeland Hydrology and Erosion Model (RHEM) was used to do assessments of runoff and erosion for this evaluation.

Definitions

Ecological Site Class

Ecological Site Classes are proposed subdivisions of a Major Land Resource Area (MLRA) or Land Resource Unit (LRU). They are similar in concept to a general soil survey map unit – a general grouping of ecological sites by major landforms and vegetation types. An Ecological Site Class generally differs from other kinds of land in the kinds and amounts of vegetation produced, and in the responses to disturbances, recovery mechanisms, and management. Eight Ecological Site Classes were initially identified, working with the expert soil and range scientists in MLRA 77C:

- Playa Site Class
- Bottom Site Class
- Terrace, Saline Site Class
- Loamy Upland Site Class
- Sandy Upland Site Class
- Limy Upland Site Class
- Limy Upland, Gravelly Site Class
- Limy Upland, Very Shallow Site Class

Each Ecological Site within the MLRA was correlated to an Ecological Site Class.

Plant Functional Groups

The Plant Functional/Structural Group indicator is defined in Interpreting Indicators of Rangeland Health (version 4) as, *"A suite or group of species that because of similar shoot or root structure, photosynthetic pathways, nitrogen fixing ability, life cycle, etc., are grouped together on an ecological site basis."*

The presence, dominance and relative proportions of plant functional groups affect soil, hydrologic and biotic variables including:

- the kinds and amounts of canopy and foliar cover
- litter cover
- plant spacing
- amount and arrangement of bare ground
- structure and continuity of vegetation which then influences the potential to carry fire and regulate fire intensity
- grazing preferences
- wildlife habitat values
- runoff and erosion rates

The change in presence, dominance and/or proportion of plant functional groups is the primary attribute used to characterize States and Community Phases within an Ecological Site Description.

Standardized Plant Functional Groups based on growth form and primary flowering season (as opposed to photosynthetic pathway) were developed for this project as a method to standardize how plant communities are evaluated and correlated to a specific Community Class. Cool season (C_3) and warm season (C_4) photosynthetic pathways are not known and/or the information is readily available for many species. Most plant references provide a flowering period for each species. The dominant flowering period (spring or summer) was used to characterize when the plants are in a reproductive phase. This is often when treatment is applied in order to encourage or suppress seed production. All plant species found in the MLRA were assigned to one of the plant functional groups, and production by functional group was calculated for each NRI Primary Sampling Unit (PSU) community.

Community Class

Community Classes are proposed as generalized plant communities within an Ecological Site Class. A Community Class is differentiated from other Community Classes by the presence and relative proportions by annual production of plant functional groups. The Community Class name is created using the most dominant 7 functional groups, in descending order. Initial Community Classes were identified using the Community Phases within the Ecological Site Descriptions, with input from the local experts in the MLRA.

Each NRI PSU in the MLRA was correlated to a Community Class where possible. Some PSU data points were not used when the data (species present and/or production) was questionable. Additional Community Classes that are not currently represented in the Ecological Site Descriptions were added based on NRI data (mostly non-native dominated communities). Community Class names are derived using the top seven plant functional groups, listed in descending order of annual production. The production for the plant functional groups is calculated from the NRI PSUs that are correlated to the Community Class.

Plant Community

The actual plant community at any given location, at a point in time.

Ecological Site Classes and Community Classes for Major Land Resource Area 77C – Southern High Plains, Southern Part

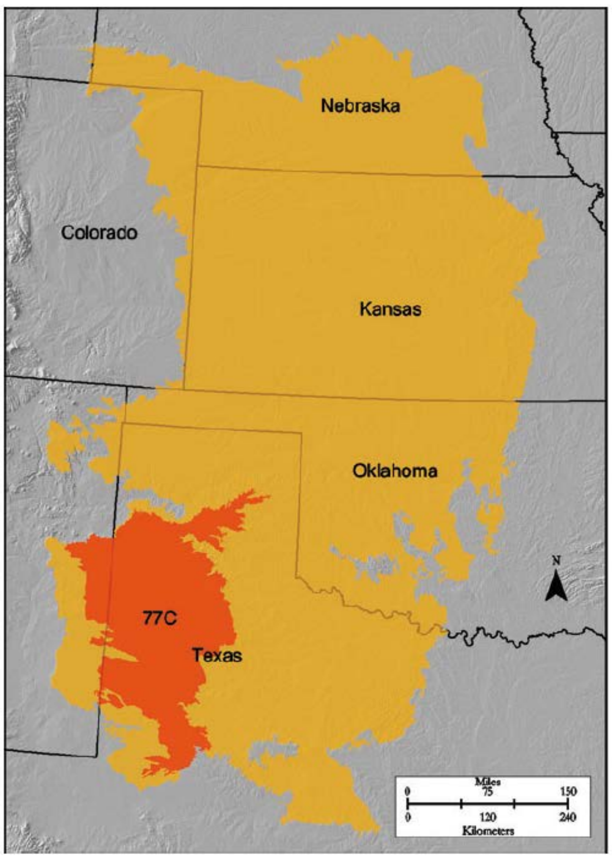

Figure 1: MLRA 77C map from Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296

Major Land Resource Area 77C occurs in western Texas and eastern New Mexico. It is part of the Central Great Plains Winter Wheat and Range Region (LRR H). The area is generally characterized by broad open plains dissected by very narrow flood plains. Elevations range from 2600 feet to 4600 feet above mean sea level. Lacustrine deposits of dolomite with interbedded clastic sediments underlay this region. Playas ranging in size from 5 to 160 acres are common. Perennial streams are uncommon.

Plant communities are dominated by short and midgrasses with sparse trees and shrubs. Typical species include blue grama, buffalograss, sideoats grama, catclaw acacia and mesquite.

The soil temperature regime is thermic, and the soil moisture regime is ustic. Texas Tech University has installed climate stations in every county that can provide continuous weather information for this MLRA - West Texas Mesonet. This is the recommended source for climate information. These stations have been in place 15-20 years.

The following climate information is from the MLRA 77C Deep Hardland 16-21" PZ Ecological Site Description:

Climate is semi-arid dry steppe. Summers are hot with winters being generally mild with numerous cold fronts that drop temperatures into the single digits for 24 to 48 hours. Temperature extremes are the rule rather than the exception. Humidity is generally low and evaporation high. Wind speeds are highest in the spring and are generally southwesterly. Canadian and Pacific cold fronts come through the region in fall, winter and spring with predictability and temperature changes can be rapid. Most of the precipitation comes in the form of rain and during the period from May through October. Snowfall averages around 15 inches but may be as little as 8 inches or as much as 36 inches. Rainfall in the growing season often comes as intense showers of relatively short duration. Long-term droughts occur on the average of once every 20 years and may last as long as five to six years (during these drought years moisture during the growing season is from 50 to 60 percent of the mean.) Based on long-term records, approximately 60 percent of years are below the mean rainfall and approximately 40 percent are above the mean. May, June and July are the main growth months for perennial warm-season grasses. Forbs make their growth somewhat earlier.

Averaged
Frost-free period (days): 205
Freeze-free period (days): 210
Mean annual precipitation (inches): 21.00

Monthly Precipitation (Inches):												
	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
High	*0.73*	*0.77*	*0.70*	*1.26*	*2.86*	*3.39*	*2.70*	*3.61*	*3.92*	*1.90*	*1.08*	*1.01*
Low	*0.17*	*0.24*	*0.20*	*0.38*	*1.29*	*1.47*	*0.94*	*1.53*	*1.07*	*0.35*	*0.34*	*0.25*

Monthly Temperature (°F):												
	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
High	*53.4*	*59.1*	*67.2*	*75.5*	*83.9*	*91.1*	*92.7*	*90.3*	*83.9*	*75.7*	*63.2*	*54.9*
Low	*23.6*	*27.1*	*33.0*	*41.8*	*52.0*	*60.6*	*63.7*	*62.2*	*55.6*	*44.1*	*32.5*	*25.2*

Climate station: TX5183, Levelland, TX. Period of record 1971-2000

Typical Agricultural Operations

Most of MLRA 77C has been converted to cropland. Most of the sandy soils that were historically farmed have now been planted to CRP.

The predominant crop is cotton, grown as either dryland, or irrigated. Many producers grow continuous cotton. Most cotton is planted in furrows, but some is planted flat. After harvest, the cotton stalks are not typically plowed under. The stalks may or may not be cut before the next crop is planted. Local cultivation practices on sandier soils includes plowing every 3 or 4 years to bring the clays from the argillic horizon up to the soil surface to help stabilize the sandy surface. An implement called a “sand buster” is also used. It has a series of rotating spokes with four harrow-type hooks that roughen the soil surface to reduce wind erosion. Some producers rotate the cotton with winter wheat or milo every two or three years. The milo is extremely valuable for dove, quail, sandhill crane and other bird species in the MLRA. Winter wheat is planted from September to October.

Groundwater in the MLRA is declining due to droughts over the last 15 years coupled with over-pumping of the Ogallala Aquifer for the last half century. Producers have had to abandon their irrigation systems, or tie multiple wells (as many as 15 or more) together to provide enough water to run the center pivots. The center pivots use low pressure emitters on drop tubes typically spaced every 60 inches.

FIGURE 2

Most of the livestock in the MLRA are run by farmers, with very few traditional ranch operations. Cattle and horses are the most common livestock grazed on the rangeland. Cattle are mostly English crosses – Angus and Hereford with cows averaging 1400 lbs and bulls averaging 2200 lbs. Calves are born year-round, but mostly from February to March. Calf weights are about 75 lbs at birth, and calves are weaned at about 8 months weighing 500-600 lbs. Stocker cattle and sheep are grazed on wheat fields in this MLRA from late summer through February.

Stocker cattle are often grazed on the winter wheat in this MLRA. Under good conditions, the stocker cattle can be grazed from November through April 1 for wheat that is planned for harvest. If the wheat is not going to be harvested, the stockers will be grazed through May. The typical stocking rate for winter wheat is 400 animal lbs per acre. Summer stocker cattle are also grazed on improved pastures from early spring through October.

Resource Management Systems

Prescribed Grazing

This MLRA can quickly recover perennial grasses. Seedling germination can occur any time during the growing season, when the soil is moist for 10-14 days. A variety of grazing rotations are used, and no specific rotation method is suggested. Typically, deferment from grazing during the growing season for regrowth and seed production is targeted at the 90 day period from April 1 to July 1, with deferment at least 2 out of 3 years. Deferment at the end of the growing season, from mid-August through November 1 is also important for developing the buds that initiate the following year's growth. The Merrill Four Pasture Rotation works well in this MLRA. It provides both the spring and summer growing season deferment needed to maintain these grasslands.

Target harvest efficiency for livestock grazing is 25%. Design utilization levels on key species are less than 50%, at the end of the growing season. Recommended stocking rates range from 40-50 acres per animal unit, to about 125 acres per animal unit.

Rainfall is below normal 6 out of 10 years in this MLRA. The best drought strategy is conservative stocking rates –at about 75% of the recommended stocking rates. As a rule of thumb, two years of recovery is needed for every year of drought to restore pre-drought production levels. Drought conditions have been occurring since 1996 in this MLRA, with a few years of normal rainfall in that period. 2011 was the worst drought year in recent times. Livestock producers trying to preserve their base herd will often provide supplemental feed on the rangeland during drought conditions, causing a variety of resource concerns on the rangelands in this MLRA. If a conservative stocking approach is not used, then the drought mitigation plan is to reduce the herd 25% when 50% of normal rainfall is not received by July 1. If 3 years continuous years of drought occur, then removing livestock from the rangeland is recommended until the range has recovered.

Prescribed Burning

Prescribed fire is rarely applied in MLRA 77C. The natural fire return period is considered to be about every 10 years. When prescribed burning is used to keep shrubs under control, 10 years is the recommended frequency. Prescribed burning is being actively applied on the USFWS Muleshoe Wildlife Refuge and the State Park to help maintain native plant communities. In the southwestern portion of the MLRA prescribed burning is used to improve Lesser Prairie Chicken Habitat.

Watering Facilities

The primary water source in MLRA 77C is wells with average water depth at 350 to 450 feet. Pipelines, storage and troughs are used to distribute livestock water. Livestock water for cattle is generally planned at 15 gallons/day for most operations and up to 20 gallons/day for 1500 lb animals. For electric pumps, about 4 days of storage is recommended, and for solar pumps, 7 days of storage is recommended. Water spacing recommendation is ¾ mile between waters.

Fencing

Standard barbed and smooth four wire fences are normally used on rangeland, and electric fences are typically used on winter wheat pastures. Permanent fences in this MLRA trap tumbleweed and other debris, which cause blowing sand to be deposited along fence lines. Fences become partially to completely buried in sand. The soil survey has mapped “fence dune” soil features.

Brush Management

Control of woody species is recommended when plant density exceeds 50 plants per acre, or when woody canopy cover is more than 10 percent.

Mesquite is sprayed in July with ¼ lb. active ingredient/acre of triclopyr (Remedy) and ¼ lb. ai/ac of clopyralid (Reclaim). Cost is about $21/ac. The goal is to achieve 70% kill, but results are highly variable. The optimum conditions for controlling mesquite are when soil temperatures are above 75 degrees at 10-12” below the soil surface. The plants should be in yellow flower stage or post-pod elongation. Plants that are in the long shoot vegetative regrowth stage will not be killed – the plants must be in a reproductive stage for effective results. Continued application, usually in the form of individual plant treatment (IPT) is necessary to maintain results. If IPT is not practiced, retreatment with aerial application is necessary within 15 years. Several chemicals are available for individual plant treatment.

Shinnery oak is controlled using ¾ lbs/ac active ingredient of tebuthiuron (Spike). Treatment is aerially applied, normally done in January or February. Response of the herbaceous vegetation is very good and the effects last for 15 – 20 years.
Sand sagebrush can be controlled with 2,4-D, but 2,4-D cannot be used anywhere within a couple miles of cotton fields. Cotton is typically at about the 2 leaf stage when sand sage should be sprayed. Cotton is very sensitive to 2,4-D. In conjunction with shinnery oak treatment with tebuthiuron, sand sagebrush is suppressed for 3 – 5 years.
Metsulfuron + chlorsulfuron (Cimarron® MAX) is effective in controlling yucca. Spraying is done in the spring, and if needed, a follow-up spraying is done the following spring.

Catclaw control is done using mechanical treatment. Saltcedar is normally treated with imazapyr (Arsenal). Cost is about $110-235/acre.

Range Planting

This practice is very rarely used in this MLRA. There is almost always a sufficient seed source available for re-establishing the native grasses and forbs. Grasses readily re-establish in this MLRA. Germination occurs any time the soil is moist for 10-14 days. Even areas of fairly solid shinnery oak normally have a very good grass recovery response following chemical control of the oak - without any seeding.

Conservation Reserve Program (CRP) planting has been done on areas that were formerly cropland. The following seed mixes are used.

Loamy Fine Sands to Sandy Soils

Grasses:		Forbs, Legumes, Shrubs:
Sideoats Grama	10-30%	Fourwing Saltbush
Sand Lovegrass	10-30%	Illinois Bundleflower

Little Bluestem	10-30%	Western Ragweed
Blackwell Switchgrass	10-30%	Partridge Pea
Indiangrass	10-30%	Awnless Bushsunflower
Plains Bristlegrass	10-30%	Alfalfa
Sand Dropseed	10-15%	Commercial Wildflower Mix
Green Sprangletop	10-15%	

Sandy Loam to Loamy Soils

Grasses:		Forbs, Legumes, Shrubs:
Blue Grama	10-30%	Fourwing Saltbush
Sideoats Grama	10-30%	Illinois Bundleflower
Blackwell Switchgrass	10-30%	Maximilian Sunflower
Plains Bristlegrass	10-30%	Western Ragweed
Sand Bluestem	10-30%	Partridge Pea
Indiangrass	10-30%	Awnless Bushsunflower
Little Bluestem	10-30%	White Prairieclover
Buffalograss	10-20%	Purple Prairieclover
Green Sprangletop	10-15%	Alfalfa
Sand Dropseed	10-15%	Commercial Wildflower Mix
Vine Mesquite	10-15%	

Clays to Clay Loam Soils

Grasses:		Forbs, Legumes, Shrubs:
Blue Grama	10-50%	Fourwing Saltbush
Sideoats Grama	10-30%	Purple Prairieclover
Buffalograss	10-30%	White Prairieclover
Blackwell Switchgrass	10-20%	Illinois Bundleflower
Arizona Cottontop	10-20%	Maximilian Sunflower
Indiangrass	10-20%	Partridge Pea
Vine Mesquite	10-15%	Western Ragweed
		Prairie Acacia
		Alfalfa
		Commercial Wildflower Mix

The native seed mixes must include at a minimum 10% forbs, shrubs, or legumes. This 10% composition can be a single or multiple species. If multiple species are used, each species must comprise at least 5% of the mix.

Wildlife Habitat Management

Wildlife in this MLRA includes lesser prairie chicken, tiger salamander, horned lizard, dune sagebrush lizard, Sandhill crane, geese, shorebirds, bobwhite and blue quail, a variety of grassland birds including sparrow and dove, pronghorn antelope, whitetail and mule deer. The Playa Ecological Site Class is the most important for wildlife. Habitat loss for the Lesser Prairie Chicken in the Sandy Upland Ecological Site Class is the greatest wildlife concern. The lesser prairie chicken was listed as threatened under the Endangered Species Act, but a court ruling in November 2015 vacated that decision. A significant amount of Lesser Prairie Chicken habitat has been converted to cropland.

Habitat requirements for the Lesser Prairie Chicken are summarized below:

- Food – Young · Insects – especially leafhoppers, beetles, and short-and long-horned grasshoppers. Food – Adult · Insects. · Vegetative material - sage leaves, buds, flowers, forbs, winter wheat, and wild buckwheat. · Mast and seeds - primarily shinnery oak acorns. · Cultivated crops – corn, oats, wheat, rye, sorghum, and other small grain crops.
- Breeding Cover (Leks) · Open rangelands, idle agricultural fields, elevated knolls and ridges with flat surfaces and low-growing vegetation, prairie dog towns. · Human disturbances such as roads, oil pads, and bare areas resulting from herbicide treatment, reverted cropland.
- Nesting, Brood Rearing, and Winter Cover · Mid-grass grasslands growing in different stages of plant succession and comprised of sand dropseed, sideoats grama, sand bluestem, and little bluestem interspersed with shinnery oak, sand plum and sand sagebrush. Nesting cover – 65% grass, 20-30% shrubs, 5-15% forbs; Brood-rearing cover – 40-45% grass, 40-45% shrubs, 15-20% forbs
- Water · Foods eaten provide adequate water. Birds will use open water from livestock ponds, playa lakes, and others during drought conditions.
- Interspersion · Prefer a complex of sand sagebrush, shinnery oak, sand plum, or skunkbush sumac shrubs, sand dropseed, side oats grama, sand bluestem, and little bluestem grasses on open rangelands with flat surfaces.
- Minimum Habitat Size · Two-square miles, or 1,280 acres, of prime nesting and brood-rearing cover surrounded by a minimum of 10,000 acres of feeding and loafing habitat.

Common Conservation Practices

The following table provides information about the kinds of conservation practices that the landowners in MLRA 77C are investing in. The table shows the most common conservation practices applied with NRCS assistance on grazed rangeland during fiscal years 2006 -2011.

Code	Practice Name	Number Applied	Amount Applied	Acres Benefitted
528	Prescribed Grazing (ac)	8,651	5,797,708	5,836,137
645	Upland Wildlife Habitat Management (ac)	7,313	5,561,068	5,519,844
314	Brush Management (ac)	1,728	536,394	1,551,918
614	Watering Facility (no)	1,330	19,134	1,619,779
382	Fence (ft)	833	5,415,119	1,029,846
516	Pipeline (ft)	720	3,131,895	824,863
327	Conservation Cover (ac)	391	55,928	64,686
533	Pumping Plant (no)	377	377	459,372
642	Water Well (no)	891	891	344,173
550	Range Planting (ac)	317	235,170	80,947
472	Access Control (ac)	133	16,452	22,899
595	Integrated Pest Management (IPM) (ac)	82	33,310	66,546
590	Nutrient Management (ac)	78	22,689	22,868
643	Restoration and Management of Rare and Declining Habitats (ac)	77	19,364	39,511
380	Windbreak/Shelterbelt Establishment (ft)	62	92,545	29,037

Figure 3

MLRA 77C Loamy Upland Ecological Site Class

The Loamy Upland Ecological Site Class is the most extensive site class in MLRA 77C. It dominates the northern portions of the MLRA. Prescribed Grazing and Brush Management are effective tools for managing these plant communities. Target species for brush management in this Ecological Site Class include mesquite, broom snakeweed, yucca and sand sagebrush. Individual plant treatment (IPT) is an important maintenance tool.

Two ecological sites have been correlated to this Site Class:

- R077CY022TX Deep Hardland 16-21" PZ
- R077CY036TX Sandy Loam 16-21" PZ

Three potential Community Classes were identified for this Ecological Site Class from the Ecological Site Descriptions and the local soil and range scientists:

- Midgrass – Shortgrass
- Shortgrass – Shrub
- Shrub - Shortgrass

The three proposed Community Classes can be represented for the Loamy Upland Ecological Site Class from NRI data. An additional Community Class dominated by annual and perennial forbs was added from the NRI data.

- **077C6.1** Summer Rhizomatous Grass, Summer Midgrass, Summer Stoloniferous Grass, Spring Perennial Forb, Summer Shortgrass, Summer Annual Grass, Summer Perennial Forb
- **077C6.2** Summer Rhizomatous Grass, Summer Perennial Forb, Evergreen Subshrub, Summer Annual Forb, Spring Annual Forb, Cacti, Spring Perennial Forb
- **077C6.3** Deciduous Tree, Summer Midgrass, Spring Perennial Forb, Evergreen Subshrub, Summer Rhizomatous Grass, Cacti, Summer Perennial Forb(I), Summer Shortgrass
- **077C6.4** Summer Perennial Forb, Spring Annual Forb, Spring Perennial Forb, Summer Annual Grass, Summer Midgrass, Summer Rhizomatous Grass, Summer Annual Forb

Average annual soil loss and average annual runoff estimates for the Community Classes in this study were estimated using the Rangeland Hydrology and Erosion Model (RHEM) developed by ARS at the Southwest Watershed Research Lab in Tucson, Arizona. Levelland (Station 415183) was selected to be the representative climate station for all the RHEM model runs for MLRA 77C. The erosion and runoff amounts are average total annual values estimated by the model, using the climate information for that station, and the site and vegetative characteristics from the NRI data points.

FIGURE 4: MLRA 77C LOAMY UPLAND ECOLOGICAL SITE CLASS

The following charts for each Community Class provide average values from NRI data and RHEM model results for the NRI points that correlated to each Community Class. A summary table with additional data can be found in Appendix D.

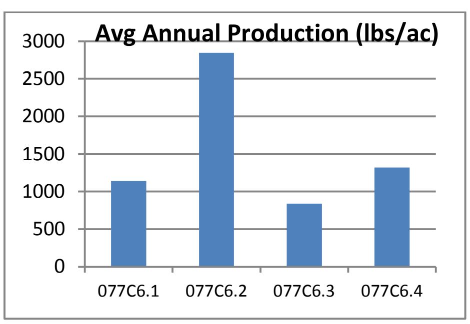

FIGURE 4

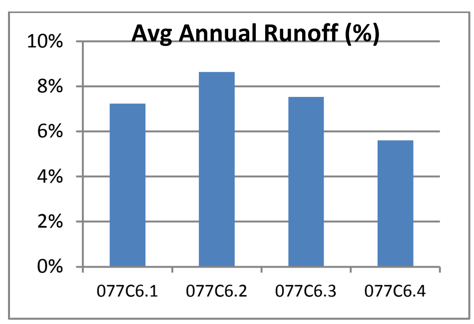

FIGURE 6

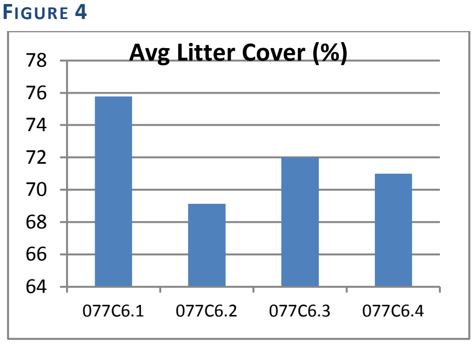

FIGURE 5

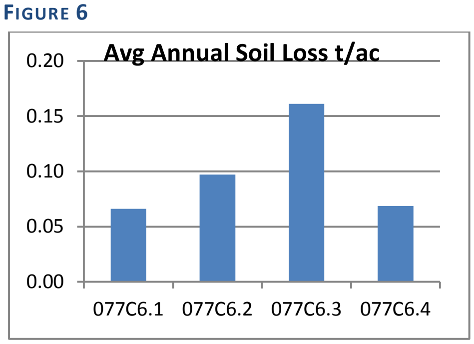

FIGURE 7

MLRA 77C LOAMY UPLAND ECOLOGICAL SITE CLASS STATE AND TRANSITION MODEL

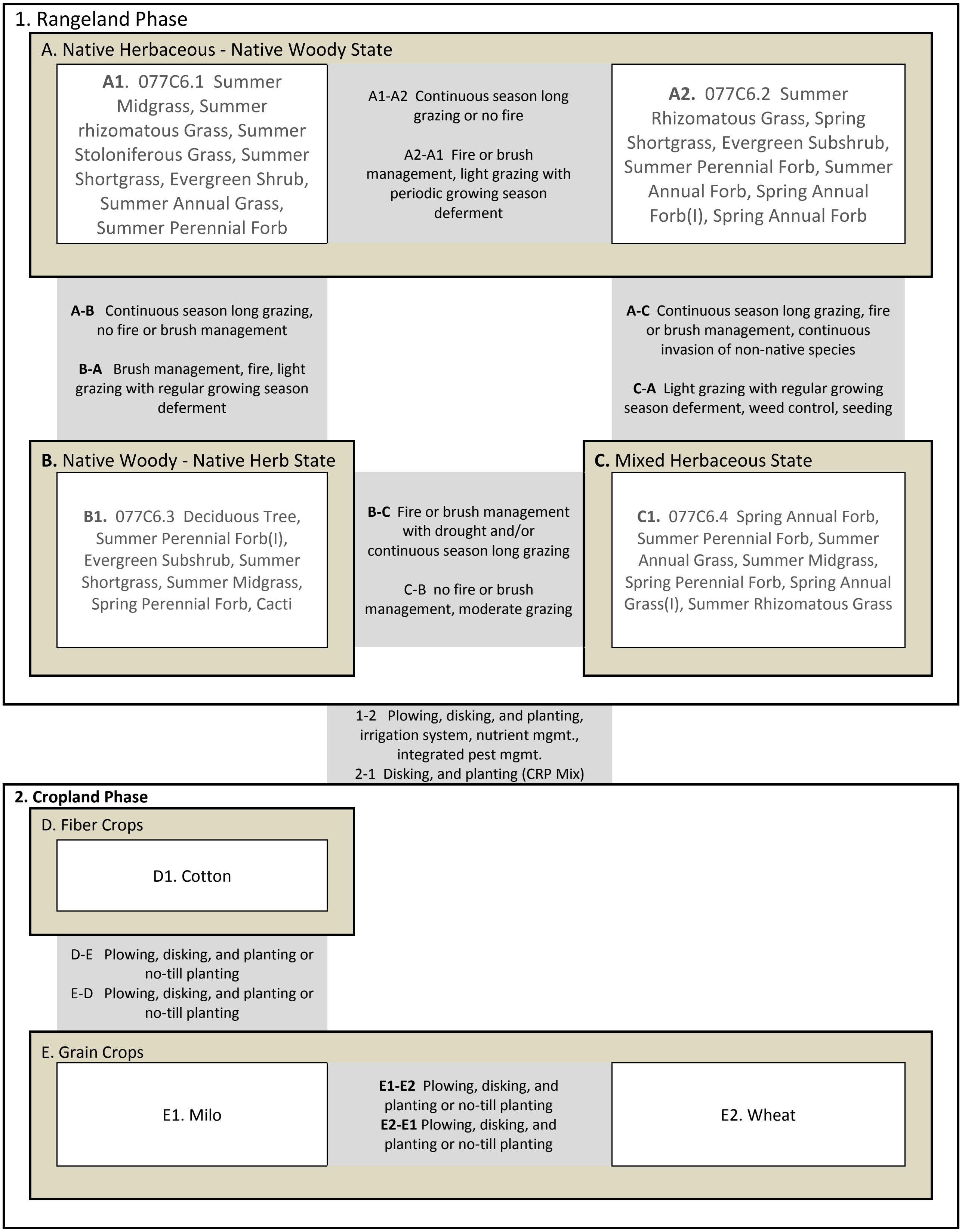

FIGURE 9

The reference state for the Loamy Upland Ecological Site Class consists of sideoats grama and blue grama. With no fire and/or continuous season long heavy grazing, it transitions into a shortgrass state of blue grama, broom snakeweed, yucca, and honey mesquite. At this point, chemical or mechanical brush treatment will return it to reference conditions, but with continued heavy grazed, no fire and/or lack of brush treatment it will transition into a shrub state. In this state, blue grama will decrease and broom snakeweed, yucca, and honey mesquite will increase.

The literature supports the STM with supportive evidence in their studies. The first publication reiterates that the use of grazing decreases woody species development on a Hardland ecological site.

Robertson Jr., T.E. and T.W. Box. 1969. Effects of Grazing on a Hardland Site in the Southern High Plains. 1969. Journal of Rangeland Management, vol 22(6): 418-423.

The effects of grazing on a Hardland ecological site were study on an isolated, ungrazed butte in the Southern High Plains. This was compared to another location in an adjacent area located on a very shallow site. Methods of study included measurement by line intercept and herbage production by weight-estimate. Twelve of the estimated plots were chosen at random and clipped. Wire cages were used to determine utilization on the grazed area. Additionally, soil samples were taken to measure pH, organic matter content, phosphorous content, and soluble salts. Infiltration tests were also conducted. The results found that there was substantial difference of vegetation between the ungrazed butte and the grazed area in both quality and quantity. The ungrazed butte supported 14 woody plant species compared to the 8 that were on the grazed and had more than twice the cover of woody plants. Of these species, redberry juniper was the most dominant with other species such as shinnery oak, narrowleaf yucca, mesquite, and skeleton goldeneye. On the grazed area mesquite was the most dominant of the woody species. The ungrazed butte produced 706 more pounds of dry herbage than the grazed. Sideoats grama, rough tridens, and blue grama were the most productive. On the grazed area, buffalograss was the most prevalent with tobosagrass and vine mesquite being labeled as increasers. The study suggested that New Mexico feathergrass and rough tridens should be considered a climax decreasers for the site, including perennial forb greenthread. Vine mesquite reacted as an increaser. For soil characteristics, infiltration rates were almost four times higher on the ungrazed. This was likely due to better soil structure, less compaction by animals, and increased organic matter in the topsoil.

MLRA 77C Sandy Upland Ecological Site Class

This Ecological Site Class is common in the southwestern portion of MLRA 77C. Four ecological sites were correlated to the Sandy Upland Class in this MLRA.

- R077CY034TX Sand Hills 16 - 21" PZ
- R077CY035TX Sandy 16 - 21" PZ

- R077CY052NM Loamy Sand
- R077CY056NM Sandy Plains

Drought in combination with poor grazing management is the dominant driver of plant community changes for this Site Class. Drought alone is not likely to drive community phase changes. Key species for utilization are normally the midgrasses like sideoats grama, which are preferred over the coarser tallgrasses.

Shrub encroachment is another important driver of plant community changes in this Ecological Site Class. Shinnery oak is the primary target species. Control of woody species is not recommended on the Sand Hills ecological site, which will readily become an active dune if plant cover is removed. Fire is rarely used in this MLRA. Fire is only viable when tallgrasses are dominant. Generally, 1500 lbs/ac of fine fuel is a minimum fine fuel load required for a prescribed burn in these sites. Burn prescriptions developed for these fires generally use air temperatures between 60° F - 75° F, relative humidity between 20% - 50% and 20’ wind speeds between 8 – 15 mph.

The lesser prairie chicken preferred habitat in this MLRA is the tallgrass - shinnery oak community that is in this site class. The shinnery oak provides an important food source for the Lesser Prairie Chicken, and the tallgrasses provide cover for the birds. Brush management is done when shrub density gets too high to maintain the grass component for the Lesser Prairie Chicken.

FIGURE 10. MLRA 77C SANDY UPLAND ECOLOGICAL SITE CLASS

Three Community Classes were identified for the Sandy Upland Ecological Site Class with input from the local soil and range scientists:

- Tallgrass
- Midgrass Shrub
- Shrub

All three Community Classes are represented by NRI data.

- **077C7.1** Summer Midgrass, Summer Tallgrass, Summer Annual Forb, Summer Perennial Forb, Summer Rhizomatous Grass, Spring Annual Forb, Summer Shortgrass
- **077C7.2** Summer Midgrass, Summer Shortgrass, Evergreen Shrub, Deciduous Shrub, Summer Perennial Forb, Evergreen Subshrub, Spring Shortgrass
- **077C7.3** Summer Midgrass, Deciduous Shrub, Evergreen Shrub, Spring Annual Forb, Summer Shortgrass, Summer Annual Grass, Summer Perennial Forb

The following charts for each Community Class provide average values from NRI data and RHEM model results for the NRI points that correlated to each Community Class. A summary table with additional data can be found in Appendix D.

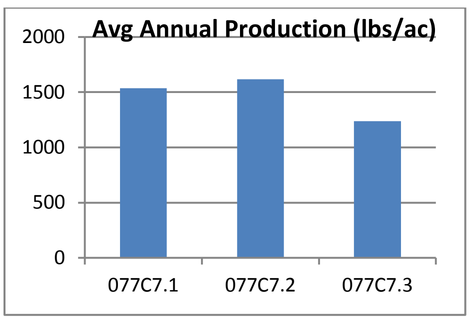

Figure 8

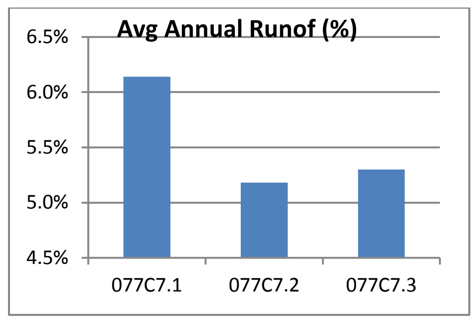

Figure 10

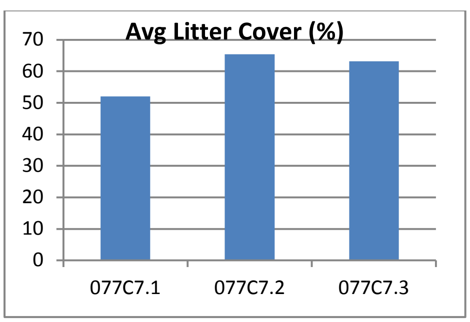

Figure 9

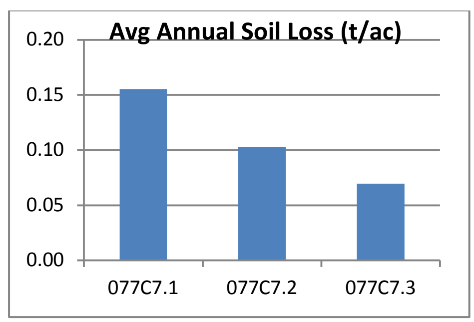

Figure 11

MLRA 77C SANDY UPLAND ECOLOGICAL SITE CLASS STATE AND TRANSITION MODEL

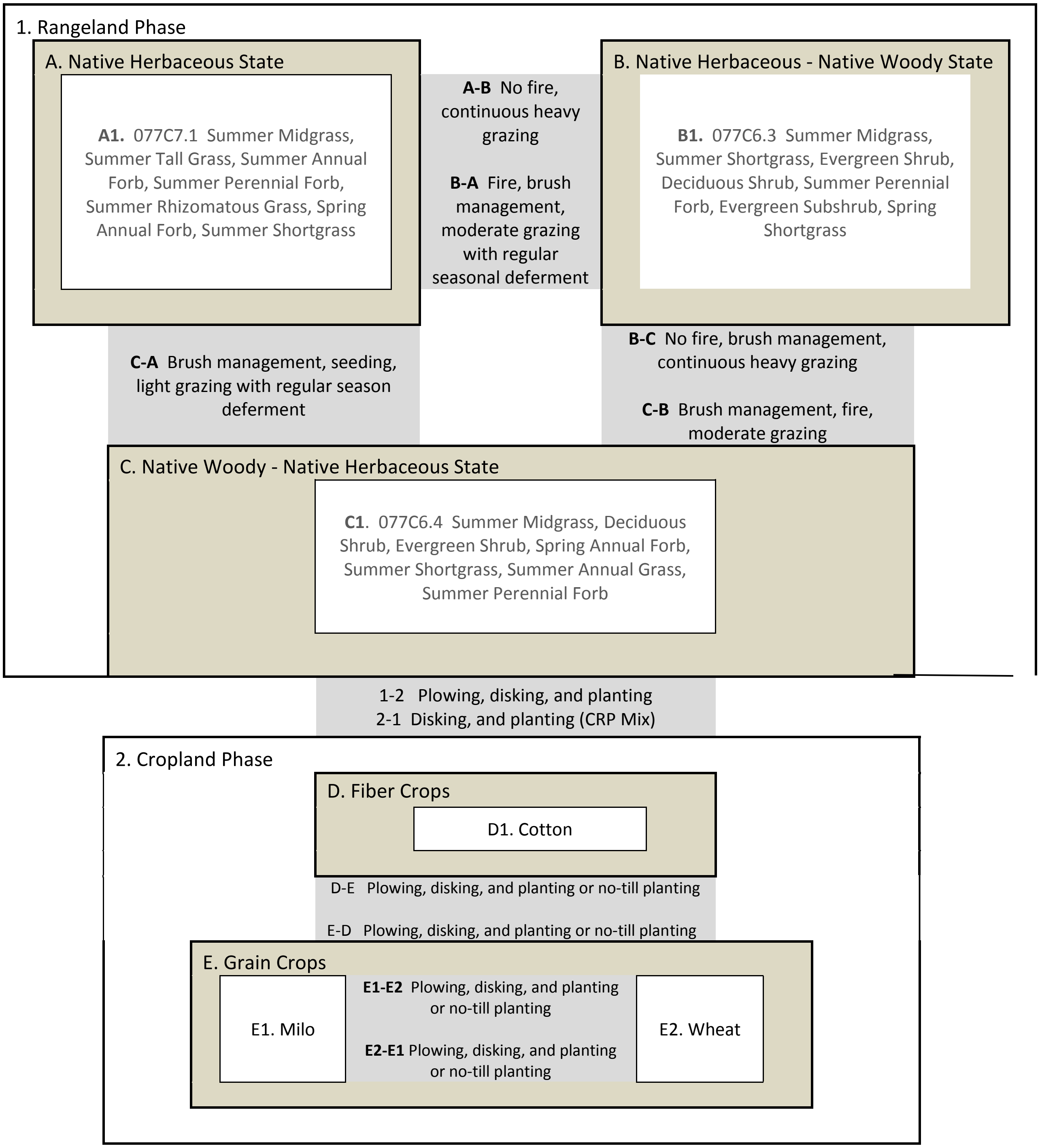

FIGURE 15

FIGURE 16. MLRA 77C SANDY UPLAND ECOLOGICAL SITE CLASS

According to the STM, the reference state of MLRA 77C Sandy site is dominated by sand bluestem, little bluestem, sand sagebrush, and sand shinnery oak. With no fire and/or continuous heavy grazing, the site is likely to transition into a midgrass/shrub state in which grasses decrease and shrubs and trees increase. If no management is implemented through fire, chemical brush management, and/or heavy grazing, the site is likely to transition into a shrub state in which these symptoms are magnified. The publications all support the STM as they address how a decrease in shinnery oak through various methods of control will increase grass species and return vegetation to within closer proximity to reference conditions.

JONES V.E. AND R.D. PETTIT. 1984. LOW RATES OF TEBUTHIURON FOR CONTROL OF SAND SHINNERY OAK. JOURNAL OF RANGE MANAGEMENT, VOL. 37(6): 488–490.

This study investigated the effect of the tebuthiuron application on sand shinnery oak on sites in the Southern High Plains of Texas. The sites were classified as Alfisol soils and described as fine sands. A motor-driven seeder dispersed tebuthiuron pellets at 0.2 kg increments to 1.0 kg kg/ha of shinnery oak onto 2-ha plots. The randomized design constituted both treatment and control plots with 3 replicates. In each plot, four transects were made perpendicular to swaths and chosen at random with 10 indiscriminate points. Density, canopy cover, and standing crop were marked at these points in the spring, summer, and fall of 1978 through 1980, as well as clippings attained.

The results showed that the shinnery oak declined cyclically in the first year in accordance to precipitation. The most notable effects were observed when soils were wet and conditions fostered high transpiration rates. In 1978, new shoots were greater than in the control, but the trend was reversed in 1979. Further, measurements taken in 1979 to 1981 determined that stands receiving more than or equal to 0.4 kg/ha of tebuthiuron had a shinnery oak standing crop reduction of 90% or more. The grass response, showed higher yields in the treated sites than in the untreated for the entirety of the study after the first year. These yields increased from 420 to 690 kg/ha on the control. Due to drought, on the untreated sites, grasses were observed to become quiescent 6 weeks earlier than on treated areas. This was likely determined to be a result of the reduced competition for soil water by the oak. Further observation of the sites showed reestablishment of sand sagebrush, but not of the shinnery oak. Conclusions stated that the tebuthiuron was able to convert a shinnery oak ecosystem to a mid-grass prairie.

Scifres, C. J. 1972. Sand Shinnery Oak Response to Silvex Sprays of Varying Characteristics. Journal of Range Management, vol. 25(6): 464–466.

This study this located in the Rolling Red Plains of Northwest Texas and featured soil grades of deep sand lowlands to hillsides with sand underlain by clay. The vegetation was dominated by shinnery oak, little bluestem with some small soapweed, sand sagebrush and pricklypear. Randomized plots were designated as 17 by 75 feet and replicated four times. A Silvex diesel oil: water emulsion (1:4) was applied with a truck-mounted sprayer at 0, 0.125, 0.25, and 0.5 lb/acre increments to the plots. A second study applied the herbicide at 0.5 lb/acre with diesel oil: water emulsion, diesel oil only, water only, or water plus 0.5% (v/v) nonionic surfactant. A third study conducted investigated 0.25 or 0.5 lb/acre of ammonium thiocyanate combined with 0.5 lb/acre Silvex in comparison to the prospective chemicals independently.

Results were estimated at 30 days and 1 year after treatment. Reduction in sand shinnery oak was linear to applications of 0.5 lb/acre or less. At 30 days and 1 year after treatment canopy cover reduced by 90% with the 0.5 lb/acre adjustment. This was reduced to about 75% two years post-treatment. The addition of ammonium thiocyanate did not help the reduction. Therefore, the most efficient and effective treatment is indicated to be at least 0.5 lb/acre Silvex without the diesel oil: water emulsion.

Sears, W.E., C.M. Britton, D.B. Wester, R.D. Pettit. Herbicide conversion of a sand shinnery oak (Quercus havardii) community: effects on biomass. Journal of Range Management, vol. 39 (5).

This research study was conducted in the southern Great Plains just east of Plains, Texas. The primary soil is characterized as a fine sand with a plant community of tall to mid-grass species under a thick covering of sand shinnery oak. These sites had been treated with tebuthiuron previously with the physiognomy altering from oak shrubland to mixed-grass prairie. For the purposes of the study, three 15 x 30m areas were established in an untreated shinnery oak grassland, a similar community treated with tebuthiuron three years prior, and one treated 6 years prior. A 30 point grid was created with 4 sample points randomly selected each sampling date during growth initiation, peak standing crop, and dormancy. Above ground biomass of live oak stems, dead oak stems, live herbaceous shoots, dead herbaceous shoots and litter were harvested at ground level in a circular quadrat. Additionally, depth effects and total seasonal biomass was measured as well.

The study results found that both the above ground and below ground biomass decreased on the treated sites because of the mortality of the shinnery oak. However, herbaceous biomass increased 6-fold greater on the treated sites than the untreated. Overall, the study concluded that following tebuthiuron treatments, the most prevalent change is in the decrease of oak biomass and the subsequent increase in herbaceous yield on treated sites. This was believed to be due to the increased availability of moisture and nutrients for grass growth. In comparison, on the untreated site only 8% of the live material was herbaceous whereas the treated site yielded 100% herbaceous above-ground biomass.

Jacoby, P.W., J.E. Slosser, C.H. Meadors. 1983. Vegetational Responses Following Control of Sand Shinnery Oak with Tebuthiuron. Journal of Range Management, vol. 36(4): 510-512.

This study was conducted on locations near Andrews and Jayton, Texas on shinnery oak sites. The Andrews location was characterized as deep, fine sand soils with main grass vegetation of sand dropseed, giant dropseed, Wright's threeawn, and common sandbur. These plots had tebuthiuron pellets aerially applied at rates of 0, 0.5, and 1.0 kg/ha. The experimental design was randomized with 2 replications. The plots were evaluated approximately 30 days after treatment by herbage clipping in 9 quadrats and then oven dried. The mortality of shinnery oak was estimated as well. Data was analyzed by variance and means and separated by Duncan's multiple range test ($P \leq 0.5$). The Jayton site was characterized as having fine sand soil and main vegetation of little bluestem, soapweed yucca, sand sagebrush. On this site, tebuthiuron was applied via hand-spreader at 1.1 kg/ha. It was evaluated 8 and 20 months following treatment with the same methods as Andrews. The three treated and untreated plot means were compared with t-tests.

The Andrews site yielded 85 and 94% mortality of shinnery oak for the 0.5 and 1.0 kg/ha rates of tebuthiuron applications at 30 months post-treatment. There was a significantly higher frequency of vegetation in the treated plots at 18 months. Annual grasses such as purple sandgrass and false buffalograss composed a large part of the community, as well as an increase in perennial grasses including thin paspalum, sand dropseed, giant dropseed and sandbur. The untreated plots had almost twice as much bare ground and had significantly more annual grasses. The Jayton site had very similar results with an increase in both annual and perennial grasses on the treated sites. Forb yields were significantly higher on the untreated and shinnery oak mortality was measured to be 84 and 97% post-treatment. The grass yields were much greater at the Jayton site, than at the Andrews likely to differing rainfall. The Jayton treated site grasses that were significant included sand dropseed, little bluestem and Wright's threeawn with sand switchgrass on the untreated. Therefore, this study found that tebuthiuron pellets effectively reduced shinnery oak and subsequently resulted in an increase in grass yield.

MLRA 77C Limy Upland Ecological Site Class

One ecological site has been correlated to this Ecological Site Class:

- 077CY028TX Limy Upland 16-21" PZ

Prescribed Grazing and Brush Management are effective conservation practices for maintaining the plant communities in this Ecological Site Class. Mesquite is the most common target species for Brush Management.

Figure 17. MLRA 77C Limy Upland Ecological Site Class

Three potential Communities were identified with input from the local soil and range scientists.

- Midgrass – Shortgrass – Shrub
- Shortgrass – Shrub
- Shrub – Shortgrass

There are only a few NRI points (4-6) available to characterize each of these Communities. Additional data would be needed to adequately model these.

- **077C8.1** Summer Rhizomatous Grass, Summer Midgrass, Evergreen Subshrub, Deciduous Tree, Spring Perennial Forb, Evergreen Tree, Summer Annual Forb
- **077C8.2** Summer Rhizomatous Grass, Summer Annual Forb, Evergreen Subshrub, Spring Perennial Forb, Summer Annual Grass, Summer Midgrass, Deciduous Shrub

- **077C8.3** Summer Midgrass, Deciduous Tree, Monocot Shrub, Evergreen Subshrub, Coniferous Tree, Spring Perennial Forb, Summer Rhizomatous Grass

The following charts for each Community Class provide average values from NRI data and RHEM model results for the NRI points that correlated to each Community Class. A summary table with additional data can be found in Appendix D.

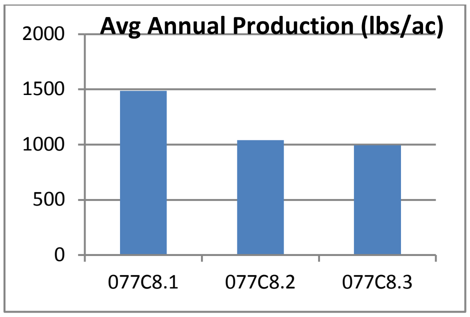

FIGURE 12

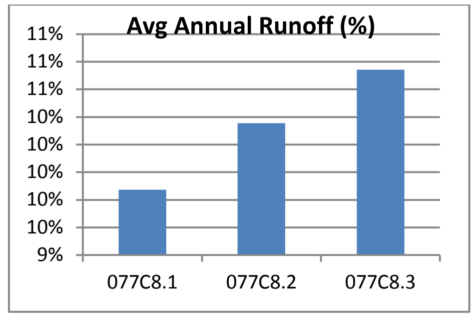

FIGURE 14

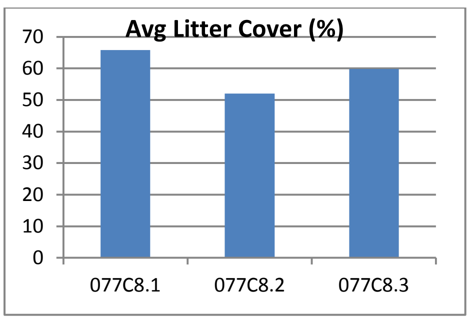

FIGURE 13

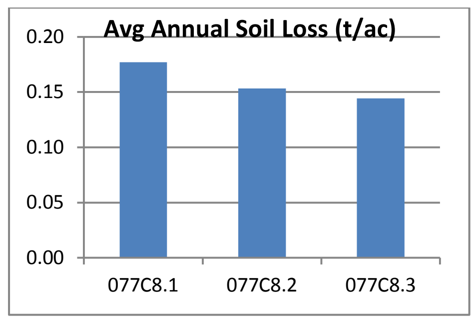

FIGURE 215

MLRA 77C LIMY UPLAND ECOLOGICAL SITE CLASS STATE AND TRANSITION MODEL

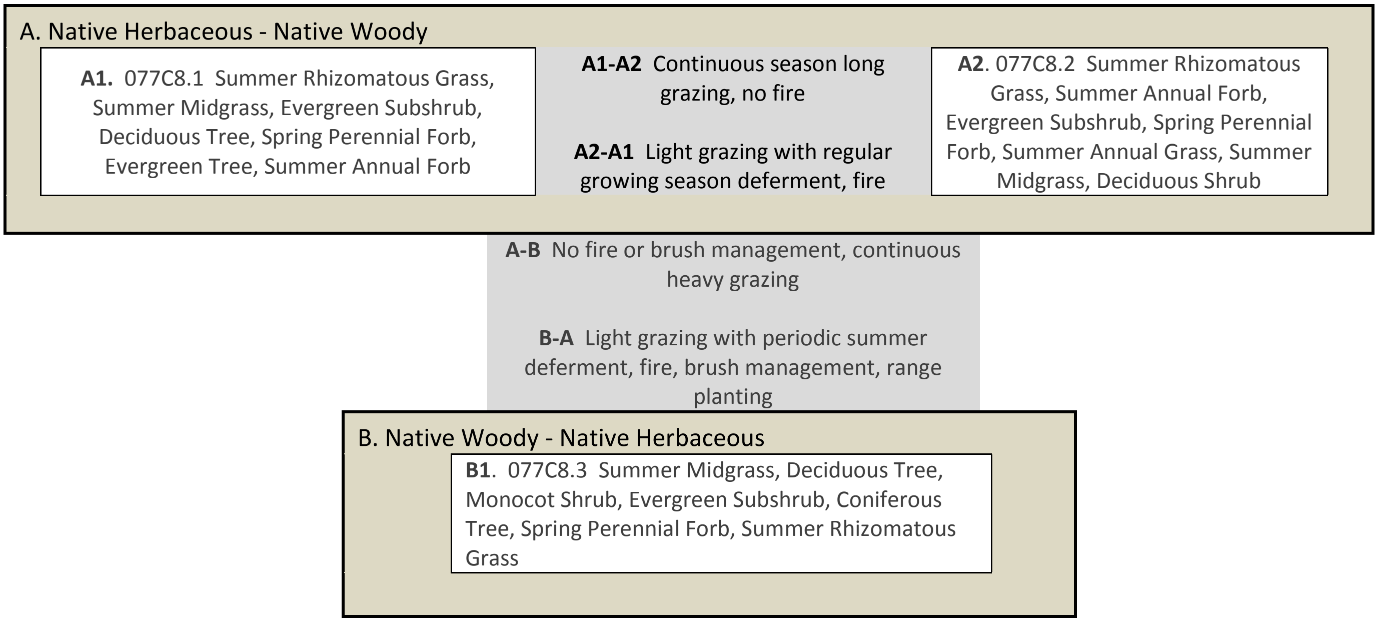

FIGURE 16

The reference state for this Limy Upland Ecological Site Class consists of sideoats grama, blue grama, Indiangrass, soapweed yucca, and broom snakeweed. With continuous heavy grazing and/or a lack of fire exceeding 20 years, it is will transition into a shortgrass state of predominantly buffalograss, soapweed yucca, and broom snakeweed. With further heavy grazing and lack of fire the site will eventually transition into a shrubland state with vegetation characteristics of threeawn, soapweed yucca, and broom snakeweed. Although the following publication is not in MLRA 77C, it supports data that the decrease in the woody species broom snakeweed will increase cover of grass species.

McDaniel, K.C., R.D. Pieper, and G.B. Donart. 1982. Grass response following thinning of broom snakeweed. Journal of Range Management, vol 35(2): 219-222.

This study was conducted east of Capitan, New Mexico and investigated grass response following thinning of broom snakeweed. Two locations were selected with varying grazing intensities and range condition, however fences were constructed to exclude grazing for the study. The sites consisted of a relatively homogeneous stand of 1-year broom snakeweed plants. It was reduced by 0, 25, 50, 75, and 100% of the mean density in the heavily grazed pasture and by 0, 33, 50, 67, and 100% in the moderately grazed site. Treatments were applied randomly four times. Basal cover and standing crop of grasses and forbs were measured annually at each location.

Mortality of the broom snakeweed on the heavily grazed ranged from 64% on the not previously thinned to 54.4, 37.2, and 30.4% on the plots thinned by 25, 50, and 75% of original density. Density on the moderately grazed had mortality to be 5 to 10% higher on unthinned plots compared to plots that had been thinned 33, 50, and 67%. On the heavily grazed pasture, blue grama basal cover was increased after the first year of treatment on sites that the broom snakeweed was thinned by at least 50%. Basal cover of sideoats grama exceeded that of all sites where snakeweed was completely removed. The complete elimination of broom snakeweed resulted in approximately 50% increase in basal cover of grasses in the moderately grazed and 89% in the heavily grazed. Standing crop of perennial grasses generally increased on both site every year of the study.

MLRA 77C Limy Upland, Very Shallow Ecological Site Class

This site is similar to the Limy Upland site class, but because potential production is higher on the Limy Upland site class, the recommendation was to keep this site separate for modeling purposes, although no NRI points occur on this Site Class.

One Ecological Site was identified for this proposed Ecological Site Class:

- 077CY037TX Very Shallow 16-21" PZ

Figure 17: MLRA77C Limy Upland, Very Shallow Ecological Site Class

The general aspect of this site is a shortgrass community with scattered shrubs. Generally, this site has less production potential than the Limy Upland Site Class because of its shallow root zone, but it can be very productive in wet years. Prescribed Grazing and Brush Management are very effective practices for maintaining the plant communities on this ecological site. Catclaw can become a problem on this site. The only effective control is to mechanically remove them.

Three Community Classes were identified for this Ecological Site Class from the Ecological Site Description with input from the local soil and range scientists.

- Midgrass – Shortgrass – Shrub
- Shortgrass – Shrub
- Shrub - Shortgrass

There are only a few (1-6) NRI points are available to characterize these Community Classes. Additional data would be needed to adequately characterize them.

- **077C10.1** Summer Rhizomatous Grass, Spring Midgrass, Summer Stoloniferous Grass, Summer Midgrass, Spring Annual Forb, Summer Annual Grass, Spring Perennial Forb, Summer Shortgrass
- **077C10.2** Summer Rhizomatous Grass, Summer Midgrass, Deciduous Tree, Evergreen Subshrub, Spring Perennial Forb, Spring Annual Forb, Summer Perennial Grasslike
- **077C10.3** Deciduous Tree, Summer Rhizomatous Grass, Summer Midgrass, Summer Stoloniferous Grass, Summer Perennial Forb, Evergreen Subshrub, Spring Annual Forb(I)

The following charts for each Community Class provide average values from NRI data and RHEM model results for the NRI points that correlated to each Community Class. A summary table with additional data can be found in Appendix D.

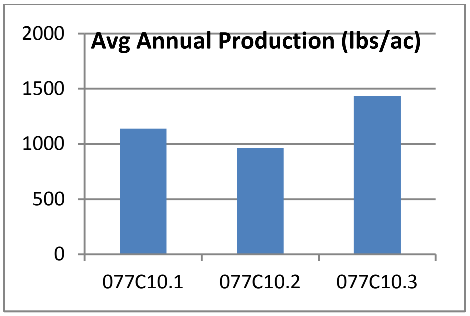

FIGURE 18

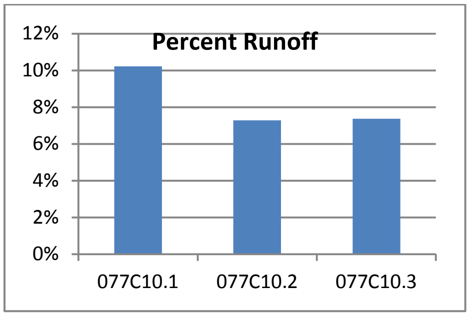

FIGURE 20

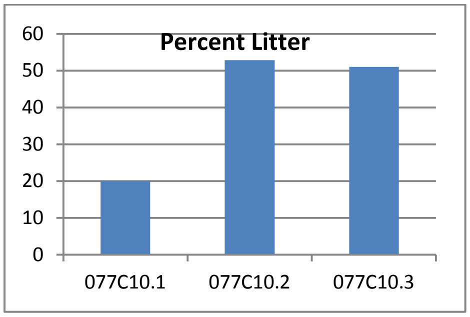

FIGURE 19

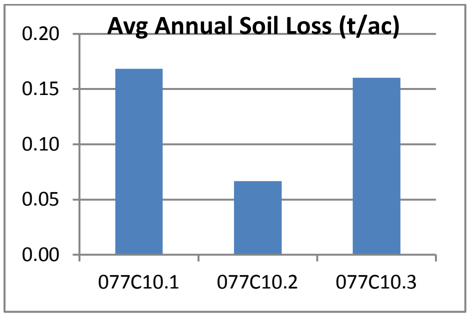

FIGURE 21

MLRA 77C Limy Upland, Very Shallow Ecological Site Class State and Transition Model

A. Native Herbaceous State

A1. 077C10.1 Summer Rhizomatous Grass, Spring Midgrass, Summer Stoloniferous Grass, Summer Midgrass, Spring Annual Forb, Summer Annual Grass, Spring Perennial Forb, Summer Shortgrass

A-B Heavy continuous grazing, no fire
B-A Moderate grazing with regular growing season deferment, fire, brush management

B. Native Herbaceous - Native Woody State

B1. 077C10.2 Summer Rhizomatous Grass, Summer Midgrass, Deciduous Tree, Evergreen Subshrub, Spring Perennial Forb, Spring Annual Forb, Summer Perennial Grasslike

B-C Heavy continuous grazing, no fire or brush management
C-B Three or more years growing season deferment, then moderate grazing, brush management, range planting

C. Native Woody - Native Herbaceous State

C1. 077C10.3 Deciduous Tree, Summer Rhizomatous Grass, Summer Midgrass, Summer Stoloniferous Grass, Summer Perennial Forb, Evergreen Subshrub, Spring Annual Forb(I)

Figure 22

The reference state in the State and Transition Model for the Limy Upland, Very Shallow ecological site class indicates vegetation will predominantly consist of little bluestem, blue grama, New Mexico feathergrass, Chalk hill hymenopappus, featherplume, broom snakeweed, and plains pricklypear. If the state undergoes heavy continuous grazing and/or no fire, it is likely to transition into a grassland/shrubland state in which little bluestem, New Mexico feathergrass, and blue grama will decrease. In its place, there will be an increase in broom snakeweed, plains pricklypear, soapweed yucca, and threeawn. Further, if this state is not returned to reference conditions through moderate grazing, fire, or chemical brush management, and instead heavy continuous grazing remains with a lack of fire or other brush management, it is likely to transition into a shrubland state. This state will an increase in hairy grama, broom snakeweed, plains pricklypear, and soapweed yucca.

The publications support this STM. The first study examines herbicidal control of pricklypear and supports the increase in pricklypear with a lack of disturbance.

Petersen, J.L., D.N. Ueckert, R.L. Potter. 1988. Herbicidal control of pricklypear cactus in western Texas. Journal of Range Management, vol. 41(4): 313-316.

This study took place north of San Angelo, Texas and evaluated herbicidal control of pricklypear on two different sites. The San Angelo study site consisted of a 7% cover of pricklypear with additional vegetation of honey mesquite, lotebush, tobosagrass, common curlymesquite, and buffalograss. The other location, the Coleman site, had a 6% cover of pricklypear and associated vegetation of honey mesquite, liveoak, sideoats grama, common curlymesquite, Texas wintergrass, and Japanese brome. Herbicide treatments were applied to 12.2 by 30.5m plots arranged in randomized blocks in factorial design with three replications. An herbicide mixture of 1:1 butoxyenthanol ester of 2, 4, 5-T and triisopropanolamine salt of picloram was applied in a foliar spray. Treatments were applied 2.2 hours after sunrise and 4.5 hours after sunset on four different dates. An untreated plot was also included in the experiment. Two permanent line intercepts were placed in each plot. The treatment efficiency was measured by the percent reduction of live pricklypear cover.

The results found that the phototoxicity of the herbicides did not come into full effect until three years post-treatment. Live pricklypear cover on the untreated plots increased 47% in the San Angelo and 38% at Coleman. This confirmed the concern that pricklypear was increasing in the area. It was found that nighttime applications of herbicide were more effective than daytime and applications were least successful in the spring. Prevailing ambient temperatures may be more important than the time of treatment for pricklypear control. It was also found that the site with the higher clay content and higher organic matter are more resistant to herbicide treatment.

MLRA 77C Limy Upland, Gravelly Ecological Site Class

This Ecological Site Class occurs on the downwind site of large playa lakes. The soils are formed from aeolian deposits out of the playa lake bed materials. One site has been correlated to this Ecological Site Class.

- 077CY026TX High Lime 16-21" PZ

This is a preferred site for equipment yards and feeding areas. It is often not well managed. Prescribed Grazing is the only conservation practice normally applied. Brush Management is not commonly used, but mesquite might be occasionally treated. This site class has a small extent within the MLRA, but the recommendation is to keep it separate for modeling purposes. Two Community Classes were identified for this Ecological Site Class from the Ecological Site Description with input from the local soil and range scientists.

- Midgrass – Shortgrass
- Shrub

Only one Community Class can be represented by the NRI data, which includes short grasses, midgrasses and shrubs.

- **077C9.1** Summer Rhizomatous Grass, Summer Midgrass, Summer Annual Forb, Summer Perennial Forb, Spring Perennial Forb, Spring Annual Forb, Deciduous Shrub, Summer Tallgrass

FIGURE 23: MLRA 77C LIMY UPLAND, GRAVELLY ECOLOGICAL SITE CLASS

Average annual production is 642 lbs/ac. Average litter Cover is 13%, average annual runoff is estimated at 12% of precipitation, and total annual soil loss is 0.34 tons/ac.

MLRA 77C LIMY UPLAND, GRAVELLY ECOLOGICAL SITE CLASS STATE AND TRANSITION MODEL

A. Native Herbaceous State

A1. 077C9.1 Summer Rhizomatous Grass, Summer Midgrass, Summer Annual Forb, Summer Perennial Forb, Spring Perennial Forb, Spring Annual Forb, Deciduous Shrub, Summer Tall Grass

A-B Continuous season long grazing, no fire

B-A Light grazing with regular growing season deferment, brush management, range planting

B. Native Herbaceous - Native Woody State

B1. Grass - Shrub Community SPAI (50 - 100), DISP (50 – 100), SPCR (50 - 100), ATCA2 (100 - 200), GUSA2 (200 – 400), PRGL2 (100 – 300)

FIGURE 24

For the High Lime Ecological Site, the reference state vegetation is suggested as alkali sacaton, sideoats grama, blue grama, vine mesquite, western wheatgrass, and fourwing saltbush. With continuous season long heavy grazing and/or lack of fire, it is likely to transition into a shrubland state. Within this state, alkali sacaton is likely to decrease and there will be an increase in saltgrass, sand dropseed, fourwing saltbush, broom snakeweed, and honey mesquite. The restoration pathway to return this site back to reference conditions is through brush management, range planting, and light grazing with growing season deferment.

The publications support the STM. The first study suggested that with a decrease in honey mesquite, there was an increase in climax grass species, just as the STM would suggest. Additionally, the second publication reiterated that a decrease in honey mesquite in the shrubland state could increase grass production, returning vegetation within closer proximity to reference conditions. The third publication examined the predicted decrease of fourwing saltbush when in competition as the STM suggested.

Helm, V. and T.W. Box. 1970. Vegetation and soils of two southern High Plains range sites. Journal of Rangeland Management, vol. 23 (6): 447-450.

This study, on the High Plains of Texas, analyzed the soil and vegetation properties of two varying sites with a similar climate and topography. The sites were adjacent to each other with one site being classified as a mixed plains with a presence of honey mesquite, and the other as a high lime site with no mesquite on it. The experimental design involved twenty sampling locations randomly selected on the pasture which had similar grazing treatments for the past decade. Species composition, basal density of grasses, and mesquite canopy cover was measured at the twenty locations with a 100 foot line intercept. Range conditions as estimated by percent climax species was estimated at each sampling location. Density was measured with the point center quarter method and composite samples with a soil auger core were taken along with water infiltration rates.

It was found that soil and vegetation properties varied on the two sites. The absence of the mesquite on the high lime was the most significant difference in the two communities. There was no difference between the total grass cover of the two sites, however the high lime supported a greater number of climax plants than the mixed plains. The most abundant on the high lime site were blue grama, sideoats grama, and vine mesquite. The major grasses on the mixed plains were buffalograss, blue grama, and tobosagrass. On this site, mesquite did not alter total grass cover but did decrease the number of climax species. The physical properties of the soils were different on both sites. The high lime had a significantly higher level of pH, phosphorus, and potassium. Infiltration rates of over 7 inches per hour were obtained on the high lime, which was significantly greater than the 3.34 on the mixed plains. It was evaluated that the high lime site was in better range condition that the mixed plains. This was deemed the case as the increased infiltration rates on the high lime led to greater climax grass species.

Dahl, B.E., R.E. Sosebee, J.P. Goen, C.S. Brumley. 1978. Will mesquite control with 2,4,5 T enhance grass production? Journal of Range Management, vol. 31(2): 129-131.

This study was conducted on the Rolling Plains land resource area of West Texas. The experiment took place on three different sites in varying counties on which an herbicide mixture of 2, 4, 5-T and diesel oil/water were applied. Additionally, one of the locations was separated and selected for five variations in topography. Soils on this site varied from clay to sandy clay loam. Depending on the uniformity of vegetation, anywhere from 9 to 25 woven cages were placed to provide livestock exclusion. Herbage yield for one of the sites were obtained for 6 years, while the other two were obtained for 4 years. Percent canopy cover of mesquite was taken using transects and mortality was obtained from 25 permanently marked trees. The predominant perennial grasses on the sites was buffalograss and tobosagrass. Other grasses included vine mesquite, Hall's panicum, blue grama, threeawns, sand dropseed, and Arizona cottontop.

Results indicated that aerially spraying honey mesquite significantly increased perennial grass production on all three sites. However, on sites in which honey mesquite was very dense, the grass production had decreased to the point that the herbicide made no significant difference. The study also determined the percent mortality of various percent cover of mesquite to produce differing grass yields. For example, the study found that it would take a 90% kill at a site of 16 or 17% canopy cover to increase grass yields to 500 lb/acre. This same yield could be produced from a 60% root kill with a canopy cover of 50%. The same data found that canopy cover of less than 10% would seldom provide a significant grass increase regardless of tree kill.

Ueckert, D.N. and J.L. Petersen. 1991. Selecting Atriplex canescens for greater tolerance to competition. Journal of Range Management, vol 44 (3): 220-222.

Fourwing saltbush is often used for rangeland seeding at disturbed sites because of its wide ability to be adaptable to soils and climate, its winter leaf retention, and its palatability for livestock. Success in planting is usually highly variable. This study, in San Angelo, Texas, involves the observation of fourwing saltbush to tolerate the competition of sideoats grama. Seeds were harvested from the natural growing site and then grown in a greenhouse for 15 weeks. Following this, 1,116 seedlings were transplanted in a stand of 'El Reno' sideoats grama. The growth rates of the surviving seedlings were recorded for 38 months post-transplant. Superior plants were identified after 17 months and stem cutting were taken from these and selected inferior plants. The field experiment was arranged as a randomized, complete block with 2 planting dates with one replication. Survival, canopy heights, and canopy diameters were evaluated. Clone responses were measured within the competition and competition-free regimens.

The results indicated that the fourwing saltbush planted with the sideoats grama were obviously stressed, compared to competition free plots. This was evidenced by their lower survival percentages and decreased canopy development. Clones planted in the sideoats grama that were planted in April versus November were more stressed due to the drier conditions of the April planting. Researchers urged for a prospective from a broader scale and indicated that performance of distinctive plants may be a product of environment rather than genetics.

MLRA 77C Playa Ecological Site Class

This Ecological Site Class is a complex of dry playas and wet playas. The dry playas only have water following rain events, and many of these have been converted to cropland. On rangeland, the dry playa sites are often used as feeding areas. The wet playas normally have some water yearlong, and support hydrophytic vegetation. These would be classified as wetlands. The Playa Site Class is the most important site for wildlife in this MLRA. The protected Tiger Salamander occurs in the wetter playas. One ecological site has been correlated to this Ecological Site Class.

- 077CY027TX Playa 16-21" PZ

Three Community Classes were identified for this Site Class:

- Midgrass-Forb
- Grasslike-Forb-Hydrophytic herbaceous
- Grasslike-Hydrophytic herbaceous

FIGURE 25: MLRA 77C PLAYA ECOLOGICAL SITE CLASS, WET PHASE

There are two Community Classes that can be characterized from the NRI data.

- **077C4.1** Summer Rhizomatous Grass, Summer Midgrass, Spring Rhizomatous Grass, Summer Perennial Forb, Spring Annual Forb, Summer Midgrass(I), Summer Annual Forb
- **077C4.2** Spring Rhizomatous Grass, Summer Rhizomatous Grass, Spring Perennial Grasslike, Summer Annual Forb, Spring Perennial Forb

The following charts for each Community Class provide average values from NRI data and RHEM model results for the NRI points that correlated to each Community Class. A summary table with additional data can be found in Appendix D.

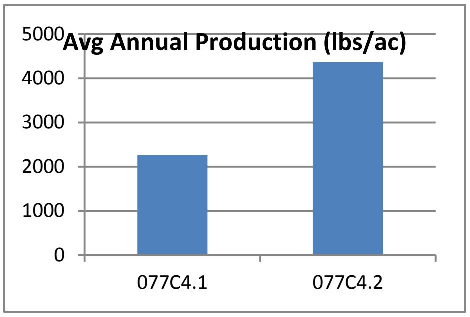

FIGURE 26

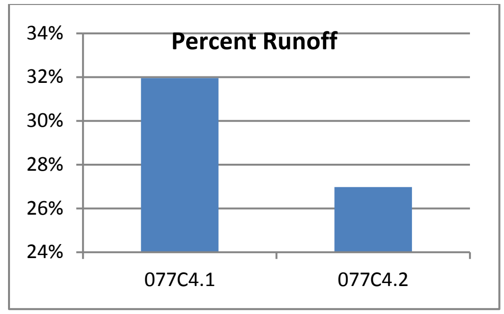

FIGURE 28

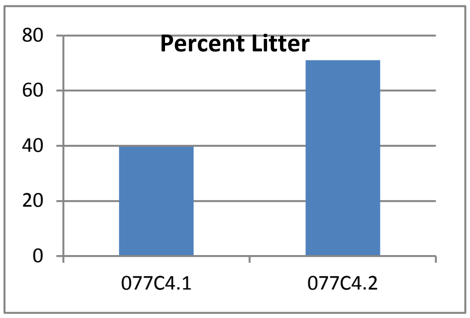

FIGURE 27

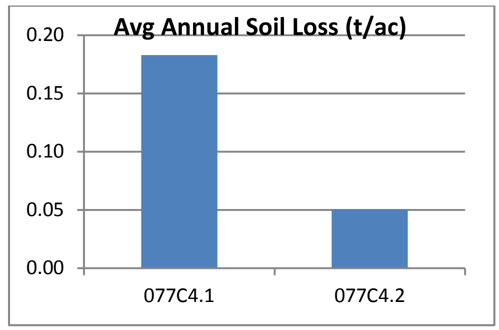

FIGURE 29

FIGURE 30: MLRA 77C PLAYA LAKE

MLRA 77C Playa Ecological Site Class State and Transition Model

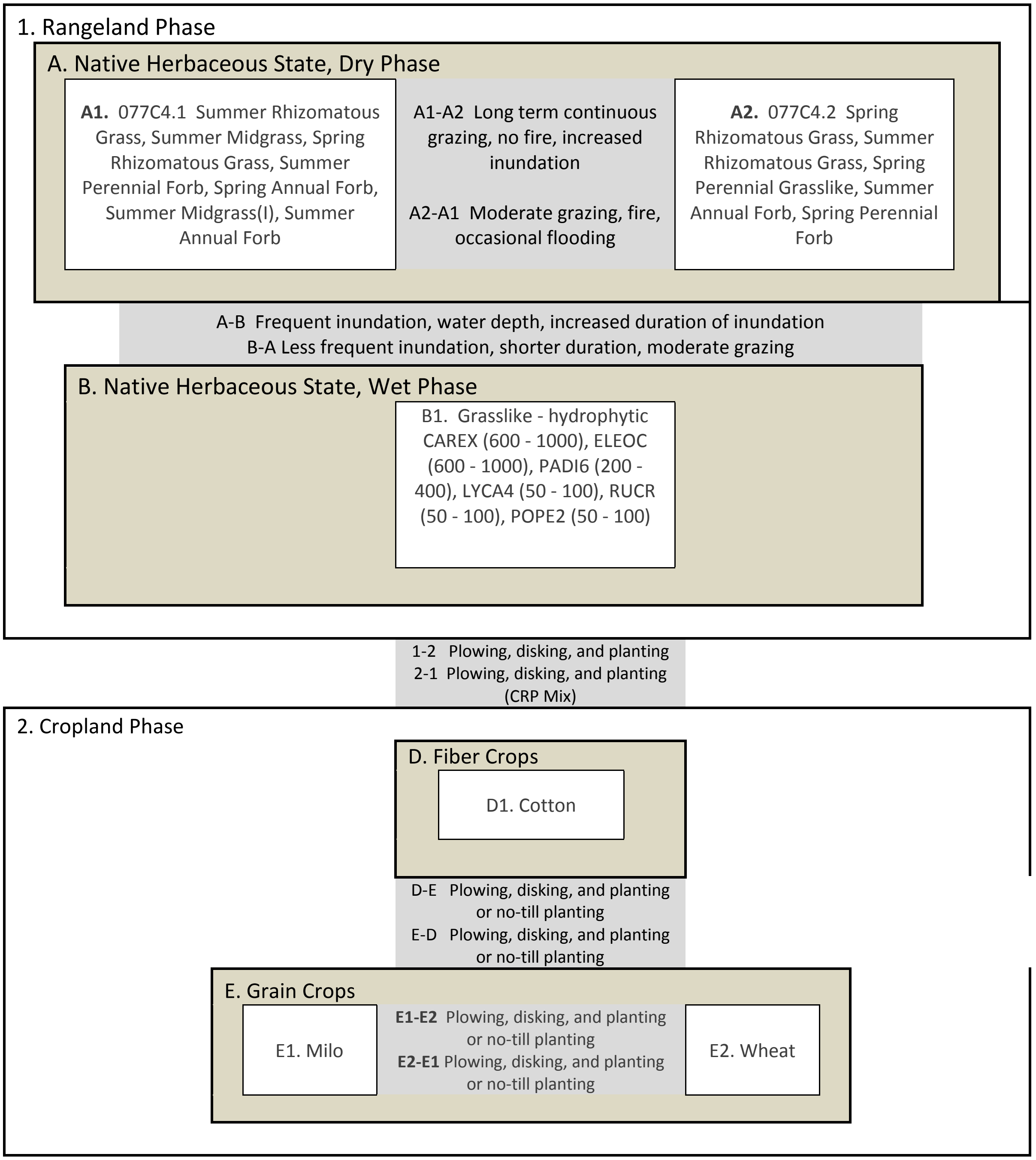

Figure 31

MLRA 77C Terrace, Saline Ecological Site Class

This Ecological Site Class is dominated by alkali sacaton. Prescribed grazing and brush management are the typical conservation practices applied to maintain or improve this ecological site. If the site is not well managed, recovery is very slow. Saltcedar is the typical target species for Brush Management. The saltcedar beetle has been present in this MLRA for 12-13 years. It is able to suppress saltcedar, but does not appear to be killing the plants. This site class has been correlated to one ecological site:

- 077CY689TX Wet Saline 16-21" PZ

Three Community Classes were identified for the Terrace, Saline Ecological Site Class:

- Midgrass – Shortgrass
- Shortgrass – Shrub
- Shrub – Shortgrass

Figure 32: MLRA 77C Terrace, Saline Ecological Site Class

No NRI data is available for the Terrace, Saline Ecological Site Class.

The STM for this group suggests a reference state of alkali sacaton, saltgrass, scratchgrass, and fourwing saltbush. With continuous heavy grazing and/or no fire it will transition to the shortgrass/shrubland state. Alkali sacaton and fourwing saltbush will decrease and there will be an increase in saltgrass, and scratchgrass with the addition of willow baccharis and saltcedar. If grazing or chemical brush management is not implemented to return to reference conditions, it is likely that it will transition to a shrubland state.

The following publications support the findings of the STM. The first publication although not in MLRA 77C, deals with similar dynamics, discusses herbicide-burn and mechanical clearing and suggests, like the STM the decrease in shrub with the input of these disturbances. The second publication focuses on fourwing saltbush and supports the STM finding that it is very adaptable to harsh conditions as there is little change throughout the various transitions.

McDaniel, K.C. and J.P. Taylor. 2003. Saltcedar recovery after herbicide-burn and mechanical clearing practices. Journal for Range Management, vol. 56(5): 439-445.

This study took place close to Socorro, New Mexico and experimented with herbicide-burn and mechanical treatments for saltcedar control. This area had been subject to some wet years in the 1940's that resulted in some significant flooding. Several control measures were put into place that have altered the natural meander of the river and influenced the establishment of native riparian vegetation communities. Additionally, wildfire had eliminated several fire-tolerant species and the site is now dominated by saltcedar. There is some happenings of Fremont cottonwood (Popular fremontii) and black willow trees with grasses such as saltgrass and alkali sacaton grown sparsely under the saltgrass canopy. Herbicide and mechanical clearing treatments were applied to 10 plots with 5 replications for each design in a randomized fashion. 5 of the plots were given herbicide treatments, then burned remove dead standing saltcedar. The other 5 plots were given mechanical treatments in 2 stages in which the aerial and stem growth was removed first, and roots growth second. Prior to treatment, parallel belt transects were spaced evenly 50 m apart in each plot to determine saltcedar density and canopy cover. These same measurements were taken after treatment for the next 6 years.

It was determined that at least three wildfires had come through the area since the 1940's which had caused some prolific resprouting of saltcedar. Pretreatment density averaged at 7,112 plant units ha-1 and canopy cover ranged from 34 to 90% with a 56% average. The first three years of treatment showed very expected results with the removal of saltcedar. However, it was found that plant densities were lower in herbicide-burn plots compared to the mechanically cleared. In the first year post-burn, saltcedar regrowth was evident. Towards the end of the study, the cover of saltcedar in the mechanically cleared became higher but still never exceeded that of the herbicide-burn. Three years after the initial treatment, mechanical control was seen to have controlled saltcedar by 54 to 88% with an average of 70%. This study concluded that removal of saltcedar is necessary to improve riparian habitats, however selecting a treatment must be relative to the plant and its environment.

Potter, R.L., D.N. Ueckert, J.L. Petersen and M.L. McFarland. 1986. Germination of fourwing saltbush seeds: interaction of temperature, osmotic potential, and pH. Journal for Range Management, vol. 39(1): 43-46.

For this study, fourwing saltbush seed from four different sites in Western Texas sites was harvested to determine interactions with temperature, osmotic potential and pH. The varying sites had different soil types including loam and clay loam on the San Angelo series and clay on the Valentine site. The Texon and Grandfalls sites were silty clay loam with the Texon site being saline. All sites were characterized as having some sort of disturbance. Fourwing saltbush seeds were collected from plants on the edge of the saline area. All seeds were oven-dried then dewinged in a modified hammer mill. Germination trials were conducted in a factorial design with 3 replications. Constant temperatures were used and polyethylene glycol was used to stimulate low, moderate, and high osmotic potentials with empirical formulas and gravimetric procedures. A replication consisted of 50 seeds on filter paper that were subjected to each combination of temperature, osmotic potential, and pH. Seeds were germinated in controlled environmental chambers.

The results found that the effect of pH based on osmotic potential was only significant in the Texon fourwing saltbush seeds at 20 degrees Celsius. Germination of seed in this population did increase with extremes of pH. This was important as rapid germination is important for establishment of range seedings. It was concluded that fourwing saltbush and other woody chenopods have the ability to adapt to harsh conditions. This was seen in the study and the plants ability to adapt to saline environments as the Texon seed germinated at lower osmotic medium potentials. The study also concluded that a temperature by osmotic interaction exists for some species but not all. This suggests that this interaction exists in some fourwing saltbush ecotypes but not others. This occurrence proposes that when seeds are exposed to higher temperatures the effects of minimal moisture in more inhibitory to germination than when temperatures are near or below normal. In contrast, when moisture is not restricted the seeds will germinate well over a wide range of temperatures.

MLRA 77C Bottom Site Class

Three Community Classes were identified for the Bottom Site Class:

- Midgrass Tallgrass
- Shortgrass
- Shortgrass, Eroded

The Shortgrass Community Class is the most common plant community being managed for. This state can be maintained with Prescribed Grazing and on-going Brush Management. Saltcedar and willow are the primary target species for brush management on this site, but the practice is rarely applied. Individual plant treatment is needed for maintenance. No NRI data is available for the Bottom Ecological Site Class.

Summary

A significant amount of time was spent analyzing available data from NRI, Soil, and Ecological Site databases to develop Ecological Site Classes and Community Classes for this project. While this approach was generally useful, the knowledge and experience of the local soil and range specialists is critical for the final selection and grouping of ecological sites in the MLRA. Local experts are able to quickly identify ecological sites that are not significant to the MLRA, and ensure that grouping sites into Ecological Site

Classes includes their responses to disturbances, use and management, which are typically not well characterized in the data.

Most of the Ecological Site Classes and the corresponding Community Classes proposed by the local experts have some NRI data that can be utilized to characterize those communities for modeling at the MLRA scale. However, the number of NRI sample units available to characterize most Site Classes within the MLRA was generally low – typically less than 8 data points. This Major Land Resource Area is relatively simple compared to other areas with more topography. In many areas, the available MLRA data will need to be supplemented with additional data to help characterize the dominant Community Classes for the Ecological Site Classes.

Appendix A. MLRA 77C Ecological Site Classes showing the Ecological Sites, Ecological Site IDs, and Plant Community Classes that were correlated to each Site Class.

MLRA	Ecological Site Class Name	Ecological Site Names	Ecological Site ID
77C	**Loamy Upland**	Deep Hardland 16-21" PZ	R077CY022TX
		Sandy Loam 16-21" PZ	R077CY036TX
		Plant Community Class Names, from NRI data	**Plant Community Class ID**
		Summer Rhizomatous Grass, Summer Midgrass, Summer Stoloniferous Grass, Spring Perennial Forb, Summer Shortgrass, Summer Annual Grass, Summer Perennial Forb	077C6.1
		Summer Rhizomatous Grass, Summer Perennial Forb, Evergreen Subshrub, Summer Annual Forb, Spring Annual Forb, Cacti, Spring Perennial Forb	077C6.2
		Deciduous Tree, Summer Midgrass, Spring Perennial Forb, Evergreen Subshrub, Summer Rhizomatous Grass, Cacti, Summer Perennial Forb(I), Summer Shortgrass	077C6.3
		Summer Perennial Forb, Spring Annual Forb, Spring Perennial Forb, Summer Annual Grass, Summer Midgrass, Summer Rhizomatous Grass, Summer Annual Forb	077C6.4
MLRA	**Ecological Site Class Name**	**Ecological Site Names**	**Ecological Site ID**
77C	**Sandy Upland**	Sand Hills 16 - 21" PZ	R077CY034TX
		Sandy 16 - 21" PZ	R077CY035TX
		Loamy Sand	R077CY052NM
		Sandy Plains	R077CY056NM
		Plant Community Class Names, from NRI data	**Plant Community Class ID**
		Summer Midgrass, Summer Tallgrass, Summer Annual Forb, Summer Perennial Forb, Summer Rhizomatous Grass, Spring Annual Forb, Summer Shortgrass	077C7.1
		Summer Midgrass, Summer Shortgrass, Evergreen Shrub, Deciduous Shrub, Summer Perennial Forb, Evergreen Subshrub, Spring Shortgrass	077C7.2
		Summer Midgrass, Deciduous Shrub, Evergreen Shrub, Spring Annual Forb, Summer Shortgrass, Summer Annual Grass, Summer Perennial Forb	077C7.3
MLRA	**Ecological Site Class Name**	**Ecological Site Names**	**Ecological Site ID**
77C	**Limy Upland**	Limy Upland 16-21" PZ	077CY028TX
		Plant Community Class Names, from NRI data	**Plant Community Class ID**
		Summer Rhizomatous Grass, Summer Midgrass, Evergreen Subshrub, Deciduous Tree, Spring Perennial Forb, Evergreen Tree, Summer Annual Forb	077C8.1
		Summer Rhizomatous Grass, Summer Annual Forb, Evergreen Subshrub, Spring Perennial Forb, Summer Annual Grass, Summer Midgrass, Deciduous Shrub	077C8.2
		Summer Midgrass, Deciduous Tree, Monocot Shrub, Evergreen Subshrub, Coniferous Tree, Spring Perennial Forb, Summer Rhizomatous Grass	077C8.3

MLRA	Ecological Site Class Name	Ecological Site Names	Ecological Site ID
77C	**Limy Upland, Very Shallow**	Very Shallow 16-21" PZ	077CY037TX
		Plant Community Class Names, from NRI data	**Plant Community Class ID**
		Summer Rhizomatous Grass, Spring Midgrass, Summer Stoloniferous Grass, Summer Midgrass, Spring Annual Forb, Summer Annual Grass, Spring Perennial Forb, Summer Shortgrass	077C10.1
		Summer Rhizomatous Grass, Summer Midgrass, Deciduous Tree, Evergreen Subshrub, Spring Perennial Forb, Spring Annual Forb, Summer Perennial Grasslike	077C10.2
		Deciduous Tree, Summer Rhizomatous Grass, Summer Midgrass, Summer Stoloniferous Grass, Summer Perennial Forb, Evergreen Subshrub, Spring Annual Forb(I)	077C10.3

MLRA	Ecological Site Class Name	Ecological Site Names	Ecological Site ID
77C	**Limy Upland, Gravelly**	High Lime 16-21" PZ	077CY026TX
		Plant Community Class Names, from NRI data	**Plant Community Class ID**
		Summer Rhizomatous Grass, Summer Midgrass, Summer Annual Forb, Summer Perennial Forb, Spring Perennial Forb, Spring Annual Forb, Deciduous Shrub, Summer Tallgrass	077C9.1
		Grass-Shrub Community (no NRI data)	n/a

MLRA	Ecological Site Class Name	Ecological Site Names	Ecological Site ID
77C	**Playa**	Playa 16-21" PZ	077CY027TX
		Plant Community Class Names, from NRI data	**Plant Community Class ID**
		Summer Rhizomatous Grass, Summer Midgrass, Spring Rhizomatous Grass, Summer Perennial Forb, Spring Annual Forb, Summer Midgrass(I), Summer Annual Forb	077C4.1
		Spring Rhizomatous Grass, Summer Rhizomatous Grass, Spring Perennial Grasslike, Summer Annual Forb, Spring Perennial Forb	077C4.2

MLRA	Ecological Site Class Name	Ecological Site Names	Ecological Site ID
77C	**Terrace, Saline**	Wet Saline 16-21" PZ	077CY689TX
		Plant Community Class Names, from NRI data	**Plant Community Class ID**
		(no NRI data)	n/a

MLRA	Ecological Site Class Name	Ecological Site Names	Ecological Site ID
77C	**Bottom**	n/a	n/a
		Plant Community Class Names, from NRI data	**Plant Community Class ID**
		(no NRI data)	n/a

Appendix B: MLRA 77C Common Plant Species, and Plants Named in the Report

Common Name	Symbol	Scientific Name	Functional Group
alfalfa	MESAS	Medicago sativa	Spring Perennial Forb(I)
alkali sacaton	SPAI	Sporobolus airoides	Summer Midgrass
annual buckwheat	ERAN4	Eriogonum annuum	Summer Annual Forb
Arizona cottontop	DICA8	Digitaria californica	Summer Midgrass
awnless bushsunflower	SICA7	Simsia calva	Evergreen Subshrub
big bluestem	ANGE	Andropogon gerardii	Summer Tallgrass
black grama	BOER4	Bouteloua eriopoda	Summer Stoloniferous Grass
black willow	SANI	Salix nigra	Deciduous Tree
blue grama	BOGR2	Bouteloua gracilis	Summer Rhizomatous Grass
bluestem	ANDRO2	Andropogon	Summer Annual Grass
bluestem	SCHIZ4	Schizachyrium	Summer Midgrass
broom snakeweed	GUSA2	Gutierrezia sarothrae	Evergreen Subshrub
broomweed	AMPHI8	Amphiachyris	Summer Perennial Forb
buffalograss	BUDA	Buchloe dactyloides	Summer Rhizomatous Grass
bushy knotweed	PORA3	Polygonum ramosissimum	Summer Annual Forb
California loosestrife	LYCA4	Lythrum californicum	Summer Perennial Forb
camphorweed	PLCA7	Pluchea camphorata	Summer Annual Forb
Canada wildrye	ELCA4	Elymus canadensis	Spring Midgrass
Canadian horseweed	COCA5	Conyza canadensis	Spring Annual Forb
catclaw acacia	SEGR4	Senegalia greggii	Deciduous Tree
Chalk Hill hymenopappus	HYTE2	Hymenopappus tenuifolius	Summer Biennial Forb
cheatgrass	BRTE	Bromus tectorum	Spring Annual Grass(I)
coastal sandbur	CESP4	Cenchrus spinifex	Summer Annual Grass
cocklebur	XANTH2	Xanthium	Spring Annual Forb
cotton	GOSSY	Gossypium	Summer Perennial Forb
Cuman ragweed	AMPS	Ambrosia psilostachya	Summer Perennial Forb
curly dock	RUCR	Rumex crispus	Spring Perennial Forb(I)
curlycup gumweed	GRSQ	Grindelia squarrosa	Summer Annual Forb
curly-mesquite	HIBE	Hilaria belangeri	Summer Stoloniferous Grass
divergent buckwheat	ERDI5	Eriogonum divaricatum	Spring Annual Forb
dotted blazing star	LIPU	Liatris punctata	Summer Perennial Forb
dropseed	SPORO	Sporobolus	Summer Midgrass
ear muhly	MUAR	Muhlenbergia arenacea	Summer Midgrass
fall witchgrass	DICO6	Digitaria cognata	Summer Midgrass
false buffalograss	MOSQ	Monroa squarrosa	Summer Annual Forb

Common Name	Symbol	Scientific Name	Functional Group
featherplume	DAFO	Dalea formosa	Spring Evergreen Subshrub
fourwing saltbush	ATCA2	Atriplex canescens	Evergreen Shrub
giant dropseed	SPGI	Sporobolus giganteus	Summer Tallgrass
giant sandreed	CAGI3	Calamovilfa gigantea	Summer Rhizomatous Grass
globemallow	SPHAE	Sphaeralcea	Spring Perennial Forb
golden currant	RIAU	Ribes aureum	Deciduous Shrub
golden pricklypoppy	ARAE	Argemone aenea	Summer Annual Forb
goldenrod	SOLID	Solidago	Spring Perennial Forb
green sprangletop	LEDU	Leptochloa dubia	Summer Midgrass
hairy grama	BOHI2	Bouteloua hirsuta	Summer Shortgrass
Hall's panicgrass	PAHA	Panicum hallii	Summer Shortgrass
honey mesquite	PRGL2	Prosopis glandulosa	Deciduous Tree
hooded windmill grass	CHCU2	Chloris cucullata	Summer Annual Grass
Illinois bundleflower	DEIL	Desmanthus illinoensis	Summer Perennial Forb
Indiangrass	SONU2	Sorghastrum nutans	Summer Tallgrass
Japanese brome	BRJA	Bromus japonicus	Spring Annual Grass(I)
juniper	JUNIP	Juniperus	Coniferous Tree
knotgrass	PADI6	Paspalum distichum	Summer Stoloniferous Grass
kochia	KOSC	Kochia scoparia	Spring Annual Forb(I)
lambsquarters	CHAL7	Chenopodium album	Spring Annual Forb
little barley	HOPU	Hordeum pusillum	Spring Annual Grass
little bluestem	SCSC	Schizachyrium scoparium	Summer Midgrass
live oak	QUFU	Quercus fusiformis	Evergreen Tree
lotebush	ZIOB	Ziziphus obtusifolia	Evergreen Shrub
lovegrass	ERAGR	Eragrostis	Spring Midgrass
low woollygrass	DAPU7	Dasyochloa pulchella	Spring Shortgrass
Maximilian sunflower	HEMA2	Helianthus maximiliani	Summer Annual Forb
mesa dropseed	SPFL2	Sporobolus flexuosus	Summer Midgrass
mesquite	PROSO	Prosopis	Deciduous Tree
Mesquite	PRJU3	Prosopis juliflora	Deciduous Tree
millet	ECHIN4	Echinochloa	Summer Midgrass(I)
milo (grain sorghum)	SOBIB	Sorghum bicolor	Summer Annual Forb
Mohr oak	QUMO	Quercus mohriana	Evergreen Tree
mustard	BRASS2	Brassica	Spring Annual Forb(I)
needle and thread	HECO26	Hesperostipa comata	Spring Midgrass
New Mexico feathergrass	HENE5	Hesperostipa neomexicana	Spring Midgrass
partridge pea	CHFA2	Chamaecrista fasciculata	Summer Annual Forb

Common Name	Symbol	Scientific Name	Functional Group
Pennsylvania smartweed	POPE2	Polygonum pensylvanicum	Spring Annual Forb
Pinchot's juniper	JUPI	Juniperus pinchotii	Evergreen Tree
plains bristlegrass	SEVU2	Setaria vulpiseta	Summer Midgrass
plains pricklypear	OPPO	Opuntia polyacantha	Caci
prairie broomweed	AMDR	Amphiachyris dracunculoides	Summer Annual Forb
prairie sagewort	ARFR4	Artemisia frigida	Evergreen Subshrub
prairie threeawn	AROL	Aristida oligantha	Summer Midgrass
prickly lettuce	LASE	Lactuca serriola	Spring Annual Forb(I)
pricklypear	OPUNT	Opuntia	Cacti
Prunus	PRUNU	Prunus	Deciduous Shrub
purple prairieclover	DAPU5	Dalea purpurea	Summer Perennial Subshrub
purple sandgrass	TRPU4	Triplasis purpurea	Summer Annual Grass
purple threeawn	ARPU9	Aristida purpurea	Summer Midgrass
ragweed	AMBRO	Ambrosia	Summer Annual Forb
red lovegrass	ERSE	Eragrostis secundiflora	Summer Shortgrass
redberry juniper	JUCO11	Juniperus coahuilensis	Evergreen Tree
redroot amaranth	AMRE	Amaranthus retroflexus	Summer Annual Forb
ring muhly	MUTO2	Muhlenbergia torreyi	Spring Rhizomatous Grass
Rocky Mountain zinnia	ZIGR	Zinnia grandiflora	Evergreen Subshrub
rough tridens	TRIDE	Tridens	Spring Midgrass
Russian thistle	SAKA	Salsola kali	Spring Annual Forb(I)
sagebrush	ARTEM	Artemisia	Evergreen Shrub
saltcedar	TARA	Tamarix ramosissima	Evergreen Tree
saltgrass	DISP	Distichlis spicata	Summer Rhizomatous Grass
sand bluestem	ANHA	Andropogon hallii	Summer Tallgrass
sand dropseed	SPCR	Sporobolus cryptandrus	Summer Midgrass
sand lovegrass	ERTR3	Eragrostis trichodes	Summer Midgrass
sand muhly	MUAR2	Muhlenbergia arenicola	Summer Midgrass
sand sagebrush	ARFI2	Artemisia filifolia	Evergreen Shrub
sandbur	CENCH	Cenchrus	Summer Annual Forb
scarlet globemallow	SPCO	Sphaeralcea coccinea	Spring Perennial Forb
scratchgrass	MUAS	Muhlenbergia asperifolia	Summer Rhizomatous Grass
sedge	CAREX	Carex	Spring Perennial Grasslike
shinnery oak	QUHA3	Quercus havardii	Deciduous Shrub
sideoats grama	BOCU	Bouteloua curtipendula	Summer Midgrass
silver beardgrass	BOLA2	Bothriochloa laguroides	Summer Midgrass
silver bluestem	BOSA	Bothriochloa saccharoides	Summer Midgrass

Common Name	Symbol	Scientific Name	Functional Group
silverleaf nightshade	SOEL	Solanum elaeagnifolium	Spring Perennial Forb
sixweeks fescue	VUOC	Vulpia octoflora	Spring Annual Grass
soaptree yucca	YUGL	Yucca glauca	Monocot Shrub
Spanish gold	GRPA8	Grindelia papposa	Summer Annual Forb
spikerush	ELEOC	Eleocharis	Spring Perennial Grasslike
sunflower	HELIA3	Helianthus	Summer Annual Forb
switchgrass	PAVI2	Panicum virgatum	Summer Tallgrass
Texas blueweed	HECI	Helianthus ciliaris	Summer Perennial Forb
Texas sleepydaisy	XATE	Xanthisma texanum	Spring Annual Forb
thin paspalum	PASE5	Paspalum setaceum	Summer Shortgrass
threeawn	ARIST	Aristida	Summer Midgrass
tumble lovegrass	ERSE2	Eragrostis sessilispica	Summer Shortgrass
tumble windmill grass	CHVE2	Chloris verticillata	Summer Annual Grass
upright prairie coneflower	RACO3	Ratibida columnifera	Summer Perennial Forb
vine mesquite	PAOB	Panicum obtusum	Summer Rhizomatous Grass
weeping lovegrass	ERCU2	Eragrostis curvula	Spring Midgrass(I)
western wheatgrass	PASM	Pascopyrum smithii	Spring Rhizomatous Grass
windmill grass	CHLOR	Chloris	Summer Annual Grass
woolly plantain	PLPA2	Plantago patagonica	Spring Annual Forb
woollyleaf bur ragweed	AMGR5	Ambrosia grayi	Summer Perennial Forb
Wright's plantain	PLWR	Plantago wrightiana	Summer Annual Forb
Wright’s threeawn	ARPUW	Aristida purpurea var. wrightii	Summer Shortgrass
yucca	YUCCA	Yucca	Monocot Shrub

Appendix C: MLRA 77C Community Classes and Number of Correlated NRI Sites

MLRA_Community Class	Number of PSUs	Community Class with Lbs/Ac	Dominant Species by Weight
077C4.1	10	Summer Rhizomatous Grass (1088), Summer Midgrass (379), Spring Rhizomatous Grass (243), Summer Perennial Forb (213), Spring Annual Forb (130), Summer Midgrass(I) (85), Summer Annual Forb (79)	Buffalograss (BUDA), alkali sacaton (SPAI), woollyleaf bur ragweed (AMGR5), blue grama (BOGR2), western wheatgrass (PASM), Pennsylvania smartweed (POPE2), Millet spp. (ECHIN4), bushy knotweed (PORA3), silver bluestem (BOSA), broomweed (AMPHI8)
077C4.2	2	Spring Rhizomatous Grass (3546), Summer Rhizomatous Grass (789), Spring Perennial Grasslike (24), Summer Annual Forb (6), Spring Perennial Forb (5)	western wheatgrass (PASM), Buffalograss (BUDA), spikerush (ELEOC), turkey tangle fogfruit (PHNO2), rose moss (POGR7), bushy knotweed (PORA3)
077C6.1	9	Summer Rhizomatous Grass (489), Summer Midgrass (276), Summer Stoloniferous Grass (82), Spring Perennial Forb (49), Summer Shortgrass (48), Summer Annual Grass (46), Summer Perennial Forb (44)	silver bluestem (BOSA), hairy grama (BOHI2), black grama (BOER4), blue grama (BOGR2), Buffalograss (BUDA), hooded windmill grass (CHCU2), Sporobolus spp. (SPORO), other native perennial forbs (2FP1), prairie broomweed (AMDR), sand sagebrush (ARFI2)
077C6.2	32	Summer Rhizomatous Grass (2174), Summer Perennial Forb (156), Evergreen Subshrub (97), Summer Annual Forb (93), Spring Annual Forb (63), Cacti (44), Spring Perennial Forb (43)	blue grama (BOGR2), Buffalograss (BUDA), vine mesquite (PAOB), other perrennial grasses (2GP1), Spanish gold (GRPA8), Cuman ragweed (AMPS), grama spp. (BUCHL), Canadian horseweed (COCA5), prairie sagewort (ARFR4), kochia (KOSC), broom snakeweed (GUSA2)
077C6.3	13	Deciduous Tree (457), Summer Midgrass (79), Spring Perennial Forb (53), Evergreen Subshrub (53), Summer Rhizomatous Grass (46), Cacti (42), Summer Perennial Forb(I) (41), Summer Shortgrass (41)	honey mesquite (PRGL2), Canada thistle (CIAR4), Mesquite (PRJU3), Prosopis spp. (PROSO), Sporobolus spp. (SPORO), hairy grama (BOHI2), silverleaf nightshade (SOEL), broom snakeweed (GUSA2), tridens (TRIDE), (GUTIE), cheatgrass (BRTE), cane cholla (OPIM)
077C6.4	3	Summer Perennial Forb (352), Spring Annual Forb (239), Spring Perennial Forb (196), Summer Annual Grass (144), Summer Midgrass (138), Summer Rhizomatous Grass (77), Summer Annual Forb (72)	lambsquarters (CHAL7), Texas blueweed (HECI), hooded windmill grass (CHCU2), globemallow (SPHAE), sideoats grama (BOCU), cheatgrass (BRTE), blue grama (BOGR2), ragweed (AMBRO), sand dropseed (SPCR), western wheatgrass (PASM), bristlegrass (SETAR)
077C7.1	4	Summer Midgrass (699), Summer Tallgrass (313), Summer Annual Forb (254), Summer Perennial Forb (157), Summer Rhizomatous Grass (38), Spring Annual Forb (19), Summer Shortgrass (19)	big bluestem (ANGE), little bluestem (SCSC), Threeawn (ARIST), ear muhly (MUAR), camphorweed (PLCA7), Hooker's evening primrose (OEEL), hoary false goldenaster (HECA8), fall witchgrass (DICO6), Cuman ragweed (AMPS), blue grama (BOGR2), greenthread (THELE)
077C7.2	13	Summer Midgrass (224), Summer Shortgrass (118), Evergreen Shrub (78), Deciduous Shrub (65), Summer Perennial Forb (40), Evergreen Subshrub (37), Spring Shortgrass (32)	Russian thistle (SAKA), black grama (BOER4), other perrennial grasses (2GP1), sand sagebrush (ARFI2), Prosopis spp. (PROSO), shinnery oak (QUHA3), little bluestem (SCSC), cane bluestem (BOBA3), witchgrass (PACA6), hairy grama (BOHI2)
077C7.3	6	Summer Midgrass (236), Deciduous Shrub (172), Evergreen Shrub (143), Spring Annual Forb (61), Summer Shortgrass (58), Summer Annual Grass (49), Summer Perennial Forb (47)	sand sagebrush (ARFI2), little bluestem (SCSC), shinnery oak (QUHA3), purple threeawn (ARPU9), hooded windmill grass (CHCU2), broom snakeweed (GUSA2), smooth sunflower (HELA2), Texas sleepydaisy (XATE), blue grama (BOGR2), Sporobolus spp. (SPORO)
077C8.1	7	Summer Rhizomatous Grass (679), Summer Midgrass (562), Evergreen Subshrub (73), Deciduous Tree (42), Spring Perennial Forb (36), Evergreen Tree (21), Summer Annual Forb (21)	alkali sacaton (SPAI), blue grama (BOGR2), sand dropseed (SPCR), sideoats grama (BOCU), broom snakeweed (GUSA2), vine mesquite (PAOB), honey mesquite (PRGL2), prairie broomweed (AMDR), silverleaf nightshade (SOEL), oak (QUERC), tridens

MLRA_Community Class	Number of PSUs	Community Class with Lbs/Ac	Dominant Species by Weight
			(TRIDE)
077C8.2	4	Summer Rhizomatous Grass (530), Summer Annual Forb (159), Evergreen Subshrub (111), Spring Perennial Forb (87), Summer Annual Grass (46), Summer Midgrass (28), Deciduous Shrub (24)	ragweed (AMBRO), blue grama (BOGR2), Rocky Mountain zinnia (ZIGR), windmill grass (CHLOR), scarlet globemallow (SPCO), tobosagrass (PLMU3), queen's-delight (STSY), nightshade (SOLAN), thistle (CIRSI), bundleflower (DESMA)
077C8.3	5	Summer Midgrass (184), Deciduous Tree (157), Monocot Shrub (154), Evergreen Subshrub (108), Coniferous Tree (106), Spring Perennial Forb (81), Summer Rhizomatous Grass (72)	Pinchot's juniper (JUPI), spiny chloracantha (CHSP11), Yucca spp. (YUCCA), sideoats grama (BOCU), honey mesquite (PRGL2), broom snakeweed (GUSA2), blue grama (BOGR2), sand dropseed (SPCR), silver bluestem (BOSA), Opuntia spp. (OPUNT), Buffalograss (BUDA)
077C9.1	6	Summer Rhizomatous Grass (211), Summer Midgrass (204), Summer Annual Forb (59), Summer Perennial Forb (38), Spring Perennial Forb (36), Spring Annual Forb (17), Deciduous Shrub (15), Summer Tallgrass (15)	alkali sacaton (SPAI), Buffalograss (BUDA), blue grama (BOGR2), ear muhly (MUAR), camphorweed (PLCA7), other native perennial forbs (2FP1), Cuman ragweed (AMPS), James' galleta (PLJA), Texas bristlegrass (SETE6), big bluestem (ANGE)
077C10.1	2	Summer Rhizomatous Grass (384), Spring Midgrass (323), Summer Stoloniferous Grass (187), Summer Midgrass (117), Spring Annual Forb (57), Summer Annual Grass (30), Spring Perennial Forb (20), Summer Shortgrass (20)	lovegrass (ERAGR), blue grama (BOGR2), black grama (BOER4), other native annual forbs (2FA1), sand dropseed (SPCR), sideoats grama (BOCU), tumble windmill grass (CHVE2), hairy grama (BOHI2), croton (CROTO), Prosopis spp. (PROSO)
077C10.2	6	Summer Rhizomatous Grass (596), Summer Midgrass (115), Deciduous Tree (70), Evergreen Subshrub (50), Spring Perennial Forb (38), Spring Annual Forb (34), Summer Perennial Grasslike (25)	blue grama (BOGR2), Mesquite (PRJU3), woolly plantain (PLPA2), thalassia (THALA), Pleuraphis spp. (PLEUR12), purple threeawn (ARPU9), sand dropseed (SPCR), honey mesquite (PRGL2), sand flax (LIAR5), black grama (BOER4), broom snakeweed (GUSA2)
077C10.3	1	Deciduous Tree (599), Summer Rhizomatous Grass (328), Summer Midgrass (238), Summer Stoloniferous Grass (189), Summer Perennial Forb (34), Evergreen Subshrub (30), Spring Annual Forb(I) (16)	Mesquite (PRJU3), tobosagrass (PLMU3), Threeawn (ARIST), black grama (BOER4), blue grama (BOGR2), broom snakeweed (GUSA2), shaggy dwarf morning-glory (EVNU), kochia (KOSC), white sagebrush (ARLUM2), sand dropseed (SPCR)

Appendix D: MLRA 77C Community Classes and Average NRI and RHEM Values

Site Class Name	MLRA Comm	Comm Class	Avg Lbs/Ac	Avg Pct Runoff	Avg Ann SoilLoss ton/ac	Avg PctCov Bunch grass	Avg PctCov Sod grass	Avg PctCov Shrubs	Avg PctCov Bare	Avg PctCov Rock	Avg PctCov Litter
Playa Class	077C4.1	Summer Rhizomatous Grass, Summer Midgrass, Spring Rhizomatous Grass, Summer Perennial Forb, Spring Annual Forb, Summer Midgrass(I), Summer Annual Forb	2260	32%	0.2	16	49	1	28	0	40
Playa Class	077C4.2	Spring Rhizomatous Grass, Summer Rhizomatous Grass, Spring Perennial Grasslike, Summer Annual Forb, Spring Perennial Forb	4370	27%	0.1	0	74	0	2	0	71
Loamy Upland Class	077C6.1	Summer Rhizomatous Grass, Summer Midgrass, Summer Stoloniferous Grass, Spring Perennial Forb, Summer Shortgrass, Summer Annual Grass, Summer Perennial Forb	1143	7%	0.1	19	44	8	9	0	76
Loamy Upland Class	077C6.2	Summer Rhizomatous Grass, Summer Perennial Forb, Evergreen Subshrub, Summer Annual Forb, Spring Annual Forb, Cacti, Spring Perennial Forb	2846	9%	0.1	5	63	5	10	0	69
Loamy Upland Class	077C6.3	Deciduous Tree, Summer Midgrass, Spring Perennial Forb, Evergreen Subshrub, Summer Rhizomatous Grass, Cacti, Summer Perennial Forb(I), Summer Shortgrass	840	8%	0.2	11	13	20	20	0	72

Site Class Name	MLRA Comm	Comm Class	Avg Lbs/Ac	Avg Pct Runoff	Avg Ann SoilLoss ton/ac	Avg PctCov Bunch grass	Avg PctCov Sod grass	Avg PctCov Shrubs	Avg PctCov Bare	Avg PctCov Rock	Avg PctCov Litter
Loamy Upland Class	077C6.4	Summer Perennial Forb, Spring Annual Forb, Spring Perennial Forb, Summer Annual Grass, Summer Midgrass, Summer Rhizomatous Grass, Summer Annual Forb	1319	6%	0.1	23	18	3	13	0	71
Sandy Upland Class	077C7.1	Summer Midgrass, Summer Tall Grass, Summer Annual Forb, Summer Perennial Forb, Summer Rhizomatous Grass, Spring Annual Forb, Summer Shortgrass	1535	6%	0.2	45	1	5	28	0	52
Sandy Upland Class	077C7.2	Summer Midgrass, Summer Shortgrass, Evergreen Shrub, Deciduous Shrub, Summer Perennial Forb, Evergreen Subshrub, Spring Shortgrass	1617	5%	0.1	37	10	20	17	0	65
Sandy Upland Class	077C7.3	Summer Midgrass, Deciduous Shrub, Evergreen Shrub, Spring Annual Forb, Summer Shortgrass, Summer Annual Grass, Summer Perennial Forb	1238	5%	0.1	25	0	37	28	0	63
Limy Upland Class	077C8.1	Summer Rhizomatous Grass, Summer Midgrass, Evergreen Subshrub, Deciduous Tree, Spring Perennial Forb, Evergreen Tree, Summer Annual Forb	1485	10%	0.2	19	48	10	13	0	66

Site Class Name	MLRA Comm	Comm Class	Avg Lbs/Ac	Avg Pct Runoff	Avg Ann SoilLoss ton/ac	Avg PctCov Bunch grass	Avg PctCov Sod grass	Avg PctCov Shrubs	Avg PctCov Bare	Avg PctCov Rock	Avg PctCov Litter
Limy Upland Class	077C8.2	Summer Rhizomatous Grass, Summer Annual Forb, Evergreen Subshrub, Spring Perennial Forb, Summer Annual Grass, Summer Midgrass, Deciduous Shrub	1040	10%	0.2	6	63	6	14	0	52
Limy Upland Class	077C8.3	Summer Midgrass, Deciduous Tree, Monocot Shrub, Evergreen Subshrub, Coniferous Tree, Spring Perennial Forb, Summer Rhizomatous Grass	994	11%	0.1	32	10	12	25	0	60
Limy Upland, Gravelly Class	077C9.1	Summer Rhizomatous Grass, Summer Midgrass, Summer Annual Forb, Summer Perennial Forb, Spring Perennial Forb, Spring Annual Forb, Deciduous Shrub, Summer Tall Grass	642	12%	0.3	10	28	21	12	0	61
Limy Upland, Very Shallow Class	077C10.1	Summer Rhizomatous Grass, Spring Midgrass, Summer Stoloniferous Grass, Summer Midgrass, Spring Annual Forb, Summer Annual Grass, Spring Perennial Forb, Summer Shortgrass	1139	10%	0.2	24	42	1	45	0	20
Limy Upland, Very Shallow Class	077C10.2	Summer Rhizomatous Grass, Summer Midgrass, Deciduous Tree, Evergreen Subshrub, Spring Perennial Forb, Spring Annual Forb, Summer Perennial Grasslike	963	7%	0.1	5	51	7	22	1	53

Site Class Name	MLRA Comm	Comm Class	Avg Lbs/Ac	Avg Pct Runoff	Avg Ann SoilLoss ton/ac	Avg PctCov Bunch grass	Avg PctCov Sod grass	Avg PctCov Shrubs	Avg PctCov Bare	Avg PctCov Rock	Avg PctCov Litter
Limy Upland, Very Shallow Class	077C10.3	Deciduous Tree, Summer Rhizomatous Grass, Summer Midgrass, Summer Stoloniferous Grass, Summer Perennial Forb, Evergreen Subshrub, Spring Annual Forb(I)	1434	7%	0.2	8	43	16	22	0	51

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