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TRANS-PECOS WILDLIFE CONFERENCE-2012
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Ranching During the Extremes

SHORT-TERM VEGETATION RESPONSE TO THE ROCKHOUSE FIRE, PRESIDIO COUNTY, TEXAS

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INTRODUCTION

Fire has historically played an important role in maintaining the health and integrity of semi-arid grasslands of the Chihuahuan Desert. Fire suppression policies in recent times have impacted rates and sizes of wildfires, increasing them due to increased fuel loads within unburned areas (Schoennagel et al. 2004). Changes in land use and grazing patterns have also supplemented this fire environment by increasing availability and connectivity of fine fuels.

Multiple years of average or above precipitation from 2007-2010 led to an abundant fuel load in both the standing grass and litter layer throughout the Trans-Pecos. After the 2010 wet season, ending late September 2010, no recordable precipitation occurred until spring 2011 (NCDC 2011). By February 2011, the Trans-Pecos was in severe drought. The drying trend continued with extreme drought conditions for the remainder of 2011. The first 6 months of 2011 has been listed as the driest 6 months in Texas recorded weather history (NCDC 2011). This period of drought and high velocity spring winds thoroughly dried out the high fuel loads and created a dangerously high fire potential.

The national 2011 fire season began early in February with the highest recorded number of fires and the second most acreage per fire for February on record. The Permian Basin and Panhandle regions of Texas were highly impacted in the February 27 fire outbreak. There were no large fires in the Trans-Pecos during February (NCDC 2011).

March continued the high level of national fire activity. Although the number of fires was below average, the total average acreage per fire was higher, with several large fires burning in Texas (NCDC 2011). The first large fire in the Trans-Pecos, the 101 fire, occurred March 2 and burned 3,358 ha. The Pinon fire was the second large fire in the Trans-Pecos burning 1,851 ha on March 8. A second large Texas outbreak of fires at the end of March involved 3 large fires in the Trans-Pecos, including the Ralph Keller fire, 862 ha, the Dipper Ranch fire, 1,012 ha, and the Cooksey fire, 432 ha (Texas Forest Service, 2011; Inciweb 2011).

April was characterized by very large fires with the average size per fire significantly higher than any April on record. With only 6,164 fires starting across the nation, the number of acres burned increased by 1.8 million (NCDC 2011). The Trans-Pecos saw multiple very large fires during the April 9-13 outbreak including the Sanderson fire, 1,455 ha, the Rockhouse fire, 127,251 ha, the Roper fire, 16,592 ha, and the Cannon group fires, 25,668 ha (Texas Forest Service 2011, Inciweb 2011).

May and June continued the national pattern of large fires, with extreme drought through much of Texas and the Southwest. West Texas reported the driest May on record. New Mexico and Arizona both experienced some of the largest fires on state record during this period (NCDC 2011). Three large fires began in the Trans-Pecos May 7-9, the Schwartz fire, 33,991 ha, the Gage Holland fire, 2,418 ha, and the Iron Mountain fire, 35,370 ha. Fire season in the Trans-Pecos began to decrease in activity with only one large fire, the Longfellow fire, with 1,416 ha, being reported in June (Texas Forest Service 2011, Inciweb 2011).

July and August brought a reprieve in the 2011 national fire season, despite drought and fire danger remaining high. There were no large fires in the Trans-Pecos during this time. September brought an increase in fire activity, particularly in central Texas, but the Trans-Pecos fire season came to a close with only one large fire, the Shackleford fire, burning 1,416 ha, on September 22 (NCDC 2011, Texas Forest Service 2011).

The 2011 fire season ended with 74,126 wildfires burning 3,525,365 ha across the United States, with 1,655 large fires with 41 fires over 16,187 ha (NIFC 2011). The Texas Forest Service reported 30,547 fires in 2011 for Texas, burning 1,616,199 ha (Texas Forest Service 2011). The Texas fires accounted for approximately half of the total fire number and acreage burned throughout the nation. Eighteen fires over 16,187 ha were reported in Texas, of these 5 occurred in the Trans-Pecos, burning 238,873 ha. There were 14 large fires reported in the Trans-Pecos burning 249,533 ha (NIFC 2011, Texas Forest Service, 2011).

STUDY AREA

The Mimms Ranch, just north of the town of Marfa, in Presidio County, within the Trans-Pecos region of Texas, had vegetation monitoring pre and post wildfire. The Mimms ranch lies within the Marfa grassland plateau and is comprised of 3 different ecological sites: Loamy Mixed Prairie; Shallow Mixed Prairie; and Igneous Hills and Mountain Mixed Prairie (USDA 2010).

The Shallow and Loamy Mixed Prairie ecological sites consists of shallow to moderately deep, generally loamy soils in elevations ranging from 1,371 m to 1,828 m. These sites are dominated by blue grama (*Bouteloua gracilis.*) and purple three-awn (*Arisitida purpurea.*) grass species with low shrub densities. The Igneous Hills & Mountain Mixed Prairie ecological site occurs on rocky hills with slopes of 20-40% with very shallow loamy soils. Vegetation on this site is sparse dominated by black grama grass (*Bouteloua eriopoda*) and shrub species of beargrass (*Nolina erumpens*) and yucca (*Yucca spp.*).

The climate for the area is semi-arid with an average annual precipitation of 40.1 cm, over half of which falls from July to September. Average maximum temperatures are 33 °C in June and 15 °C in January (National Weather Service 2006).

The Mimms ranch encompasses 4,390.6 ha northwest of Marfa and is bounded by Highway 17 to the east and Highway 90 to the south. The ranch is privately owned by the Dixon Water Foundation, which purchased it in 2008.

On April 9, 2011 the Rockhouse Fire, the largest grass fire in Texas history, began just west of the town of Marfa and continued burning for 34 days, consuming more than 127,251 ha. Regional weather that day included a high temperature of 30° C, 10 % relative humidity, and wind speeds gusting up to 23 m/s. The Rockhouse Fire burned a vast portion of the Mimms ranch, including many previously established vegetation transects.

Vegetation sampling was conducted on the Mimms Ranch from November 2009 through June 2012. Perennial grass and forb basal cover were analyzed both pre and post-fire.

METHODS

Vegetation sampling remained constant for the entire project. Thirty-seven total transects were established prior to this project. Nineteen of these transects were inside of 0.4 ha exclosures fenced with 5-strand barbed wire. Eighteen were open and subject to grazing. All transects were 50 m in length.

Each transect was evaluated for basal cover of all plant species, bare ground, rock, and biotic crust. These were measured using the Daubenmire quadrat method (Daubenmire 1959). Basal cover was assessed within the quadrat every 5 m on alternate sides of the transect, beginning at 0 m and ending at 50 m. Basal cover was recorded to the nearest 5% with each reading totaling 100%.

Pre-fire vegetation measurements were conducted in the winter of 2009 (Nov-Dec), spring 2010 (Mar-Apr), fall of 2010 (Sep-Oct) and winter 2010 (Feb-Mar). Post-fire measurements occurred in the fall of 2011 (Oct), winter 2012 (Jan-Feb), and late spring 2012 (May-June).

A burn assessment was conducted immediately following the fire. Each transect was measured along the line and areas were given either a burned or unburned status. Precipitation was monitored throughout the duration of the project. Rainfall amounts were assessed using National Weather Service data based on the readings for the town of Marfa, Texas.

Simple descriptive analysis was used to evaluate vegetative characteristics pre and post-fire. Mean basal cover and density were calculated and compared among the 3 ecological sites and for pre and post-fire measurements. The Loamy Mixed Prairie and Shallow Mixed Prairie each had at least 1 transect that was not burned and was used as a control during post-fire analysis.

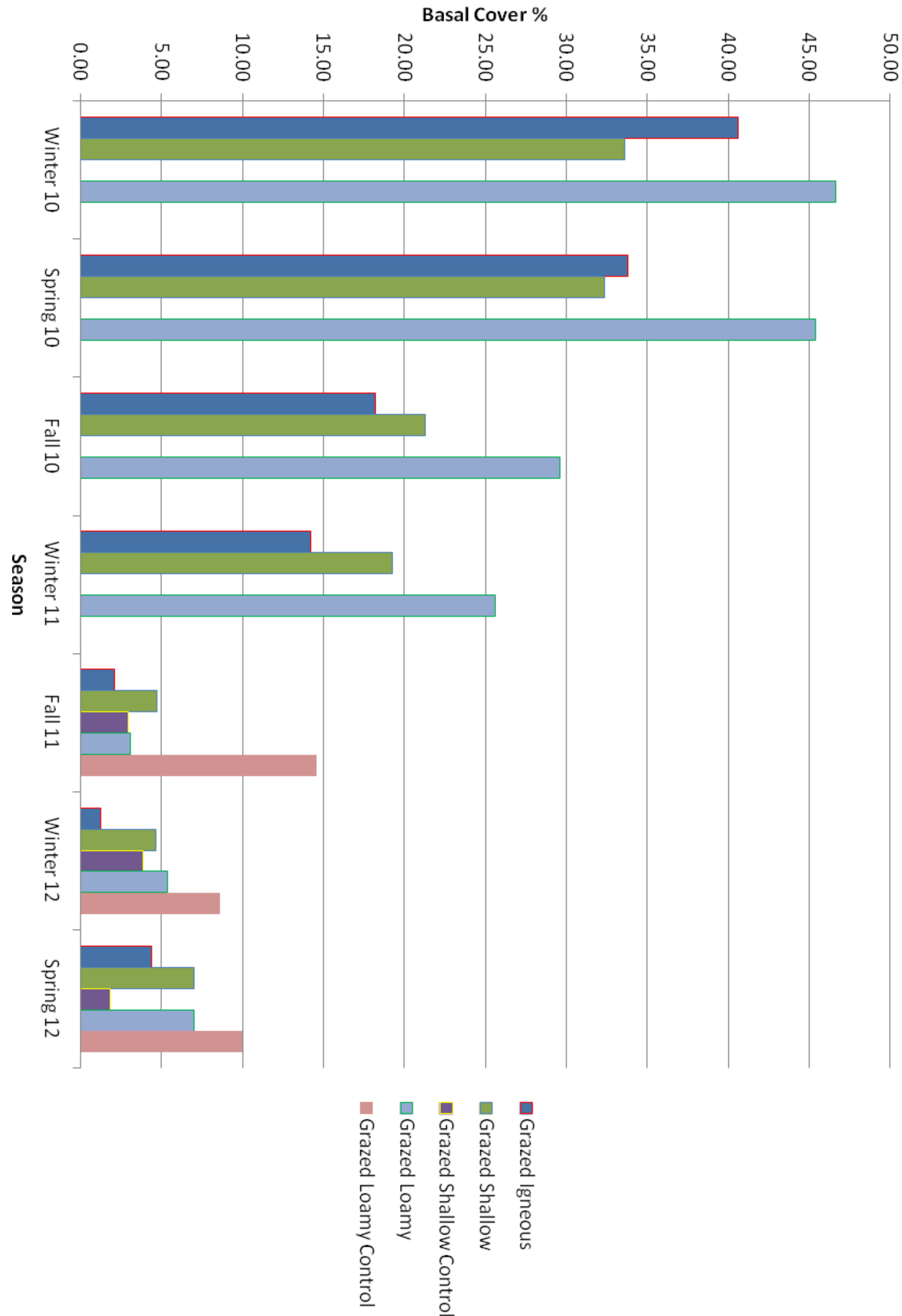

Figure 1. Perennial grass basal cover on transects that were grazed prior to the Rockhouse Fire, which occurred between the winter 2011 and Fall 2011 sampling seasons.

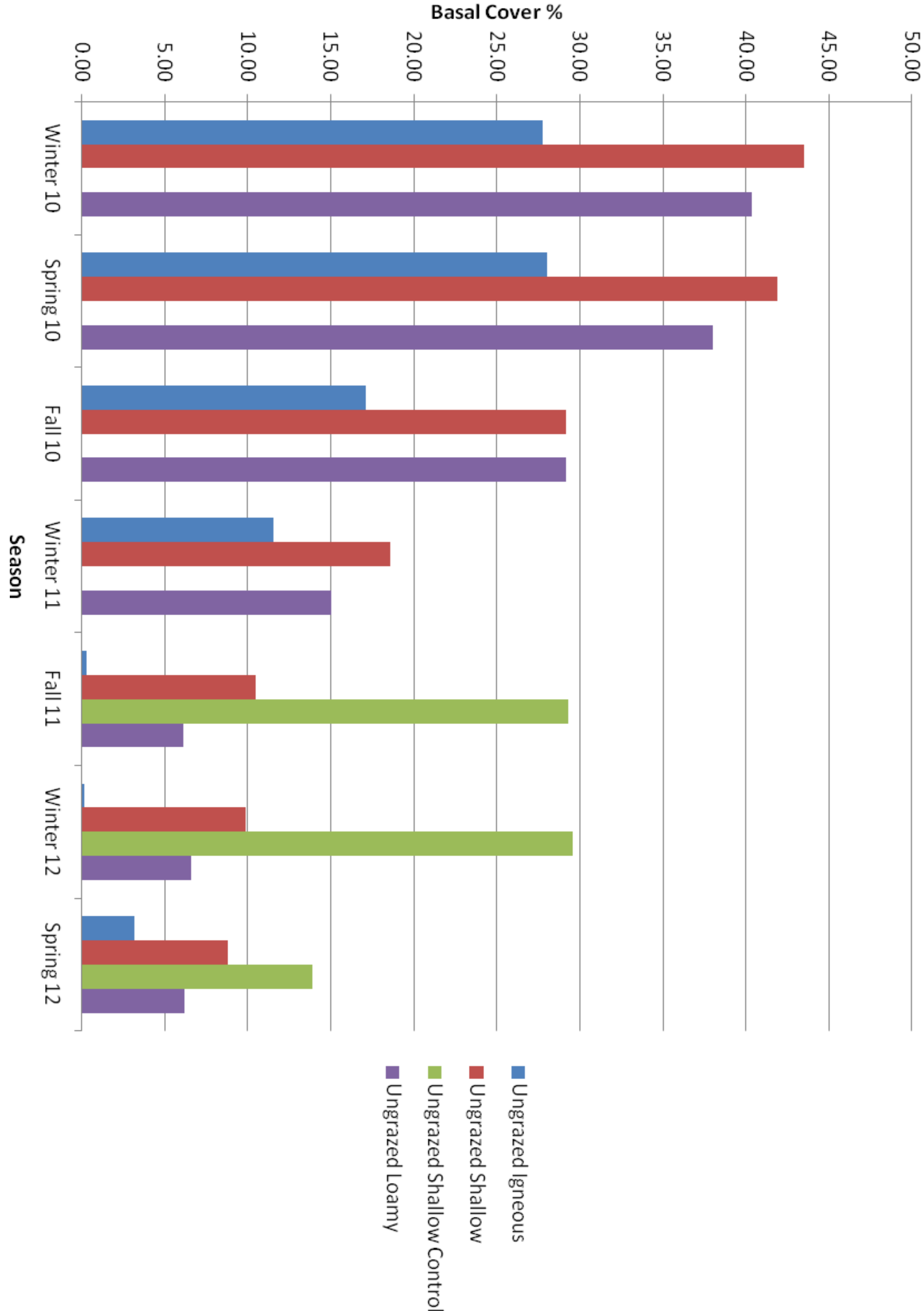

Figure 2. Perennial grass basal cover on transects that were ungrazed prior to the Rockhouse Fire, which occurred between the winter 2011 and Fall 2011 sampling seasons.

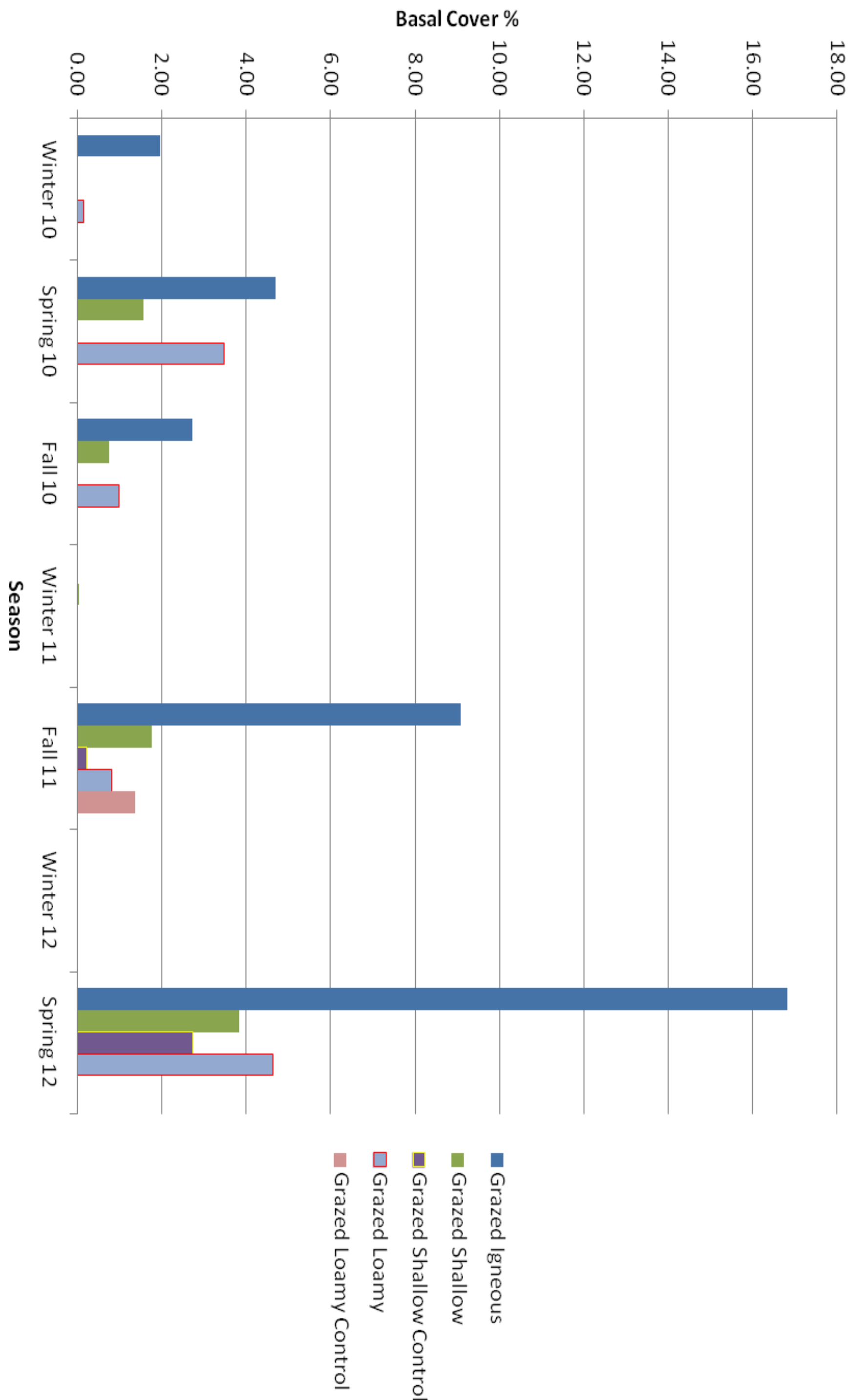

Figure 3. Forb basal cover on transects that were grazed prior to the Rockhouse Fire, which occurred between the winter 2011 and Fall 2011 sampling seasons.

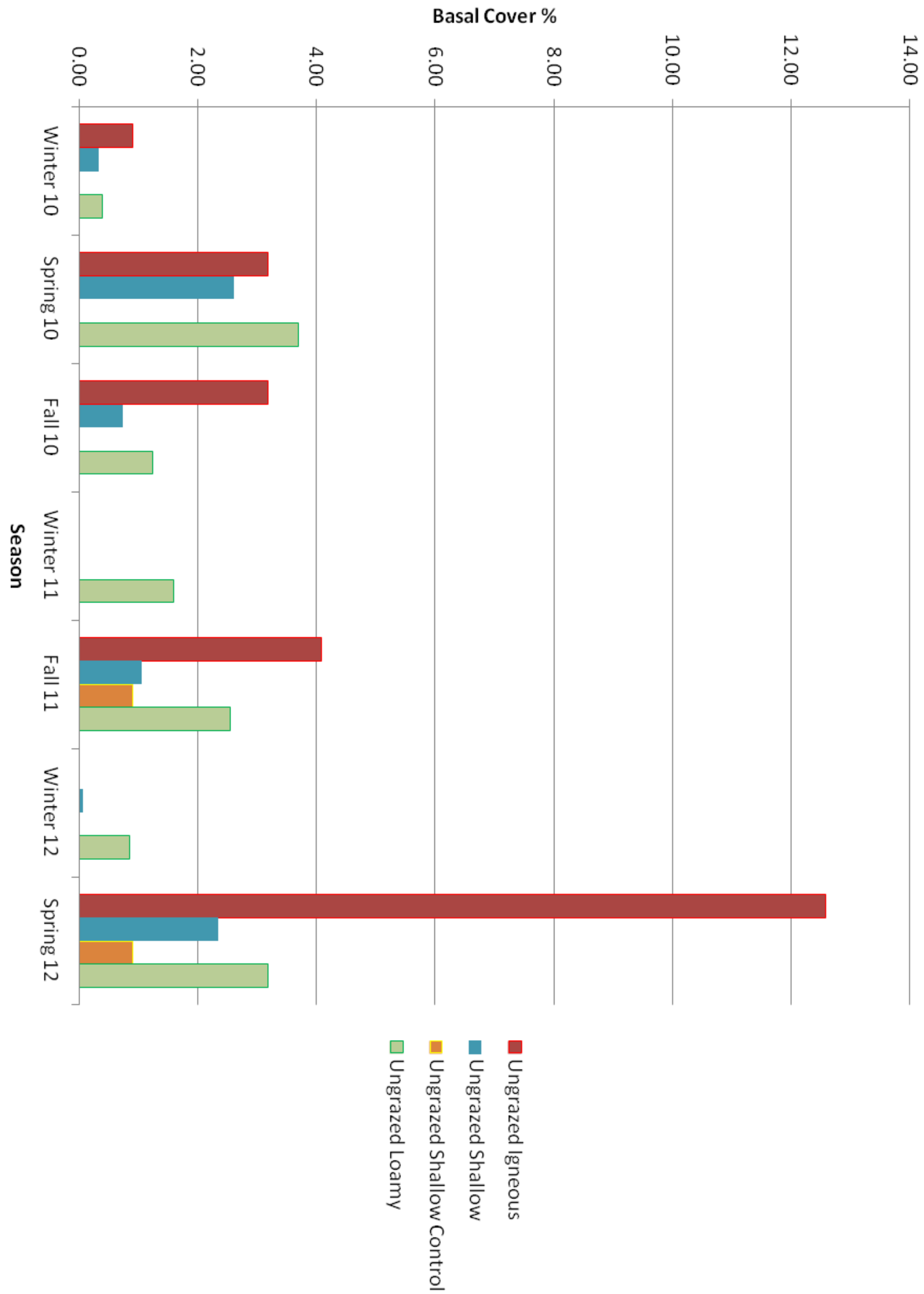

Figure 4. Forb basal cover on transects that were ungrazed prior to the Rockhouse Fire, which occurred between the winter 2011 and Fall 2011 sampling seasons.

RESULTS

Results for mean basal cover and density of perennial grass and forb species were analyzed by ecological site and for pre and post-burn characteristics (Figures 1-4). Pre-fire cover levels and densities of perennial grasses were relatively the same among the Shallow Mixed Prairie (Shallow) and Loamy Mixed Prairie (Loamy) ecological sites, whereas the levels were much lower in the Igneous Hill & Mountain Mixed Prairie (Igneous) site. This relationship still holds in post-fire measurements. Six months post-fire (Fall 11) densities were ≤20 % of pre-fire levels on all sites. Sites saw no significant increase in perennial grass cover 10 months post-fire (Winter 12), but increased ≤5 % 14 months post-fire (Spring 12). Forbs yielded nearly opposite results. Initially forb levels during Spring and Fall seasons were highest in the Igneous site, with the Shallow and Loamy sites showing near equal cover. Forbs continued to follow this trend post-fire. The Shallow and Loamy sites reached near pre-fire levels of basal cover in the Fall 11 and Spring 12 seasons, while the Igneous site showed a dramatic increase in these seasons.

A burn assessment of the 36 vegetation transects indicated that the percentage of transects burned was 25 at 100%, 6 at between 80% and 100%, 1 at 31%, and 4 at 0%. Based on analysis of unburned sections of transects compared to post-fire gap-intercept measurements, 2.7% of vegetative matter was from previously unburned material, while 97.3% was from new growth.

Annual precipitation was above or average for 2007-2010. No measureable rainfall occurred from mid-September 2010 until late June 2011. Precipitation for 2011 was well below average. Winter and spring precipitation for 2012 was slightly above average.

DISCUSSION

Rangelands in the Texas experienced record drought and fire during 2011. These two major disturbances led to a decrease in perennial grass cover and an increase in forb cover. Many perennial plants appear alive, although basal cover is reduced. Grass mortality has been recorded but, it is still unclear if the major cause of mortality was fire or drought. Areas that were ungrazed prior to and after the fire maintained the highest basal cover on shallow sites, but response was similar in both burned and unburned sites on other soils and with grazing. Even with adequate rainfall, grasslands will need to be carefully managed if recovery from the double impact of fire and drought is to occur for perennial grasses. Forb response has been very favorable to moderate amounts of precipitation and should continue this trend.

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Habitat Management

MECHANICAL BRUSH MANAGEMENT IN TRANS-PECOS, TEXAS

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OVERVIEW

Woody plants perform a variety of jobs in the ecosystem such as food, cover, nesting, and roosting for wild and domestic animals. They can also negatively impact accessibility, visibility, and forage production. Therefore, correct identification of trees and shrubs and knowledge about their value is an important first step in developing a brush management plan. Plants of Texas Rangelands, http://essmextension.tamu.edu/plants, is a helpful online resource.

Mechanical brush control is one technique used to reduce density and canopy cover of woody plants using a tractor or bulldozer along with a variety of implements and attachments. Mechanical brush control can be costly compared with other brush control methods such as herbicide application and prescribed burning but it also offers several advantages: (1) the results are immediate, (2) it can be used to manage brush adjacent to crops that are sensitive to range and pasture herbicides, and (3) it allows the selective removal of undesirable plants within a mixed stand of desirable trees.

TECHNIQUES AND EQUIPMENT

Once you've chosen the mechanical option, you must decide whether the broadcast or individual plant method is appropriate; this will largely depend on plant size and density and to a lesser extent your management goals. Complete removal of individual plants is practical in pastures with large, widely scattered trees. Currently the most common technique is to grub the entire plant from the soil with a U shaped blade attached to an excavator on tracks. Excavators have a rotating arm so multiple trees can be removed without having to reposition the equipment. This makes it less expensive to operate and reduces soil disturbance compared to a tractor or dozer. This method has largely replaced root plowing whereby a large V shaped blade is pulled below the soil surface. Root plowing requires a large tractor and creates a lot of soil disturbance. Root plowing is not recommended for the Trans-Pecos region due to shallow, rocky soils and low rainfall. Hydraulic shears are also used one plant at a time. They are used to cut the trunk either above or below ground level but this does not effectively control root sprouting species such as redberry juniper, mesquite, whitebrush, algerita, and catclaw acacia.

Non-selective, broadcast treatments include chaining, shredding, roller chopping, and aerating. Chaining results in some complete plant removal and all of these techniques remove the above ground portion of the plants, thereby encouraging regrowth of root sprouting species and release of forbs, both of which are preferred by many wildlife species.

Chaining is accomplished by dragging anchor chain between two tractors. Double chaining once in each direction leaves a lot of debris it so should be followed by raking and stacking or prescribed burning to remove the plant litter. Chaining is also useful to clear standing dead debris after the third growing season following herbicide application. Optimum conditions include moist soil and target plants greater than 18 inches tall; small stems just bend under the chain and are not broken or removed.

Like chaining, shredding is a broadcast treatment used to suppress woody plants by removing the top growth. Shredding is appropriate where stem diameters are less than 2.5 inches. Some species regrow slower than others but total regrowth can be expected by the end of 4th growing season.

Roller chopping uses a drum about 2.5 feet in diameter with blades that are welded on the long axis of the drum and can penetrate the soil 6 to 20 inches. Similar to the roller chopper, an aerator has smaller cutting blades welded to the drum in a staggered configuration so it creates multiple divots as it chops the stems. Depressions or divots created by roller chopping and aerating collect rainfall and prepare the surface for reseeding.

If there are cacti in the pasture, broadcast treatments may cause them to spread and increase. Therefore, hot and dry conditions are optimal when shredding, chopping, or aerating where cacti are present. This will encourage the plants to dry out and discourage rooting of broken pads and root fragments.

IMPLEMENTATION

Although a park-like landscape is attractive to people it is not particularly attractive to many kinds of wildlife. It often is not feasible to treat brush from fenceline to fenceline and this limitation necessitates a targeted brush control strategy sometimes called brush sculpting. Brush sculpting creates a mosaic of cleared areas interspersed in brushy wildlife habitat. The sculpting plan can be developed using digital aerial images of the ranch using a geographic information system (GIS). Patches of brush to be cleared can be drawn over the images and the geographic coordinates associated with those patches can be transferred to a mobile global positioning system (GPS) mounted on the tractor or dozer. The GIS system on the tractor allows the operator to see his location in relation to the areas that are to be cleared. The cleared areas should be irregularly shaped, creating maximum boundary or edge effect between cleared and uncleared pasture. Cleared areas should be no longer than 300 feet and no wider than 150 feet; avoid removing woody plants along waterways. While single trees can provide shade for livestock, they will not be heavily used by wildlife. Brush mottes or clumps should be at least the size of a compact car.

FOLLOW-UP MANAGEMENT

Brush management is a long term commitment that requires planning, monitoring, and maintenance. Eradication is not possible and follow-up management will be critical to the success of the plan. New plants in cleared areas should be controlled early, while they are less than 2 feet tall, with herbicide or prescribed fire for the most economical and effective control.

Top removal practices such as shredding and aerating will need to be retreated about every 5 years. Often as many as 40 to 100 small plants per acre will be overlooked by the operator carrying out individual tree removal. Grazing deferment or reseeding may be necessary to allow grasses to recover or establish.

SUMMARY

Mechanical brush control is expensive but the results are immediate and highly effective. Brush height and density will strongly influence which mechanical approach you select. Grubbing is best suited for pastures with few, large plants and may be used to create open areas or savannas and increase grass production. Conversely, broadcast treatments such as shredding may suppress brush growth while encouraging browse regrowth and forb production. A maintenance strategy that includes brush control and grazing management should be in place to ensure a successful land management plan and to protect your investment.

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RESOURCES

Custom fabrication
HOLT AgriBusiness - San Antonio
3302 South W.W.White Rd.
Bldg. 200, Suite A
San Antonio, Texas 78222
877-882-5992

Construction plans for front-mounted grubbers
Texas Agricultural Experiment Station
P.O. Box 1658
Vernon, TX 76385

Implements
Alamo Group
1502 East Walnut Street
Seguin, TX 78155
800-882-5762
www.alamo-group.com

Aerators
RanchWorx
877-401-4069
www.ranchworx.com

Used anchor chain
Anchor Marine, Houston
800-233-8014
www.anchormarinehouston.com

Grubbers and rakes
Browne Bros., Inc.
900 West I-20
Colorado City, TX 79512
800-545-4068
www.brownebrosinc.com

USE OF TEBUTHIURON IN THE TRANS-PECOS REGION

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Tebuthiuron has been applied in the Trans-Pecos Region of Texas since the early 1980's. Applications made on creosote and tarbush infested rangelands have yielded excellent kill rates in the past with very desirable responses in forage production. Tebuthiuron provides consistent and high levels of control, has low sensitivity to season of application, has high sensitivity to percent active ingredient distribution and pellet integrity, and has a treatment life in excess of 30 years. Species to treat, rates, timing, and how soil properties affect rates will be discussed.

WILDLIFE AND VEGETATION RESPONSE TO SPIKE 20P IN THE TRANS-PECOS REGION OF TEXAS

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Abstract: The Trans-Pecos region of Texas was historically considered a desert grassland until Europeans settled the area. Due to fire suppression, overgrazing, and drought, brush species like creosote (*Larrea tridentata*) and tarbush (*Flourensia cernua*) have encroached on these grasslands. Spike 20P, tebuthiuron, is increasing in use in the Trans-Pecos because of its effectiveness at killing a variety of brush species like creosote, tarbush, and whitebrush (*Aloysia lycioides*). Two study sites were selected to monitor the effects of Spike 20P on grasses, forbs, brush, and wildlife. Elephant Mountain Wildlife Management Area was used to monitor the effects of Spike 20P on vegetation using four different application rates in five different plant communities. The Boracho Peak Ranch was primarily used to monitor the effects of Spike 20P on wildlife. Spike 20P was found to be effective at controlling brush species like creosote and tarbush. Grass biomass increased after application of Spike 20P. Forbs may be negatively affected by the herbicide. Spike 20P did not appear to negatively affect mule deer habitat use. Road survey results for other species of wildlife varied. Our findings show that Spike 20P can be a useful tool in restoring desert grasslands.

The Trans-Pecos region of Texas was generally considered a large expanse of desert grasslands until Anglo settlement in the late 1800's. It is evident that desert grasslands throughout the southwestern United States, including the Trans-Pecos region, have changed since Anglo settlement (Richardson 2003). Woody species like creosote (*Larrea tridentata*), tarbush (*Flourensia cernua*), mariola (*Parthenium incanum*), whitethorn acacia (*Acacia constricta*), and honey mesquite (*Prosopis glandulosa*) have encroached on historical grasslands of the Trans-Pecos. Most investigators attribute the increase in shrubs to overgrazing of grasslands by livestock and fire suppression (Richardson 2003).

Spike 20P, a Dow AgroScience product, has increased in popularity and use in the Trans-Pecos. Spike 20P contains 20% of the active ingredient tebuthiuron {N-[5(1,1-dimethylethyl)-1, 3, 4-thiadiazol-2-yl]-N, N'-dimethylurea} (Meyer and Bovey 1979 and 1980, Jacoby et. al. 1982, Masters and Scifres 1984). Emmerich (1985) explains that the herbicide inhibits photosynthesis in the leaves and prevents plants from using the sun's energy. The leaves then become chlorotic, exhibit symptoms of aging, and are shed. Cycles of shedding and regrowth of new leaves continue until the carbohydrate energy reserves are exhausted and the plant dies. At a lower concentration of tebuthiuron, woody brush species are more sensitive than grasses or forbs

(Emmerich 1985). Brush species with shallow root systems, which can easily take up the surface-applied tebuthiuron, are more susceptible than deep-rooted species (Emmerich 1985). The use of Spike 20P is commonly recommended by the Natural Resource Conservation Service (NRCS) as a method to control invasive brush species like creosote, catclaw mimosa (*Mimosa biuncifera*), whitebrush (*Aloysia lycioides*), and tarbush. Little data is available regarding its effectiveness at controlling invasive brush species, effects on grass and forb production, and effects on wildlife in the Trans-Pecos.

Herbicides are typically considered a last resort prescription for brush control. Many wildlife professionals view herbicides negatively. Herbicides can be expensive when compared to other brush control methods and can have detrimental effects on desirable plant species. Observed forage-plant reestablishment in tebuthiuron treated plots can be relatively slow and consist of grasses and forbs of low grazing value (Jacoby et al. 1982). Application of some herbicides may decrease the abundance of perennial and annual forbs for two to three years after application. The decrease in forbs may have a negative impact on wildlife by decreasing the amount of available forage.

Tebuthiuron may indirectly enhance herbaceous plant production by increasing the availability of water, soil nutrients, and light (Olson and Whitson 2002). Jacoby et al. (1982) conducted a study with tebuthiuron in Pecos County, Texas on rangelands dominated by creosote. Grass production 32 months after treatment was 174 to 305% greater in tebuthiuron-treated plots than on untreated rangelands. Gibbens et al. (1987) found that perennial grass production was nearly 11-fold greater in tebuthiuron treated areas, but 43% of the production was due to fluffgrass. Tebuthiuron pellets significantly increased grass standing crops at one, two, and three years after treatment (Scifres and Mutz 1978). Jacoby et al. (1983) found that treated plots produced almost three times as much grass as untreated plots eight months after treatment and six times as much grass 20 months after treatment. Tebuthiuron may also increase the palatability and nutritional value of some grasses (Masters and Scifres 1984).

A common concern with tebuthiuron is its effects on forbs. Some research has shown decreased forb production post-treatment (Jacoby et al. 1982, Scifres and Mutz 1978, Tjelmeland et. al. 2008). Jacoby et al. (1982) found that forb production decreased by 38% or more in tebuthiuron treated plots. Scifres and Mutz (1978) found that forb production was almost eliminated for two years following application of tebuthiuron, but recovery of the population was evident after three years. Scifres and Mutz (1978) found that detrimental effects on forbs increased with increasing application rates. However, a few studies have shown positive effects of tebuthiuron on forbs. Gibbens et al. (1987) stated that the treatment of tebuthiuron did not affect forbs greatly. Jacoby et al. (1982) found that annual forb production was nearly seven-fold greater in the treated than in the untreated area.

Little data is available regarding tebuthiruon's effectiveness at controlling invasive brush species in the Trans-Pecos. Jacoby et al. (1982) achieved kill rates of 86% to 100% on creosote in Pecos County, Texas. Morton et. al. (1990) had similar results with creosote mortalities, achieving kill rates of 72% to 93%. Morton et. al. (1990) used a variety of application rates and found that tebuthiuron killed whitethorn acacia, honey mesquite, tarbush, javelina bush (*Condalia ericoides*), and mariola. After the fourth season following treatment, control of creosote, honey mesquite, and tarbush was 87, 48, and 100% respectively (Gibbens et. al. 1986). Meyer and Bovey (1980) found that tebuthiuron was one of the most effective herbicides on whitebrush.

Very little research has been conducted on tebuthiuron's effects on deer and other wildlife species. The effects of tebuthiuron on browse may sufficiently alter deer habitat quality (DeFazio et al. 1988). Tebuthiuron appeared to have little consistent effect on deer habitat, and what negative impacts occurred seemed to be balanced by positive impacts on forage availability (DeFazio et al. 1988). During incubation, daily survival of nests of grassland birds was greater in untreated plots; however, during the nestling period, daily survival of nests was greater in tebuthiuron-treated plots (Smythe and Haukos 2009).

Mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra americana*), and scaled quail (*Callipepla squamata*) are a few obligate species of desert grasslands. These species possess a large economic value for many landowners in Texas (Payne et al. 1987, Cantu and Richardson 1997, Harveson 2007, Conner 2007). Recent accounts suggest a general decline of mule deer throughout their range (Gill 1999, Heffelfinger 2008). Similarly, populations of grassland species such as pronghorn and scaled quail have also declined (Brennan and Kuvlesky 2005, Bristow and Ockenfels 2006, Sauer et al. 2007, Silvy et al. 2007, Simpson et al. 2007, Cearley 2008). It is reasonable to conclude that broad-scale habitat change (e.g., brush encroachment) is a likely candidate to explain these population declines. However, studies that describe the ecology of these species relative to long-term environmental and habitat changes in the Trans-Pecos are lacking.

Two separate Spike 20P studies were combined due to their similarity and importance to the Trans-Pecos. The first study occurred at Elephant Mountain Wildlife Management Area (EMWMA). This study focused on vegetative response to Spike 20P for 3 years post treatment. The research was designed to evaluate the efficiency of Spike 20P to control a variety of invasive brush species and monitor the effects on grasses and forbs. The Boracho Peak Ranch (BPR) study also monitored the effects of Spike 20P on vegetation, but primarily focused on habitat use of mule deer and other wildlife following application of Spike 20P. This study focused on the effects of Spike 20P from 2 to 5 years post treatment.

STUDY AREA

Both study sites occurred in the Trans-Pecos region of Texas, located within the Chihuahuan Desert. The region's boundaries are New Mexico to the north, the Pecos River to the east, and the Rio Grande River to the South and West (Hatch et al. 1990). The Trans Pecos is characterized by scattered mountain ranges with elevations ranging from 2,500 to 8,750 feet. Annual precipitation ranges from 7.8 to 18.1 inches. Soil types of the region vary with deep sands along desert washes, gravel in desert lowlands, and shallow rocky soils on the slopes and mountains (Powell 1998). Typical plant species include creosote, lechuguilla (*Agave lechuguilla*), sotol (*Dasylirion* sp.), honey mesquite, yucca (*Yucca* sp.), mariola, blue grama (*Bouteloua gracilis*), black grama (*Bouteloua eriopoda*), and low native grasses. Fauna of the region include scaled quail, mule deer, desert bighorn sheep (*Ovis canadensis*), pronghorn, coyote (*Canis latrans*), bobcat (*Lynx rufus*), gray fox (*Urocyon cinereoargenteus*), and a mixture of song birds.

EMWMA, 23,147 acres, was selected as one study site. The wildlife management area is located in the south-central portion of the Trans-Pecos, 26 miles south of Alpine, Brewster County, Texas. The topography of EMWMA is a single igneous mountain with numerous canyons and washes that is surrounded by flats, with the Del Norte Mountain range as the eastern boundary.

BPR, 99,437 acres, is located 10 miles west of Kent, TX in Culberson and Jeff Davis counties. The topography of the ranch is varied; including flats, gentle rolling hills, and steep mountains. Vegetation on both EMWA and BPR primarily consisted of typical Chihuahuan desert scrub and desert grasslands.

METHODS

Elephant Mountain WMA Study

Mariola, creosote-tarbush, whitebrush, mesquite-mixed brush, and catclaw mimosa were selected for treatment by Spike 20P at EMWMA. On 27 August 2008, M&M Air Service of Beaumont, TX applied Spike 20P aerially in the mariola, mesquite-mixed brush, and creosote-tarbush areas. Based on product label and recommendations by NRCS, application rates for these 3 areas were 0.75 pound active ingredient per acre (lb ai/ac) and 1 lb ai/ac. A total of 414 acres, 178 acres at 0.75 lb ai/ac and 236 acres at 1 lb ai/ac, were treated.

In March of 2009, the whitebrush and catclaw plots were treated. A Solo 454 backpack blower and powder metering kit was used to apply the Spike 20P pellets in these two communities. Four plots in each community were treated, two plots for 1.5 lbs ai/ac and two plots for 2 lbs ai/ac. A total of 5.89 acres of whitebursh were treated, 2.28 acres at 1.5 lbs ai/ac and 3.61 acres at 2 lb ai/ac. In the catclaw mimosa area, a total of 15 acres were treated, 7.9 acres at the 1.5 lb ai/ac rate and 7.1 acres at the high 2 lbs ai/ac rate.

Four, 50 m line-intercept transects were established in each application rate of each of the 5 plant communities. Four control transects were also ran for each area treated. The control-low represents the controls for the 0.75 and 1 lb ai/ac. The control-high represents the control plots for the 1.5 and 2 lbs ai/ac. To measure non-woody plant response, 1 m x 1 m quadrants were placed on the ground, centered over the tape, every 10 m along the transect. For each quadrant, species were identified, number of individuals counted, and the percent coverage of each species was estimated. To measure woody plant response, the standard line intercept method was used. Every time a woody or succulent plant crossed the tape, the plant was identified, classified as mature or immature, classified as dead, decadent or healthy, and the length the individual plant crossed the tape was measured. Each transect was run twice a year, once in the fall (August-October) and once in the spring (March-May), until the spring of 2011.

Boracho Peak Ranch Study

Radio collared mule deer were monitored for two years (2009 and 2010) at BPR. Johnson's (1980) three orders of selection were used to determine preferences between six habitat classifications. Habitats with ratios greater than 1 were used more than expected, less than 1 used less than expected, and equal to 1 used according to availability. Average selection ratios of all deer (*n* = 37) as well as differences between males (*n* = 16) and females (*n* = 21) were compared. The research design consisted of 5 treatments or habitats (3 different Spike treatments and 2 controls). Habitats included Spike 20P treated years 2.5 years post treatment (yrs-PT), 3.5 yrs-PT, and 4.5 yrs-PT; control-hilly-mountain (C-hill-mntn), control-flat (C-flat), and control-riparian (C-rip). Spike treatments 2.5 yrs-PT, 3.5 yrs-PT, and 4.5 yrs-PT were treated during winter 2005-06, winter 2006-07, and winter 2007-08, respectively. Control-hilly-mountain, C-flat, and C-rip treatments were not treated with Spike. C-hill-mntn was hilly and mountainous. C-flat habitats were relatively flat and most closely resembled sites treated with Spike. Control-riparian habitats were ephemeral draws or washes. Spike treatments totaled approximately 14,905 ac, 21,637 ac, and 16,961 ac for 2.5 yrs-PT, 3.5 yrs-PT, and 4.5 yrs-PT, respectively at a rate of 0.75 lb ai/ac.

EFFECTS OF SPIKE 20P ON VEGETATION

Brush

In the EMWMA study, kill rates at the 0.75 lb ai/ac rate were 51.47% of creosote, 90.63% of tarbush, 73.62% of mariola, and 100% of whitebrush. At a rate of 1 lb ai/ac, kill rates were 72.58% of creosote, 88.46% of tarbush, 86.90% of mariola, and 90.91% of whitethorn acacia. At the 1.5 lb ai/ac application rate, kill rates were 100% of tarbush, 94.74% of mariola, 97.83% of whitebrush, 94.44% of whitethorn acacia, and 100% of catclaw mimosa. Kill rates at 2 lb ai/ac were as follows: 100% of mariola, 97.96% of whitebrush, 100% of whitethorn acacia, and 100% of catclaw mimosa. Mesquite was not effectively killed at any application rate. Several other species of brush also occurred along the transects, but the number of individual plants were too low to draw any conclusions. Total woody canopy cover was reduced by 36.32%, 46.52%, 26.54% and 22.50% at 0.75, 1, 1.5, and 2 lbs ai/ac application rates, respectively. In the BPR study, creosote mortality was 95%, 100%, and 100% in the 3.5 yrs-PT, 4.5 yrs-PT, and 5.5 yrs-PT, respectively. Tarbush mortality was 100% in all treated areas.

Grass

During the EMWMA study, mean grass coverage was highest in the control-high rates with 31.68%. Mean grass coverage at the application rate of 1.5 lbs ai/ac was 30.65%. At the application rate of 2 lbs ai/ac, mean grass coverage was 28.48%. At the rate of 1 lb ai/ac, mean grass coverage was 24.46%. Mean grass coverage at the 0.75 lb ai/ac rate was 22.05%. Mean grass coverage was lowest in the control-low rates with 21.09%. At BPR, trends suggested after 4 yrs-PT to 5 yrs-PT grass biomass began to plateau.

Forbs

During the EMWMA study, mean forb cover was highest in the control-low rate plots at 2.46%. The control-high rates had a mean forb cover of 2.04%. The 1 lb ai/ac had the third highest mean forb cover with 1.52%. The 0.75 lb ai/ac had a mean forb cover of 1.46%. The application rate of 1.5 lbs ai/ac had a mean forb cover of 1.23%. The lowest forb cover was at the 2 lbs ai/ac rate with 0.77%. When broken down into perennial forbs, the control-high rates had the highest mean cover with 1.05%, and the control-low rates had a mean coverage of 0.55%. At application rates of 0.75, 1, 1.5, and 2 lbs ai/ac, perennial forb coverage was 0.50%, 0.49%, 0.44%, and 0.49%, respectively. For annual forbs, the highest mean coverage was observed in the control-low rates at 1.87%. The control-high rates had a mean annual forb coverage of 0.82%. At application rates of 0.75, 1, 1.5, and 2 lbs ai/ac, mean annual forb coverage was 0.89%, 0.87%, 0.70%, and 0.21%, respectively. Throughout the study, several forbs were unidentified, therefore could not be classified as annuals or perennials.

At BPR forb biomass and cover was highest in C-rip and 4.5 yrs-PT habitats. However, in Spike treated habitats forb species richness was less than half the amount found in similar controls (C-upland). The majority of forb biomass and cover in 4.5 yrs-PT habitats was attributed to Russian thistle.

EFFECTS OF SPIKE 20P ON WILDLIFE

Habitat Use of Radio-Collared Mule Deer

Treatments C-hill-mntn and C-rip were preferred by mule deer in all 3 orders of selection. C-hilly-mountain habitats provided topography important for escape cover. Control-riparian habitats not only provided brush as a source of escape cover, but also provided the highest diversity of forage. In addition to preferences toward C-hill-mntn and C-rip, the first 2 orders of selection showed mule deer preferences toward 2.5 yrs-PT. This may partially be due to the location of this treatment lying adjacent to the foothills of the Davis Mountains. Spike 20P habitats 2.5 yrs-PT and 4.5 yrs-PT closely bordered a major mountain range. In addition, 2.5 yrs-PT habitats may have provided more brush that had not yet been killed by the herbicide. This brush may have been used for cover and forage. The third order of selection suggested 2.5 yrs-PT habitats were used equally to their availability, while 4.5 yrs-PT habitats were avoided. In all three orders of selection both 3.5 yrs-PT and C-flat were avoided. The 3.5 yrs-PT had the least amount of forb biomass and forb species richness, while C-flat habitats might not have provided ideal topography that is usually desired by mule deer. Females preferred C-hill-mntn habitats more than males. Previous mule deer studies have suggested that these habitats have been important for fawn cover and predator avoidance. In general, the results from radio collared mule deer appear to suggest that Spike 20P did not negatively affect mule deer habitat.

Habitat Use of Other Wildlife

To help determine the effects of Spike 20P on mule deer and other wildlife, road surveys were conducted from October 2009 to October 2010. Wildlife monitored included mule deer, pronghorn, scaled quail, and javelina.

Selection ratios suggested that Spike 20P has differing effects on each species' habitat use. Similar to radio collared mule deer, road surveys suggested that Spike 20P did not appear to negatively affect mule deer habitat. Riparian habitats with higher brush diversity were important habitats for mule deer and other species such as scaled quail, and pronghorn.

Spike 20P's effectiveness in controlling invasive brush may further benefit true grassland species such as pronghorn. Pronghorn depend on eyesight and speed as their primary modes of defense against predators (Hailey 1986). Thus, habitats with high brush densities are usually avoided. This may explain the higher encounter rates of pronghorn in the 3.5 yrs-PT and 4.5 yrs-PT habitats. Most of the C-flat habitats on survey routes were void of pronghorn.

Broad scale Spike 20P applications may be harmful to scaled quail habitat when sufficient amounts of brush are not available after treatments. In the Chihuahuan Desert, scaled quail use habitats that have a mixture of plant communities that vary in structure and composition (Saiwana et al. 1998). A trend of declining use was observed as years post treatment increased. This was likely due to the lack of brush in habitats treated with Spike 20P.

Control-riparian habitats appeared to be important to all species except javelina. However, this was likely due to the difficulty in seeing javelina in brushy riparian habitats. Javelina were frequently encountered in C-hill-mntn habitats. Javelina preferred the 2.5 yrs-PT habitats more than 3.5 yrs-PT or 4.5 yrs-PT. 2.5 yrs-PT habitats were preferred probably due to slightly higher levels of brush diversity and density.

KEY POINTS CONCERNING SPIKE 20P

- Spike 20P was effective at killing creosote, tarbush, mariola, whitethorn acacia, catclaw mimosa, and whitebrush
- Application rates higher than 1 lb ai/ac may not be necessary for effective brush control and herbaceous plant response
- Potentially harmful to some key browse plants, especially at higher application rates
- Possible decreases in forb diversity should be considered
- Spike 20P may increase grass biomass for several years post-treatment
- Spike 20P did not appear to negatively affect mule deer habitat
- Spike 20P appeared to benefit pronghorn habitat
- Spike 20P may have negatively affected scaled quail habitat due to the reduction of brush cover
- Recommend mosaic or smaller plots be treated in successional years rather than broad scale application that may be harmful to wildlife

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TEXAS CONSERVATION AT THE WATERSHED SCALE

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The Watershed Policy and Management Program was created by the Texas Parks and Wildlife Department as a way to more effectively work with landowners to improve awareness and implement conservation and recovery of habitats. The TPWD *Land and Water Resources Conservation and Recreation Plan* directs the Department to work with landowners, regulatory agencies and river authorities on a watershed management approach to improve water supplies for people and wildlife. The Watershed Policy and Management Program provides inter-divisional coordination and collaboration that will enable the Department to leverage knowledge, effort and resources to conserve the aquatic resources of Texas.

Our approach to watershed management is to plan and implement means of protecting and improving habitat quality and quantity so as to provide environmentally and economically healthy watersheds that benefit the landowners and natural resources of the state. Watershed management also helps to raise awareness of the resource value of watersheds and often provides recreational benefits to our constituents.

Our goals are best achieved by guiding development of watershed management projects with private landowners throughout the state and coordinating these efforts among the Inland Fisheries, Wildlife and State Parks divisions as well as with NGOs, other agencies and appropriate local governments. There are many tools that can help us reach these goals, including watershed conservation partnerships, conservation workshops and one-on-one work with landowners. Incentive programs such as Watershed Landowner Incentive Program are essential to the success of all of these.

Our efforts are currently focused primarily on watersheds in West Texas and in the Texas Hill Country. Some of the projects currently underway or in development include:

Giant river cane (*Arundo donax*) eradication in the Nueces Basin – working with our biologists, the Nueces River Authority and landowners, a program is underway to eradicate this invasive plant before it becomes more fully established. It is estimated that *Arundo* now covers as much as 5 percent of the flood plain in the upper reach and around 1 percent in the lower sections. It creates problems by replacing native riparian plants, choking flows, consuming water (estimates of 5.5 acre-feet of water per acre per year), possibly interfering with stream meander and reducing the ability of the river to dissipate energy.

Guadalupe Bass Restoration Initiative – TPWD, Texas Tech, the South Llano Watershed Alliance and the city of Junction have begun the first phase of this initiative. Guadalupe bass broodstock were collected in fall 2010 and so far (spring 2011 and 2012) we have stocked approximately 275,000 pure Guadalupe bass fingerlings in the South Llano River to help rid the system of hybrids with smallmouth bass. We have also initiated six restoration projects with landowners in the area. Specific actions include stream bank stabilization and reestablishment of native vegetation to support functional riparian zones, removal or redesign of road crossings that serve as barriers to fish passage or that alter natural fluvial processes in the river, instream structural habitat enhancements, including placement of root wads, log and boulder complexes that support sustainable populations of Guadalupe bass and other native fishes, and upland grasslands restoration to reduce erosion and support recharge of springs and restored hydrologic flows. Additionally, this summer we will begin riparian restoration at South Llano River State Park and have begun developing a design for an improved bridge for the Park. The full Guadalupe Bass Restoration Initiative has been accepted by the National Fish and Wildlife Foundation and when funding is secured will entail more than $10 million to address watershed conservation and restoration projects throughout the Edwards Plateau.

In West Texas, a series of watershed projects are in various stages that entail grassland restoration and spring enhancement in the Alamito Creek and Terlingua Creek drainages. They complement the work planned under the Big Bend Conservation Cooperative which is a collaborative effort among agencies of the Department of Interior and TPWD that will help to coordinate conservation of more than 3,000,000 acres in the Big Bend region.

We also provide watershed conservation workshops that are designed to help TPWD staff guide landowners on proper watershed stewardship. The Workshops include details on physical and biological functions, species identification, conservation methods and funding sources.

Through this holistic approach to conservation of Texas watersheds, we hope to provide a more healthy and resilient landscape that will continue to yield benefits for many future generations of Texans throughout the state.

Carnivores, Nongame, and Disease Management in the Trans-Pecos

USING MUSEUMS TO INFORM MANAGEMENT: GENETIC INSIGHTS INTO TEXAS MOUNTAIN LION POPULATIONS

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Abstract: We used genetic tools to evaluate genetic diversity, genetic differentiation among regions, and long-distance movements of mountain lions in Texas. We analyzed 299 mountain lions collected in Texas during 1935–2010. We used tissues donated by hunters and trappers to index the contemporary populations and specimens from museum collections to represent the historical populations. Our goal was to examine how mountain lion populations in south and western Texas have changed during the past century. We estimated genetic diversity, genetic differentiation, and effective population size. Historical populations from the 1930's had similar levels of genetic diversity in south and west Texas, with minimal genetic differentiation. Genetic diversity in contemporary south Texas lions has declined by 10–20%, while diversity in western Texas remained stable over time. Genetic differentiation between western and southern Texas has increased more than twofold. Effective population size in southern Texas declined by > 50%, whereas effective size in western Texas has remained stable. South Texas lions have clearly experienced a loss of diversity and reduced effective size during the past 70 years. We also identified recent long-distance movements and evidence for dispersal among south Texas, the Trans-Pecos, and adjacent populations in New Mexico. Mountain lions in Texas are composed of 2 distinct populations or management units, the Trans-Pecos and southern Texas.

Mountain lions are a difficult species to manage. Lions are clearly a rare and valued quarry for many hunters. Unfortunately, lion predation on livestock, wildlife, and pets often brings the charismatic cats into conflicts with humans. Biologists need science-based information to ensure the persistence of these charismatic animals, yet minimize human-wildlife conflicts. This is no easy task, as the management of lions is complicated by their behavior. Mountain lions are secretive, solitary animals that range over vast areas and occur in low numbers. It is difficult to estimate population size or track population trends. Thanks to advances in genetic techniques, instrumentation, and computing power, wildlife biologists can now draw upon an array of sophisticated tools to aid in the management of our natural resources.

In 2009, the Texas Parks and Wildlife Department funded a genetic study of lion populations in Texas. Mountain lions were historically widespread throughout much of the state, but experienced a decline in overall numbers and geographic distribution during the 1900's due to loss of habitat and damage mitigation practices for livestock. Breeding populations of lions presently occur only in south Texas and the Trans-Pecos. Our goals were to compare levels of genetic diversity and differentiation among contemporary populations to that of historical populations. We were also interested in dispersal and movements among contemporary populations. We obtained samples from contemporary populations through tissue donations from hunters and trappers, as well as some road-kills. We assessed the genetic diversity in historical populations by extracting DNA from museum specimens. Museums have recently become an important source of historical materials, and fortunately Texas is well-represented in the historical record.

Through persistent efforts, we were fortunate to secure permission to sample specimens from more than a dozen museums. We obtained genetic data from 103 museum samples collected during 3 distinct time periods: 27 west Texas lions taken during 1935-1955; 34 south Texas lions taken during 1934-1942; and 42 west Texas lions dating from 1979-1989. We compared these to 168 west Texas lions taken during 2000-2010, and 28 south Texas samples taken during 1985-2009. We estimated genetic diversity, genetic differentiation, and the effective population size. The effective size is a population genetic term that is often described as the number of breeding individuals. Because any natural population contains juveniles (non-breeders), and offspring lost to natural mortality, the effective size is often much lower than the total population.

We found that the historical populations from the 1930's had similar levels of genetic diversity in south and west Texas, with minimal genetic differentiation. However, south Texas lions have experienced a loss of diversity and reduced effective size during the past 70 years. Specifically, genetic diversity in contemporary south Texas lions has declined by 10–20%, while genetic diversity in western Texas remained stable over time. Genetic differentiation between western and southern Texas has increased more than twofold in recent decades. Effective population size in southern Texas declined by > 50%, whereas effective size in western Texas has remained stable.

Overall, west Texas lion numbers have remained relatively stable, probably due to their proximity to lion populations in New Mexico, Mexico, and elsewhere throughout the Rocky Mountains. As the Rio Grande Valley and central Texas regions have experienced increasing urbanization, south Texas has become nearly isolated from other lions in Mexico and west Texas. If the present trend continues, the south Texas lion population may continue to lose genetic diversity and may eventually be extirpated.

Today's south Texas population was genetically differentiated from both Trans-Pecos and adjacent populations in New Mexico (F_{ST} = 0.10 to 0.15). However, we did find clear evidence for long-distance movements and dispersal among south Texas, the Trans-Pecos, and New Mexico. The low genetic diversity in south Texas and genetic differentiation from the other 2 regions suggest that dispersers do not successfully reproduce in south Texas. Our results suggest mountain lions in Texas are composed of 2 distinct populations or management units, the Trans-Pecos and southern Texas. The future of the south Texas population will depend on immigration and survival of adults and young within the region. Mountain lions in New Mexico and the Trans-Pecos appear to be sources for lions dispersing eastward into areas without breeding populations. Mexico probably contributes dispersers as well, though we are unable to evaluate this without genetic data from south of the US border. Identification of dispersal paths will be important to delineate travel corridors and areas of potential mountain lion-human conflict.

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Holbrook, J. D., R. W. DeYoung, M. E. Tewes, and J. H. Young. 2012. Demographic history of an elusive carnivore: using museums to inform management. Evolutionary Applications: *In press*. doi:10.1111/j.1752-4571.2012.00241.x

PREDATOR/PREY RELATIONSHIPS, DIET, AND DEMOGRAPHY OF MOUNTAIN LIONS IN THE DAVIS MOUNTAINS

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ABSTRACT**:** Since April 2011 we have captured and radio collared, with GPS and VhF radio collars, 11 mountain lions *(Puma concolor*) in southwest Texas. Satellite technology has identified over 172 possible kill and feeding sites of adult or subadult study animals from $\geq$ 2 consecutive nighttime GPS points < 200 meters apart. We have investigated 138 of these sites and located 104 kill sites and 5 scavenging sites. Minimum convex polygons (calculated at 95% MCP) for habitat occupation by female study animals ranged from 5,340 to 16,514 ha^2 and averaged 12,473 ha^2. The home range of the adult male was considerably larger at 52,170 ha^2. We have documented the emigration of 2 dispersing subadults from the study area. In the future we will use molecular identification and relatedness of individuals from 100 scats and all blood samples from captured animals and camera trap capture-recapture data to determine a minimum population size. Prey selection by mountain lions relative to availability in the Davis Mountains will be further described in the future after an analysis of camera trap data from an ongoing parallel study.

INTRODUCTION

The mountain lion (*Puma concolor*), as an apex carnivore, is considered a keystone species and plays a major role in maintaining stable trophic interactions within the ecosystems it inhabits (Estes et al. 2010). Breeding populations in Texas are known to persist primarily in the Trans-Pecos and South Texas Plain ecoregions of western and southern Texas, respectively (Schmidly 2004). Holbrook et al. (2012) documented that differences in genetic structure and diversity between southern and western Texas supports the designation of separate management units. It is hypothesized that the mountain lion population within the Davis Mountains of western Texas is a source population for the Trans-Pecos ecoregion and possibly additionally for the South Texas Plain ecoregion. If so, it is important to understand the ecological "cost" of maintaining a genetically significant population on a sustainable basis through an analysis of diet and population demographics.

We present here the methods and initial findings of an ongoing study with the following objectives: (1) determine the minimum population size for mountain lions in the Davis Mountains using mark-recapture analysis from camera traps and molecular data from scat and blood samples, (2) define the demographic ecological setting (movements, home ranges, survivorship) for mountain lions in the Davis Mountains, and (3) describe mountain lion diets, or the "cost" of maintaining and managing a sustainable source population of this apex carnivore in the Davis Mountains.

STUDY AREA

Trans-Pecos, Texas is an area of contrast and diversity. Located within the Chihuahuan Desert Biotic Province, the Trans-Pecos ecoregion is approximately 7.3 million ha and is bordered to the east by the Pecos River, to the west and south by the Rio Grande, and to the north by New Mexico (Hatch et al. 1990). Desert island mountain ranges are scattered throughout the Trans-Pecos with elevations ranging between 762-2,667 m (Harveson 2007).

The Davis Mountains are centrally located within Jeff Davis County and represent the largest and highest land mass in Texas (207,000 ha area >1,500 m). Annual average precipitation ranges from 45-58 cm with most of the precipitation occurring during the months of July-August. Other precipitation occurs, in the form of snow during December and January. Soils include shallow to deep, well drained, hilly to steep, non-calcareous, and loamy soils. Oak savannah vegetation dominates lower elevations. The dominant grasses in the area include bull grass (*Mullenbergia spp*.)cane bluestem (*Bothriochloa barbinodis*), side-oats grama (*Bouteloua curtipendula*), and blue grama (*Bouteloua gracilis*). Primary forbs in the area include Mexican sagewort (*Artemisia spp*.), bush sunflower (*Asteraceae spp*.), and crotons (*Croton spp*.). Typical woody species that occur include ponderosa pine (*Pinus ponderosa*), white pine (*Pinus strobiformis*), Mexican pinyon (*Pinus cembroides*), and alligator juniper (*Juniperus deppeana*) (Warnock 1977).

METHODS

Mountain lions were captured using leg-hold snares built to our specifications by Morgan Supply, Canada (morgansupply.com), set in areas of frequent lion visitation as determined by sign such as scrapes, tracks and scat. Snares were used in combination with a variety of battery-powered mountain lion communication calls (whistles, yowls, growls) equipped with solar switches that played continuously during the night at preselected timed intervals constructed in collaboration with the company Wasatch Wild (wasatchwild.com). Trained hounds were additionally used seasonally (October – May) to capture mountain lions. Lions were immobilized and fitted with ATS G2110E Iridium/GPS location collars or North Star satellite collars scheduled to collect 6 locational fixes during a 24-hour period (daytime at 1200 hours and night time at 1800, 2100, 0100, 0400 and 0600 hours).

Kill and/or feeding sites were defined as locations consisting of two or more consecutive GPS coordinates less then 200 meters apart downloaded between the night-time hours of 1800 – 0600 hours and then uplinked to an Iridium satellite/website center. GPS location clusters were investigated using the center of cluster coordinates after it was determined that an animal moved off from a suspected kill/feeding site, so as not to influence (increase) kill/feeding rates through our investigative presence. In the field we are differentiating cluster sites as either a kill site, determined by the presence of evidence of a lion-caused mortality (e.g. evidence of an attack, venous blood associated with an attack site), or a feeding site, defined as the site of a carcass whose mortality was not directly attributed to a mountain lion attack (e.g. feral hog carcass shot during control activities). Information recorded at kill/feeding sites includes: species, age class, breeding condition and gender of prey. Various habitat characteristics are also recorded such as slope, aspect, vegetation, elevation, percent canopy cover and distance from water. This same information is currently being collected in additional ongoing lion prey studies in at least three additional ecoregions in North America for later comparison. We feel it is important that wildlife researchers communicate with project personnel conducting similar studies in other locales so that the power of data sets can be increased when combined in future analysis.

RESULTS

To date we have captured and radio collared 11 mountain lions, including 4 kittens (2 males and 2 females classified as dependent young), 3 subadults (2 males and a female determined to be independent or dispersing animals <3 years of age), and 4 adults (3 females and 1 male that are independent and breeding animals $\geq$3 years of age). We have investigated 138 kill/feeding sites as delineated from 172 GPS cluster locations of 4 adult and 4 subadult animals. 5 sites were located with evidence of scavenging (mortalities that were not lion-caused). Access to private properties has limited us in our ability to investigate all identified cluster sites.

Diet

We have located 104 kill sites and 5 feeding sites (scavenging) and identified, aged and sexed 11 prey species as shown in **Figure 1.** We have excluded kill sites of unknown deer species (n = 4).

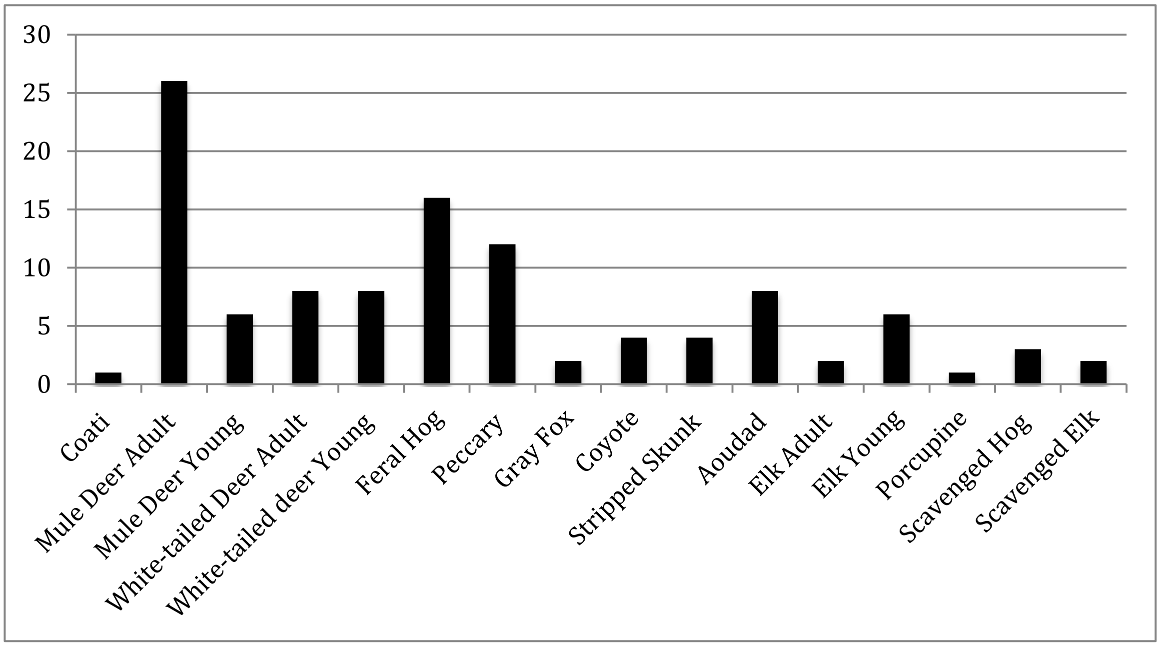

Figure 1. Prey identified from 104 kill sites and 5 scavenging sites.

Kill or feeding sites with no prey item located were often described as possible bedding or ambush hunting sites (e.g. sites in close proximity to water, game trails, peccary and feral hog bedding grounds and fence crossings). Prey identified from carcass remains to date have included: white-tailed deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus)*, collared peccary (*Pecari angulatus*), elk (Cervus elaphus), feral hog (Sus scrofa), striped skunk (*Mephitis mephitis*), aoudad (*Ammotragus lervia*), gray fox (*Urocyon cinereoargenteus*), coyote (*Canis latrans*), white-nosed coati (*Nasua narica*), and porcupine (*Erethizon dorsatum*). The white-nosed coati was verified as a new species occurrence in the Davis Mountains.

Prey species were identified, aged and sexed from gross examinations of carcass remains that included parts mountain lions normally do not consume, such as antlers, skulls, mandibles, tails, teeth, tusks, hides, quills, hooves and rear legs with intact metatarsal glands for species identification of deer (Heffelfinger 2006). Deer and elk were classified as adults or young and aged to the nearest year class ((Heffelfinger 2006) Young animals were further classified as yearlings ($\geq$1 and < 1.5 years) or fawns and calves (elk) <1 year of age.

Movements

GPS collars have logged over 4,000 GPS locations from radiocollared lions in the study area. Minimum convex polygons (calculated at 95% MCP) for habitat occupation by female study animals ranged from 5,340 to 16,514 ha^2 and averaged 12,473 ha^2. The home range of the adult male was considerably larger at 52,170 ha^2. We have had 2 dispersal events, one each by a female and male subadult. The female was trapped on day 85 following the first day of dispersal. The male's fate is unknown at this time.

DISCUSSION

The findings presented here are preliminary. Our study goal is to investigate 30 confirmed kill sites for each of 10 adult or sub-adult mountain lions during the course of the study. Our rate of locating kill/feeding sites on properties we have been granted access is typical of on-going prey studies currently being conducted in Sonora, Arizona, Utah, and Colorado.

The most important product of GPS satellite technology, when used for diet investigations of a far ranging apex carnivore such as the mountain lion, is its accuracy of detecting prey composition and feeding site locations. Limitations are transmitter battery life, the field assistance needed to investigate all possible kill sites by trained field biologists and access provided by landowners. We hypothesize that we will underestimate the amount of prey weighing less than 15 kg using GPS downloads taken at 3-hour intervals during the nighttime.

Not only can the information be used for informed planning of landscape habitat improvements such as water developments and artificial feeding sites for livestock and wildlife, but for broader landscape treatments such as prescribed fire and invasive vegetation management and the evaluation of anthropogenic barriers to genetic exchange.

When managing both livestock and wildlife in multi-prey systems for economic and conservation/management reasons it is important to understand predation as “offtake” of prey from the landscape that is cause-specific and attributed to mountain lions (WAFWA 2009). Offtake of prey will differ according to prey abundance and species presence or absence from ecoregion to ecoregion and temporally from within each ecoregion. Offtake of prey by mountain lions in Texas has only been thoroughly documented in the south part of the state by Harveson (2000). Predation studies in other states should not be extrapolated to different ecoregions (Ruth and Murphy 2009) but future comparisons between study sites may prove valuable to understanding how offtake differs temporally and between ecoregions. Aside from differences in daily predation rates for individual mountain lions, rates of offtake vary due to differing compositions and sizes of mountain lion populations and variation in prey population size (Logan and Sweanor 2001). These are data that are needed for accurate offtake calculations. In order to calculate prey offtake biologists and land managers must also determine or designate what kind and how much prey might be available within their area of management responsibility for a known population of mountain lions. We hope to further elucidate this with a parallel just-initiated camera trap study that will estimate prey numbers and density of both carnivores and prey. Such data will then tell us if mountain lions are selecting for one species over another relative their availability in the Davis Mountains.

Mountain lion harvest is currently not managed in Texas. Mountain lions have been designated a nongame species by the Texas Parks and Wildlife Department (Harveson et al. 1996; Russ 1996). Limited data available suggests that populations in both western and southern Texas are restricted by low survival rates (Harveson 1997; Pittman et al. 2000; Young et al. 2010). Recent genetic analyses found that mountain lions in southern Texas have low levels of genetic diversity and appear to be isolated from western Texas (Walker et al. 2000; Holbrook et al. 2012).

Failure to provide science-based information on mountain lion ecology at landscape scales may significantly reduce efforts to manage both the predator and its prey. In the future, this research might profitably focus on relationships among harvest, methods of harvest, dynamics of local prey populations within management areas, and predator-prey relationships particularly for desert bighorn sheep. Attempting to manage mountain lions merely on the basis of an unregulated nongame harvest strategy may result in costly consequences for landowners, wildlife and recreation managers alike.

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MANAGING YOUR LANDS FOR NONGAME

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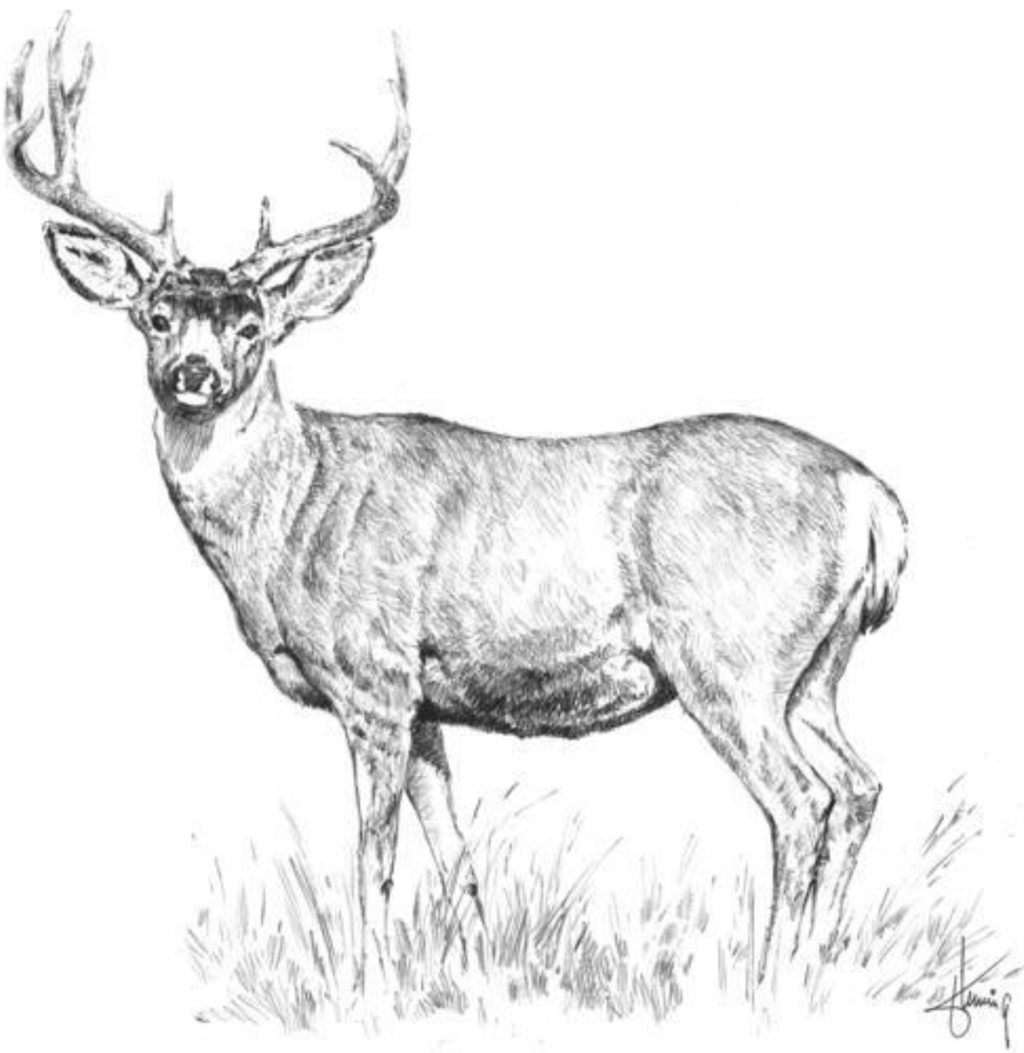
Non-game refers to native animals that are not commonly hunted. Non-game wildlife includes mammals, birds, reptiles, amphibians, and invertebrates. While land managers often consider game species first, non-game species make up the vast majority of animals found on any property. Additionally, many non-game species play important roles in the ecosystem such as bats consuming mosquitoes or foxes eating mice and rats. An ecosystem is made up of a complex web of interactions and knowledge of non-game species increases your effectiveness as a manager and your understanding of the land. Many of the management practices frequently used to benefit game species such as supplemental water, prescribed fire, and selective brush control can have beneficially effect non-game species as well. Several of these practices will be discussed in the presentation.

Wildlife tax valuations in Texas offer landowners incentives for managing their land for wildlife, including non-game species. Many Texas landowners are now effectively managing their land for songbirds and other non-game species. Contact your local Texas Parks and Wildlife biologist for more information. TPWD also has excellent information for getting started at this link: http://www.tpwd.state.tx.us/landwater/land/private/agricultural_land/tp2010/

Big Game Management



TEXAS PARKS AND WILDLIFE DEPARTMENT'S DEER MANAGEMENT PROGRAMS IN THE TRANS-PECOS – AN UPDATE

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Texas Parks and Wildlife Department (TPWD) offers several programs that can assist deer managers with their individual goals and objectives.

The Managed Lands Deer Permit (MLDP) program is available for both white-tailed and mule deer. This program allows landowners involved in a formal management plan to have the state's most flexible seasons and increased harvest opportunities. The program is incentive based and habitat focused. Participation in the MLDP program requires a written Wildlife Management Plan (WMP) approved by a Texas Parks and Wildlife Department (TPWD) biologist or technician. There is no fee or written application, other than the WMP, for the MLDP program. Based on the goals of the landowner and population data, the biologist issues a set number of permits. Once permits are issued, all deer harvested (with the exception of buck deer on Level 1 properties) on that property must be tagged with the appropriate MLD permit. Completion of the hunting license log and use of a hunting license tag are not required for deer harvested under the authority of MLD permits, except for bucks harvested on Level 1 properties.

There are 3 levels of MLDPs for white-tailed deer. Higher levels offer additional harvest flexibility for the landowner, but also have more stringent requirements. Level 1 MLDPs offer liberalized antlerless harvest opportunity for landowners in counties with restrictive antlerless harvest regulations. In fact, most requests for Level 1 MLDPs are in areas where county regulations restrict antlerless harvest during all or part of the general season. No buck permits are issued under Level 1. Level 1 participants are required to provide current deer population data, as well as reporting the number of bucks and does harvested.

Level 2 MLDPs provide additional harvest flexibility for landowners, but require active habitat and population management. Participants in a Level 2 MDLP program may harvest antlerless deer by any lawful means from the Saturday closest to September 30 until February 28th. They may also harvest bucks from the beginning of the general season until February 28th. Level 2 participants must provide population data for the current year and preceding year, deer harvest data (including age, weight, and antler data) from the preceding year, and must identify at least 2 recommended habitat management practices that are being conducted or will be conducted (within 3 years of permit issuance) on the property.

Level 3 MLDPs allow maximum harvest flexibility for landowners, but require active habitat and population management. Participants in a Level 3 MLDP program may harvest either sex by any lawful means from the Saturday closest to September 30 until February 28th. Participants must provide deer population data for the current year and preceding 2 years, deer harvest data from the 2 preceding years, and must identify at least 4 recommended habitat management practices that are being conducted or will be conducted (within 3 years of permit issuance) on the property.

In contrast, MLDPs for mule deer have only one level, offer harvest flexibility, and participants may harvest either sex by any lawful means from the first Saturday in November until the first Sunday in January. The program requires landowners to provide 3 years of survey data, 2 years of harvest data, and agree to implement 3 habitat management practices that must have been (or will be) conducted within 3 years of permit issuance.

The Trap, Transport, and Transplant (TTT) Program for both mule deer and white-tailed deer is available to help reduce population densities in areas where surplus deer occur. All proposed release sites must have a current Texas Parks and Wildlife Department Wildlife Management Plan approved by a TPWD Wildlife Biologist. Applications will be denied if the proposed activities may detrimentally affect population status on adjacent properties, deer resource and/or habitat, or if the proposed release site is outside of the suitable range of either species. There is an application processing fee of $750.00 per release site.

The Trap, Transport and Process Surplus (TTP) White-tailed Deer Permit program is a mechanism to help reduce deer population densities in areas where white-tailed deer are overpopulated. Through use of this permit, areas with surplus white-tailed deer can capture surplus deer, process their carcasses, and donate the resulting venison to penal facilities or charitable organizations for human consumption. This program is not available for mule deer. There is no application fee or permit fee associated with this permit.

Antlerless and Spike-buck deer Control Permits (ADCP) program provides landowners an additional mechanism to control overpopulation of white-tailed deer on their property. Participation in the ADCP program requires a written Wildlife Management Plan (WMP) that specifies a harvest quota of more than 20 antlerless deer. The WMP must be in a format approved by TPWD, submitted to TPWD, and approved by an authorized Wildlife Division Biologist. There is an application processing fee of $378.00. Applicants must provide a list of hunters (designated harvesters) who will be authorized to use the control permits. This program is not available for mule deer.

The Deer Management Permit (DMP) authorizes owners of high-fenced properties to temporarily detain white-tailed deer in breeding pens located on the property for the purpose of natural breeding. Deer may not be detained for purposes that do not include natural breeding (i.e. "soft release" of bred TTT deer). All facilities must be completed prior to submitting the application and deer management plan to the local TPWD Wildlife Biologist for review and approval. The application and deer management plan must be approved and signed by an authorized TPWD Wildlife Biologist. Participation in the DMP program requires a written Deer Management Plan that details the proposed breeding operation. There is a non-refundable application processing fee of $1,000.

Senate Bill 460 of the 82nd Texas Legislature authorized TPWD to implement a DMP program for mule deer, which would not require a high fence boundary. The Department is currently working through possible implementation of this program, via a task force.

SEASONAL HOME RANGES OF DESERT MULE DEER IN THE APACHE MOUNTAINS

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Desert mule deer *(Odocoileus hemionus)* are a prominent animal in Texas, but limited research has been conducted on them in the Trans Pecos region of the state. From 2006-2010 approximately 40 mature bucks ($\geq$4.5 yrs. old) were captured using a helicopter and net gun from two study areas. One area had supplemental feeders while the other was a non-fed site. Once the deer were captured the age and antler measurements were recorded, and a global positioning system (GPS) radio collar was placed around the neck before being released. The radio collars were programmed to record each deer's location as well as a date and time every 5 hours. Deer were then recaptured annually to retrieve the GPS collars, and measure antler development. The data suggests that home ranges are much larger than previously estimated. Using the fixed kernel home range analysis tool with a 95% confidence level, home ranges for mature mule deer averaged 35.3 km^2 on the supplemental fed site and 45.0 km^2 on the non-fed site with a range from 20.5 km^2 to 96.2 km^2. Home ranges during the winter (includes the rut) was nearly double the size of any other season (spring, summer, fall). Data also shows that deer move less during the fall than any other season. Supplemental feed and water availability and the effects they may have on home ranges and habitat use of mule deer is also being analyzed and included as a major segment of this study. With the completion of this project, understanding mule deer annual and seasonal home ranges will allow biologists to make better recommendations on how to manage mule deer in the Trans-Pecos.

DESERT BIGHORN SHEEP MANAGEMENT: PARTNERSHIPS ON THE BORDER

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Abstract: The native Texas desert bighorn sheep (*Ovis canadensis mexicana*) were extirpated from their historic range in the Trans-Pecos by the early 1960s. Their demise is attributed to unregulated hunting, the introduction of domestic sheep and goats that competed with bighorns for resources as well as diseases that bighorns had not been exposed too, and net-wire fencing that impeded natural movements. Identifying bighorn requirements (e.g. terrain, dietary needs, and water) and recognizing potential impacts (e.g. exotic ungulate completion, predator impacts, and domestic sheep interactions) in conjunction with establishing partnerships allowed for the reintroduction of bighorns into historic ranges which are currently at 1880 levels. To manage bighorns on a bi-national landscape, partnerships must be formed with international/national state and federal conservation agencies/organizations, NGOs and interest groups. However, differences in individual governing styles, economic limitations, and resource/fund availability can complicate and/or hinder progress. A consolidation of management resources on a bi-national level to the greatest extent possible can be a consideration to mitigate some of the economic limitations. Implementing a landscape level ecosystem management approach to promote the conservation of biodiversity can also alleviate some of the pressure of different management priorities set by individual governing bodies.

The native Texas desert bighorn sheep (*Ovis canadensis mexicana*) historic range included most of the arid mountain ranges in the Trans-Pecos region (Cook 1994). In the 1880s, an estimated 1500 bighorns inhabited these mountain ranges and possibly 2500+ prior to 1880. However, by the mid-1940s they had disappeared from much of their native mountain ranges (Carson 1945). And by the early1960's, the native bighorns had been extirpated (Cook 1994). Their demise is attributed to unregulated hunting, the introduction of domestic sheep and goats that competed with bighorns for resources, domestic sheep/goat diseases that bighorns had not been exposed too, and net-wire fencing that impeded natural movements in search of food and water.

Protective measures were taken as early as 1903 with the prohibition of bighorn hunting and later with the establishment of the Sierra Diablo WMA (1945), a sanctuary for the few remaining bighorns. A cooperative agreement in 1954 between the Arizona Game and Fish Commission; Boone and Crockett Club; Texas Game, Fish and Oyster Commission; U.S. Fish and Wildlife Service; and Wildlife Management Institute marked the beginning of the restoration efforts in Texas. These efforts focused primarily on captive propagation. The first propagation facility was constructed on the Black Gap WMA and stocked with 16 desert bighorn sheep from Arizona in 1959. Additional facilities were constructed at the Sierra Diablo WMA in 1970 and 1983, and Chilicote Ranch in 1977.

Today, desert bighorns are coming back to their historic mountain ranges. Greatly in part to decades of work by Texas Parks and Wildlife Department, various state agencies including Arizona, Utah, and Nevada, as well as wildlife conservation groups such as Texas Bighorn Society, Wild Sheep Foundation, and Dallas Safari Club. Of equal importance have been the many private landowners and individuals committed to the restoration and management of desert bighorn sheep.

REQUIREMENTS

Words typically used to describe desert bighorn habitat include, rugged, broken up, steep, and convoluted terrain. Desert bighorns are well adapted to thrive in this harsh arid terrain with sparse vegetation (Krausman et al. 1999). Topography, food, water, and space are also essential components that need to be present throughout the habitat in an arrangement usable by desert bighorns (Brewer 2002).

Though bighorns consume a wide variety of vegetation based on what is the most nutritional and seasonally available, their diet predominately consists of browse species (Brewer and Harveson 2007). Seasonally, newly emergent grasses and forbs are favored during the summer-fall rainy season. As grass quality and forb availability declines in the winter and early spring, shrubs become an important component of their diet.

Water is used year-round by desert bighorn sheep. Bighorns are adapted to make use of ephemeral water sources and succulent plants. However, water is readily used when provided and considered an important factor in home range selection (McCarty and Bailey 1994). It is likely that declines have occurred in ephemeral water sources in Far-West Texas during the past 150 years, primarily because of decreased rainfall infiltration and deep water percolation as a result of reduced ground cover (e.g. perennial bunchgrasses) (Richardson 2003).

POTENTIAL IMPACTS

Exotic ungulates, such as aoudad sheep (*Ammotragus lervia*) are frequently observed within bighorn habitat and pose a potential threat. Aoudads have a higher reproductive potential than bighorn sheep, the ability to subsist on lower quality forage, and a preference for habitat similar to that of bighorn (Seegmiller and Simpson 1979). Aoudads are socially aggressive and have been observed herding female bighorn (Foster 2002). Although their potential to transmit disease is unclear, they may be reservoirs of parasites and diseases detrimental to desert bighorn sheep and other native ungulates (McCarty and Bailey 1994). Exotic ungulates not only compete with bighorns for resources, but also for space.

The principal predator of bighorn sheep in Texas is the mountain lion (*Puma concolor*). Other potential predators include coyotes (*Canis latrans*), bobcats (*Felis rufus*), black bears (*Ursus americanus*), and golden eagles (*Aquila chrysaetos*). Large free-ranging bighorn populations are generally not limited by predation. However, predation can have significant negative impacts on recently introduced or small populations (Wehausen 1992).

Domestic sheep are currently the greatest disease threat to bighorn sheep. Abundant evidence implicates domestic sheep as one cause of bighorn declines and localized population extinctions due to bacterial pneumonia outbreaks resulting from domestic sheep/wild sheep interactions. Domestic and/or feral sheep can use similar habitats and carry diseases that are lethal to bighorns (McCarty and Bailey 1994). Domestic goats also are considered a potential health threat to bighorn sheep.

BI-NATIONAL RESTORATION AND MANAGEMENT

Understanding bighorn requirements and potential impacts is only 1/3 of the restoration-management equation. These requirements and impacts have been identified through years of science based research as well as anecdotal field observations. But some of the potential impacts must be periodically reviewed and management actions adjusted to stay current with changing times.

Another crucial part of that equation includes partnerships. These partnerships may be viewed as the second third of the equation and formed with international/national state and federal conservation agencies/organizations, NGOs and interest groups. Solid relations must be well established, as well as clear attainable goals and objectives described to increase the potential for successful reintroductions and restoration.

The last third is made up by private landowners. Without landowner cooperation progress (e.g. captures, transplants, expansion, public awareness, etc.) will be extremely difficult to achieve. This is particularly true for a state such as Texas where over 95% of the land is privately owned.

The three components of the bighorn restoration and management equation should be identical on a bi-national level. However, differences in individual governing styles, economic limitations, and resource/fund availability can complicate and/or hinder progress.

A consolidation of management resources on a bi-national level to the greatest extent possible can be a consideration to mitigate some of the economic limitations. Implementing a landscape level ecosystem management approach to promote the conservation of biodiversity can also alleviate some of the pressure of different management priorities set by individual governing bodies.

The bi-national restoration effort would benefit greatly from habitat enhancement projects and sound wildlife management practices when conducted simultaneously on both sides. Predator management can be applied to keep predation at a level that does not prevent the establishment of self-sustaining desert bighorn populations. Additionally, the removal of exotic ungulates as needed would increase the potential for bighorn population establishment into reintroduced areas, and subsequent natural expansion. Furthermore, the protection of bighorns coupled with promoting habitat management, including movement corridors, would facilitate natural expansion.

Public awareness and disseminating information to the media, advocacy groups, wildlife organizations, and interest parties will not only improve overall relations, but also perceptions.

In time, these partnerships will clearly demonstrate the strategic importance of parties that have shared interest consolidating their capacities and resources to achieve a common goal.

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AN INVESTIGATION INTO THE RECENT PRONGHORN DECLINE IN THE TRANS-PECOS REGION OF TEXAS

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Since the late 1980s the pronghorn population of west Texas has been in a steady decline without many exceptions. The 2011 surveys showed that the population was estimated to be around 3,700 animals, an all-time low for the region. Previous research has shown there is a strong relationship between pronghorn demography and precipitation which has led to die-offs in the past. Despite abundant and timely precipitation in 2009 and 2010, pronghorn populations have not recovered. In 2011, we experienced extremely dry conditions, and the pronghorn population is still declining. We are investigating the roles of parasites, diseases and predation of pronghorn in the Trans-Pecos region as limiting factors. We collected samples of hunter-harvested pronghorn in October of 2009, 2010, and 2011 to evaluate parasite loads, as well as the occurrence of blue tongue, epizootic hemorrhagic disease, and copper and selenium levels. We obtained 102 pronghorn samples in 2009, 95 samples in 2010, and 49 samples in 2011. Prevalence of barber pole worm was 94%, that is 201 of the 215 samples that were analyzed had barber pole worms. In 2009, the average number of barber pole worms/pronghorn was 510 and ranged from 0 to 4,080. The average in 2010 was 286 worms/pronghorn, but parasite loads still ranged form 0 to 3,145. In 2011, the average of barber pole worms/pronghorn was 381and ranged from 0 to 2,507. Also, in 2011 we were able to sample 178 animals from the panhandle region of Texas. This resulted in an average of 117 eggs/gram in the fecal egg counts and only 54% prevalence of *Haemonchus*. This is much lower than the Trans-Pecos fecal egg count averages and prevalence's in 2010 and 2011. The panhandle samples also displayed a much higher selenium level when compared to the Trans-Pecos, which is important in reproduction. Predation is a greater problem with pronghorn fawns than with adults therefore we wanted to look at fawn survival and causes of mortality. Throughout the last couple years Texas Parks and Wildlife Department's pronghorn surveys, have shown a decline in recruitment throughout the Trans-Pecos. In 2011, surveys showed some areas to have fawn crops as low as 0% (0 fawns: 100 does). In 2011, TPWD surveys indicated that the fawn crops averaged 10% Trans-Pecos

wide, which means they observed only 10 fawns for every 100 does. These low fawn crops are a major contributing factor to the overall pronghorn decline in the Trans-Pecos. We are conducting a pronghorn fawn mortality study, which will allow us to better understand why pronghorn are experiencing low fawn recruitment in the Trans-Pecos. In 2011, we captured and radio collared 26 fawns over 4 study sites in the Trans-Pecos region. We found mortality on these fawns to be very high, with only 2 out of the 26 surviving. We contributed 23 out of the 24 mortalities to predation. Bobcat predation accounted for 29%, coyote predation accounted for 25%, and 42% of predation could not be attributed to a specific predator. We attributed 1 mortality (4%) to trampling by cattle. We also happened to find an unmarked fawn that had just been killed by a bobcat and added this mortality to our data. One of our collared fawns was never located after capture and therefore the fate is unknown. One contributing factor to 2011's low fawn crops and survival was probably the lack of precipitation. Fawn weights were extremely low in some areas and that is an indicator of poor nutrition, both in the does and the fawns.

SURVIVAL AND MOVEMENTS OF TRANSLOCATED PRONGHORN IN THE TRANS-PECOS REGION OF TEXAS

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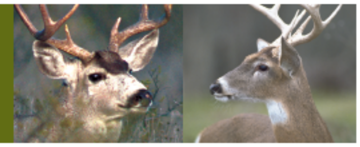
Translocating pronghorn antelope (*Antilocarpa americana*) has been a key component in improving and sustaining pronghorn populations in the western United States especially those areas where pronghorn were nearly extirpated in the early 1900s. Unfortunately, many pronghorn translocations were not monitored, as a result; little information is available for resource managers to understand the survival and movements of pronghorn following a translocation. Recently, pronghorn in the Trans-Pecos (e.g. Marfa Plateau) have suffered large population declines with little indication on the causes of the decline. In response, we captured 200 and released 194 pronghorn (176 F, 18 M) in February 2011 on 5 release sites in the Marfa Plateau. To monitor mortality and investigate limiting factors affecting their survivability as well as investigating post-release behavior; 80 (40%) pronghorn were equipped with either GPS (15 F, 13 M) or VHF (47 F, 5 M) radio-collars. GPS radio-collars were designed to attain 1 location/hr with a 300-day battery life. The objectives of this study were to 1) monitor survivability and determine sources of mortality, and 2) analyze spatial characteristics exhibited by translocated pronghorn following a translocation which included dispersal from initial release site and 3) quantify and assess home range establishment and movements. As of June 2012, 69 (86%) mortalities have occurred for radio-collared pronghorn. Causes of mortality were transport (*n*=3; 4%), capture myopathy (*n*=8; 11%), predation (*n*=17; 20%), car collisions (*n*=2; 3%), Haemonchosis (*n*=2, 3%) and unknown causes (*n*=37; 45%). In the first 4 weeks following initial release, 21 (30%) mortalities occurred with transport, capture myopathy, and predation being the main causes. Mortality occurrences were highest following initial release and during times of persistent drought. As range conditions worsened, pronghorn were forced to increase their movements and expand their home range sizes for available forage. However, immediately following precipitation; survival significantly improved among translocated pronghorn. Mortality data has also shown higher mortality rates in older-aged animals (4-5 years old) averaging 4.32 years old compared to those currently alive at 3.56 years old. In addition to survival, we assessed the behaviors and movements of the translocated pronghorn antelope. The average dispersal distance for each of the 5 release sites was 5.77, 6.75, 6.8211.52, and 15.85 km in the 300 days following translocation. In the first 24 hours, dispersal averaged 1.38, 2.91,5.35,

5.92,and 8.7 km. The differences in dispersal for each release site suggests habitat and resource availability, fences, resident pronghorn, and other factors influenced the degree of dispersal exhibited. Home ranges were measured by utilizing 100% Minimum Convex Polygon (MCP) and Fixed Kernal Density Estimator (KDE) at both 95% and 50% contours. Home range sizes when utilizing 100% MCP were 131.28 km^2 with KDE 95% and 50% being 83.82 and 16.59 km^2, respectively. Pronghorn movements averaged 306.96 m/hr with diurnal and nocturnal movements averaging 491.64 and 274.81 m/hr. respectively. In addition, we found as temperatures increased, so did the movements and activity exhibited by the translocated pronghorn. Home range sizes and movements were most influenced by forage availability, life-cycle events, and environmental conditions. Understanding the limiting factors to the survival of translocated pronghorn and their movements following release is critical to restoring pronghorn in areas of dwindling populations. Further, this information will allow wildlife managers in the future to understand how pronghorn initially adapt to a new environment and assist in improving monitoring and site preparation efforts for future translocations. As populations continue to decline in the Trans-Pecos, translocations will serve as a vital tool in sustaining and recovering these pronghorn populations in the future. Therefore, ensuring greater survival and understanding their behavior for future restoration efforts is essential.

Appendix

CHRONIC WASTING DISEASE FACT SHEET



Chronic Wasting Disease (CWD) is a neurological disease in deer, elk, moose and other members of the deer family, known as "cervids." The disease was first recognized in 1967 in captive mule deer in Colorado, and has since been documented in captive and free-ranging deer in 21 states and two Canadian Provinces. This disease presents numerous challenges for state wildlife agencies across North America. Of concern is the potential for significant declines within deer, elk, or other susceptible cervid populations. In addition, CWD could have indirect impacts on hunting, hunter participation, and economic benefits derived from big game hunting. In Texas, hunting is a $2.2 billon economic engine, supporting many rural towns across the state.

Because eradication is nearly impossible once CWD becomes established in a population, it is imperative that a sound CWD management program is established to reduce the severity of implications resulting from the disease. Of course, disease prevention is the best approach to protect cervid populations and prevent social and economic repercussions. Texas Parks and Wildlife Department (TPWD) and Texas Animal Health Commission (TAHC) have developed a cooperative CWD management plan to guide both agencies in addressing risks, developing management strategies, and protecting big game resources from Chronic Wasting Disease (CWD) in captive or free-ranging cervid populations.

What is Chronic Wasting Disease (CWD)?

Chronic Wasting Disease belongs to a family of diseases known as Transmissible Spongiform Encephalopathies (TSE) or prion diseases. Other TSEs include bovine spongiform encephalopathy (BSE) in cattle, scrapie in sheep, feline spongiform encephalopathy (FSE) in cats in Europe, and Creutzfeldt-Jakob disease (CJD) and a new variant (vCJD) in humans. While CWD is similar to BSE ("mad cow disease"), there is no evidence that CWD can be transmitted to people. CWD, which is 100% fatal with no known cure, is believed to be transmitted through prions, or misfolded proteins that attack the nervous system of the host. These prions accumulate in the brain, spinal cord, eyes, spleen, and lymph nodes of infected animals, but are found ubiquitously throughout the animal.

How does it spread?

CWD can spread through natural movements of infected animals, and transportation of infected animals or carcasses. Deer and other cervids may become infected with CWD by animal-to-animal contact or by animal contact with a contaminated environment. Prions are shed from infected animals in saliva, urine, blood, soft-antler material, feces, or from the decomposition of an infected animal which ultimately contaminates the soil and environment in which deer and other cervids live. Prions shed into the environment can remain capable of infecting other animals for many years. As more deer become infected over time the number of infectious CWD prions in the environment increases. Once CWD prions become established in an area, deer are more likely to become exposed to CWD by coming into contact with prions shed in the environment. Conversely, in areas where CWD is not well established, and where the environment is relatively uncontaminated, animal to animal contact is the most likely source of transmission of CWD to uninfected deer.

There are no known management strategies to mitigate the risk of indirect transmission of CWD once an environment has been contaminated with infectious prions. This makes eradication of CWD almost impossible in areas where CWD may have been established for a long period before initial detection. Removing infected animals from the population early in an outbreak offers some hope of limiting the geographic extent of the disease as well as prevalence within the deer population by reducing direct transmission between animals and limiting the potential for environmental contamination.

Where has it been found?

CWD has been detected in captive and free-ranging deer and elk in 21 states and two Canadian Provinces: Colorado, Wyoming, Saskatchewan, South Dakota, Nebraska, Montana, Wisconsin, New Mexico, Minnesota, Oklahoma, Illinois, Alberta, Utah, New York, West Virginia, Kansas, Michigan, Virginia, Missouri, North Dakota, Maryland, Iowa and Texas.

How can you tell if a deer has CWD?

The disease cannot be diagnosed by symptoms alone since some toxic and other neurologic afflictions can cause the animal to exhibit similar symptoms. A portion of the brain or lymph nodes found in the throat of an animal must be tested to confirm if the animal in question is infected with CWD. Unfortunately, there is no live-animal test to detect CWD. Symptoms of infected animals include: emaciation, excessive salivation, lack of muscle coordination, difficulty in swallowing, and excessive thirst and urination. Clinically-ill animals may have an exaggerated wide posture, may stagger and carry the head and ears lowered, and are often found consuming large amounts of water. However, as previously noted, these symptoms are similar to numerous toxic or neurological afflictions so diagnosis cannot be made by symptoms alone.

What should I do if I see a deer that shows symptoms of CWD?

Accurately document the location of the animal and immediately contact the nearest TPWD Wildlife Division or Law Enforcement Division office or call TPWD headquarters in Austin toll-free at (800) 892-1112 and enter 5 for wildlife and 1 for general wildlife information. Or contact TAHC toll-free at (800) 550-8242. Do not attempt to touch, disturb, kill or remove the animal.

Is CWD dangerous to humans?

Epidemiologists with the Federal Center for Disease Control and Prevention in Atlanta, Georgia, and along with the Colorado Department of Public Health and Environment, have studied CWD and have found no evidence that CWD poses a serious risk to humans or domestic animals. Years of monitoring in the affected area in Colorado has found no similar disease in people or cattle living there. The World Health Organization (WHO) has likewise advised that there is no current scientific evidence that CWD can infect humans. However, as a precaution, the WHO advises that no part of a deer or elk with evidence of CWD should be consumed by people or other animals.

What precautions should hunters take?

Health officials advise hunters not to consume meat from animals known to be, or believed to be, infected with CWD or any other disease. Since it's not always apparent that a deer may be carrying a disease, hunters should take simple precautions such as wearing latex gloves when field dressing carcasses, and washing hands and instruments thoroughly with a 50/50 chlorine bleach and water mixture after field dressing is complete. Another precautionary recommendation is to bone out meat and avoid the central nervous system (e.g., brain and spine). Finally, when taking deer to a game processor, hunters may consider requesting their animals be processed individually, without meat from other animals being added to meat from your animal.

Can I have deer venison tested?

Deer "venison" cannot be tested; only brain and lymph node tissues can be tested to detect the presence of CWD. Texas Veterinary Medical Diagnostic Laboratory (TVMDL) can test appropriate samples for CWD at the owner's expense. If you wish to have your harvested animal tested, please DO NOT freeze the head. The tissue sample must be removed soon after harvest. The entire head (it is acceptable to remove the antlers and the top of the skull) may be chilled overnight in a water-tight container and shipped to TVMDL. It is advisable to contact the lab (979-845-3414) before you send the sample. Arrangements can also be made through your local veterinarian to collect the appropriate tissue sample and store it in formalin. Once the sample is stored in formalin, it can be sent by regular post. TPWD biologists will be collecting tissue samples from hunter-harvested deer at meat processors and check stations located throughout the state.

What can hunters do?

Hunters should report any suspected cases of CWD to the TPWD or TAHC immediately. Proper disposal of carcasses is recommended for big game harvested in any area identified as a Containment Zone or High Risk Zone, in order to minimize the risk of spreading CWD via infected carcass parts to other areas of the state. Unused carcass parts could be disposed of at the site where the animal was harvested, in a landfill, or buried. Hunters should also support Texas surveillance efforts and should report any suspected movement or importation violations. Finally, hunters should become familiar with information about CWD as well as practical tips they may use in the field to help prevent spread of CWD and minimize any risks associated with the disease.

To learn more:

Texas Animal Health Commission: **www.tahc.state.tx.us**
Chronic Wasting Disease Alliance: **www.cwd-info.org**
Texas Parks and Wildlife Department: **www.tpwd.state.tx.us/cwd**
USGS National Wildlife Health Center: **www.nwhc.usgs.gov/disease_information/chronic_wasting_disease/index.jsp**
Department of Health & Human Services Center for Disease Control: **www.cdc.gov/ncidod/dvrd/cwd/**

To find the Texas AgriLife Office in your county, please go to:
https://agrilifepeople.tamu.edu/index.cfm/event/publicCountyList/

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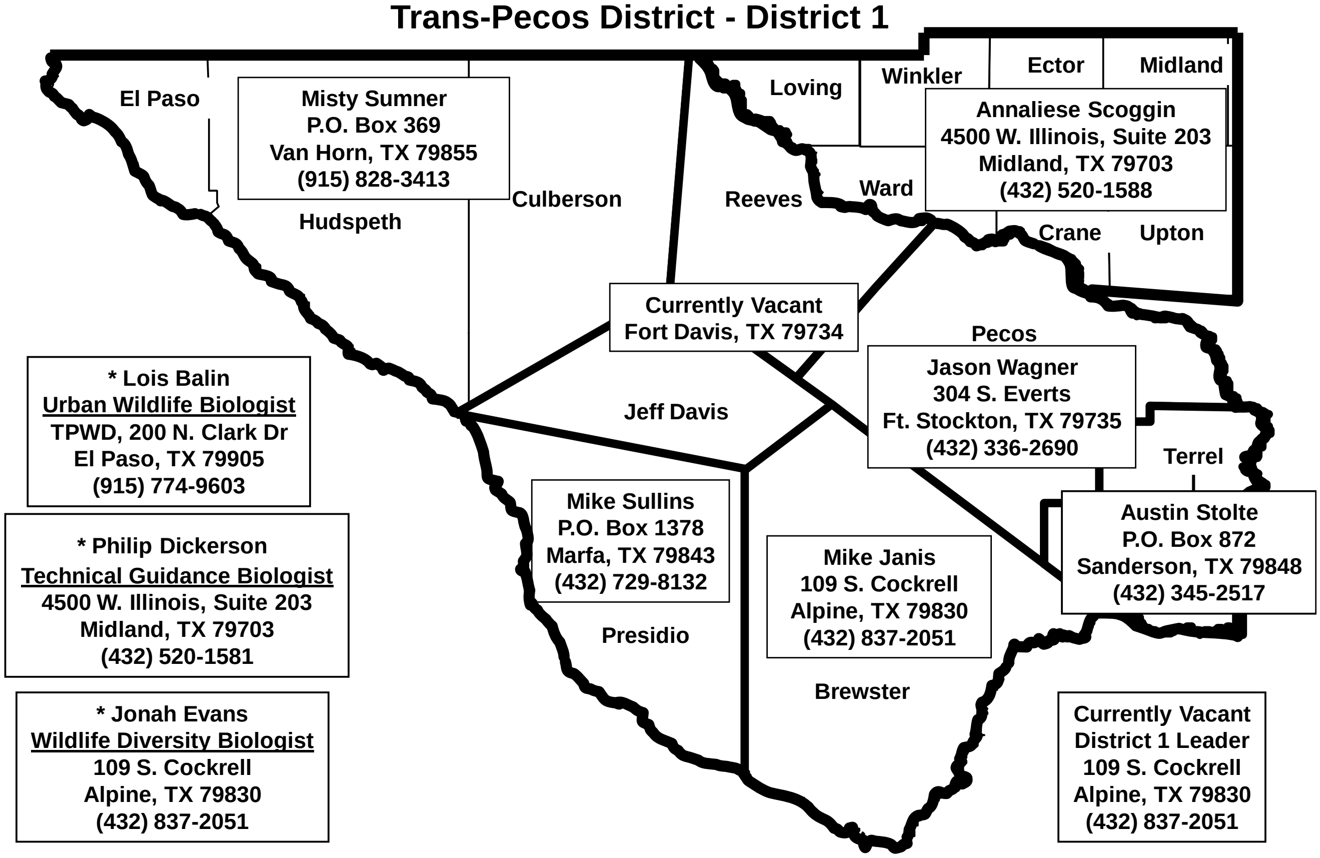
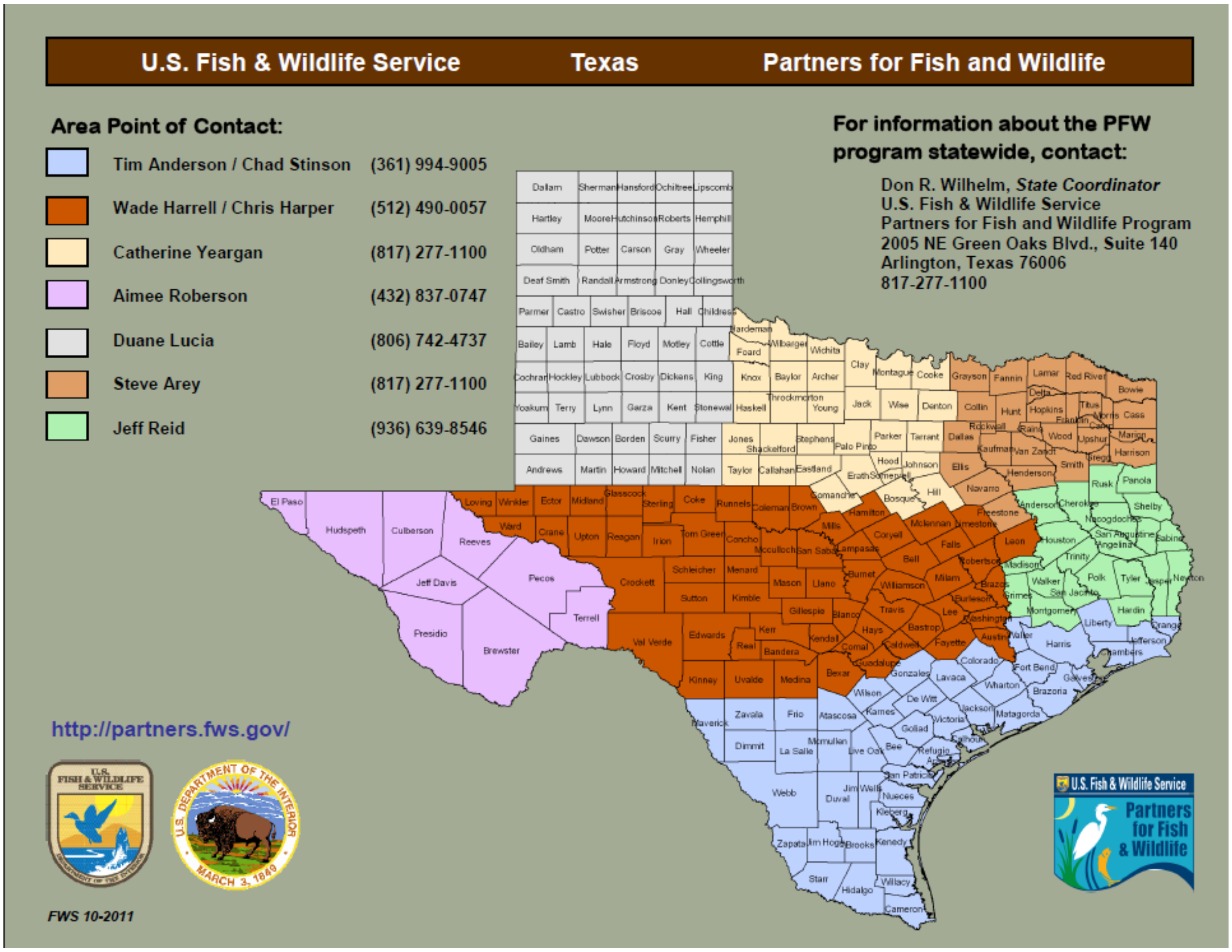
TPWD – Wildlife Division – Region 1
Trans-Pecos District - District 1



*** District-Wide Responsibility**

Updated: July 2012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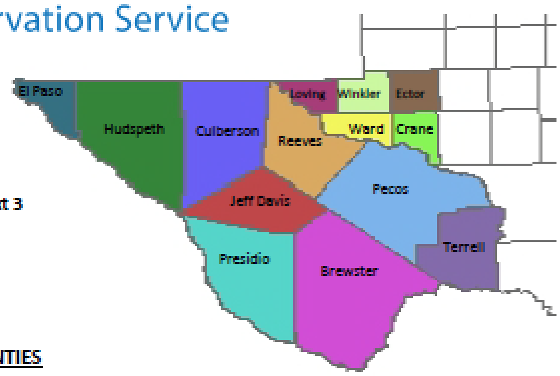

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