PERFORMANCE REPORT

As Required By

FEDERAL AID IN WILDLIFE RESTORATION ACT

TEXAS

Federal Aid Project No. W-127-R Segment 20

BIG GAME RESEARCH AND SURVEYS

Investigation of Diseases Occurring in Pronghorn

Principal Investigator: Shawn S. Gray

Clayton Wolf
Director
Wildlife Division

Carter Smith
Executive Director
Texas Parks and Wildlife Department

July 15, 2013

ABSTRACT

Hunter-harvested pronghorn from the Trans-Pecos ecoregion were collected during October 2009–2011, to evaluate parasite loads, titers to blue tongue (BT) and epizootic hemorrhagic disease (EHD), and copper and selenium levels. A total of 102, 95, and 49 pronghorn samples were obtained in 2009, 2010, and 2011, respectively. Prevalence of barber pole worms *(Haemonchus spp.)* was 94% (201 of 215 samples) for pronghorn that were analyzed.

In 2009, the average number of barber pole worms per pronghorn was 510 and ranged from 0–4,080. The mean in 2010 was 286 worms, which was 44% less than 2009, but parasite loads still ranged from 0–3,145. In 2011, worm loads increased to 381 worms per pronghorn. In June/July of 2011, fecal samples were collected from 64 individuals throughout the Trans-Pecos the fecal egg counts averaged 1,271 eggs/gram. In July of 2012, fecal samples were collected from 27 individuals and fecal egg counts averaged 173 eggs/gram. The McMaster's fecal flotation technique was significantly correlated to abomasal worm counts; therefore, was used to increase sample size and compare worm loads temporally.

The occurrence of BT and EHD titers were similar for each year. Copper levels in blood serum were highest in 2011 (0.84 ppm), while liver samples contained the highest copper concentrations in 2010 (8.56 ppm). Selenium levels from whole blood varied from 133.88 ppb in 2009 to 212.10 ppb in 2011.

Samples were also taken from Panhandle pronghorn in 2010, 2011, and 2013. In 2010, samples were collected from 20 harvested pronghorn during January. Average *Haemonchus spp.* load was 90.1 worms per abomasum. Copper levels from liver tissues averaged 10.41 ppm, and copper levels from blood samples averaged 0.40 ppm. The mean selenium level from whole blood samples was 164.4 ppb. In July 2011, fecal samples were obtained from 20 individuals with the average fecal egg count of 608 eggs/gram.

In February 2011 and January/February 2013, samples were collected from approximately 200 and 130 translocated pronghorn, respectively. Average fecal egg count for both years was very low. Average copper levels were 0.74 ppm with mean selenium levels being 208.43 ppb in 2011. Average copper, selenium, and iron levels for 2013 were 0.63 ppm, 283 ppb, and 2.1 ppm, respectively. The prevalence of titers for BT was 87% and 50.5% for EHD in 2011 with increasing prevalence in 2013. A total of 198 samples were tested for brucellosis in 2011 with none having the disease.

In 2013, a commercial dewormer was given to 93 translocated pronghorn. Parasite monitoring, post-release, was done by fecal sample collection. Fecal samples were collected from treated, untreated, and local animals with no difference between fecal egg counts between groups.

Fawns were captured from 4 disease sampling units throughout the Trans-Pecos in 2010 and 2011. A total of 60 fawns were captured and collared during May–

June each year. Average fawn weight was 5.1 lbs in 2010 and 8.4 lbs in 2011. Mean fawn age at time of capture was about 11 days old.

A total of 52 mortalities and 8 surviving fawns were recorded. Predation accounted for 92.3% (48/52) of the mortality for collared fawns. Coyote predation was 25.0% (13/52), whereas bobcat predation averaged 30.8% (16/52).

PERFORMANCE REPORT

State:_____Texas_____   Project Number:_____W-127-R-20_____

Project Title:_____Big Game Research and Surveys_____

Program:_____Big Game_____

Project Title:_____Investigation of Diseases Occurring in Pronghorn_____

Period Covered:_____May 1, 2012 through April 30, 2013_____

I. Objective:

Simpson et al. (2006) found a strong relationship between precipitation and pronghorn demography (e.g., abundance and productivity). However, precipitation does not appear to be the only factor affecting pronghorn numbers in the Trans-Pecos. Our objectives were to (1) determine the prevalence of *Haemonchus spp.* and other diseases in pronghorn in the Trans-Pecos, (2) establish baseline levels of *Haemonchus spp.* and other diseases for pronghorn in the Panhandle (a likely source for restoration efforts), (3) evaluate the resistance and origin of *Haemonchus spp.* affecting pronghorn, and (4) monitor the survivability of pronghorn fawns in the Trans-Pecos.

II. Background:

Historically, pronghorn (*Antilocapra americana*) were distributed over approximately two-thirds of Texas including all areas west of the 97th meridian (Buechner 1950) (Figure 1). Today pronghorn populations are restricted to the Chihuahuan Deserts (Trans-Pecos), High Plains, Southwestern Tablelands, and Edwards Plateau Level III ecoregions (Figure 1, 2). These ecoregions lie within the Trans-Pecos (Chihuahuan Deserts), Panhandle (High Plains and Southwestern Tablelands), and Possum Kingdom (northwestern Edwards Plateau) wildlife regulatory districts. The Trans-Pecos district supported approximately 60–70% of the state's pronghorn, with numbers reaching a high of 17,000 animals during the wetter years of the mid-1980s. With few exceptions, the pronghorn population in the Trans-Pecos has been in a steady decline since the 1980s and recently has fallen below the 1938 estimate of 3,888 pronghorn which triggered a restoration effort beginning in 1939.

Following an 8-month drought in the Trans-Pecos during 2008, TPWD documented a significant die-off of adult pronghorn where an estimated 2,000–3,000 pronghorn succumbed in one of the most productive regions of west Texas (e.g., the Marfa Plateau). Given the relationship between precipitation and pronghorn demography, the 2008 die-off was not surprising. However, in 2009, biologists were not able to attribute the continued decline to precipitation-mediated variables alone. Specifically, the first half of 2009 brought timely and abundant precipitation, which provided ideal habitat conditions with abundant

forage (forbs and browse) and cover (perennial grasses) for a population recovery. Surprisingly, pronghorn did not respond to the excellent habitat conditions and population productivity and abundance fell even further. A mean fawn:doe ratio of 13:100 was recorded with a population estimate of 6,000 animals (near record lows) in 2009.

In spring/summer 2009, two necropsies were conducted on pronghorn from the region. A host of physiological and anatomical factors were evaluated, but the presence and abundance of barber pole worms (*Haemonchus* spp.) was note worthy.

Research conducted during the late 1960's in the Trans-Pecos documented the presence of *Haemonchus spp.*; however, they were not thought to be of concern. Investigators concluded the pronghorn herds were extremely clean of external parasites and diseases because of the relatively dry climate helping to prevent the spread of diseases (Hailey 1986).

Haemonchus spp. is one of the most highly prolific parasitic nematodes afflicting both domestic and wild ruminants causing deleterious effects to the animal, entire populations, and animal wildlife industry (McGhee et al. 1981, Newton and Mann 1999). As a prolific breeder, a single female worm produces about 10,000 eggs per day and larvae can rapidly accumulate on pastures as the prepatent period (length of time between infection of host and parasite maturity) is between 17 to 21 days (Prichard 2001, Zajac 2006).

The life cycle of *Haemonchus spp.* involves an adult female in the abomasum ingesting a blood meal and laying eggs daily that are subsequently passed in the host's fecal material (Zajac 2006). Fecal material provides the eggs protection from environmental conditions and optimal temperature and moisture for further development (O'Conner et al. 2006). As the first-stage larva forms and hatches from the egg, larvae feed on bacteria and undergo two molts before reaching the infective third larvae stage (L3; Zajac 2006). The optimal conditions for development of *Haemonchus spp.* eggs into infective larvae occur at 73°F and 70% fecal moisture content, yet can still occur at a range between 50°F to 96°F (O'Conner et al. 2006, Zajac 2006). However, it should be noted that development can be accelerated if temperatures and moisture content increased or decreased when conditions are less than optimal (O'Conner et al. 2006). Once L3 stage development is complete and in the subsequent presence of rain, larvae make their way out of the fecal material and migrate onto forage to be later ingested (O'Conner 2006, Zajac 2006). L3 stage *Haemonchus spp.* are considerably less susceptible to unfavorable climatic conditions and is thought to be attributed to their migratory behavior. The population size of *Haemonchus spp.* on a pasture is considered much greater than the number of parasites within a single ruminant (Prichard 2001). As the infective larvae are ingested, *Haemonchus spp.* molts once more into the L4 stage and shed their protective 3rd stage larvae sheath in the abomasum.

Severe outbreaks of *Haemonchus spp.* infection are most often reported to occur during warm summer rains, among young, non-immune animals, immunocompromised adult animals, or animals exposed to high levels of

parasites (Zajac 2006). Because of the prevalence in many ruminants and reproductive success in tropical and sub-tropical areas, or regions with summer-dominant rainfall, *Haemonchus spp.* encompasses an enormous environmental range of suitable habitat (O'Conner et al. 2006).

Although a majority of all grazing ruminants are infected with stomach worms, only sub-clinical and clinical effects of disease are observed under heavy worm burdens. Clinical signs of disease involve weight loss, diarrhea, bottle jaw, protein loss across the gut wall, anemia, weakness, and death (McGhee et al. 1981, Simpson 2000, Zajac 2006). *Haemonchus spp.* has been responsible for numerous infections on a wide variety of ruminants, commonly and most often reported in domestic ruminants such as sheep, goats, and cattle (McGhee et al. 1981, Lichtenfels et al. 1994, Zajac 2006). *Haemonchus spp.* has also been documented in wild ruminants such as white-tailed deer (*Odocoileus virginianus*), bighorn sheep (*Ovis canadensis mexicana*), and pronghorn (Allen et al. 1970, McGhee et al. 1981, Lichtenfels et al. 1994, Newton and Munn 1999). Because *Haemonchus spp.* is found in livestock and wildlife there is cross-transmission potential.

The ability for *Haemonchus spp.* to infect a wide variety of hosts with little geographic impediment allows for great genetic diversity, as well as a high rate of mutation (Prichard 2001). Furthermore, in combination with the use of a broad-spectrum and frequent use of chemical treatment, widespread resistance in *Haemonchus spp.* populations to anthelmintics exists. Chronic problems in the sheep and goat industry have emerged because of the increased resistance of *Haemonchus spp.* to wormers and other treatments. The sheep industry estimates a loss of >$100,000,000/year from the treatment of *Haemonchus spp.* (Newton and Mann 1999).

Therefore, the infection of pronghorn in west Texas with *Haemonchus spp.* poses a series of concerns for the population and future management. However, further research/monitoring/investigation of host-parasite interaction is imperative to make sound decisions on methods of control or prevention to be utilized.

Along with the recent decline and high concentrations of *Haemonchus spp.*, the Trans-Pecos has also experienced extremely low fawns crops. The average fawn crop in the Trans-Pecos for 2008–2012 was 17%, approximately half of the long-term mean.

Copper levels are tied to productivity in some free-ranging ruminants (Zimmerman et al. 2008). Copper deficiencies in deer cause enzootic ataxia, weight loss, and infertility (Puls 1994). Selenium levels have also been tied to infertility in small ruminants. O'Gara and Yoakum (2004) reviewed several studies on Cu and Se levels in pronghorn and concluded that in general the most productive herds had the highest levels of these trace elements.

Blue tongue has been documented to adversely affect pronghorn in Wyoming during the 1970s and 1980s (Thorne et al. 1988). Positive titers for BT and EHD have been reported for mule deer in west Texas. Pittman (1987) reported prevalence of BT for mule deer at Black Gap WMA at 76.7%. On Sierra Diablo

WMA, Waldrup et al. (1989) reported prevalence of BT and EHD in mule deer at 25% and 20%, respectively. Prevalence of BT and EHD antibodies for aoudad on Big Bend Ranch State Park was at 56% and 33%, respectively (TPWD unpublished data). In Arizona, Heffelfinger and Olding (1997) found 78.5% of 288 hunter-killed pronghorn tested positive for exposure to BT.

Many studies have shown that predation is the major cause of fawn mortality, and with low pronghorn numbers across the Trans-Pecos, predation may be more significant than normal (Beale and Smith 1973). Although pronghorn have high reproductive potential given adequate nutrition. In fact, pronghorn may begin breeding as early as fawns; however, 16 months is usually the earliest (O'Gara and Yoakum 2004). Pronghorn have the ability, during good range conditions, to produce healthy twins. In northern regions, yearlings generally produce twins 90% of the time, and does 2 years old and older twin 99% of the time (Edwards 1958). In order to accomplish this, pronghorn habitat must meet the necessary requirements. Recent low fawn production in the Trans-Pecos is having negative impacts on pronghorn populations. Determining the cause of these low fawn crops is significant in sustaining a viable population.

A primary assumption of radio-telemetry studies is that radio-marking does not affect the animals' behavior, survival, or reproductive success (Holt et al. 2009). We selected a lightweight, self-adjusting collar used for young ungulates described by Keister et al. (1988). For a pronghorn fawn, a collar should weigh no more than 5% of their total body weight, which is about 4.2 ounces (119 grams). Our study collars weighed only 68 grams and fell off fawns once growth exceeded adjustment of collar. Since there is a risk of abandonment, we used cryptic collars.

Study Area

In the Chihuahuan Desert (Trans-Pecos) ecoregion, pronghorn principally reside in the Chihuahuan Desert Grassland Level IV ecoregion, which ranges in elevation from 3,500–5,500 feet and receive 10–18 inches of annual precipitation (Figure 3). Rainfall is from monsoonal events peaking during the months of July–September. The average growing season is about 190–240 days. Dominate plant species include black, blue, and sideoats grama (*Bouteloua* spp.), bush muhly (*Muhlenbergia porteri*), beargrass (*Nolina arenicola*), tobosa grass (*Pleuraphis mutica*), and galleta (*Pleuraphis jamesii*), with scattered creosotebush (*Larrea tridentata*), tarbush (*Flourensia cernua*), acacias (*Acacia* spp.), yucca (*Yucca* spp.), and cacti (*Opuntia* spp.) (Griffith et al. 2007, LBJ School of Public Affairs 1978).

Land use practices vary across the Trans-Pecos, but most rangelands in pronghorn habitat are used for livestock grazing (cattle production). Seven disease sampling units have been delineated in the Trans-Pecos where we have initiated surveillance (Figure 8).

Panhandle pronghorn populations are found in the High Plains and Southwestern Tablelands Level III ecoregions with most occurring in the Canadian/Cimarron High Plains, Rolling Sand Plains, and Canadian/Cimarron Breaks Level IV

ecoregions (Figure 2, 3). These ecoregions are characterized by short to mid-grass vegetation communities with plant species such as gramas, buffalograss (*Buchloe dactyloides*), bluestems (*Andropogon, Bothriochloa, Schizachyrium* spp.), sand dropseed (*Sporobolus cryptandrus*), Havard (shin) oak (*Quercus havardii*), Sand sagebrush (*Artemisia filifolia*), yucca, mesquite (*Prosopis glandulosa*), skunkbush sumac (*Rhus trilobata*), and Chickasaw plum (*Prunus angustifolia*) being the most common. In addition, large areas of croplands dominate the landscape with a scattering of playa lakes. Elevations vary from 2,300–4,500 feet. Average rainfall is between 16–23 inches and is more bimodal than the Chihuahuan Desert ecoregion with the greatest amount of precipitation falling in the spring and fall months. The average growing season is from 170–200 days (Griffith et al. 2007, LBJ School of Public Affairs 1978).

III. Procedures:

A. Disease and Parasite Sampling Methods:

Blood Samples

Pronghorn were sampled during the 9-day hunting season using hunter harvested animals to evaluate potential infertility of pronghorn; mineral tests (copper and selenium) were performed on blood and liver samples. All pronghorn sampled were bucks.

Upon harvest, blood samples were collected from pronghorn via cardiac puncture and blood was transferred to non-additive tubes. Blood tubes, were then transported to Sul Ross State University (SRSU). Within 24 h of collection, blood was centrifuged and serum samples extracted and froze. Sera were analyzed by the Texas Veterinary Medical Diagnostic Laboratory (TVMDL) in College Station, Texas for measurement of copper (Cu) and selenium (Se) levels, as well as for the presence of antibodies for BT and EHD.

Parasite Counts

Abomasum samples were collected from harvested pronghorn during evisceration. Once the abomasum was located, 2 strings were used to tie off the abomasum above (below omasum) and below (above duodenum of small intestine) the abomasum (Figure 4). After knots were secured, the abomasum was cut and removed from the body cavity. Abomasums were placed in clean labeled plastic bags and transported to SRSU lab on ice. Upon arrival to SRSU lab, abomasums were cut laterally and contents were rinsed carefully into a collection vessel. During 2009, abomasums were quantified using a sampling technique; however, in 2010 and 2011 a total count was applied to each abomasum. For sampling, contents of the wash were gently stirred and 200 ml of fluid content was collected off the surface. All nematodes found in the supernatant and abomasums were counted and stored in alcohol (or formalin) for species identification.

Since several species of nematodes may occur in pronghorn and identification of different *Haemonchus* species may be difficult, we preserved samples of the parasitic community in formalin for identification by the USDA's Animal Parasitic

Diseases Laboratory in Beltsville, Maryland (Hoberg et al. 2001). *Haemonchus spp.* experts identified and archived these samples in the laboratory.

To better understand the possible host and origin of *Haemonchus spp.*, we sent fecal samples off to the University of Georgia's College of Veterinary Medicine to have the DrenchRite® Larval Development Assay (LDA) test performed. LDA is an *in vitro* test for the detection of anthelmintic resistance in the major gastrointestinal nematode parasites infecting small ruminants (sheep, goats, llama, alpaca, etc). LDA evaluates the resistance to benzimidazole (Valbazen, Panacur, Safeguard), levamisole (Totalon, Levasol, Prohibit), and avermectin/milbemycin (Ivomec, Cydectin). Nematode resistance to all drug classes listed above are tested in each assay from a single pooled fecal sample. For LDA, nematode eggs are isolated from feces and placed into the wells of a microtiter plate containing growth media and anthelmintic. The concentration of anthelmintic required to block development of nematode larvae is related to the effectiveness of the drug in the animal.

Tissue Samples

Samples were taken from carcasses, labeled and placed in clean plastic bags and stored on ice. Liver samples were sent with sera to TVMDL and analyzed for copper levels. A tongue sample was also obtained from all pronghorn for a concurrent population genetics study. In 2010 and 2011, a tooth was also extracted for age estimation by centum annuli and a kidney was collected from all pronghorn sampled for a nutritional index in 2010 and 2011. Kidney fat index was calculated according to Riney (1955) in equation below:

 KFI = [(weight of fat/weight of kidney)] x 100

Horn Measurements

Horn measurements (horn length, base circumference, prong length, and spread) were also taken from each harvested pronghorn in 2010 and 2011. All horn measurements were taken on the animal's right horn and collected in inches. Horn length was measured by running a cloth tape along the center of the outer curve from tip of horn to a point in line with the lowest edge of base. Base circumference was estimated by measuring around base of horn at a right angle to long axis with the cloth tape always being in contact with the lowest circumference of the horn in which there were no serrations. Prong length was documented by stretching cloth tape from the tip of the prong along the upper edge of the outer curve to the horn; then continuing around the horn to a point at the rear of the horn. Spread was measured at a right angle to the centerline of the skull, at widest point between main beams.

Fecal Samples

Fecal samples were extracted directly from the rectum of all hunter-harvested pronghorn. Eight to 12 pellets were placed in a plastic bag, stored on ice, and transported to SRSU lab. Fecal samples were analyzed using the McMaster's fecal flotation technique to determine the amount of nematode eggs per gram of feces.

B. Fawn Mortality Methods:

In order to assess fawn mortality and survival we captured and collared neonate pronghorn in 4 (Marathon, Marfa NW and SW, Hudspeth) of 7 disease sampling units, throughout the Trans-Pecos (Figure 6). Collars with VHF technology and motion-sensitive mortality sensors set to 4 hours of inactivity were used for monitoring fawns. Full necropsies were performed to determine cause of death on all fawn mortalities. Pronghorn fawns were monitored daily using standard radio-telemetry techniques. Fawns were monitored for 3 months or until collars fell off.

Capture and Handling

The nighttime capture method was used for this study. Fawns were captured shortly after parturition using 4-5 personnel, hoop-nets, spotlights, and vehicles. A hoop-net, 3 feet in diameter and a 10-foot extractable handle, was the tool of choice when catching pronghorn fawns (Hailey 1968).

During the fawning season, field staff traveled the study sites by vehicles and glassed for pronghorn fawns. Once fawns were located, teams congregated on the fawning areas using vehicles and/or all-terrain vehicles (ATVs) and spotlights. After fawns were seen at night, researchers approached fawns on foot or with ATVs. Fawns were blindfolded to reduce struggling and capture related stress (Byers 1997, Cancino et al. 2005).

An effort was made to minimize capture and handling times to reduce scent transfer and capture myopathy potential. Rubber gloves were used by handlers to decrease the amount of scent transferred to the fawn. We attached an ATS M4210 Expandable Breakaway Collar that was self-adjusting, lightweight (68 grams), and programmed with a 4-hour mortality sensor to each fawn captured. We also measured neck circumference, total body length, and new hoof growth. Using a regression equation ($Y = 0.893549 + 2.3419353\ Xi$; $P < 0.01$), fawn ages were estimated using the new hoof growth measurements (Tucker 1979) (Figure 5).

Monitoring

Monitoring of fawns was time intensive because of the need for researchers to get to deceased fawns before carcasses were scavenged. Using standard radio-telemetry techniques fawns were monitored each day from the ground to document survival or mortality. If a mortality signal was detected, the researcher would locate the fawn and perform a thorough investigation to determine cause of death. The immediate area around the carcass was examined for clues, then the carcass was brought to the Veterinarian Technology Lab at SRSU for a complete necropsy. After the first 14–21 days of monitoring, monitoring was reduced to 3–4 times per week.

Survival

Handling mortality or abandonment of fawns could have occurred because of transfer of human scent or the visual effect of a collar, which may have increased the chances of abandonment. For this reason, and to reduce possible trapping stress bias, fawns that perished within the first 3 days of trapping and tagging were eliminated from survival analyses (Cannon 1993). Mortalities occurring after the 3-day period were treated as normal events and used in analyses.

IV and V. Findings and Analysis:

A. Disease and Parasite Results:

Trans-Pecos

We collected samples from hunter-harvested pronghorn in October of 2009, 2010 and 2011, to evaluate parasite loads, the occurrence of BT, EHD, and copper and selenium levels. We obtained 102 pronghorn samples in 2009, 95 samples 2010 and 49 samples in 2011. Average prevalence rate of barber pole worms was 94%, that is 201 of the 215 samples that were analyzed had barber pole worms. In 2009, the average number of worms per pronghorn was 510 and ranged from 0 to 4,080 worms. The average in 2010 was 286 worms, which was 44% less than in 2009, but parasite loads still ranged from 0 to 3,145. In 2011, parasite numbers went back up and pronghorn averaged 381 worms per animal (Table 1). In 2010 and 2011, we used the McMaster's fecal flotation technique, which resulted in an average of 1,278 and 1,053 eggs/gram, respectively. The prevalence of BT was above 96% for each year. The prevalence of EHD was around 91% for both 2010 and 2011. Copper levels from blood sera increased between years. Average copper levels from liver samples increased from 2009 to 2010, but decreased in 2011. Selenium levels from whole blood increased throughout the study (Table 2). Normal levels for copper and selenium in pronghorn are still unknown at this time. However, it appears that mineral levels (at least copper) increased with improved nutrition from timely and favorable precipitation.

In June/July of 2011, fecal samples were collected from 64 individuals throughout the Trans-Pecos and the fecal egg counts averaged 1,271 eggs/gram. In July of 2012, fecal samples were collected from 27 individuals and the fecal egg counts averaged 173 eggs/gram (Table 1).

Panhandle

Samples were collected in January 2010 from 20 harvested pronghorn throughout 5 different herd units (4, 7, 10, 15, and 27) in the Panhandle. The average worm load was 90.1 worms per pronghorn, which was much lower than concentrations seen in the Trans-Pecos (Table 1). Copper levels from liver tissue averaged 10.41 ppm, and copper levels from blood samples averaged 0.40 ppm. Selenium levels from blood samples averaged 164.4 ppb (Table 2).

In February 2011, we collected fecal samples from 178 captured pronghorn that were to be translocated to the Trans-Pecos. We found the average fecal egg count to be 117 eggs/gram. During summer 2011, 20 fecal samples were collected from pronghorn in herd units 4, 7, 9, and 10 with an average egg count

of 608 eggs/gram. Panhandle fecal egg counts were significantly lower than Trans-Pecos estimates (Table 1). Blood was drawn and results were provided from almost all animals captured in February 2011 (n = 195 for Cu, n = 196 for Se). Average copper and selenium levels that we attained from blood samples were 0.74 ppm and 208.43 ppb, respectively. The prevalence of BT was 87%, where the prevalence of EHD was only 50.5% (Table 2). In addition, 198 samples were tested for brucellosis with all resulting in negatives.

In January/February 2013, samples were again collected from captured pronghorn moved to the Trans-Pecos. Fecal samples were obtained from 124 individuals. The average fecal egg count was 87 eggs/gram. Blood results were provided for all animals captured (n = 130 for Cu, Se, and Fe). Average copper level was 0.63 ppm with a mean selenium level of 283 ppb (Table 1). The average iron level was 2.1 ppm. The presence of antibodies for BT was 88.5% and 84% for EHD (Table 2).

A commercial dewormer (LongRange™; eprinomectin) was given to 93 of the 130 animals translocated to the Trans-Pecos. Post-release parasite monitoring was conducted by fecal sample collection. In March/April 2013, 19 fecal samples were collected from local pronghorn, which resulted in an average fecal egg count of 63 eggs/gram. Also, 4 samples were collected from unwormed, translocated individuals, which had a fecal egg count average of 38 eggs/gram. Another 16 samples were collected from wormed, translocated individuals who had an average fecal egg count of 91 eggs/gram.

Other Results

A. Species Identification and Drug Resistance:

Samples sent to the USDA's Animal Parasitic Diseases Laboratory in Beltsville, Maryland, showed that these pronghorn were carrying more than one species of *Haemonchus*. The laboratory reported *H. contortus* and *H. placei* in the pronghorn samples. The lab also reported mixed infections of these species in some hosts, and indicated that there may be evidence for the occurrence of hybrids of these species based on structural characteristics of the adult worms.

As for drug resistance, 4 commercial dewormers (Benzimidazole, Levamisole, Ivermectin, and Moxidectin) were tested and all had very good results reducing *Haemonchus spp.* loads. The worms showed very high susceptibility to all treatments; therefore, showed no resistance. This suggests that the *Haemonchus spp.* in pronghorn were of wild origin and not from livestock. If resistance was documented, then most likely the origin would have been from livestock because most livestock are treated for worms regularly.

B. Ages of Harvested Pronghorn:

Cementum annuli were used to estimate age of bucks harvested in 2010 and 2011 in the Trans-Pecos. The ages ranged from 2–13 and averaged 5.2 years of age in 2010. In 2011, ages ranged from 2–12 and averaged 5 years old, very similar to 2010 (n = 88, 2011; n = 39, 2012). Our data indicate that pronghorn

harvest is conservative in the Trans-Pecos and is more than adequate to produce trophy quality animals.

C. Nutrition Index:

Kidney fat index for 2010 was 13.7 and 8.9 for 2011. The Palmer Drought Severity Index (PDSI), a comprehensive measure of climatic dryness, indicated above average precipitation during 2010 and historic drought conditions in 2011 (NOAA 2012). The kidney fat index seemed adequate in providing a nutritional index for Trans-Pecos pronghorn during hunting season.

D. Horn Measurements:

Horn measurements were averaged for 2010 and 2011 for hunter-harvested bucks in the Trans-Pecos and compared by age classes. Ages were estimated by cementum annuli. Although, a small sample size was collected for each age class, data indicates no significant differences in all horn measurements by age class (Table 3). Data from other studies using cementum annuli for aging estimates report that greatest horn growth occurs from 4–6 years of age with many representatives in younger age classes (2–3) being similar to the peak horn growth age classes (4–6) (Brown et al 2002, Morton et al 2010, Zornes et al 2010).

E. Fawn Mortality Results:

In 2011, fawns were captured from 6 different ranches and 4 disease sampling units (Hudspeth, Marathon, and Marfa NW and SW) throughout the Trans-Pecos (Figure 6). A total of 26 fawns were captured and fitted with radio-collars from May 4–June 2. Average weight for fawns captured was 5.3 lbs with a range of 2.1–10.0 lbs. Mean neck circumference and total body length was 15.7 cm and 61.5 cm, respectively. New hoof growth averaged 4.97 mm.

Fawns were captured from 4 different ranches in 2 disease sampling units (Marfa NW and SW) in the Marfa Plateau in 2012 (Figure 6). A total of 34 fawns were captured from May 3–June 29 and fitted with radio-collars. The average weight of fawns caught was 8.4 lbs and ranged from 4.5–13.7 lbs. Mean neck circumference was 16.6 cm with body length averaging 62.2 cm. New hoof growth averaged 3.98 mm.

Mean age of fawns caught was about 11 days old in 2011. The youngest fawn caught was around 3 days old, while the oldest captured fawn was approximately 23 days old. Fawning dates were highly variable resulting in a relatively long fawning period (Figure 7). This may be caused from the diversity and distance between study sites. One study site was located in Hudspeth County, which appeared to fawn first, followed by the other 3 study sites. The lack of precipitation throughout the winter and spring may have also been an important factor in later fawning dates in 2011.

In 2012, average age of fawns captured was about 10 days old. The youngest fawn was 3 days old while the oldest fawn was 27 days. The 2012 fawning period was significantly longer than 2011 (Figure 7). This could be because of extreme drought conditions during the previous breeding season.

In 2011, of the 26 fawns collared 53.8% were twins, and the dam was present during capture 84.6% of the time. Out of the 34 fawns caught in 2012, 56% were twins and the dam was present 97% of the time. A higher percentage could have been twins, but were not found during capture or had perished before capture effort occurred.

A total of 25 mortalities, a lost transmitter deemed a mortality, and 1 surviving fawn was recorded in 2011. Predation accounted for 92% or 23/25 of the mortalities. Only 1 mortality was believed to be caused by possible abandonment. Coyote predation accounted for 28% (7/25), whereas bobcat predation was similar at 24% or 6/25. Another 40% (10/25) was recorded as unknown predation (Figure 8). In these cases, the animal had either been dead too long to determine what type of predation had occurred or a bloody collar was all that was found. A bloody collar indicated that the animal was attacked by a predator, not simply scavenged after it had already died.

In 2012, 27 mortalities were recorded. Bobcat predation was highest of all predators accounting for 37% (10/27) of the mortalities. Coyote predation was second at 22% (6/27), while unknown predation was 15% (4/27). Other mortality factors totaled 26% (7/27), which included grey fox (2) and eagle (1) predation, abandonment (2), and unknown causes (2) (Figure 8, 9).

VIII. Prepared by: ___Shawn S. Gray___   Approved by: _____Amber Andel___

                          Program Specialist V   Federal Aid Coordinator

            Date: ___July 15, 2013___   ___Mitch Lockwood___

                                             Big Game Program Director

LITERATURE CITED

Beale, D. M. and A. D. Smith. 1973. Mortality of pronghorn antelope fawns in western Utah. Journal of Wildlife Management 37:343–352.

Beckmann, J. P., K. M. Berger, J. K. Young, and J. Berger. 2008. Wind and energy development –Pronghorn of the Upper Green River Basin–Year 3 Summary. The Wildlife Conservation Society.

Brown, D. E., W. F.Fagan, and R. E. Turner. 2002. Pronghorn horn sheath growth, age, and precipitation on a ranch in southern New Mexico. Proceedings of the Biennial Pronghorn Workshop 20:17–23, Kearney, NE.

Buechner, H. K. 1950. Life history, ecology, and range use of the pronghorn antelope in Trans-Pecos of Texas. American Midland Naturalist 43:257–354.

Byers, J. A. 1997. Mortality risk to young pronghorns from handling. Journal of Mammalogy 79:1416–1431.

Cancino, J., V. S. Sotomayor, and R. Castellanos. 2005. From the Field: Capture, hand-raising,and captive management of peninsular pronghorn. Wildlife Society Bulletin 33:61–65.

Canon, S. K., and F. C. Bryant. 1997. Home ranges of pronghorn in the Trans-Pecos region of Texas. Texas Journal of Agricultural and Natural Resources 10:87–92.

Edwards, W. C. 1958. A study of the reproductive potential and ovarian structures in the pronghorn antelope, *Antilocapra americana* (Ord) in Wyoming. M.S. thesis, University of Wyoming, Laramie. 63 pp.

Griffith, G., S. Bryce, J. Omernik, and A. Rogers. 2007. Ecoregions of Texas. Texas Commission on Environmental Quality, Austin, Texas. 134 pp.

Hailey, T. L. 1968. A handbook for pronghorn antelope management in Texas. FA report series number 20, Texas Parks and Wildlife Department, Austin, Texas.

Hatch, S. L., K. N. Gandhi, and L. E. Brown. 1990. Checklist to the vascular plants of Texas. Publication MP-1655, Texas Agricultural Experiment Station, Texas A&M University, College Station, Texas.

Heffelfinger, J. R. and R. J. Olding. 1996. Occurrence and distribution of blue tongue in pronghorn antelope. P-R Performance Report, Project W-53-M-47. Arizona Department of Game and Fish, Phoenix, Arizona. 12pp.

Hoberg, E. P., J. R. Lichtenfels, and L. Gibbons. 2004. Phylogeny for species of *Haemonchus* (Nemotoda: Trichostrongylodiea): Considerations for their evolutionary history and global biogeography among Camelidae and Pecora (Artiodactyla). Journal of Parasitology 90:1085–1102.

Holt, R. D., L. W. Burger, Jr., S. J. Dinsmore, M. D. Smith, S. J. Szukaitis, and K. D. Godwin. 2008. Estimating duration of short-term acute effects of capture handling and radiomarking. The Journal of Wildlife Management 73:989–995.

Keister, G. P. Jr., C. E. Trainer, and M. J. Willis. 1988. A self-adjusting collar for young ungulates. Wildlife Society Bulletin 16:321–323.

LBJ School of Affairs. 1978. Preserving Texas' natural heritage. Pages 17–24 *in* LBJ School of Public Affairs Policy Research Project Report 31. University of Texas at Austin, Texas.

Lichtenfels, J.R., P.A. Pilitt, and E.P. Hoberg. 1994. New morphological characters for identifying individual specimens of *Haemonchus* spp. and a key to species in ruminants of North America. Journal of Parasitology 80:107–119.

McGhee, M. B., V. F. Nettles, E. A. Rollor III, A. K. Prestwood, and W. R. Davidson. 1981. Studies on cross-transmission and pathogenicity of *Haemonchus contortus* in white-tailed deer, domestic cattle and sheep. Journal of Wildlife Diseases 17:353–364

Morton, K. A., P. F. Jones, and M. G. Grue. 2010. Pronghorn age and horn size in southern Alberta. Proceedings of the Biennial Pronghorn Workshop 24:146, Laramie, WY.

Newton, S. E. and E. A. Munn. 1999. The development of vaccines against gastrointestinal nematode parasites, particularly *Haemonchus contortus*. Parasitology Today 15:116–122.

National Oceanic and Atmospheric Administration. The Palmer drought severity index, ftp://ftp.ncdc.noaa.gov/pub/data/cirs/drd964x.pdsi.txt. (July 15, 2012).

O'Conner, L. J., S. W. Walkden-Brown, and L. P. Kahn. 2006. Ecology of the free-living stages of major trichostrongylid parasites in sheep. Veterinary Parasitology 142:1–15.

O'Gara, B. W. 1968. A study of the reproductive cycle of the female pronghorn (*Antilocapra americana* Ord). Ph.D. thesis, University of Montana, Missoula. 161 pp.

O'Gara, B. W. and J. D. Yoakum. 1992. Pronghorn Management Guides. Fifteenth Biennial Pronghorn Antelope Workshop. Rock Springs, Wyoming.

O' Gara, B. W., and J. D. Yoakum. 2004. Pronghorn: Ecology and management. University Press of Colorado, Boulder, Colorado. 903 pp.

Pittman, M. T. 1987. Mule deer reproduction. P-R Report number 51-W-109-R-10, Texas Parks and Wildlife Department, Austin, Texas.

Prichard, R. K. 2001. Genetic variability following selection of *Haemonchus contortus* with anthelmintics. Trends in Parasitology 17:445–453.

Puls, R. 1994. Mineral levels in animal health diagnostic data, second edition. Sherpa International, Clearbrook, British Columbia, Canada.

Simpson, H. V. 2000. Pathophysiology of abomasal parasitism: Is the host or parasite responsible? The Veterinary Journal 160:177–191.

Simpson, D. C., L. A. Harveson, C. E. Brewer, R. E. Walser, and A. R. Sides. 2007. Influence of precipitation on pronghorn demography in Texas. Journal of Wildlife Management 71:906–910.

Thorne, E. T., E. S. Williams, T. R. Spraker, W. Helms, and T. Segerstrom. 1988. Bluetongue in free-ranging pronghorn antelope (*Antilocapra americana*) in Wyoming: 1976 and 1984. Journal of Wildlife Diseases 24:113–119.

Tucker, R. D. 1979. Pronghorn antelope fawn mortality, home range habitat, and behavior in Brewster County, Texas. M.S. thesis, Sul Ross State University, Alpine, Texas.

Waldrup, K. A., E. Collisson, S. E. Bentsen, C. K. Winkler, and G. G. Wagner. 1989. Prevalence of erythrocytic protozoa and serologic reactivity to selected pathogens in deer in Texas. Preventive Veterinary Medicine 7:49–58.

Zajac, A. M. 2006. Gastrointestinal nematodes of small ruminants: Life cycle, anthelmintics, and diagnosis. Veterinary Clinics-Food Animal Practice 22:529–541.

Zimmermann, T. J., J. A. Jenks, D. M. Leslie, Jr., and R. D. Neiger. 2008. Hepatic minerals of white-tailed and mule deer in the southern Black Hills, South Dakota. Journal of Wildlife Diseases 44:341–350.

Zornes, M., P. Burke, B. R. Kroger, T. J., Ryder, and W. J. Rudd. 2010. Horn growth and age in harvested Wyoming pronghorn. Proceedings of the Biennial Pronghorn Workshop 24:144–145, Laramie, WY.

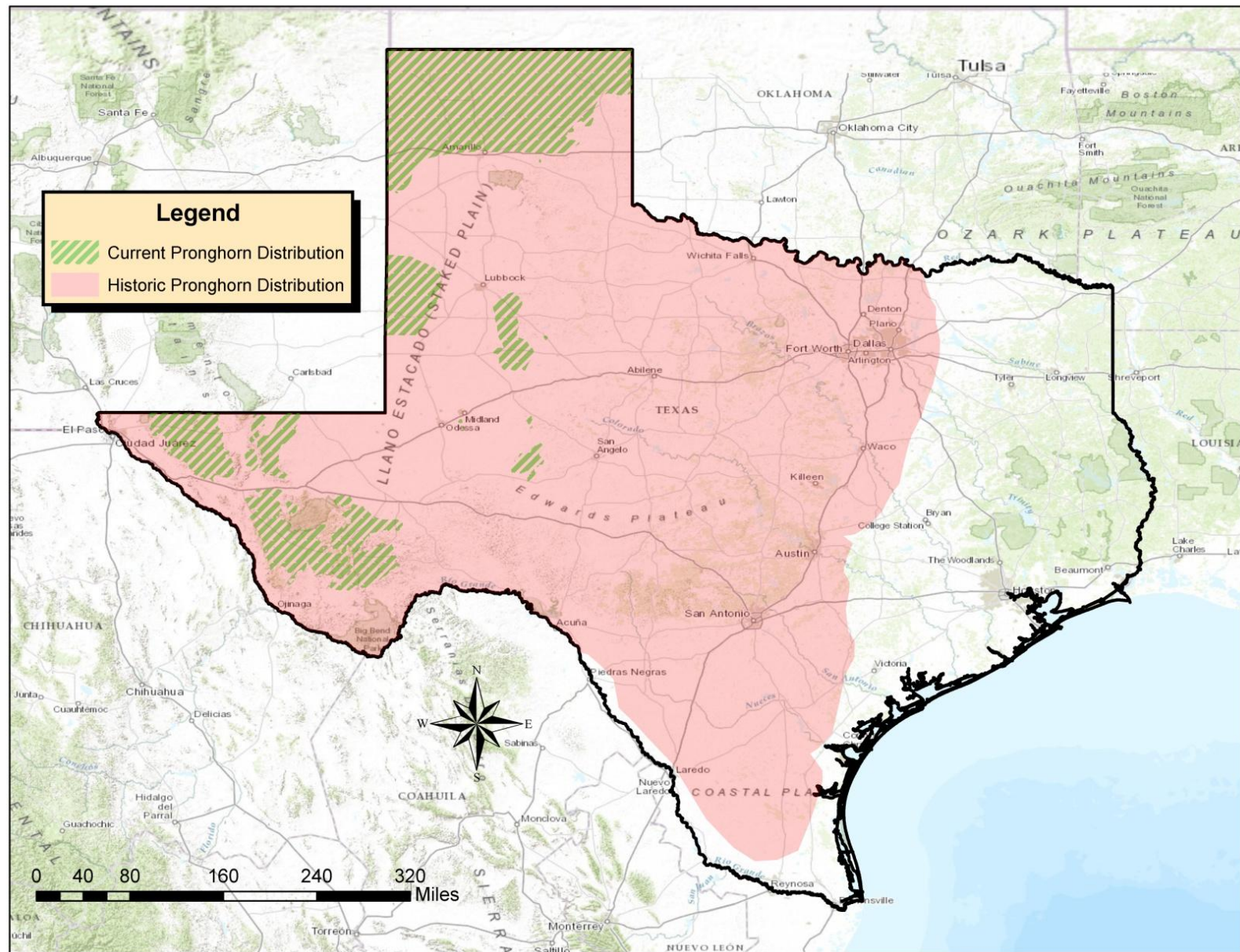Figure 1. Current and historic pronghorn distribution in Texas.

Legend
Current Pronghorn Distribution
Historic Pronghorn Distribution

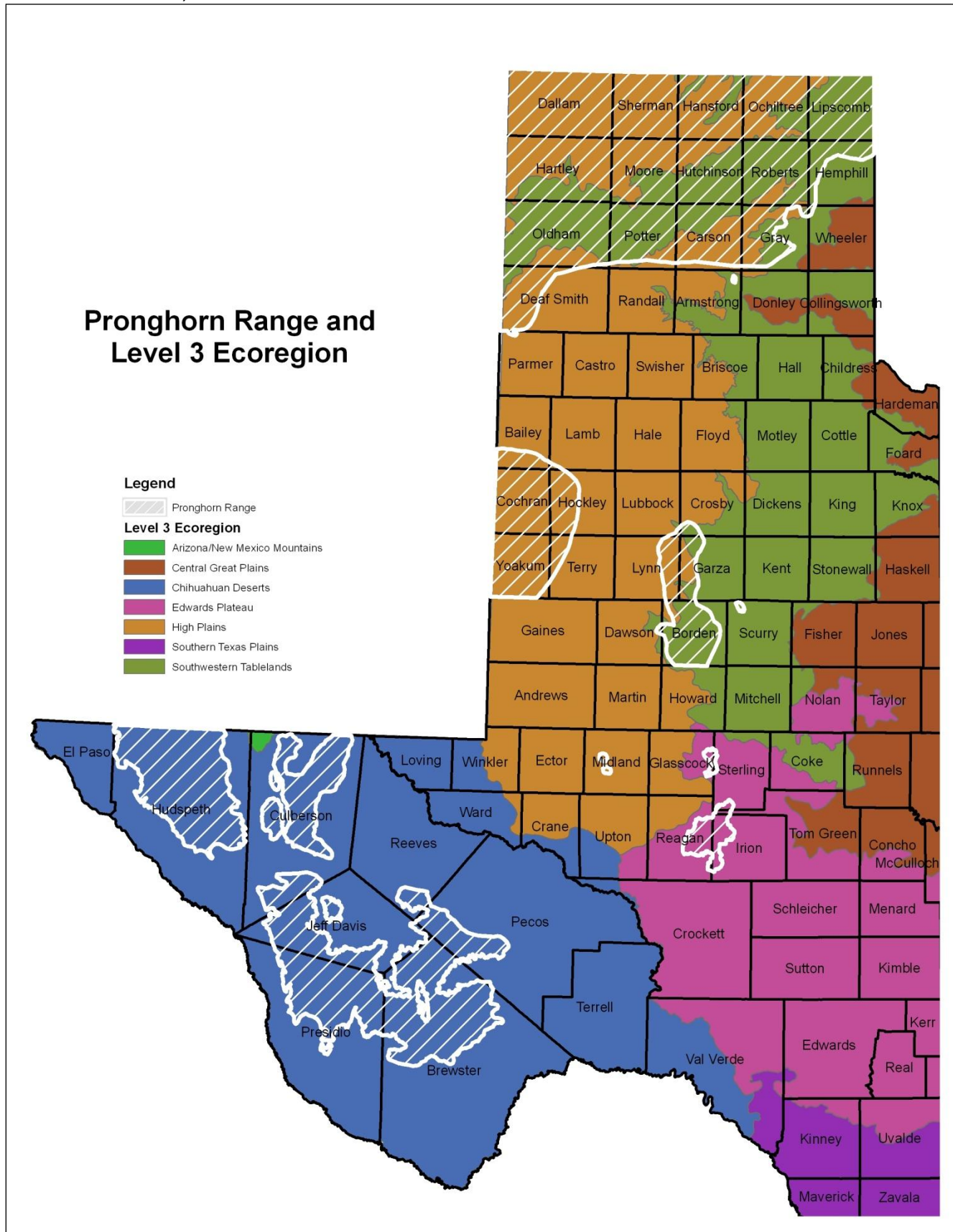Figure 2. Estimated current pronghorn distribution with Level III Ecoregions, 2011 (Revision of Griffith et al. 2007).

Pronghorn Range and Level 3 Ecoregion

Legend

Pronghorn Range

Level 3 Ecoregion

- Arizona/New Mexico Mountains
- Central Great Plains
- Chihuahuan Deserts
- Edwards Plateau
- High Plains
- Southern Texas Plains
- Southwestern Tablelands

Figure 3. Estimated current pronghorn distribution with Level IV Ecoregions, 2011 (Revision of Griffith et al. 2007).

Pronghorn Range and Level 4 Ecoregion

Legend

Pronghorn Range

Level 4 Ecoregion

- Arid Llano Estacado
- Balcones Canyonlands
- Canadian/Cimarron Breaks
- Canadian/Cimarron High Plains
- Caprock Canyons, Badlands, and Breaks
- Chihuahuan Basins and Playas
- Chihuahuan Desert Grasslands
- Chihuahuan Desert Slopes
- Chihuahuan Montane Woodlands
- Edwards Plateau Woodland
- Flat Tablelands and Valleys
- Limestone Plains
- Llano Estacado
- Low Mountains and Bajadas
- Montane Woodlands
- Northern Nueces Alluvial Plains
- Red Prairie
- Rio Grande Floodplain and Terraces
- Rolling Sand Plains
- Semiarid Canadian Breaks
- Semiarid Edwards Bajada
- Semiarid Edwards Plateau
- Shinnery Sands
- Stockton Plateau
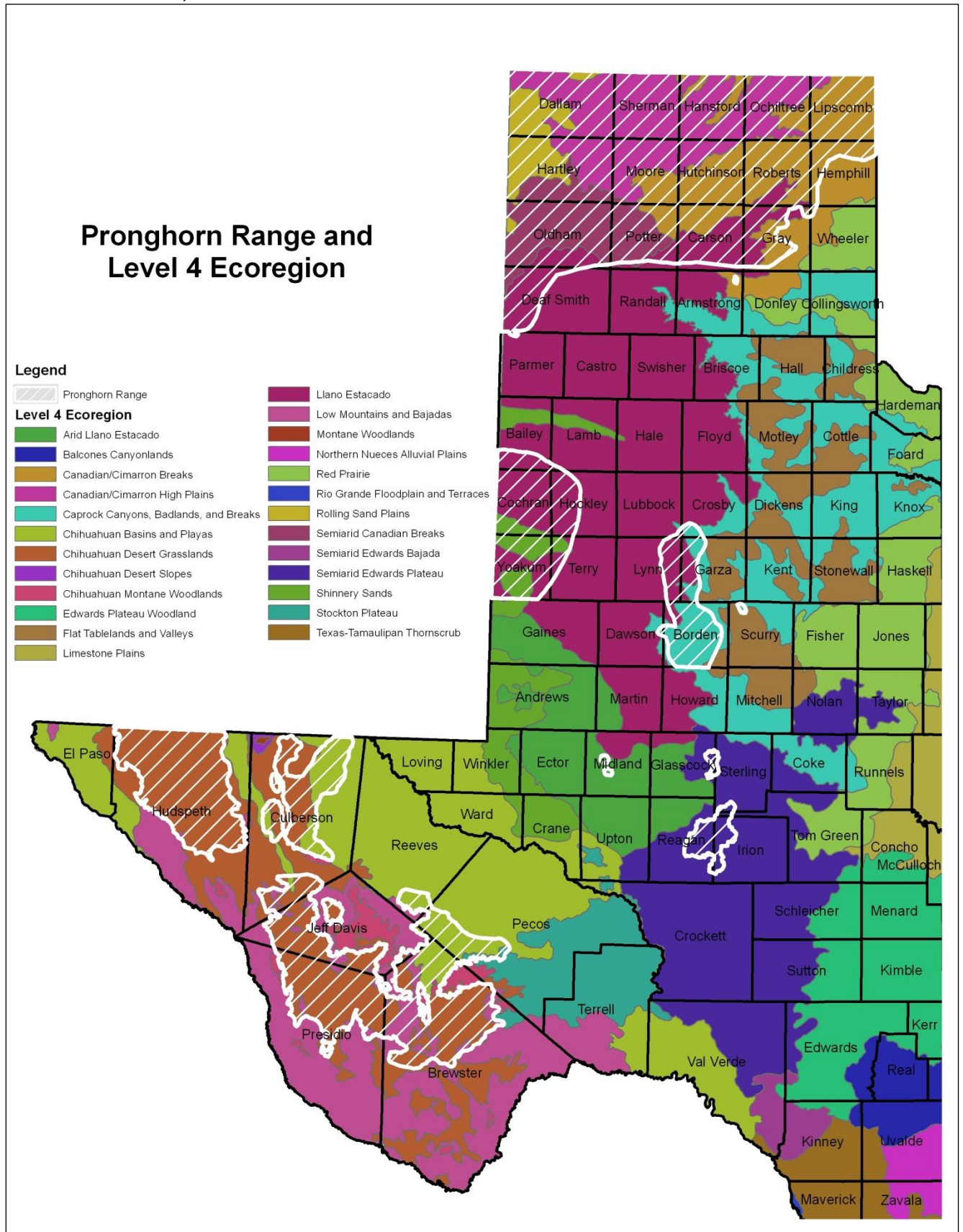- Texas-Tamaulipan Thornscrub

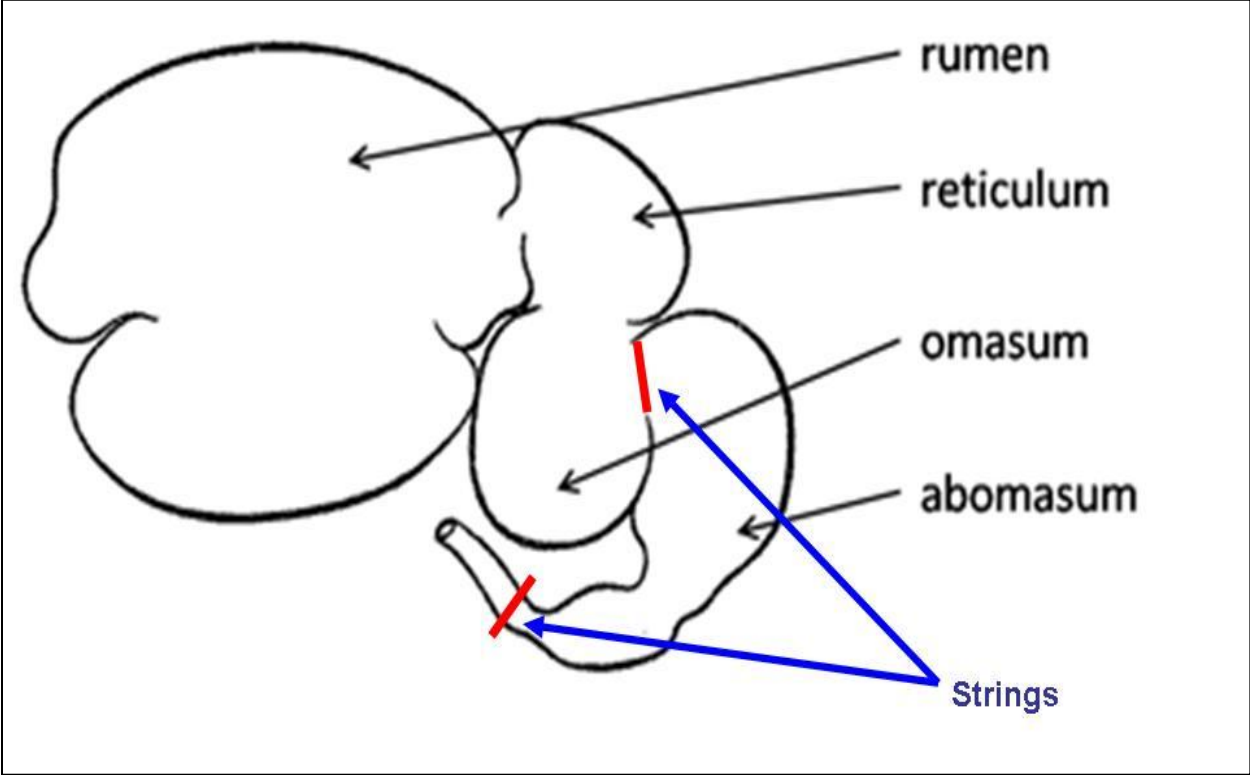Figure 4. Abomasum identification and collection model.

Figure 5. New hoof growth method used for aging neonate pronghorn.

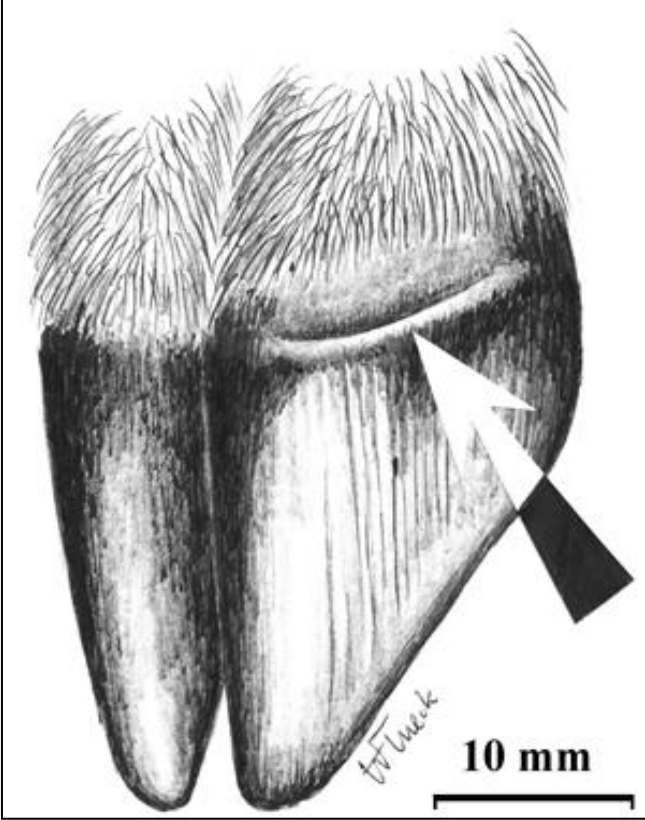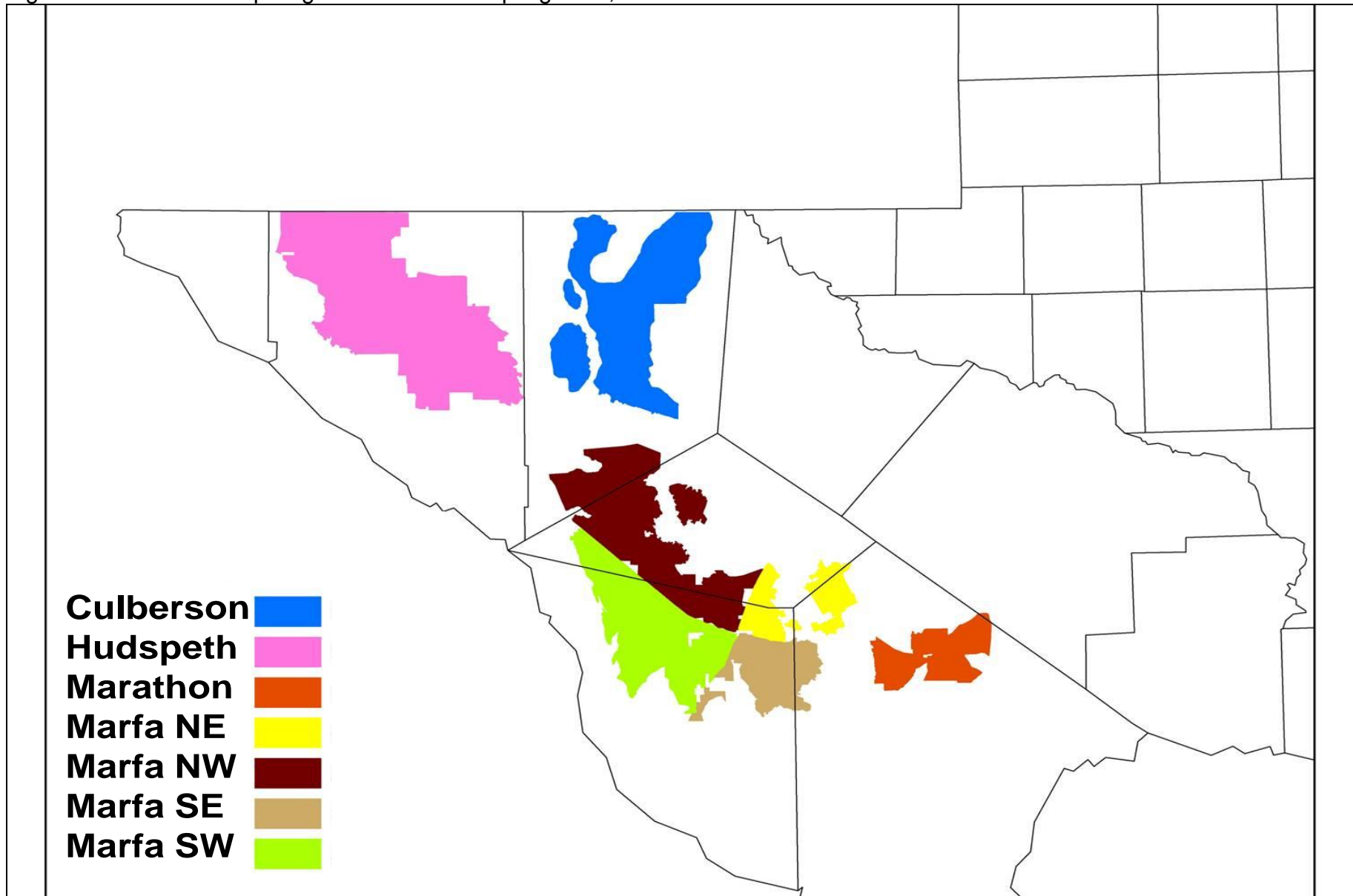Figure 6. Trans-Pecos pronghorn disease sampling units, 2009–2011.

Culberson
Hudspeth
Marathon
Marfa NE
Marfa NW
Marfa SE
Marfa SW

Figure 7. Pronghorn fawning dates throughout the Trans-Pecos, 2011–2012.
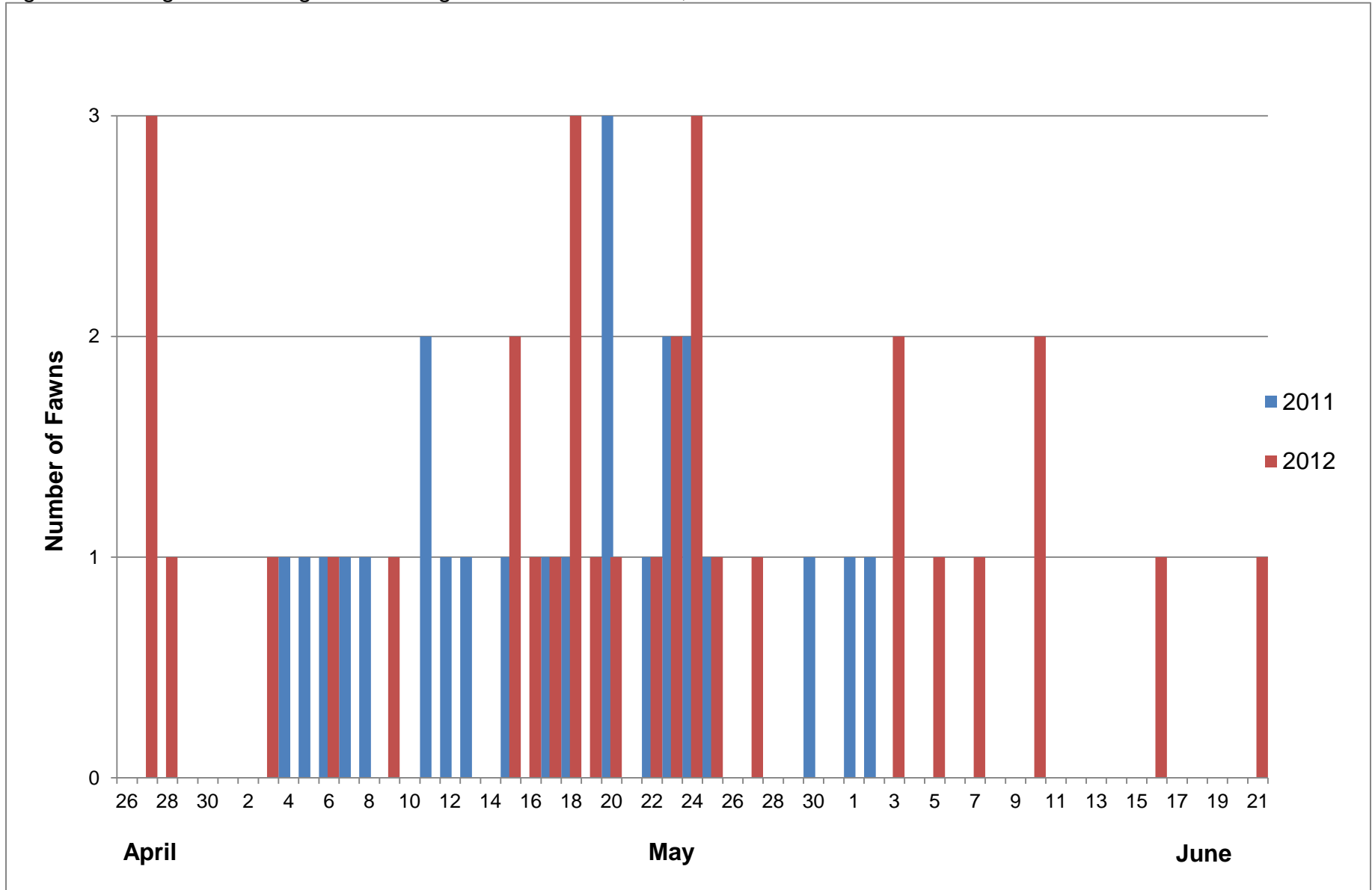
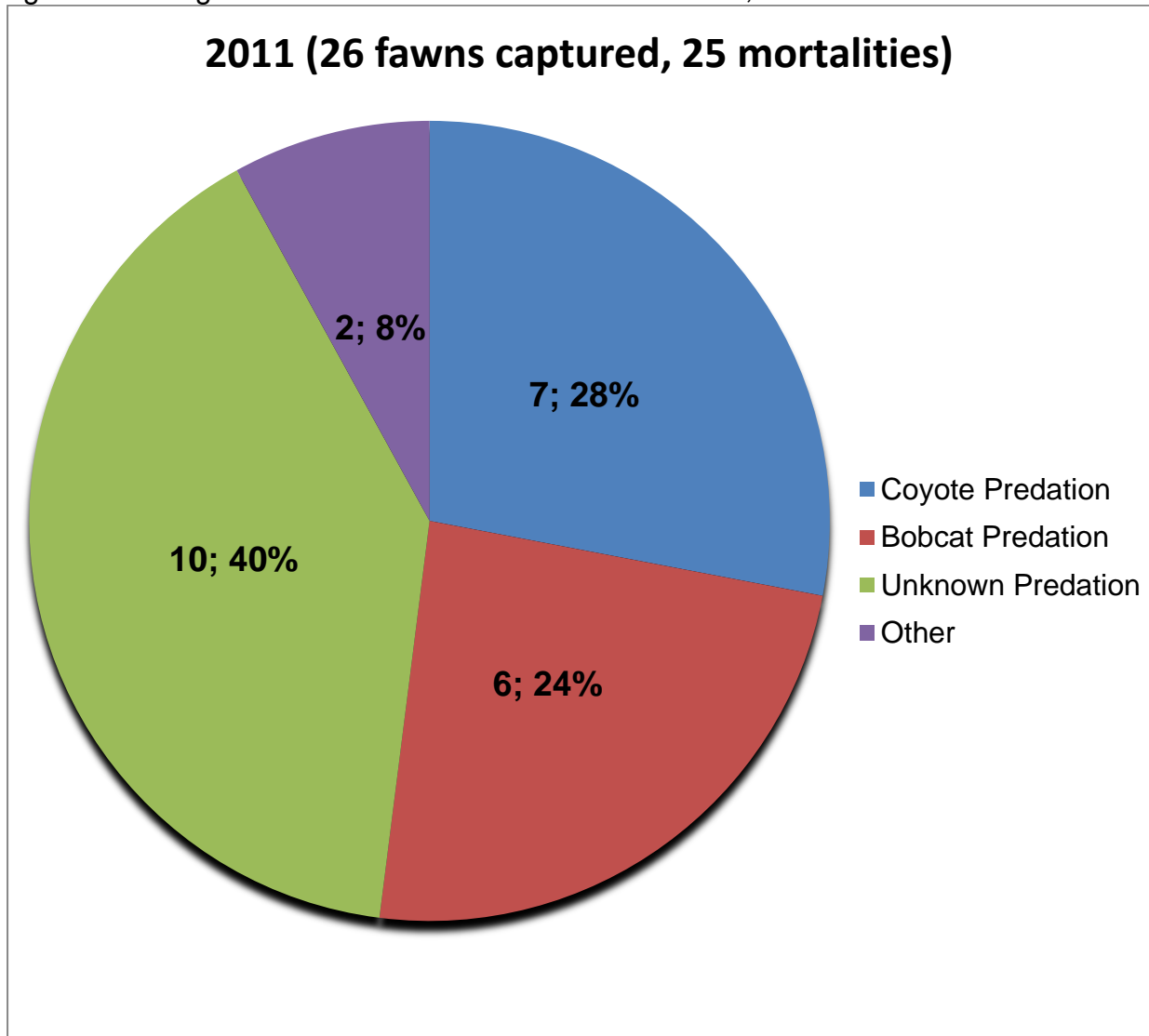Figure 8. Pronghorn fawn mortalities in the Trans-Pecos, 2011.

2011 (26 fawns captured, 25 mortalities)

- 7; 28%
- 6; 24%
- 10; 40%
- 2; 8%

Legend:
- Coyote Predation
- Bobcat Predation
- Unknown Predation
- Other

Figure 9. Pronghorn fawn mortalities in the Trans-Pecos, 2012.

2012 (34 fawns captured, 27 mortalities)

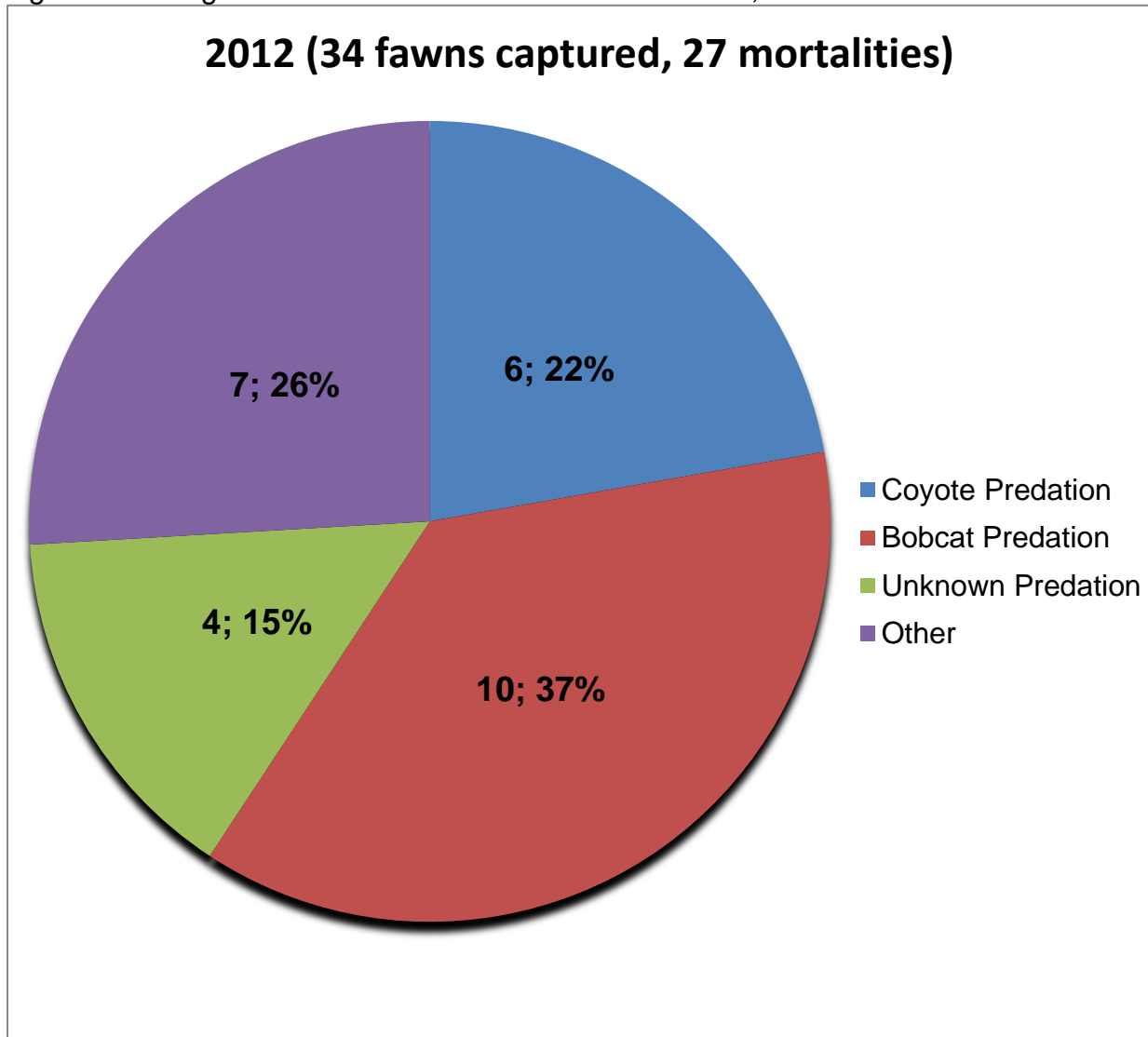- Coyote Predation
- Bobcat Predation
- Unknown Predation
- Other

Table 1. Average *Haemonchus* estimates in pronghorn abomasums and fecal material from the Trans-Pecos and Panhandle, 2009–2011.

Trans-Pecos			Panhandle		
Season/Year	Worm Counts (Abomasum)	Eggs/Gram (Fecal)	Season/Year	Worm Counts (Abomasum)	Eggs/Gram (Fecal)
Fall-2009	552	–	Winter-2009	90	–
Fall-2010	269	1,278	Fall-2010	–	–
Fall-2011	381	1,018	Winter-2011	–	117
Summer-2011	–	1,271	Summer-2011	–	608

Table 2. Average disease prevalence and mineral levels from pronghorn collected in Texas, 2009–2011.

Trans-Pecos Testing	2009 n = 102 Samples	2010 n = 95 Samples	2011 n = 49 Samples
EHD Prevalence (%)	89	92	93
BT Prevalence (%)	97	96	100
Cu Liver (ppm)	7.80	8.56	7.93
Cu Serum (ppm)	0.67	0.72	0.84
Se Blood (ppb)	133.88	176.98	212.10
Panhandle Testing	2010 (Harvested) n = 20 Samples	2011 (Captured) n = 200 Samples	2013 (Captured) n = 130 Samples
EHD Prevalence (%)	–	50.5	84
BT Prevalence (%)	–	87	88.5
CU Liver (ppm)	10.4	–	–
CU Serum (ppm)	0.40	0.74	0.63
SE Blood (ppb)	164.4	208.4	283

Table 3. Average horn measurements (inches) of hunter-harvested Trans-Pecos pronghorn bucks by age class, 2010–2011.

Age Class	Horn Length	Base Circumference	Prong Length	Inside Spread	Sample Size
2	14.75	5.88	4.50	15.00	2
3	13.63	5.66	4.33	10.06	13
4	13.51	5.56	4.46	10.47	24
5	13.61	5.92	4.31	10.31	39
6	13.44	5.86	4.46	10.26	25
7	13.30	5.64	4.11	10.91	11
≥8	12.81	5.75	4.22	10.70	8