Wildlife Research Highlights 2007

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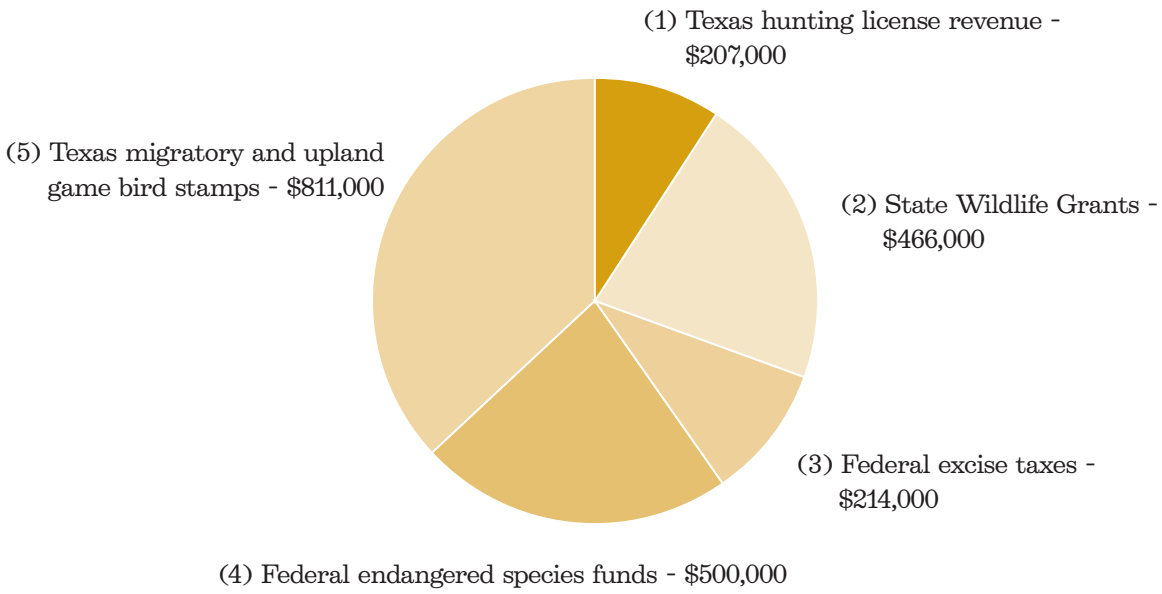
The Wildlife Division of the Texas Parks and Wildlife Department is continuing to develop a more coordinated approach to wildlife research. With ever-expanding responsibilities for wildlife management, the Wildlife Division has recognized the need for additional emphasis on wildlife research. Our primary objectives for conducting research are to seek answers for important management questions, train our staff, expand scientific knowledge, publish results and inform the public.

Each year, the Wildlife Division identifies its top research priorities, and research proposals on these topics are solicited from qualified department and university personnel. A multi-discipline research review committee selects the best proposals, contracts are prepared and projects are conducted. Department personnel take the lead on some of the projects; university personnel lead others. In cases where a university is selected to conduct the research, department biologist are selected to serve as field advisors, graduate committee staff and publication coauthors.

The Wildlife Division budgeted over $2,198,000 for 62 wildlife research projects during Fiscal Year 2007. Funding for this research has come from several sources, including (1) Texas hunting license revenue, (2) State Wildlife Grants, (3) federal excise taxes (Pittman-Robertson Act funds), (4) federal endangered species funds (Section 6), and (5) Texas migratory and upland game bird stamps.



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Mammals

Big Game

Cause-Specific Fawn Mortality of Sympatric Deer Species

Shawn Haskell, David Butler, Warren Ballard, Mark Wallace, Texas Tech University; Roy Welch, Clay Brewer, Mary Humphrey, TPWD

Crockett County, Texas, lies on the western edge of the Edward's Plateau and has populations of both desert mule deer (*Odocoileus hemionus*) and white-tailed deer (*O. virginianus*). Previous studies have shown high survival rates for adults of both species. TPWD and private landowners need additional information concerning rates of productivity and fawn survival in order to manage both species more effectively in areas of overlap.

In April 2004 and 2005 we captured 50 pregnant deer (25 of each species) and fitted them with radio collars and vaginal implant transmitters (VIT). We recorded body measurements, collected blood and DNA samples, and used ultrasound to determine pregnancy status and estimate body fat of does. In the wet years of 2004 and 2005, all does were pregnant. Most were pregnant with twins, and at least one mule deer carried triplets. In 2006, following a dry year, three does were barren, and a higher proportion were pregnant with singles.

When births occurred, we used the VIT frequency to locate the birth site and capture and fit fawns with expandable radio collars which allowed researchers to track the fawns and determine cause-specific mortality. We captured fawns from late May through mid-August. We captured 172 fawns within hours of birth. White-tailed fawns were more difficult to locate than mule deer fawns and comprised only 37% of our total fawn captures. Fawn survival was greater in 2004 (53% overall) than 2005 (36% overall); 2004 was one of the wettest years in West Texas history. In both years, white-tailed fawns had greater survival than mule deer. However, a drought persisted from autumn 2005 through autumn 2006. Data from 2006–2007 are preliminary but, as predicted, suggest much lower survival of white-tailed fawns this year with little change for mule deer fawns compared to 2005. In 2004 and 2005, mule deer fawns were more likely to die from sickness or starvation than white-tailed fawns, and white-tailed fawns were more likely to be killed by predators. The greater mortality of white-tailed fawns this year appears to be the result of additional sickness and starvation. Bobcats (*Lynx rufus*) are abundant at our study site, perhaps due to extirpation of larger predators such as coyotes (*Canis latrans*), and appear to kill at least 20% of white-tailed fawns. White-tailed maternal antipredator behavior may be fixed allowing small predators to experience relatively high success killing fawns. In contrast, mule deer behavior may be more flexible, and mule deer does seem to keep their fawns closer and together so they can actively defend them from small predators. High variability of juvenile recruitment in response to weather may indicate a stressed deer herd without top-down regulatory influences.

Funding provided by TPWD

Estimating Browse Utilization at Three Deer Densities with the Stem Count Index Method

Jimmy Rutledge, Ty Bartoskewitz, Alan Cain, Daniel Kunz, Evan McCoy, TPWD; Timothy Fulbright, Charles DeYoung, David Hewitt, Texas A&M–Kingsville; Don Draeger, Comanche Ranch

The Stem Count Index is used by TPWD to estimate use of browse plants. In this method, browses are classed according to palatability with first-choice plants the most palatable and third-choice plants the least palatable. The percentage of browsed twig tips is estimated on a minimum of 100 twigs/plant species. Our objective is to determine intensity of use of browse by the Stem Count Index in 81-hectare enclosures.

Research is being conducted on the Faith and Comanche Ranches near Carrizo Springs, Texas. Enclosures on each ranch contain 10, 25 or 40 deer, with one of each pair of enclosures supplementally fed with protein pellets. Use of browse species was estimated in February and August, 2004 and 2005, and January 2006.

Use of first- and second-choice browse species did not differ between enclosures where deer (*Odocoileus virginianus*) were supplementally fed and enclosures where deer were not supplementally fed on the five sampling dates. Use of third choice species was greater in enclosures where deer were not supplementally fed only in February 2005. Use of first-, second-, and third-choice browse species was generally greatest in high density enclosures. Results indicate use of second-choice browse species strongly correlated with deer density.

The Stem Count Index Method appears to be a reliable index of deer densities. Thus far, results show no evidence that supplemental feeding affects the indices of use estimated by the Stem Count Index Method.

Funding provided by Comanche Ranch, T. Dan Friedkin, Faith Ranch and the Neva and Wesley West Foundation

Evaluation of Eight Census Surveys for White-Tailed Deer Population Estimation

Kevin Schwausch, Mark Mitchell, Jason Carroll, Ryan Rietz, TPWD

Determining white-tailed deer (*Odocoileus virginianus*) abundance and populations characteristics on a tract of land is critical to good deer management. Estimates are especially important on small acreages enclosed by a game-proof fence, as low deer numbers and obstructed immigration and emigration might make the population especially susceptible to slight perturbations. Furthermore, a continuing decrease in average landholding size and the increasing interest by small landowners in various types of deer management programs has created a need for a reliable method of estimating deer populations on small acreages.

Our objective is to determine the accuracy and precision of abundance and sex/age ratio estimates derived from night spotlighting (traditional, distance sampling, ArcView), mobile surveys (traditional, ArcView), Hahn-line surveys (traditional), infrared-triggered camera counts, and blind counts of white-tailed deer by comparing the results of the survey methods to the known deer populations in a high-fenced enclosure. The

research will be conducted on Mason Mountain Wildlife Management Area, located in Mason County, Texas. Over a three-year period, the study will utilize one high-fenced white-tailed deer enclosure of 211 hectares. TPWD personnel will obtain white-tailed deer that will be trapped from private properties utilizing landowner contracted trappers in the Central Texas area each January–March of the study period. The enclosure will be stocked with a herd of known population size and composition. After the counts are conducted during August and September, all deer in the enclosure will be harvested to determine the known number of deer. Census results will then be compared to the actual known population.

In March 2006, the first population of deer was transported to the Mason Mountain enclosure. All survey methods were performed in August and September of that year. The known population for enclosure was determined upon completion of the harvest in November. To further the accuracy of the known population, the enclosure was flown with a department helicopter equipped with a Forward Looking Infrared system (FLIR). At the time of printing results were pending.

Funding provided by TPWD

Factors Affecting the Mating Success of White-Tailed Bucks

Randy DeYoung, David Hewitt, Texas A&M Kingsville; Mickey Hellickson, King Ranch, Inc.; Kenneth L. Gee, Samuel Roberts Noble Foundation; Mitchell Lockwood, TPWD

Recent research into the breeding success of white-tailed deer (*Odocoileus virginianus*) bucks using genetic parentage techniques has revealed that some long-held assumptions about buck breeding behavior are not necessarily true. For instance, more bucks are breeding than was previously thought, including some young bucks less than 3.5 years old. Second, a large percentage of twin litters are sired by more than one buck. Finally, the breeding success of individual bucks appears difficult to predict based on easily quantified physical characters, such as antler size. Because many deer management strategies make direct or indirect assumptions about buck breeding success, more information is needed to understand the white-tail breeding system. The overall goal of this research is to gain a better understanding of the factors influencing individual breeding success in a free-ranging population. We are using genetic parentage methods to assign paternity and reveal the relative influence of antler size, body size and age on breeding success. We are also studying fine-scale movements during the rut using GPS radio collars to reveal how buck behavior and movements relate to breeding success. The GPS data also will be used to assess the spatial scale that must be controlled to attain management goals. We anticipate that the information gleaned from this study will be useful for designing more efficient management plans or for predicting the effects of harvest on the physical attributes of deer populations.

Funding provided by TPWD, National Fish and Wildlife Foundation, Quality Deer Management Association, Texas A&M University–Kingsville, King Ranch, Inc., and the Samuel Roberts Noble Foundation

Feral Swine Interaction with Domestic Swine: Potential for Disease Transmission

Christy Wyckoff, Scott Henke, David Hewitt, Texas A&M–Kingsville; Wes Littrell, TPWD; Tyler Campbell, Kurt VerCauteren, USDA

Feral swine (*Sus scrofa*) are found in at least 233 of the 254 Texas counties, and their range continues to expand. With this expansion, conflicts between feral swine, humans and livestock increase. Feral swine are known carriers of several economically significant diseases that could be transmitted to disease free domestic swine. Our objectives were to (1) determine serum antibody levels to pseudorabies virus (PRV), swine brucellosis, porcine reproductive and respiratory syndrome (PRRS), and classical swine fever (CSF) in Texas feral swine populations, and (2) determine the frequency of feral swine contact with domestic swine. Our study sites were located ≤10 km from domestic swine facilities in southern Texas outside of Kingsville, and in eastern Texas outside of Palestine on the Gus Engeling and Big Lake Bottom WMAs, and outside of Diboll on industrial pine plantations. Prevalence of antibodies to brucellosis and PRV in feral swine was 11% and 30%, respectively. Feral swine from southern Texas were eight times more likely to have been exposed to PRV than brucellosis, whereas feral swine from eastern Texas were 1.3 times more likely to have been exposed to brucellosis than PRV. Seroprevalence of PRRS antibodies was low at 2% of the sampled feral population; this is the third recorded incidence of the disease in feral swine from the United States. All samples tested negative for antibodies to CSF. Of the 79 individuals collared, we recovered data from 37 animals. We documented seven (19%) radio collared swine that came within 100 m of domestic swine facilities, providing opportunity for disease transmission by fence line contact. Feral swine activity around domestic facilities was predominantly at night and away from brush areas. Thirty-three feral swine utilized habitat within 2 km of domestic swine, which is considered a threat to domestic swine health due to the potential of PRV and PRRS agents by aerosol transmission. From our data, we demonstrate that feral swine enter into contact zones with domestic swine and present opportunity for disease transmission.

Funding provided by TPWD and the National Wildlife Research Center/Wildlife Services/APHIS

Fawn Birth Site and Bed Site Microhabitat Parameters

David Butler, Warren Ballard, Mark Wallace, Shawn Haskell, Texas Tech University; Roy Welch, Clay Brewer, Mary Humphrey, TPWD

Crockett County, Texas, lies on the western edge of the Edwards Plateau and has populations of both desert mule deer (*Odocoileus hemionus*) and white-tailed deer (*O. virginianus*). Previous studies have shown high survival rates for adults of both species. TPWD and private landowners need additional information concerning rates of productivity and fawn survival in order to manage both species more effectively in areas of overlap.

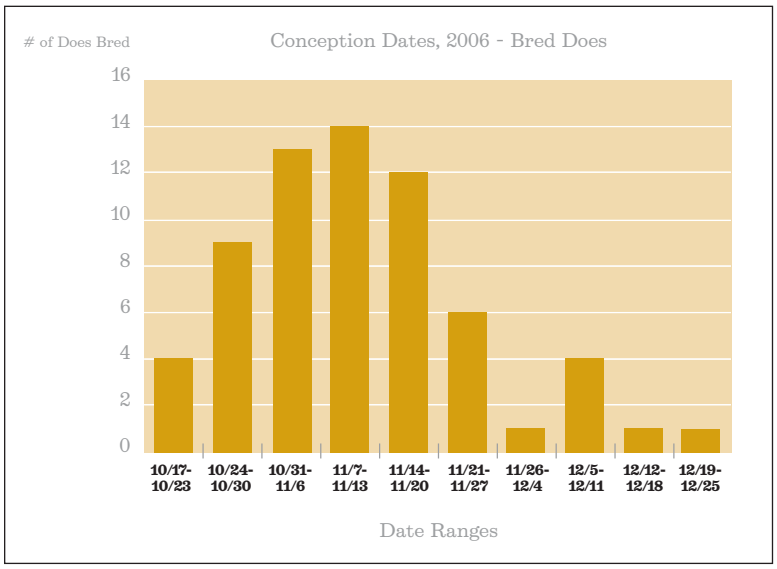
In April 2004 and 2005 we captured 50 pregnant deer (25 of each species) and fitted them with radio collars and vaginal implant transmitters (VIT). The VIT emitted a signal when it was expelled allowing biologists to locate birth sites. Once a VIT site was determined to be a birth site, we began searching for newborn fawns. Once a fawn was found and captured, it was fitted with an expandable radio collar used to visually locate bed sites. We returned to sites and recorded data concerning the vegetation. We used univariate tests to identify differences in birth site characteristics and parturition timing between the two species. We compared seven models using AICC parameter estimates and *P*-values to differentiate between fawn bed sites used by each species.

We found 13 and 32 birth sites and captured 51 and 56 fawns in summer 2004 and 2005, respectively. The timing of birth differed between species with white-tails birthing approximately one month earlier than mule deer. Mule deer birthed at higher elevations and on steeper slopes than white-tailed deer. Mule deer birthed under juniper (*Juniperus* spp.) more often than did white-tails. Birthing differed by vegetation type as well; mule deer birthed more commonly in juniper mix and yucca (*Yucca* spp.) mix, while white-tails used mesquite (*Prosopis glandulosa*) dominated areas. Elevation, height of cover, vegetation type, canopy shrub, and the interaction between vegetation type and canopy shrub were important in differentiating between fawn bed sites of each species. Mule deer fawns bedded at higher elevations, in shorter hiding cover and, more commonly, under juniper. White-tailed deer fawns commonly bedded under mesquite or in herbaceous vegetation. Vegetation type also differed by species with mule deer using more of the juniper mix and yucca mix, while white-tails used more mesquite mix types. We conclude that deer fawns partition habitat in similar fashion to adults.

Funding provided by TPWD

White-Tailed Deer Breeding Chronology

Gary Calkins, Micah Poteet, Sean Willis, TPWD



Since the conclusion of the last breeding chronology study in 1994, there have been significant changes in harvest regulations of white-tailed deer (*Odocoileus virginianus*) in many of the Pineywoods ecoregion counties. During the annual collection of age/weight/antler data, as well as incidental observation data during hunting season, field staff observed what they felt was a significant change in the breeding chronology of the Pineywoods deer herd. Empirical data indicated that the peak breeding date and range of breeding dates may have shifted. Observations also suggested that there may no longer be a defined peak in breeding as was illustrated in the previous study, and that the period of breeding may have been extended by several weeks.

Antler restriction regulations can alter the age structure of the buck segment of the deer herd. A change in buck age structure could potentially alter breeding chronology, thus, current breeding chronology data would serve as a baseline for monitoring subsequent changes in breeding chronology that may occur due to changes in buck age structure.

The Davy Crockett National Forest in Houston County was selected as the study site to collect data to compare to the 1990s study and to serve as the aforementioned baseline data. The study site was selected based on the biological factors of the local deer herd. Data indicate that the average age of bucks harvested in this area is 2.4 years old, the deer density is one per 9.5 hectares, and fawn recruitment has averaged 30%.

Adult does were collected between February 9 and March 3, 2005 (n = 28), and January 6 and March 7, 2006 (n = 39). A total of 97 fetuses were collected and measured. Four does had no fetuses, 29 had one fetus, and 34 had two. Ovaries were also collected and will be examined to determine ovulation rates. The average age of adult does collected was 4.28 years. Of the 97 fetuses, 50 were female, 45 were male, and two were too small to determine sex. Conception rate averaged 1.45 fetuses per doe, with 94% of adult does being bred. Conception dates had a range of 67 days with the earliest conception date being October 17 and the latest December 22. Data collection will continue during January and February 2007.

Funding provided by TPWD

Predators

Black Bear Population Status in East Texas

Christopher Comer, Pat Stephens, Daniel Scognamillo, Stephen F. Austin State University; Rickey Maxey, Nathan Garner, TPWD

Although black bears (*Ursus americanus*) were extirpated from East Texas in the mid-20th century, recent evidence suggests that they are naturally recolonizing this portion of their former range. Based on documentation of reliable sighting information, black bears have occurred periodically in East Texas since 1977. Furthermore, the number of sightings and other documented occurrences has increased since 1991, suggesting that the frequency of occurrence may also be increasing. Despite widespread popular and scientific interest in the status of black bears in East Texas, no formal survey work has been done to define the distribution and abundance of black bears in the region. An accurate and reliable assessment of the current status of black bears in East Texas is necessary to efficiently plan for future management and conservation of populations in this region.

In the next two years we will use hair snares and genetic mark-recapture techniques to determine occurrence and estimate population size, distribution, and demographics of black bears using habitats in the Red River, Sulphur River, White Oak Creek, and Cypress Basins in northeast Texas. We will also be examining public perceptions and opinions in the area. Current population assessment and monitoring efforts related to black bears in East Texas are limited to the sightings database, which does not provide quantitative abundance information or population demographic information. Recent sighting data have shown a concentration of bear activity in the area described, and an evaluation of potential black bear habitats in East Texas identified the Sulphur River/White Oak Creek area as one of four areas of suitable habitat in the region. Furthermore, a pilot assessment of hair snaring techniques by TPWD biologists was conducted in this area in 2004, so potential hair snare locations have been identified. If the technique proves successful, further studies can be used to assess black bear populations using other appropriate habitats in East Texas.

Funding provided by TPWD

Black Bear Reintroduction in the Big Thicket National Preserve

Anita Morzillo, Michigan State University; Rickey Maxey, Nathan Garner, TPWD

The black bear (*Ursus americanus*) population in East Texas was extirpated during the early 1900s, but a recent increase in the number of bear sightings in the area has prompted creation of a management plan and a simultaneous interest in recovering bear populations. Big Thicket National Preserve (BTNP) is a potential location to reintroduce bears, but its small size and disjunct distribution require the consideration of private timberlands and national forests in bear recovery planning.

To determine the ecological feasibility, remote sensing data were used to identify potential bear habitat across the 2.6 million-hectare study area. Approximately 1.3 million hectares of highly suitable habitat existed on both private and public lands. At a density of one bear/100 hectares, and considering core habitat areas, there is enough habitat for approximately 2,200 bears.

Since humans also inhabit the area, a study of social feasibility was necessary. We surveyed 1,006 local residents to gain insight into attitudes toward black bears and a preferred recovery strategy. Males, younger residents, those with more knowledge about bears, and participants in passive-appreciative activities related to wildlife were more likely to have positive attitudes toward bears and to support increasing the bear population. Concern about the problems that bears may cause was a significant predictor of a respondent's preferred management strategy. Two significant clusters of survey respondents expressed support for a bear recovery: the first in proximity to Angelina National Forest, and the second in Orange County.

A simple systems model was developed to integrate ecological and socioeconomic data. Model results suggested that national forests might be better potential release sites for bears than BTNP. An earlier trend of declining timberland area is likely to continue, and will be the main driver of bear habitat degradation over time. Consequently, timberland loss will likely promote urban development. Furthermore, highest ecological feasibility did not overlap. Ecological feasibility for bear recovery was greatest in Sabine, Trinity and San Augustine counties, whereas social feasibility was greatest in Jasper, Tyler and Newton counties. Public outreach aimed at increasing residents' knowledge about bears, as well as gaining insight into why local residents do or do not support bear recovery, are necessary before deciding whether and where bears should be released. The model framework provides a useful approach for assessing feasibility of a reintroduction and may be adapted for conservation programs in other locations.

Funding provided by TPWD

Genetic Structure of Texas Mountain Lion Populations

Jan Janecka, Michael Tewes, Lon Grassman, Jr., Jacob Garza, Texas A&M University–Kingsville; John Young, TPWD, Rodney Honeycutt, Texas A&M University

We examined the genetic structure of mountain lions (*Puma concolor*) from six areas of Texas. Analysis of 18 microsatellite loci in 89 mountain lions revealed moderate levels of genetic variation (*Ho* = 0.36–0.48) characteristic of mountain lion populations in North America. Long-term effective population size for mountain lion in Texas was estimated to be 5,607 animals. Model-based analysis revealed subdivision of the Texas mountain lions from the six localities examined into five clusters. Two clusters corresponded to

geographic origin of individuals, whereas three clusters were composed of individuals of mixed geographic origin. Genic, genotypic, Fst and assignment tests suggested differentiation of populations located in the Guadalupe Mountains and southern Texas from other populations in the state. These tests also supported high levels of gene flow among the remaining four localities in western Texas. Phylogeny reconstructed using proportion of shared alleles revealed similar patterns, showing Guadalupe Mountains and southern Texas populations as most divergent. The Mantel test showed that some of this differentiation was a result of isolation by distance. The patterns in genetic variation suggest mountain lions in Texas exist as metapopulations and fall into a minimum of three management units. This study supports structuring management of mountain lions in Texas based on subpopulations and more active monitoring and management to further define mountain lion populations based on meaningful biological and genetic subdivisions.

Funding provided by TPWD

Habitat Fragmentation Influences on Swift Fox Distribution and Genetic Diversity Patterns

Donelle Schwalm, Warren Ballard, Robert Baker, Ernest Fish, Texas Tech University; Heather Whitlaw, TPWD

Although once considered abundant throughout the short to mid-grass prairies of North America, the swift fox (*Vulpes velox*) has experienced range-wide declines. Habitat loss and fragmentation have been implicated as contributing factors. At least 50% of the historic range in Texas is currently unsuitable for swift fox use, due primarily to habitat fragmentation resulting from agricultural development. Only two of the 76 Texas counties which historically supported swift fox are known to currently be inhabited by swift fox. Understanding the influence of habitat fragmentation on the long-term viability of swift fox populations is limited. We are using molecular and geospatial techniques to study the potential interactions between habitat fragmentation and genetic diversity in swift fox populations.

We used scat transect surveys to determine the current distribution of swift fox in 36 counties located in the Texas panhandle. Surveys were completed between July and November; each transect was surveyed once per year in 2005 and 2006. We collected 174 potential swift fox scats along 1,416 km of road-based transects associated with grassland fragments. Mitochondrial DNA analysis of scats collected in 2005 detected swift fox in only two of the 36 counties surveyed—Dallam and Sherman. Analysis of scats collected in 2006 is ongoing.

Tissue samples were collected from 41 swift fox live trapped in Dallam and Sherman counties in 2005 and 2006. In addition, in 2006 tissue samples were collected from 35 foxes in Kansas while assisting the Lower Brule Sioux Tribe of South Dakota with their effort to translocate and reintroduce swift fox to the Tribe's land. Tissue and hair samples were also submitted by private, state, and federal entities in seven of the nine states within the swift fox range. Microsatellite analyses of samples will be conducted to determine genetic diversity, gene flow (dispersal) rates between subpopulations, and the level of genetic structuring exhibited throughout the species' range. Using ArcGIS, genetically unique subpopulation groupings will be mapped. Subpopulation boundaries will be compared to natural and anthropogenic data layers in ArcGIS to assess the relationship between landscape and gene flow in swift fox populations.

Funding provided by TPWD and the National Fish and Wildlife Foundation

Landscape Analysis of Black Bear Habitat in the Trans-Pecos Region

Mindy Rice, Warren Ballard, Ernest Fish, Texas Tech University; Dave Holdermann, TPWD

Black bears (*Ursus americanus*) were reportedly widespread across Texas in the 1800s, but their numbers were reduced due to hunting, predator control and loss of habitat in the early 1900s. In the early 1980s, a small population from northern Mexico served as a source population for recolonization of the Trans-Pecos region in Texas. There are now repeated sightings of black bear in the area, suggesting that the bears are continuing to expand their distribution into parts of west Texas.

We utilized black bear sightings from 1904 to 2003 to map the current distribution. First, we used land cover selection to determine daily movement was the most appropriate scale for the rest of our study. We found that bears were selecting woodland, while avoiding all other land cover types, including urban, grassland, shrubland, wetland and bare. Second, we predicted the distribution of black bears in the Trans-Pecos region using the following layers: land use/land cover, elevation, aspect, slope, vegetation, distance to water sources, distance to roads, water density and road density. Results indicate that bear presence was positively associated with slope and urban land use, and negatively associated with road density, distance to highways, distance to intermittent water, cropland, shrubland and grassland. These results indicate that sighting data can be useful in predicting the expansion of the black bear population in the Trans-Pecos of Texas. More importantly, the model can identify critical areas where black bears may expand, which will enable management to mitigate the potential impacts black bear may have on the ranches in this region.

Another purpose of our study was to determine attitudes of landowners towards black bear. In September 2004, we mailed 1,100 landowner surveys to landowners with areas large enough to support black bear. There were 472 responses (43% response rate). The response was split with 45% of responses against, 40% for, and 15% having no opinion on the recolonization of black bear. Landowners most sympathetic to black bear recolonization are those that are younger, have graduate degrees, owned the land less than two generations, and own less than 405 hectares. The primary reason landowners were against black bear recolonization was potential livestock losses and the primary reason they were for the recolonization was bears being part of their heritage.

Funding provided by TPWD

Survey of Stakeholder Attitudes Concerning Black Bear

Adam Keul, Pat Williams, Ray Darville, Chris Comer, Stephen F. Austin State University; Nathan Garner, Ricky Maxey, TPWD

The Louisiana black bear (*Ursus americanus luteolus*) is an endangered species that was once native to the wooded eastern third of Texas. Though the species was removed from the region around the turn of the century due to over-hunting and habitat loss, there has been a re-emergence of documented sightings over the last 30 years. Reintroduction to suitable habitats in Louisiana, Arkansas and Oklahoma has caused a small but ever-increasing opportunity for migration into the bottomland hardwood forests in East Texas. TPWD has responded to this issue by implementing the Black Bear Management Plan, which outlines suitable habitats and probable management strategies over the next 15 years, and by implementing studies to look at the human dimensions aspect of stakeholders' attitudes towards bear and bear management.

An initial stakeholders study was conducted in Southeast Texas. A study was implemented encompassing 12 counties and including the semi-urban areas of Lufkin, the outskirts of Beaumont and suburban Houston. Our study builds on this one to further advance the concept of black bear management in East Texas by implementing a public attitudes survey in the region of Northeast Texas that would have the opportunity to be most impacted by black bear populations. This area, termed the Sulphur River Bottom, is a six-county watershed that is heavily wooded and rural. The counties included in the survey are Red River, Cass, Bowie, Titus, Morris and Franklin. All border the Sulphur River and are predominately rural, containing only a few small towns, with the exception of Texarkana in Bowie. TPWD has deemed the region biologically suitable habitat for black bear population with a 0.76 Habitat Suitability Index. Since the residents of these counties are most likely to be affected by any future management, their attitudes and opinions are the most vital in determining the viability of management.

A self-administered survey was mailed to a random sample of residents in the six-county study area in April 2006. Following the Dillman method, reminder postcards and second surveys followed. Data analysis is going on at this time and results will be available late spring 2007.

Funding provided by TPWD and Stephen F. Austin State University

Other Mammals

Distribution and Habitat Requirements of Bats in the Pineywoods Ecoregion

Christopher Comer, Warren Conway, Stephen F. Austin State University; Michael Morrison, Texas A&M University; Ricky Maxey, Meg Goodman, TPWD

In general, little quantitative information is available regarding species composition, seasonal occurrence, abundance and habitat use of bats in throughout Texas, including the Pineywoods ecoregion of East Texas. Both the Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) and the southeastern myotis (*Myotis austroriparius*) are of special concern in eastern Texas, due to perceived declining population numbers and a general paucity of information on habitat needs and population trends. Rafinesque's big-eared bat is considered a threatened species in Texas and is the only threatened bat species in the Pineywoods ecoregion, while the southeastern myotis is rare in East Texas and has been considered as a candidate for federal listing as a threatened or endangered species. The association of both species with bottomland hardwood forests has been hypothesized to be a primary cause of range wide declines in these species. Moreover, both are apparently vulnerable to disturbances in and around natural roost sites, which are a primary limiting factor in their occurrence and population stability throughout their range. Although the big-eared bat has been studied in various parts of its range, no comprehensive treatment of the species' requirements has been formulated and data for East Texas are limited. Data on habitat requirements for the southeastern myotis are even more limited.

Fieldwork for this project will commence in spring 2007 and continue through summer 2008, with several objectives. First, we will survey public and private lands in East Texas to determine range and distribution of the target species in the region. We will use a combination of acoustic monitoring with Pettersson 240Dx ultrasonic detectors and SonoBat™ software, mist netting, and active searches of potential roost sites to determine occupancy of study areas by the target bat species. Second, we will quantify the characteristics of natural tree roosts and other roost sites using radiotelemetry to track captured bats to roost sites. Roost sites will be compared to random, non-used locations both in terms of tree characteristics and general features of surrounding habitats. These data will be used to derive a quantitative model of roost characteristics for the purpose of determining the availability of suitable sites in the region.

Funding provided by TPWD

Ground-Penetrating Radar Mapping of Underground Pocket Gopher Burrow Systems

Jorge Cortez, Scott Henke, Tim Fulbright, Texas A&M University–Kingsville; John Young, TPWD; Rich Riddle, Naval Air Station Corpus Christi

Fossorial animals spend the majority of their lives in their underground burrow systems. Therefore, understanding the burrow systems is an integral part of understanding the species. Mapping of the burrow systems can provide useful social and behavioral information on a population. The Maritime pocket gopher (*Geomys personatus maritimus*) is a fossorial rodent which has no social or behavioral information available.

Previously burrow systems were mapped out by digging up the burrow systems or pumping foam into the tunnels and digging up the foam. Both methods are detrimental to the animal due to the fact that the end result leaves the burrow system uninhabitable. Ground-penetrating radar is an innovative method of mapping underground burrow systems. This noninvasive method uses radar to penetrate the burrow systems and is presented as digital images.

A ground-penetrating radar survey was conducted at NAS Corpus Christi on areas of high gopher mound densities. The areas surveyed were five separate 15.24 m x 15.24 m locations. Each survey area was scanned with a GSSI SIR-3000, GPR digital control unit and a 900 MHz antenna. The depth of investigation was to about 1 m. A main tunnel appeared in most of the survey areas at about 0.15 to 0.45 m below ground. Below this main tunnel were chambers and other gopher related features connected to the main tunnel. The mounds on the surface appear to correlate well with the main tunnel on each site. Old tunnels did not show up well in the radar data due to the fact that some had collapsed. These collapsed tunnels appear as short disconnected tunnels. Subsequent trapping of gophers has been conducted, but not completed. Trapping data should reveal social and behavioral information on the Maritime pocket gopher populations present on these survey areas. Ground-penetrating radar is a nondestructive alternative to digging and breaks new ground on how fossorial mammals' underground habitat is studied.

Funding provided by TPWD

Spatial Distribution, Cover Type and Activity of Ocelot Prey

Michael Tewes, Lon Grassman, Texas A&M University–Kingsville; John Young, TPWD

Research has shown that the effects of weather (particularly drought) can cause major declines in reproduction, decreased transient survival, increased dispersal, and increased mortality in ocelots (*Leopardus pardalis*) and bobcats (*Lynx rufus*) occupying southern Texas. Although the causal mechanism is not fully understood, the prey component is believed to be the "missing link" in understanding this important ecological phenomena.

This preliminary study contributed toward achievement of describing the spatial patterns and habitat use of ocelot prey and their interactions with ocelots, assessing overlap in activity patterns between ocelots, bobcats, and their prey, and evaluating environmental factors affecting ocelot and bobcat competition for prey.

The Yturria Ranch and Corbett Ranch study sites experienced nearly ninefold and fourfold increases in small mammal captures from Phase 1 to Phase 2 (32 days and 39 days, respectively). Extended rainfall occurred on several occasions between these two sampling periods and vegetation was noticeably greener and fuller during Phase 2 compared to Phase 1. It is likely that small mammal production increased between the sampling phases as vegetation primary production increased. Results of Phase 2 trapping indicated an increase in the hispid pocket mouse (*Chaetodipus hispidus*) population at both study sites following the end of the drought. Cottontail rabbit (*Sylvilagus* spp.) abundance decreased from Phase 1 (n = 24) to Phase 2 (n = 12) at the Yturria Ranch and remained low during both sampling periods at the Corbett Ranch. Mexican spiny pocket mice (*Lyomys irroratus*) and hispid pocket mice were the dominant species trapped. These mice are thornshrub obligate species, and represent a substantial component of ocelot diet. The effects of drought and precipitation appeared to influence these species' abundance. Given low small mammal abundance during drought periods, bobcat removal in strategic locations of overlap may be a recommendation if the microhabitat use of selected prey and ocelot suggests the possibility of competition. This competition may be more likely during certain periods, such as seasons of low prey reproduction and densities (e.g., winter), or other ecological factors. Conclusive recommendations can only be developed following a better understanding of the ocelot-prey community, and their interaction with the habitat and other predators.

Funding provided by TPWD

Studies of Biogeography and Biodiversity of Texas Mammals

John Patton, John Bickham, Texas A&M University; Duane Schlitter, John Young, TPWD

The developing State Conservation Plan has identified a number of species for which appropriate data are not available to answer a variety of questions regarding distribution, abundance, and genetic distinctiveness among and in many cases what is currently considered to be within species. Our objective is to conduct field studies of mammals from the state of Texas to document the occurrence a variety of species of rodents and bats in particular. These species have been identified as species in need of additional data by the Texas Parks and Wildlife Department. Genetic, distributional, and abundance data for the identified species are needed to allow development of an appropriate understanding of biogeography and biodiversity of the mammalian fauna of Texas. As an adequate representation of genetic samples is currently not available for the species which have been identified, particularly to answer questions relating to possible cryptic species, a significant component of the proposed field work this year will be to collect tissues for later genetic analyses of the identified species. The documentation of occurrence and abundance of these species together with tissues collected from the specimens collected will allow an improved understanding of the biogeography and biodiversity of the mammals of Texas as required for the developing State Conservation Plan.

Funding provided by TPWD

Birds

Doves

Assessing Habitat Adjacent to Mourning Dove Call-Count Transects

Brian Pierce, Nova Silvy, Markus Peterson, Fred Smeins, Ben Wu, Texas A&M University; Jay Roberson, TPWD

In order to investigate the relationship between mourning dove (*Zenadia macroura*) population density, habitat and harvest regulations in Texas, we repeated an earlier (1976) study of mourning dove habitat in Texas. We used a novel method of canonical discriminant analysis (CDA) to evaluate four contemporary classification schemes, and to determine the extent of temporal change in land use adjacent to the 133 call count survey (CCS) routes within Texas. We used distance-based redundancy analysis (db-RDA) to examine the correlation between habitat variables and call-count survey results, and to identify important habitat variables for use in future mourning dove research. In contrast with the earlier study, which utilized univariate analysis of CCS results to identify sampling units, the present study partitioned Texas into homogenous habitat areas based solely upon environmental variables. By delineating experimental units based upon habitat variables directly, rather than using a proxy variable (CCS dove heard or route regression parameter) influenced by detectability, we tried to identify and alleviate the potential confounding between habitat and density in future dove research efforts. CDA results derived from the 2002 data set indicated that the Gould (Cohen's Kappa = 0.76) and Omerick (Cohen's Kappa = 0.70) classifications are currently the most suitable for use as experimental units in Texas. The classification error matrix derived from this analysis indicates that as the human population grows, it will become harder to differentiate the natural underlying (background) habitat from the perturbations caused by anthropomorphic influences. Additional CDA results indicate that significant (P = 0.0001) changes in habitat occurred along the 84 CCS routes that remained spatially congruent between 1976 and 2002. The number of linear features, such as roads and buildings, and the index of interspersion increased substantially between the two periods. Increased amounts of physiognomic categories such as parkland, woodland, and shrub parkland, and decreased amounts of pasture, forest, savannah, shrub savannah, and shrubland are indicative of habitat fragmentation as a result of anthropomorphic land use. Distance-based redundancy analysis showed that grain density, diffuse canopy cover and interspersion were positively correlated with dove seen and dove seen driving between CCS count points, while dense canopy cover was negatively correlated with dove seen and dove seen driving between CCS count points. The number of doves heard were positively correlated with deciduous canopy cover, abundance of linear perching features, low traffic roadways, and more rural settings, while negatively correlated with human population density, high traffic roadways, building density and coniferous canopy cover. Finally, these db-RDA results illustrate how differences in detectability between habitat types may produce similar numbers of dove heard and/or dove seen in areas with disparate mourning dove densities.

Funding provided by TPWD

Developing an Aging Criteria for Hatch-Year White-Winged Doves

Alan Fedynich, David Hewitt, Texas A&M University–Kingsville; T. Wayne Schwertner, TPWD

The white-winged dove (*Zenadia asiatica*) has expanded its geographic range in Texas, prompting additional research and monitoring to learn more about the ecology of this species. To aid researchers and biologists in determining population characteristics, it is often necessary to assign individuals into age classes. Unfortunately, there is little information regarding how to determine the specific age of hatch-year (HY) white-winged doves based on feather development and replacement. Therefore, we will characterize feather development, persistence of immature secondary coverts, and primary feather replacement in captive HY white-winged doves.

Wild adult white-winged doves will be captured in baited walk-in traps beginning in early spring 2007 near Kingsville, Texas. Forty adult white-winged doves will be paired by gender and placed into 20 pair-only breeding pens at the Caesar Kleberg Wildlife Research Institute research aviary. Upon hatching, nestlings will be monitored, measured and photographed from their first day up through replacement of their 10th primary (approximately 160 days).

From the above information, we will have a database chronicling feather development, persistence of immature secondary coverts and primary feather replacement of each individual HY as it develops into an adult. This information will allow more accurate descriptions of white-winged dove productivity and annual population structure by allowing researchers and biologists to back-date HY individuals using feather characteristics, thereby allowing calculations of hatch dates, incubation period, egg laying and nest initiation.

Funding provided by TPWD

Development and Evaluation of Methods for Regional Monitoring of Mourning Dove Recruitment

David Otis, U.S. Geological Survey; David Miller, Iowa State University

Parts collections are a traditional method for estimating fall age ratios for game bird species. However, before a reliable operational wing survey can be implemented for doves (*Zenadia macroura*), a number of issues needed to be addressed. These include the need to calibrate harvest wing age ratios to produce an estimate of true age ratios, to evaluate the efficiency of different sampling protocols to meet the information needs for doves, and to validate the accuracy of age ratio estimates using independent data. Finally, there is a continuing need to increase our understanding of the basic breeding biology of the species, which will in turn assist with interpretation of recruitment estimates.

Thanks to the enthusiastic effort of the participating state agencies, the pilot program has been successful in meeting and exceeding goals for the wing collection portion of the study. In 2006, four new states (North Dakota, South Dakota, Tennessee and Texas) and about 15 new blocks as defined for the late summer

banding program were added to the 17 states and 46 blocks that participated in 2005. During the first two years, these 21 states have collected more than 65,000 wings from 58 unique blocks. In almost all cases, states have been successful in meeting the goals of collecting 400 wings and banding 200 birds per block.

Preliminary efforts began this past year to begin to calibrate wing survey estimates to account for unknown age birds. Classification of unknown age wings has focused on projecting primary molt scores from hatch year and after hatch year birds captured during late summer when almost all can be aged to the time of harvest. We have developed initial statistical estimation models to predict the proportion of unknown age birds that should be present from each age class. Initial results from simulations and 2005 data are promising. To this point we have had better success in projections of after hatch year molt scores and continue to work to improve hatch year projections.

Wing collections as part of the pilot program will continue during 2007. We are hoping, in conjunction with the USFWS, to also conduct a parts collection mail survey program in 2007 to compare results and cost-efficiency of this alternative monitoring design. We also will continue to refine statistical methods for calibrating age ratio estimates in order to improve information gained from the pilot program and to produce methods that could be used in future wing collection efforts.

Funding provided by TPWD

Differential Survival in Radio-Transmittered White-Winged Doves

Michael Small, John Baccus, Texas State University; T. Wayne Schwertner, TPWD

Captive and field studies conducted on mourning doves (*Zenadia macroura*) and white-winged doves (*Z. asiatica*) suggest that subcutaneously implanted radio transmitters are the preferred method of radio-transmitter attachment in this species. However, captive studies were conducted in cages and flight pens with physiological and behavioral parameters measured. Field studies addressed the likelihood of harvest by hunters of implanted versus non-implanted individuals and indicated that transmitter attachment does not increase the likelihood of being harvested.

However, we compared survivorship of urban white-winged doves with subcutaneously implanted radio transmitters with percutaneous external antennas to those without transmitters in the wild under more extreme conditions. Our study, conducted in Mason, Texas (Mason County), was in an area with high predator levels. Additionally, our study was conducted during cold weather months of January–May 2006.

We compared survivorship of transmittered doves with captured birds receiving only identifying leg bands. We used Kaplan-Meier product limit estimator to determine survivorship of transmittered doves and program MARK to ascertain survivorship of doves without transmitters. Goodness-of-fit tests indicated survivorship of white-winged doves with radio transmitters was significantly lower than doves without transmitters. We hypothesize that high predatory pressure and heavy reliance of white-winged doves on anthropogenic food sources during cool weather may explain the difference. Researchers should be cautious when using radio transmitters to monitor white-winged doves in similar urban environments.

Funding provided by TPWD

Effects of Diet Composition on White-Winged Dove Production

Kenneth Pruitt, University of Texas; David Hewitt, Texas A&M University–Kingsville; Nova Silvy, Texas A&M University; Stephen Benn, TPWD

Declining white-winged dove (*Zenadia asiatica*) populations in the Lower Rio Grande Valley cannot be fully explained by factors such as habitat loss, hunting pressure or nest predation. Previous studies have examined forage resources, but have generally focused on forage availability and energetic constraints. We examined the role of native seeds in the breeding of white-winged dove using captive birds offered either a diet composed solely of sorghum (*Sorghum bicolor*) or a diet composed of sorghum, croton (*Croton* spp.) and native sunflower (*Helianthus* spp.). Absence of native seeds in the diet did not affect egg production as much as it reduced survival and growth of the young. More than twice as many young/pair were fledged on the native seed diet than the sorghum-only diet. Chicks grew faster when offered native seeds and were 32% heavier at fledging. Finally, doves were better able to fledge young from multiple clutches on the native seed diet. We conclude that sorghum is inadequate to properly support white-winged dove reproduction. We hypothesize that low protein content in agricultural grains may be a factor causing the reduced production. For these reasons, it appears that native seeds, which are higher in protein and have a more appropriate protein-to-energy ratio, are necessary for white-winged doves to realize their reproductive potential.

Funding provided by TPWD

Effects of Traffic Noise on Auditory Bird Surveys

Jeff B. Breeden, Fidel Hernandez, Ralph Bingham, Texas A&M University–Kingsville; Nova Silvy, Texas A&M University; Gary Waggerman, TPWD

Auditory surveys are commonly used to monitor bird populations. Many variables affect detection, including weather, habitat and environmental noise. Expansion of the urban-wildlife interface has forced bird surveys to be conducted in environments where they may be affected by factors such as traffic noise. We used white-winged doves (*Zenadia asiatica*) as a model to investigate the effects of urban noise on auditory density estimates. We conducted auditory point counts throughout the morning in San Antonio (n = 6) and Austin, Texas (n = 10) during weekdays (when traffic noise is presumed to be higher) and weekends. To further assess the impact of traffic noise, we categorized survey points as near and far from roads (<0.8 and >0.8 km, respectively) for comparison. We consistently documented lower density estimates on weekday mornings than on weekend mornings. We also documented a lower density estimate for weekday counts at survey points near roads as compared to those far from roads. Our results indicate that traffic noise may bias auditory surveys and therefore noise disturbance should be considered when designing urban surveys. Survey methods that account for differences in detectability should be used to correct for noise bias.

Funding provided by TPWD

Evaluation of Distance Sampling Survey Methodology for White-Winged Dove

Jeff Breeden, Fidel Hernandez, Texas A&M University–Kingsville; Nova Silvy, Markus Peterson, Texas A&M University; Jay Roberson, TPWD

Obtaining reliable estimates of wildlife abundance is important for conservation and management efforts. A call-count index has been used to monitor breeding populations of white-winged dove (*Zenadia asiatica*) in Texas for over 50 years. The technique assumes that the number of birds heard calling during spring is correlated to the breeding density during summer. Although indices are a popular technique for counting birds, there has been substantial criticism of their use in estimating densities and an increasing trend in research to include methods that consider detection probability. Distance sampling is a method that has been gaining popularity as a reliable alternative for estimating abundance of wildlife populations. The purpose of this study was to evaluate the use of distance sampling for estimating abundance of breeding white-winged doves. We surveyed six cities in Texas during 2004–2005 using distance sampling and the call-count index and compared density estimates. We also compared potential variability in density estimates between two observers in two cities. The call-count index reported higher density estimates and coefficient of variation than distance sampling. Both observers in each city estimated similar density estimates with overlapping 95% confidence intervals using distance sampling. Our data suggested critical assumptions of distance sampling were met given trained observers. This method is a more reliable method for surveying white-winged dove in urban areas than the call-count index and should be considered as an alternative for monitoring populations.

Funding provided by TPWD

Evaluation of Sampling Methods for White-Winged Dove Surveys in Urban Areas

Jeff Breeden, Fidel Hernandez, Ralph Bingham, Texas A&M University–Kingsville; Nova Silvy, Texas A&M University; Gary Waggerman, TPWD

TPWD has used auditory call counts annually since 1949 to monitor white-winged dove (*Zenadia asiatica*) populations in the Lower Rio Grande Valley of Texas. Recently, white-winged doves have been expanding their distribution, and now the largest populations occur in urban areas north of their historic South Texas range. It has become necessary to develop an urban survey method to better monitor these populations. We compared two call-count sampling methods for surveying white-winged doves in urban environments (i.e., transects vs. grid-points in Austin during 1999–2002 and San Antonio, Texas during 2001–2002). We also determined the percent annual population change we were able to detect for each year with the current sample size using the grid-point survey method. Estimates of white-winged dove breeding density were higher using the transect method compared to the grid method each year. Power analysis indicated that with current sample sizes in each city, we were able to detect between a 20 and 30% annual change in mean population density in both Austin and San Antonio. We conclude the grid method can be more effective at reflecting the spatial distribution of white-winged doves in urban areas than the original transect approach. The grid method should be improved to reduce variance if it is to be used in the future. Accuracy of survey methods were not evaluated here. To obtain more reliable estimates of density, other methods such as distance sampling should be evaluated.

Funding provided by TPWD

Impacts of Eurasian Collared-Dove on the Breeding Ecology of White-Winged Doves

Timothy Ludwick, Alan Fedynich, Glenn Perrigo, Texas A&M University–Kingsville;
T. Wayne Schwertner, TPWD

The range expansion of the Eurasian collared-dove (*Streptopelia decaocto*) in North America has recently brought it into contact with the white-winged dove (*Zenadia asiatica*), an important game species in South Texas. There is concern that competition for nest sites might be occurring in urban areas where both species co-occur, and that white-winged dove populations could be negatively affected. The two main goals of this project are to determine the nesting ecology of the Eurasian collared-dove in South Texas and investigate whether nest site competition with white-winged doves could be occurring within urban areas. Data collected on Eurasian collared-dove breeding ecology included initiation breeding activity, nest establishment and nest distribution patterns. Each nest location was characterized by tree type and six descriptive variables. Nest plots were set up in four South Texas towns in which nest stage was recorded for each nest found; nests were monitored until they either failed or fledged young.

In the first year of this study, we found Eurasian collared-doves breeding from early March to late October. Each pair averaged 1.3 fledglings per nest and had a nest success rate of 69%. Eurasian collared-doves appear to show a preference for green ash (*Fraxinus pennsylvanica*), and it was the most common tree species used for nesting. Average canopy cover for a nest was 59.3%, but varied with tree species. The other measures seem to indicate that Eurasian collared-doves are nesting in large, mature trees, which tend to be common in urban areas. We found that white-winged doves nested most often in hackberry (*Celtis* spp.), the most abundant tree in most urban areas in our study. Additionally, of the six descriptive variables examined, Eurasian collared-doves tended to nest in more open locations than white-winged doves and appear to be the only way in which the two species nest locations differ. GIS analysis of nest locations indicated that the white-winged dove is more tolerant of close nesting of other species than the Eurasian collared-dove. Despite the similarity of nesting locations, the data suggest that within the study area the Eurasian collared-dove is not currently a competitive threat because of its relatively small population size compared to the white-winged dove.

Funding provided by TPWD

Isotopic Characterization of White-Winged Dove to Determine Wintering Ground Distribution

Scott Carleton, Carlos Martinez del Rio, University of Wyoming

Migratory birds spend as much as 80% of their lives on wintering grounds or in transit to and from breeding areas. Very little is still known about the biology of most of these species outside the breeding season. The white-winged dove (*Zenadia asiatica*) breeds in North America and has migratory populations that breed in the United States and winters across southern Mexico and northern Central America. In the last century, this species has experienced extensive population explosions and declines. These population fluctuations are, to a large extent, consequences of the reliance of this species on human-modified landscapes that can undergo rapid changes. Although the potential consequences of these changes in land use have been well described in the breeding grounds, very little is known about the biology of these birds while inhabiting wintering areas. Traditional methods for tracking migratory birds, such as band recoveries, have yielded few returns and the distribution of migratory white-winged doves on wintering grounds is still poorly understood.

A new molecular tool, stable isotope analysis, is proving to be very effective in linking breeding and wintering grounds in migratory bird species. Variation in temperature, humidity and rainfall across the breeding range of white-winged doves in North America creates unique hydrogen isotope signatures in plants and sources of water. These hydrogen isotope signatures are then incorporated into feathers grown prior to migration. The result is that every bird becomes a banded bird, traveling to and from the wintering grounds, with a unique signature of its geographic breeding origin contained within its feather tissues. We used this technique to characterize the breeding ground feather hydrogen isotope signatures of the eastern population of white-winged doves (*Z. a. asiatica*) from Brownsville to El Paso, Texas and the western population (*Z. a. mearnsii*) from Tucson to Yuma, Arizona. We discovered a gradient of decreasing hydrogen isotope signatures in bird feathers collected from Houston, Texas to Yuma, Arizona. Hydrogen isotope values ranged from -50 to -90‰ in Texas and from -80 to -120‰ in Arizona. Discriminant analysis correctly identified 1,080 out of 1,200 feather samples as belonging to either the eastern or western populations based on hydrogen isotope values. In addition, feather hydrogen isotope analysis across the years 2003, 2004 and 2005 revealed little inter-annual variation.

We are currently undertaking the final stage of this project by collecting feather samples from white-winged doves across southern Mexico. By linking feather hydrogen isotope values collected in Mexico to those characterized on the breeding grounds we hope to determine the distribution of the eastern and western populations on the wintering grounds. Determining the distribution of this species in Mexico is an important first step in understanding its biology and facilitating answers to future research and management questions.

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Landscape Change Near White-Winged Dove Nesting Colonies

Yara Sanchez-Johnson, Fidel Hernandez, David Hewitt, Eric Redeker, Texas A&M University–Kingsville; Jay Roberson, T. Wayne Schwertner, TPWD

Land use changes resulting from factors such as agricultural practices, timber exploitation, and dam construction have resulted in much habitat loss for white-winged doves (*Zenadia asiatica asiatica*) in northeastern Mexico and southern Texas. This habitat loss has occurred within historic nesting colonies, most of which are located in the state of Tamaulipas, Mexico. Unfortunately, knowledge of the precise location of these historic colonies and even knowledge of the current ones lie with a small number of people, primarily retiring personnel of conservation agencies and elder, local townsmen, particularly in Mexico. Because of the importance of Tamaulipas and southern Texas for nesting white-winged doves and dove hunting, and because of ongoing habitat changes, the objectives of this study were to (1) document and geographically record the location of all known nesting colonies, (2) determine land use changes that have occurred on the landscape surrounding nesting colonies since 1970, and (3) correlate changes in the fate of dove colonies with large-scale changes in the landscape surrounding the colonies.

During the May–June 2004 and 2005, we visited northern Mexico and obtained GPS coordinates for the boundaries of all current colonies and most of the historic colonies. Using aerial photo interpretation of imagery, landscape components (i.e., percent coverage of native brush, water, agricultural fields and urban) were identified and delineated within 1.6-km, 3-km, and 6-km radius of each colony. From an initial list of 50 nesting colonies that were thought to exist in Tamaulipas, only 31 colonies were located, of which 12 were active (i.e., colonies remained active to the present) and 19 inactive. Landscape composition of colonies during the 1970s did not differ between active and inactive colonies. In comparing landscape composition between 1970 and current imagery for colonies that became inactive, we documented a reduction in the amount of native brush and an increase in agricultural field coverage, whereas urban development and water sources indicated no apparent change. Our findings suggest that the loss of nesting habitat, primarily due to agricultural development, has contributed to the abandonment or disappearance of white-winged nesting colonies in northeastern Mexico in the last 30 years.

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Monitoring Survival, Harvest and Recruitment of White-Winged Doves

Bret Collier, Brian Pierce, Roel Lopez, Mike Morrison, Nova Silvy, Markus Peterson, Texas A&M University; Jay Roberson, T. Wayne Schwertner, TPWD

Prior to the 1980s, white-winged doves (*Zenadia asiatica*) were confined to northern Mexico and the southwestern United States. Recently, white-winged doves have experienced a range expansion, although declines in abundance have also occurred. For example, white-winged doves currently breed in 196 Texas counties versus <10 in 1980, and only 16% of the white-winged dove breeding population in Texas occurs in the traditional breeding sites in the Lower Rio Grande Valley. Outside the historic range, white-winged doves are confined almost exclusively to urban environments and preliminary evidence from Texas suggests most birds breed in the residential core of cities which has unknown impacts on reproduction, survival, and harvest. In order to provide U.S. Fish and Wildlife Service (USFWS) with an approach to harvest management of white-winged doves in the CMU and WMU, a coordinated banding program and recruitment evaluation was needed. We have developed and are implementing a white-winged dove banding program beginning in 2007 in conjunction with Texas Parks and Wildlife Department, Arizona Game and Fish, New Mexico Game and Fish, California Game and Fish and SEMARNET as a foundation for future harvest management and monitoring programs in the southern CMU.

Our objectives are to implement an initial national white-winged dove banding and demographic monitoring program to be used for future harvest management decisions. Under this a framework we have initiated a white-winged dove population management program in the United States addressing survival, harvest and reproduction as a foundation for a future Adaptive Harvest Management (AHM) programs. We are (1) developing long-term banding program for white-winged doves in the southwestern United States, (2) developing parts collection program using harvest age ratios to predict annual productivity, (3) developing sampling designs for estimating and calibrating white-winged dove recruitment parameters with the parts collection survey, and (4) exploring the relationships between estimated population productivity from field studies and harvest age ratios, correcting for differential, age-specific vulnerability in harvest.

Our study will have an immediate impact on national management of white-winged doves as it will provide (1) current estimates of age-specific annual survival across the primary United States range of the white-winged dove, (2) current estimates of age-specific recovery rates, (3) updated information on the distribution of white-winged doves banded in both urban and rural populations, (4) estimates of age-specific harvest vulnerability which when combined with harvest age ratio information can be used to estimate preseason age ratio as an annual index of recruitment, and (5) a foundation for evaluating the potential bias in survival and recovery estimates due to unreported recoveries in Mexico. Once estimates of these population parameters are quantified, predictive population models can be developed which will assist management with harvest management.

Funding provided by TPWD

Morning Versus Evening Distance Sampling of White-Winged Doves

Michael Small, John Baccus, Texas State University; T. Wayne Schwertner, TPWD

We compared morning versus evening density estimates for white-winged doves (*Zenadia asiatica*) on the Edwards' Plateau of Texas using program DISTANCE sampling point count methodology. We conducted three trials, replicated temporally, consisting of an inexperienced individual making observations with a second person recording data, an experienced individual making observations with a second person recording data, and an experienced individual making observations and recording data. Encounter rates and density estimates were similar for each morning and evening sampling period. Although there was difference between observers, morning and evening density estimates were the same.

Our results suggest the strict standardization of diel sampling period frequently used to reduce variation in population indices may be unnecessary to achieve accurate estimates of density for this species. Advantages of these findings include a doubling of daily sampling time and potentially greater convenience for surveyors. This combination of benefits should increase sample size, and subsequent power, for density estimates of this species.

Further studies in multiple ecoregions and in areas with varying levels of human density and varying levels of white-winged dove density will be conducted to determine if these results are ubiquitous or unique to the population sampled.

Funding provided by TPWD

National Reward Banding Study

David Otis, U.S. Geological Survey

Efforts are underway to use the best available data to construct demographic models that can be used as the basis for long term informed harvest management strategies. A critical component in these strategies is an understanding of the relationship between population harvest and survival rates. Given the lack of current information on survival and harvest rates, a logical first step toward is to conduct a reward banding study. The primary objectives of such a study are to produce estimates of band reporting rates that can be used to convert standard band recovery rates into harvest rates using well-established analysis techniques. Secondary objectives are to (1) establish protocols, training, and cost estimates for a future coordinated nationwide operational banding program designed to monitor harvest and survival rates, (2) provide information on geographical distribution of harvest, and (3) provide initial estimates of annual survival and breeding site fidelity.

Banding quotas were developed on a subregion scale, with allocations to individual states determined by relative Call Count Survey indices and geographic area. In 2003, 26 states volunteered to participate in the three-year study, and participation grew to 29 states by 2005. The initial banding study protocol specified that 2,000 birds would be banded in each subregion with standard bands only in 2003 and 2005. Quotas increased to 3,100 in 2004; 2,400 of these bands would be put on juveniles and every third juvenile received a $100 reward band in addition to its standard band. Based on results from 2004 and availability of funding, supplemental reward banding was repeated in 2005 in eight states in the Central and Western Management Units. Nearly 100,000 birds were banded in the summers of 2003–2005. Approximately 5,000 recoveries have been reported, including approximately 600 reward bands. State reporting rate estimates ranged from 0.31–1.00, with an unweighted average of 0.56. Average CV of state estimates was 28%; CVs for subregions averaged 19%.

Harvest rates varied substantially both spatially and across years. Averages ranged from 0.018–0.204 for adults and from 0.021–0.176 for juveniles. Averaged over all hunting states, at least 80% of the harvest of the banded cohorts in a state occurred in the same state. Also, an average of >90% of a state's total harvest of both age classes was derived from that same state. For all but four states, annual adult survival was greater than juvenile survival, and there was considerable variation among states.

Funding provided by TPWD

Nesting Habitat of Breeding White-Winged Doves in Urban Environments

Jeff Breeden, Fidel Hernandez, Texas A&M University–Kingsville; Nova Silvy, Fred Smeins, Texas A&M University; Jay Roberson, TPWD

Changes in white-winged dove (*Zenadia asiatica*) distribution and habitat use have been occurring in Texas since the 1940s. Although breeding populations were originally restricted to rural environments in the Lower Rio Grande Valley, breeding populations now are common in urban areas throughout Texas. These changes have resulted in unique monitoring challenges for breeding populations inhabiting urban environments (e.g., traffic). Delineating potential breeding habitat within urban areas may be helpful to make surveys more efficient. Our objectives were to examine nest-site selection and use regression models to determine the relationship of white-winged dove density to habitat characteristics for an urban white-winged dove population in southern Texas. To document nest-site selection, we conducted nest searches at 15 auditory-count survey points in Kingsville, Texas, in 2003, and measured nesting habitat at nest sites and random points. In addition, we evaluated the relationship between white-winged dove density (n = 49 survey points) and fine-resolution (favorable tree density, mesquite (*Prosopis glandulosa*) tree density, and total tree density) and course-resolution habitat variables (percent favorable tree canopy cover, mesquite tree canopy cover and open lawn) in 2005. We documented that white-winged doves selected for live oak (*Quercus virginianus*) and selected against mesquite for nesting. The strongest relationships we found with fine-resolution and course-resolution habitat variables, respectively, were between white-winged density and favorable tree density and favorable tree canopy cover. Our finding suggest that dense canopy trees such as live oak may be the best indicator of suitable nesting habitat in urban areas and therefore best predictors of white-winged dove presence. These data will be useful in predicting potential white-winged dove habitat in urban areas not yet colonized and may be useful in refining survey protocol regarding allocation and distribution of survey points.

Funding provided by TPWD

Nesting Productivity of an Urban White-Winged Dove Population

Michael Small, John Baccus, Texas State University; T. Wayne Schwertner, TPWD

We conducted our study in Mason, Texas in the Edwards Plateau ecoregion. Mason encompasses 958.3 hectares with a population of about 2,211. We collected data from May 25, 2006 through August 10, 2006 and will repeat data collection in 2007.

We used the 1992 National Land Cover Data Set 2002 to delimit urban land classification for Mason, Texas and ArcView GIS to buffer the area by 500 m to account for urban sprawl, thus designating our sample area. We then randomly selected 10 points within the sample area. From each unique point we expanded outward until each sample point consisted of a contiguous sample unit of $\geq$1 hectare.

We conducted white-winged dove nest searches at each sample unit weekly. We considered nests to be new and active if an adult was seen on the nest on consecutive visits and rechecked nests to verify their status. We checked progress of all nests for the presence of adults, eggs, hatchlings and juveniles. We verified nest contents using a wireless camera on an extendable pole with an LCD monitor. We monitored nests for a maximum of 28 days. When appropriate, nests were categorized as successful (at least one juveniles fledged) or unsuccessful (no juveniles fledged).

We estimated overall nest success using the Mayfield method. We used 28 days (14 incubation, 14 hatchling) as our measure of success and considered eggs and hatchlings equally vulnerable because hatchlings are altricial and completely reliant on parents until fledging. Nest success for 2006 was 47.6%, similar to that found in Kingsville and Waco, Texas.

Funding provided by TPWD

Retrospective Analysis on 30 Years of White-Winged Dove Reproductive Ecology Data

Bret Collier, Nova Silvy, Markus Peterson, Texas A&M University; Mike Frisbie, Jay Roberson, T. Wayne Schwertner, TPWD

Currently, Texas represents the primary continental United States range of the eastern, Mexican highland and upper Big Bend breeding populations of white-winged doves (*Zenadia asiatica*). Mourning dove (*Zenadia macroura*) population management has received considerable management attention recently with the development and evaluation of monitoring programs to estimate population demographic parameters for use in population models to assist managers with harvest management decisions. Our objectives were to determine (1) which white-winged dove reproductive parameters are necessary (e.g., average nesting season length and number of young fledged per nest attempt) to support a regional harvest management strategy, (2) obtain similar recruitment and survival information between Texas and Mexico to support development of a formal harvest management approach, and (3) define recruitment parameter values as decision criteria to explicitly identify when hunting regulation changes should be made, what those changes will be and evaluate the effects of those changes on those recruitment parameters.

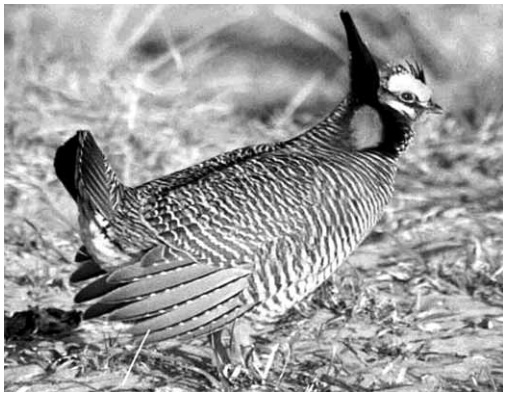
Most reproductive ecology work on white-winged doves has focused on general estimates of nest success typically expressed as a percentage (e.g., 40% nest success). We are conducting a retrospective analysis of the historic white-winged dove reproductive data collected by Texas Parks and Wildlife Department (1966–2001) focused on estimation of nest survival rates. For the past 30 years, active nests were located, nest stage was identified (egg-laying, incubation, nestling) and nestling age (when plausible) was estimated. Fate was determined as whether a nest survived (i.e., a least one nestling was produced), or failed (no production). Because active nests were checked irregularly (ranging from daily to once per week), we will apply a recent approach to modeling nest survival based on the number of exposure days between nest checks. Historical models of nest survival (e.g., Mayfield estimates) assume constant survival rates within researcher specified nesting stages. However, recent analytical techniques for nest survival modeling with variable times between nest checks have increased the ability of researchers to evaluate a host of factors affecting variation in nest survival at finer temporal scales including techniques which account for time-dependent variation using polynomial or cubic model parameters. As TPWD collected transect data for each located nest, we will estimate nesting density using this transect data evaluated with distance-based methods. We will then evaluate the relationship between nest density, nest survival and recruitment to determine if nest density can be used to adequately predict recruitment.

Funding provided by TPWD

Prairie Chickens

Effects of Shinnery Oak Control on Lesser Prairie Chickens

John Leonard, Nova Silvy, Roel Lopez; Texas A&M University; Heather Whitlaw, Stephen DeMaso, TPWD



The historic range of the lesser prairie chickens (LPC, *Tympanuchus pallidicinctus*) has decreased significantly in the past century due to numerous human-induced changes to the landscape. Cultivation of native rangeland, control of sand sagebrush (*Artemesia filifolia*) and shinnery oak (*Quercus havardii*), and fragmentation of existing suitable habitat are hypothesized to be the primary factors responsible for shrinkage of the species range. We initiated a study in 2003 to evaluate the effects of herbicide treatment of shinnery oak on habitat use and survival of LPC in northern Yoakum County, Texas. Herbicide treatment for shinnery oak on two of the four study pastures was completed during March and April 2004. LPC were trapped during spring and fall on breeding grounds (leks) using non-explosive drop nets. Radio-marked LPC were monitored daily (five to seven days per week) during one of four random-tracking periods using a truck-mounted antenna to monitor survival (adult and chick), movements, and habitat use.

From April 1–20, 2006, 28 (24 females, 4 males) LPC were trapped and radio-collared. Preliminary results for summer 2006 indicated nest (40%) success was consistent with previous years, however, brood success (0%) was low. One female moved with a brood over 2.4 km to the west before being killed by a mammalian predator. Upon completion of the nesting season (late July) all birds except two females left the study area. Both females moved to the northern part of the study area into sand sagebrush habitat. This was the first year that males have left the study area and the first year where birds were found east of Highway 214. The lack of rain and subsequent lack of forbs and insects probably accounted for these unusual movements away from the study area. Birds were found up to 8 km away from display grounds on which they were trapped. Vegetation points were sampled on treated and non-treated sites during this period and will be compared with previous sample taken during spring and summer.

Motion-sensitive cameras on dummy nests were used to determine potential nest predators. Ground squirrels (*Spermophilus* spp.) were repeatedly photographed actively trying to eat the eggs but were unable to because of their large size. Since the chicken eggs used in dummy nests were larger than actual LPC eggs, ground squirrels may still be a significant nest predator. Only crows (*Corvus brachyrhynchos*) were photographed actually eating eggs.

Funding provided by TPWD and Texas A&M University

Evaluation of Aerial Line Transect Surveys to Estimate Lesser Prairie Chicken Density

Warren Ballard, Matthew Butler, Jon McRoberts, Mark Wallace, David Wester, Texas Tech University; Gary White, Colorado State University; David Haukos, U.S. Fish and Wildlife Service; Heather Whitlaw, TPWD

Objectives of this study are to evaluate the use of line-transect surveys by helicopter and fixed-wing aircraft for estimating the number of lesser prairie chicken (*Tympanuchus palladicinctus*) leks, the number of males per lek, and the density of male lesser prairie chickens in several study areas. New methodology will be compared with existing ground-based methods. We will determine the benefits, disadvantages and costs associated with each method. We will also develop sampling protocols (i.e., type of aircraft, distance between transects, height of aircraft, speed of aircraft, number of observers) for each survey method.

From March 29 through May 2, 2006, we flew 20 surveys with the three survey aircraft; four with Cessna 172, seven with R22, and nine with R44. Number of observers in Cessna aircraft varied from two to three. Number of observers in R22 was always two and numbers of observers in R44 ranged from two to four. We surveyed 51.7 hours.

Surveys from Cessna aircraft appeared to have the lowest percent of observed leks in relation to known leks of the survey aircraft used even when March surveys were excluded (0 to 25%). The R22 helicopter appeared to have a higher percentage of observations in relation to known leks (March: 4–50%, April: 29–93%). It appears that the best survey aircraft for surveying for prairie chicken leks was the R44 helicopter. Percent of leks observed in relation to known leks ranged from 43 to 200%.

Excluding the Cessna surveys we observed a fairly large number of single birds during these surveys. Because the traditional definition of a lek is >2 birds we could not count singles as a lek. The relatively high numbers of single birds observed could be due to several factors. We have several observations of birds flushing from the lek prior to arrival of the helicopter and the helicopter tallied no observed birds. Thus some of the single birds we observed could have been birds from a single lek. The other explanation is that there are many single birds out there that are not attending leks. We have not yet analyzed these data to account for these possibilities but we plan to have still cameras on the leks during the 2007 surveys to determine the behavior of the birds during the surveys.

If we assume that the surveys are not very reliable for detecting known leks our methodology may still have some value for finding new leks that have not been discovered. The aggregate of the three surveys flown by helicopter suggest that at least four and possibly six new leks may have been identified.

Funding provided by TPWD

Evaluation of Portable Infrared Cameras for Detecting Lesser Prairie Chickens

Shawn Locke, Roel Lopez, Markus Peterson, Nova Silvy; Texas A&M University; T. Wayne Schwertner, Stephen DeMaso, TPWD

The historic range of the lesser prairie chicken (LPC; *Tympanuchus pallidicinctus*) has decreased significantly in the past century due to numerous human-induced changes to the landscape. In Texas, the LPC appears to be declining throughout its range and data collected by TPWD indicated habitat occupied by lesser prairie chicken in the Texas Panhandle has contracted substantially since 1940. Estimates for LPC numbers in Texas were based on lek counts from only a few areas within the Texas Panhandle and current survey methods have been questioned as to their ability to detect changes in population abundances. The overall objective of the proposed study was to evaluate forward-looking infrared in detecting LPC in the differing habitats of the two subpopulations within the Texas Panhandle.

We conducted aerial FLIR surveys in two LPC subpopulations situated in the northeastern (Hemphill, Lipscomb and Wheeler counties) and southwestern (Yoakum and Cochran counties) portions of the Texas Panhandle as distinct and independent. Known, active lek sites were located based on concurrent radio telemetry studies. Flights were conducted at sunrise at a beginning altitude of 152 m using a helicopter with a FLIR ThermaCAM® handheld infrared camera with a 24-degree lens. We attempted to count the number of LPC on each lek site and differentiate between males and females. We conducted six aerial FLIR surveys of LPC lek sites in Hemphill County (three surveys, five leks) and Yoakum and Cochran counties (three surveys, six leks). We determined the optimum altitude to detect LPC with the FLIR camera was 45–61 m above the ground.

The use of FLIR technology in aerially detecting LPC on lek sites was limited primarily by the low altitude required to detect birds and the lack of thermal contrast between the birds and their background. The low altitude flights often flushed birds prior to the camera operator having sufficient time to scan the entire lek site, thereby potentially missing numerous birds. The combination of low altitude flights for detection and lack of thermal contrast limited the ability to detect LPC using a portable thermal imaging camera. We recommend that TPWD investigate alternative methods for estimating LPC abundance.

Funding provided by TPWD and the Texas A&M University System

Evaluation of the Status of Lesser Prairie Chickens in Texas

Eddie Lyons, Roel Lopez, Nova Silvy, Texas A&M University; Stephen DeMaso, Heather Whitlaw, TPWD

Populations of the lesser prairie chicken (*Tympanuchus pallidicinctus*; LPC) have contracted substantially in Texas since 1940, and currently consist of two disjunct populations in the northeastern and southwestern portions of the Texas Panhandle. In 1998, the United States Fish and Wildlife issued a "warranted but precluded" listing. With the accelerated decline of LPC in the last 60 years, information on the current status and population viability of remaining populations is needed. Our study objectives were to (1) estimate annual survival of LPC, (2) determine reproductive parameters, and (3) conduct a population viability analysis (PVA) to evaluate the status of LPC in Texas.

We trapped female LPC on lek sites (n = 40, $\bar{x}$ = 14, SE = 1.73) in the Texas Panhandle using drop nets from 2003–2005. Birds were fitted with numbered aluminum leg bands and radio transmitters prior to release. Annual survival was estimated using the Kaplan-Meier estimator modified for staggered-entry. During the nesting season, radio-marked birds were monitored more intensely to determine nest and renest attempts, nest success and average clutch size. These data along with parameter estimates from published studies on LPC in Texas were used in evaluating the status and population viability of LPC in Texas. We conducted a population viability analysis (PVA) of LPC female populations in two counties (Yoakum and Cochran) in the southwestern portion and in three counties (Hemphill, Lipscomb and Wheeler) in the northeastern portion of the Texas Panhandle using a demographic, stage-structured metapopulation model. We also evaluated the effects of hunting in eight Panhandle counties on LPC from 2000–2004 using data based on the two-day, two-bird-per-day season.

Female LPC survival ranged from 0.21–0.24 annually. Nest attempts (n = 22, $\bar{x}$ = 0.542, SE = 0.093) and nest success (n = 8, $\bar{x}$ = 0.375, SE = 0.125) were low. Clutch sizes of nests was low (n = 13, $\bar{x}$ = 10, range 5–14). Using our LPC PVA model, we estimated female LPC in Texas have a terminal extinction risk of 1.00 (probability of all populations going extinct in 20 years), a median time to extinction of 10 years, a finite rate of increase (λ) of 0.51, and an average ending population of 31 females at five years for the Texas LPC populations. The outlook for LPC populations slightly improved assuming a no hunting season (e.g., median time to extinction = 16.3, λ = 0.66). Sensitivity analyses indicated adult and juvenile survival estimates were the most sensitive model parameters. Future research will include the integration of spatially explicit data (i.e., land use and land cover information) into our LPC model to increase our knowledge of where and in what vegetation types chickens occur (i.e., patches and dispersal, habitat suitability). Our study suggests immediate conservation efforts are needed in the recovery of LPC populations in Texas.

Funding provided by TPWD and the Texas A&M University System

Quail

Delineation of Habitats and a Comparison of Density Estimators for Gambel's Quail

Alfonso Ortega-Sanchez, Louis Harveson, Sul Ross State University; Michael Sullins, TPWD

Gambel's quail (*Callipepla gambelii*) occur along desert riparian habitats throughout the southwestern United States and northwestern Mexico. Much of the native riparian habitat has been invaded by salt cedar (*Tamarisk* spp.), but the effects salt cedar have on Gambel's quail are unknown. We initiated this study to evaluate the effects of salt cedar on Gambel's quail density by (1) delineating salt cedar and native riparian habitats along the Rio Grande corridor in the Trans-Pecos, (2) estimating the amount of suitable habitat for Gambel's quail, and (3) comparing Gambel's quail density estimates using distance sampling methods and the strip-transect methods. Brewster County had the highest ratio (21.2%) of salt cedar vs. native riparian vegetation within the distribution of Gambel's quail. The largest extension of salt cedar occurred in Presidio County with 6,656.3 hectares. For both study sites, density estimates for Gambel's quail were similar using distance sampling and strip-transect methods. Gambel's quail densities were >2x higher on native riparian habitats than salt cedar habitats. However, this was not statistically significant. We recommend that future protocols for monitoring Gambel's quail populations in Texas use strip transect, since they require less time and therefore money. Additionally, future research should focus on developing more precise density estimates for Gambel's quail.

Funding provided by TPWD, United State Department of Agriculture, Sul Ross State University and Texas Council of Quail Unlimited

Dispersal, Habitat Area, and Effective Population Size of Northern Bobwhites

David Garcia-Solorzano, Leonard Brennan, Fidel Hernandez, Randy DeYoung, Texas A&M University–Kingsville; Robert Perez, Stephen Demaso, TPWD

Although the northern bobwhite (*Colinus virginianus*) one of the most studied birds in the world, many important aspects of their life history remain unknown. For example, we have yet to unravel basic aspects of bobwhite sociology and demography that have direct and indirect implications for management. The recent development of new molecular markers and molecular techniques offers a powerful new tool for studying the population biology of wildlife species. Coupled with recent advances in automated genetic analysis, these new markers provide the potential for large-scale genetic examination of wildlife populations. The objectives of this study are to use molecular genetic (DNA) tools to provide the first reliable estimates of dispersal, habitat area, and effective number of breeders for bobwhites in South Texas; supplementing ongoing bobwhite research projects at the Encino Division of King Ranch, and the Chaparral Wildlife Management Area.

During 2006 we collected 132 feather samples and eggshells from Chaparral Wildlife Management Area. We have collected feathers and eggshells samples of 20 nests located at from located at Encino Wildlife Management Area. Additionally, we collected 110 feather samples from Mad Island Wildlife Management Area, and from some private ranches located at Matagorda and Fayette counties.

At this time we have extracted DNA from 105 feather samples collected during 2005 at Chaparral Wildlife Management Area and now are being processed using a microsatellite panel consisting of 10 highly variable loci. Fragments were amplified via polymerase chain reaction (PCR) using fluorescent-tagged primers in single or multiplexed reactions. The PCR products were applied to a denaturing formamide and size standard mix and loaded onto an automated sequencer for separation and detection. DNA fragments are being quantified and analyzed.

The data gathered from these genetic markers will allow empirical estimates of dispersal and number of breeders which will then be used to quantify habitat area (neighborhood size) and the effective number of breeding individuals. By estimating dispersal, habitat area and effective population sizes for bobwhites in South Texas, we will provide a basis for understanding management and sound population restoration in other parts of Texas where available habitat is significantly more fragmented.

Funding provided by TPWD, Richard M. Kleberg Jr. Center for Quail Research and Caesar Kleberg Wildlife Research Institute

Historic and Contemporary Distributions of Montezuma Quail in Texas

David Holdermann, TPWD

Montezuma quail (*Cyrtonyx montezumae*) are classified as a game bird in Texas, but currently there is no open season. It is a Partners in Flight Tier I species (highest conservation concern) in the Chihuahuan Desert and Edwards Plateau physiographic regions. In Texas, it occurred historically in an extensive region in the Edwards Plateau and scattered mountain ranges in the Trans-Pecos region. The Edwards Plateau distribution was significantly reduced to portions of a four-county area centered on Edwards County by the early 20th century. In the mid-1980s, a partial survey of this quail's range in the Trans-Pecos showed it occurred principally in Jeff Davis and Brewster counties. This study attempts to critically review the historic distribution (pre-1950) by examining existing sources of information and to determine the contemporary distribution (1950 to present) from a combination of existing information and new field reconnaissance. Documentation and interpretation of these distributions on a statewide basis will provide a foundation for Montezuma quail conservation in Texas.

I searched North American and European museum collections for historic Montezuma quail specimen records from Texas and have identified 48 skins (1854–1940) and three egg sets (1906–1916) to date. The Edwards Plateau distribution was represented by 18 specimen records from eight present-day counties and the Trans-Pecos distribution by 33 specimens from four counties. My review of published and unpublished historic manuscripts is ongoing and has revealed historic sightings and collection information of Montezuma quail from 11 additional Edwards Plateau counties and four additional Trans-Pecos counties.

Since March 2004, I have conducted detection surveys for Montezuma quail using dog-assisted ground searches (7,061-minute search effort) and playback recordings (158 playback stations) on private and public lands in the Trans-Pecos region. These efforts have resulted in the detection of 62 Montezuma quail representing 24 groups. I detected Montezuma quail in the Chinati, Chisos, Davis, Del Norte, Elephant and Glass mountains and the western Stockton Plateau, but not in the Delaware, Franklin and Guadalupe mountains or the Sierra del Carmen, Sierra Diablo and Sierra Vieja.

Efforts to conduct detection surveys for Montezuma quail in additional Trans-Pecos mountain ranges and the Edwards Plateau are scheduled for Calendar Year 2007.

Funding provided by TPWD

Influence of Buffelgrass on Northern Bobwhite Habitat Use and Selection

Joseph Sands, Leonard Brennan, William Kuvlesky, Jr., Fidel Hernandez, James Pittman, Texas A&M University–Kingsville; Donald Ruthven, III, James Gallagher, TPWD

There is growing concern that exotic grasses adversely affect diversity of native fauna and flora and disrupt ecosystem function. Many rangelands in South Texas have been seeded to or have been invaded by buffelgrass (*Cenchrus ciliaris*) and Lehmann lovegrass (*Eragrostis lehmanniana*), perennial bunchgrasses native to Africa. The objective of this research was to quantify impacts that these exotic grasses may have on northern bobwhite (*Colinus virginianus*) habitat use on a South Texas rangeland during the breeding period and how buffelgrass influences forb communities.

Research was conducted on the Chaparral Wildlife Management Area during 2005 and 2006. Logistic regression of radiotelemetry based habitat data (n = 86 individuals) indicated that exotic grass coverage was a significant factor influencing habitat use, and that quail preferred less exotic grass than was randomly available. Univariate selectivity modeling produced a selection ratio model that revealed northern bobwhite avoidance of areas with exotic grass coverage of >30%. Comparative analysis of forb communities in 15 1-hectare plots (n = 20 quadrats/plot; 5 plots/type) of heavy, moderate, and light buffelgrass coverage shed additional light on the patterns revealed in the multivariate and selectivity modeling. For both years, percent coverage (2005: 3.41 $\pm$ 1.16, 7.55 $\pm$ 0.87, 11.72 $\pm$ 0.86; 2006: 1.00 $\pm$ 0.39, 1.43 $\pm$ 0.18, 4.90 $\pm$ 0.81, heavy, moderate, and light, respectively), richness (2005: 2.36 $\pm$ 0.64, 4.04 $\pm$ 0.54, 6.36 $\pm$ 0.28; 2006: 0.80 $\pm$ 0.35, 1.01 $\pm$ 0.14, 2.27 $\pm$ 0.38), and density (2005: 11.72 $\pm$ 3.85, 38.68 $\pm$ 9.15, 52.83 $\pm$ 9.49; 2006: 2.63 $\pm$ 1.03, 3.77 $\pm$ 0.78, 13.10 $\pm$ 4.32) of forbs was less ($P \leq 0.05$) in heavily infested buffelgrass plots.

Results from each of these three multiscale analyses suggest that avoidance of areas with high exotic grass coverage may indicate a reduction in useable foraging habitat space for northern bobwhite within semiarid subtropical rangeland communities in South Texas. Management techniques favoring native grass stands on a landscape scale and implementing localized control methods for exotic grasses are two potentially important strategies to maintain and maximize usable habitat space for northern bobwhites.

Funding provided by TPWD, Caesar Kleberg Wildlife Research Institute and the South Texas Quail Associates Program

Northern Bobwhite Sustained Yield Harvest Regulation of Consumptive Use

Matthew Schnupp, Fidel Hernandez, Leonard Brennan, Texas A&M University–Kingsville; Dale Rollins, Texas Cooperative Extension; Stephen DeMaso, TPWD

The biological justification and effects of fixed harvest regulations (i.e., a daily bag limit of 8 to 15 birds and a season length of 2.5 to 4 months) for northern bobwhite (*Colinus virginianus*) have recently received considerable attention. Data emerging from this research indicate that although hunting appears self-regulatory (i.e., hunter numbers decline with decreasing quail abundance), it is indeed not self-regulatory when corrected for hunter skill (hunter skill increases when abundance decreases). Consequently, quail abundance (and not wildlife agencies) appears to be the primary factor influencing hunting pressure, harvest and hunter efficiency. These findings indicate that fixed harvest regulations appear to have limited, if any, impact on regional or state populations of quail. However, quail over-harvest can still occur at small scales, even if bobwhite harvest is occurring within the legal regulations. Sustained-yield harvest has been recommended as a method well suited to manage quail harvest at the same spatial scale as hunting effort. The objectives of our study are to (1) determine if sustained-yield harvest is a feasible strategy to manage quail populations, (2) determine the minimum spring density necessary for population persistence, and (3) evaluate the existence and strength of compensatory mechanisms (i.e., density-dependent reproduction and survival) in quail populations at southern latitudes. Our experiment design will be replicated within three ecoregions of Texas (South Texas Plains, Coastal Prairies and Marshes, and Rolling Plains). Three study sites within each ecoregion (2 harvested + 1 control) will be evaluated during 2006–2009. Northern bobwhite densities will be estimated by distance sampling, morning covey-call counts, radiotelemetry and mark-recapture. The ability of sustained-yield harvest to produce sustainable populations of bobwhite will be evaluated by demographic models using 100-year simulations and including environmental stochasticity. We anticipate that implementing sustained-yield harvest will allow landowners and managers to harvest quail populations more efficiently while maintaining a sustainable population.

Funding provided by TPWD

Presence-Absence Monitoring Approach to Monitor Montezuma Quail Population

Cristela Gonzalez, Fidel Hernandez, Eric Redeker, Texas A&M University–Kingsville; Louis Harveson, Sul Ross State University; Dave Holdermann, Froylan Hernandez, TPWD

Very little information is known about Montezuma quail (*Cyrtonyx montezumae*) due to the lack of research and management. This bird is considered secretive because of its cryptic plumage, which makes it hard to detect. No data currently exists on densities and population trends, causing them to be classified as a game bird with no open season. Using the presence-absence monitoring technique, estimated occupancy, detection probability, abundance and temporal changes of Montezuma quail is expected to be found, as well as specific habitat chosen. The advantage of using the presence-absence monitoring technique is that "absence" will not necessarily mean that the bird is truly absent; it can account for non-detection of present individuals. This study will be conduced on Elephant Mountain Wildlife Management Area and the Fort Davis Nature Conservancy Preserve during July–August 2007 and 2008. Resulting data will permit the Texas Parks and Wildlife Department to assess the current status of Montezuma quail as well as the option to monitor future population trends.

Funding provided by TPWD

Restoring Northern Bobwhite Populations in Fragmented Landscapes

Jason Scott, Fidel Hernandez, Leonard Brennan, Bart Ballard, Texas A&M University–Kingsville; David Forrester, Mike Janis, Royce Jurries, TPWD

Habitat fragmentation has been identified as a contributing factor to declining populations of northern bobwhite (*Colinus virginianus*), especially in certain regions of Texas such as the southern Post Oak Savannah. Our objective is to determine if bobwhites can be restored on large habitat patches (i.e., >405 hectares) within this ecoregion using habitat management and translocations of wild bobwhite.

This study involved three sites (one control site and two treatment sites [habitat management + translocations]) located in Caldwell and Fayette counties. We translocated 232 and 318 bobwhites to Caldwell and Fayette counties, respectively, January through April, 2004–06. Of these 550 translocated bobwhites, we radio-marked 221 females and 31 males in order to monitor movements and nesting attempts, and determine survival rates. Hens were marked preferentially because we deemed reproductive success an integral component of restoration. Survival rates (April 6–August 15, 2004–06) averaged 35% (range 27–44%) on treatment sites. Twenty-four nests were discovered during summer radio-tracking sessions, of which 42% hatched successfully. We calculated summer use areas for bobwhites (n = 44) that were located >25 times following release. Post-release summer use areas (hectares/bird) averaged 464.3 hectares (range 11.3–3,265.7). Movements >1.6 km were common, and one bobwhite traveled >38.6 km from its release point.

In summary, translocated bobwhites experienced low survival and poor reproduction but exhibited extensive movements. As a result, restoring bobwhite populations in this highly fragmented region may be beyond the realm of practical management given poor population performance of translocated bobwhites. This study has wide-ranging implications considering bobwhites are faced with declining habitat on continually smaller tracts of land. The results of this study will assist biologists and managers in assessing potential restoration efforts of this species.

Funding provided by TPWD, Alice Kleberg Reynolds Meyer Foundation, Larry J. Doherty, David L. Hatcher, KMG-Bernuth, Inc., Audubon Texas and Anonymous Donors

Seasonal Call Response of Montezuma Quail to a Taped Playback Recording

David Holdermann, TPWD

My primary interest in testing the playback technique was to determine the feasibility of using recorded calls to detect Montezuma quail (*Cyrtonyx montezumae*) populations in the context of mapping Montezuma quail distributions in Texas. I conducted call response trials monthly (December 2005 to February 2007) for Montezuma quail by broadcasting a taped recording of human-imitated male "buzz" and flock "assembly" calls at 20 call stations located along Texas Route 118 in the Davis Mountains of the Trans-Pecos region. The call route traversed occupied Montezuma quail habitat in montane oak (*Quercus* spp.) and mixed oak-juniper (*Juniperus* spp.) woodlands with dominant understory vegetation of perennial grasses.

I identified a brief response period in March (six birds at five stations) and a second, more intense, response period that began June (five birds at five stations), peaked in July (19 birds at 12 stations) and then slowly tapered off through early October. The March response period coincided with pair formation while the July peak in callback response rate coincided with the onset of monsoonal precipitation and presumably nesting by Montezuma quail. My findings suggest that a combination of taped male "buzz" and flock "assembly" calls can be used to detect presence of Montezuma quail in the Trans-Pecos region during the period from July through at least early September. Further, there may be potential to use the playback technique as a basis to estimate Montezuma quail population parameters via occupancy modeling techniques.

Funding provided by TPWD

Status, Distribution and Principal Foods of Gambel's Quail

Michael Sullins, TPWD; Louis Harveson, Sul Ross State University

Aside from a few unpublished documents, virtually no data exists regarding Gambel's quail (*Callipepla gambelii*) in Texas. Information on distribution in Texas is ambiguous, and food habits are unknown. We initiated this study in order to assess their distribution and status, and to determine the principal foods items.

Distribution occurs from El Paso County southeast to Brewster County below 1,350 m within the Rio Grande Valley and intermountain basins along low elevation drainages supporting alluvial plant associations. Small sporadic populations also occur along major drainages on the east and west sides of the Beach and Sierra Diablo Mountains in Hudspeth and Culberson counties, north to Dell City, Texas.

Food habits of 392 Gambel's quail were determined for a 24-month period in 2002 to 2004. Twenty foods constituted 91.1% of the volume of all items consumed. These were: seeds of *Salsola kali, Chilopsis linearis, Descurania pinnata, Verbesina enceloides, Mentzelia multiflora, Setaria leucopila, Lepidium virginicum, Prosopis glandulosa, Acacia constricta, Acaciia greggii, Lupinus* spp. *Ambrosia* spp., *Oligomeris lineofolia*, and *Lesquerella* spp.; fruits of *Lycium berlandieri, Rhus microphylla, Condalia warnockii*, and *Celtis reticulata*; green vegetation; and arthropods. Forb seeds were the most consumed food type followed by fruits of woody perennials, seeds of woody perennials, green vegetation, animal material and grass seeds. Plant species that provided food for Gambel's quail also provided critical escape, loafing and roosting cover. Promoting or protecting existing woody cover is critical to maintaining Gambel's quail habitat. Native brush removal should be weighed against loss of habitat and possible reduction in quail numbers.

Funding provided by TPWD, Sul Ross State University and Texas Council of Quail Unlimited

Turkey

Annual Range Differences in Regions of Stable and Declining Rio Grande Wild Turkey Abundance

Jody Schaap, Nova Silvy, Markus Peterson and Fred Smeins, Texas A&M University; Ray Aguirre, Stephen DeMaso; T. Wayne Schwertner, TPWD

Since the late 1970s, the Texas Parks and Wildlife Department and local ranchers reported that Rio Grande wild turkey (RGWT, *Meleagris gallopavo intermedia*) abundance has declined significantly in the southern region of the Edwards Plateau while remaining stable in the rest of the Edwards Plateau.

To determine the possible cause of the decline in the southern Edwards Plateau, we conducted research on four sites, two each in stable regions (Kerr and Real counties) and declining regions (Bandera and Medina counties). RGWT were radio-tagged and subsequently located an average of three times per week. Annual ranges were constructed with 95% kernels using ArcView Spatial Analyst software and the Animal Movement Extension. When annual ranges were analyzed, RGWT in the declining region showed less variation in individual range size ($\bar{x}$ = 1,082.7, SD = 739.3) than in the stable region ($\bar{x}$ = 2,397.4, SD = 3,005.3). Annual range sizes on the two original sites show a larger mean distribution (P = 0.025) in the stable region than in the declining region.

This discrepancy (birds used larger area on the stable site) is counterintuitive to literature on the movements of RGWT in relation to habitat quality. We hypothesize that "usable space" has been decreasing on declining sites and may be limiting RGWT populations on these sites.

Funding provided by TPWD and Texas A&M University

Camera Station Population Survey of Eastern Wild Turkey

Greg Creacy, Chris Gregory, Dan Jones, TPWD

During Eastern wild turkey (*Meleagris gallopavo silvestris*) restoration efforts in East Texas, birds were translocated to San Jacinto, Montgomery and Walker Counties. In 2000, research was initiated to develop an improved method of monitoring turkey population distribution, indices and demography in these counties. Bait stations with infrared sensor-equipped cameras were established in suitable turkey habitat on the 67,200-hectare Sam Houston National Forest Wildlife Management Area (SHNFWMA) located in the three counties.

This study area was divided into three compartments, with an average of 10 stations monitored annually, based on equipment and personnel availability. Stations were pre-baited and cameras were operated for 30-day periods during June–August in 2000–2006. Photo data was used to determine sex, age, and ratios, occurrence of banded birds, group size, and visitation times and duration. Pooled study area data indicated an increase in total individuals from 2000 to 2001, with subsequent declines in annual detections through 2006, when no individuals were detected at camera stations. Poults were detected only in 2004 and 2005, and only in low numbers. These trends are generally consistent with harvest and hunter observations from turkey check stations on the study area.

We consider this method to be a useful tool for long-term monitoring of population trends during the continuing eastern wild turkey restoration on the SHNFWMA. Camera stations will continue to supplement other survey methods of assessing turkey survival and distribution in low-density populations and monitoring future restoration efforts.

Funding provided by TPWD

Diet of Rio Grande Wild Turkey in the Texas Panhandle

Brian Petersen, Warren Ballard, Mark Wallace, Texas Tech University; Derrick Holdstock, TPWD

To manage turkey (*Meleagris gallopavo*) populations effectively, it is important to understand their food habits. Wild turkeys are opportunistic and nomadic foragers with a seasonally varied diet. Previous studies suggest that supplemental feeding may be useful in maintaining wild turkey populations. Supplemental feeding can be intentional or accidental and can take on various forms such as feeders for turkeys, feeders for other wildlife, food plots and livestock feeding operations. The objectives of this study are to determine male and female Rio Grande wild turkey diet in relation to season of year and assess the importance of supplemental feed in the diet of wild turkey in the Texas Panhandle.

We conducted fieldwork on the Matador WMA, Gene Howe WMA, private ranches adjoining the WMAs, and a private ranch near Clarendon, Texas, which lie in the western Rolling Plains along the eastern half of the Texas Panhandle. Male (n = 35) and female (n = 35) wild turkey were collected seasonally during 2005 and 2006 to assess food habits. Preliminary crop analysis indicates that green vegetation and insects are an important part of spring and summer diet. Mast and grass seed tend to dominate fall diet. Diet diversity appears to vary from bird to bird. The number of different food items range from four to more than 20 with an average of about 10. Examination of digestive tracts is ongoing and further analysis of diet among study sites, season and sex are forthcoming. Results of this study will assist managers in assessing and managing habitat for wild turkey in the Rolling Plains.

Funding provided by TPWD, the Texas Chapter of the National Wild Turkey Federation and the National Wild Turkey Federation

Evaluation of Distance Sampling for Rio Grande Wild Turkeys from Roads

Devin Erxleben, Matthew Butler, Warren Ballard, Mark Wallace, Texas Tech University; Stephen DeMaso, TPWD

Many techniques have been used to index or estimate abundance, density, and trends of Rio Grand wild turkey (*Meleagris gallopavo intermedia*) populations. Though traditional index-based monitoring techniques can indicate trends in wild turkey populations, they were not designed with the sensitivity necessary to detect anything but drastic changes. Recent research on line transect-based distance sampling from roads has indicated road-based surveys can provide an efficient, effective and inexpensive technique for monitoring wild turkey populations in the Texas Rolling Plains. Our goal is to evaluate the applicability of road-based distance sampling in four Texas ecoregions: Southern Rolling Plains, Cross-Timbers, Edwards Plateau and South Texas. We have several research objectives. First, using radiotelemetry data, we plan to quantify the association of wild turkeys to roads and examine the potential biases of using roads as transects for distance sampling. Second, we plan to estimate encounter rates of wild turkeys during road surveys in each ecoregion. Encounter rates will be used to determine the amount of effort (i.e., km of roads) required to obtain adequate sample sizes for road-based distance sampling. Third, we will evaluate the relationship between flock detectability, flocking behavior and visual obstruction in each ecoregion. Finally, we will evaluate the accuracy and precision of density estimates using computer simulations. We are currently in the planning stages and will begin field activities in August 2007.

Funding provided by TPWD

Evaluation of Portable Infrared Cameras for Detecting Rio Grande Wild Turkeys

Shawn Locke, Roel Lopez, Markus Peterson, Nova Silvy; Texas A&M University; T. Wayne Schwertner, Stephen DeMaso, TPWD

Recent declines in turkey (*Meleagris gallopavo*) abundance have prompted the Texas Parks and Wildlife Department (TPWD) to assess landscape-scale methods of surveying turkey populations. Brood counts and harvest data have been used by TPWD to estimate population trends and numbers, but presently no methods to estimate Rio Grande wild turkey densities are used. Here we describe our application of FLIR technology in detecting wild turkeys in three Texas Ecological Regions where they commonly are found (Edwards Plateau [EP], Rolling Plains [RP], and Gulf Prairies and Marshes [GPM]). We sought to estimate turkey abundance using aerial thermal imaging surveys and to assess the accuracy of these estimates by comparing to independent estimates from ground surveys.

We conducted eight ground and aerial FLIR surveys (4 EP, 3 RP, and 1 GPM) of roost sites during predawn hours (0300–0600) of winter months (November 2004–April 2005) to take advantage of the leaf-off period for each ecological region. We located three roosts in the EP, with two roosts of 28–33 turkeys and the third roost consisting of 14–17 turkeys. The RP roost sites consisted of a large roost with 66–75 turkeys and a smaller roost with 47–52 turkeys. We located nine roost sites in the GPM and each included 5–15 turkeys. Ground counts were estimates of roosting turkeys, and variation in counts was due to actual changes in the number of turkeys from night to night or counting error. In our study we were unable to aerially detect

roosting turkeys using the portable infrared camera due to altitudinal restrictions required for safe helicopter flight and lack of thermal contrast. Based on the analysis of the radiometric thermal images, we found the external temperatures of turkeys, tree branches and other background objects (i.e., rocks, bare ground) to be within 1.5°C of each other despite ambient temperatures or other weather variables (i.e., wind speed, humidity and cloud cover). Therefore, there was not sufficient difference in the radiant temperature of a turkey and its background to permit adequate detection from an aerial perspective.

The combination of inadequate thermal contrast caused by background objects and the required altitude needed to adequately detect roosting Rio Grande turkeys (due to small thermal signature) limited the use of FLIR technology for all three Texas study areas. Due to the limitations of aerial FLIR surveys for wild turkeys, we recommend TPWD seek alternative methods for estimating Rio Grande wild turkey densities in the state of Texas.

Funding was provided by TPWD and Texas A&M University

Evaluation of Surgically Implanted Radio Transmitters on Turkey Poults

Stephanie McKenzie, Mark Wallace, Warren Ballard, Texas Tech University; Donald Ruthven, III, TPWD; Peter Alcumbrac, Wildlife Health Services; Chris Kochanny, Advanced Telemetry Systems

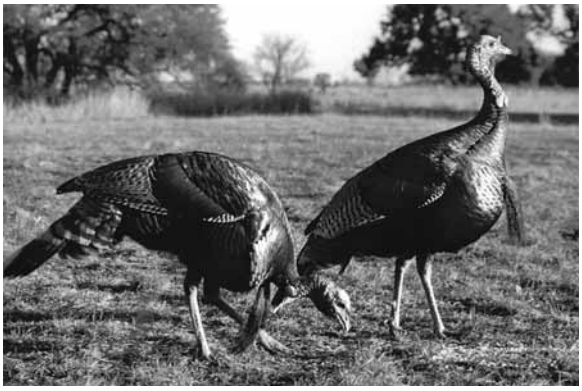
Poult survival is a key parameter needed to understand turkey (*Meleagris gallopavo*) population dynamics. However, limited knowledge about this critical life-history stage has made it difficult for biologists to evaluate annual variation in population numbers. Reliable estimates of poult mortality can be obtained using radiotelemetry. However, data on poult mortality >4 weeks post hatch does not exist due to limitations of transmitter attachment methods. With the aid of suitable turkey poult radio transmitters it would be possible to gain reliable survival estimates for poults surviving into their first winter (February–March). By this age turkey poults can be recaptured and equipped with a transmitter using traditional methods. We initiated a study that would examine the affects of a new surgically implantable radio-transmitter prototype on turkey poult behavior, growth and survival.

In spring 2006, a new surgically implantable radio-transmitter prototype (Advanced Telemetry Systems) weighing 2.2 g (8 x 13 mm) was implanted into the abdominal cavity of three- to five-day-old Rio Grande turkey poults. We evaluated three treatment groups: (1) control (no transmitter or surgery; n = 21); (2) surgery without transmitter (n = 26); and (3) surgery with transmitter (n = 34). Poult behavior and survival was monitored daily. We measured growth on a weekly basis. Survival rates differed one-week post-surgery with 17% and 33% mortality rates for poults receiving surgery or surgery with transmitter, respectively, whereas the control group only suffered 10% mortality during the same time period. Survival >1 week post-surgery did not differ among treatment groups. There was no difference in growth between treatment groups. Detectable transmitter signals lasted three months from implantation, which is half of predicted battery life. Additional analyses on the effects of transmitter implantation on behavior are forthcoming.

Funding provided by TPWD and the National Wild Turkey Federation

Evaluation of Survey Techniques for Rio Grande Wild Turkey Populations

Matthew Butler, Warren Ballard, Mark Wallace, Texas Tech University; Stephen DeMaso, TPWD



Many wild turkey (*Meleagris gallopavo*) surveys have been limited, unstandardized, and unsuccessful. Our objectives were to develop and evaluate Rio Grande wild turkey (*M. g. intermedia*) survey techniques in the southern Great Plains and determine if trends in population change are detectable. Aerial surveys have been used to estimate abundance for several wild bird species. We used inflatable turkey decoys and radio-tagged wild turkey flocks to evaluate detectability during aerial surveys. We conducted simulations to evaluate aerial surveys and examined power to detect trends. Simulations suggested fixed-wing surveys would underestimate abundance by 10–15% (2.0–4.8% CV), but helicopter surveys would underestimate by 5.6% (4.6% CV). Power was sufficient to detect a 10–25% change in four to five years. Helicopter surveys can cost six times more than fixed-wing surveys. Ground-based surveys can be improved with line transect-based distance sampling from roads. Because wild turkeys may avoid or be attracted to roads, we examined their distributional patterns around roads and found autumn midday and winter mornings were the best times for road surveys. We used decoys to evaluate detectability during road surveys. We conducted simulations to evaluate road surveys and examined power to detect trends. Simulations suggested density would be underestimated by 24% during winter (11.2% CV) and by 37% during autumn (13.3% CV). Power was sufficient to detect a 10–25% change in five to seven years during winter. Aerial surveys were better, but are expensive. Problems with road surveys include responsive movements, avoidance-attraction behaviors, and lack of representative samples. Also, fixed-wing aerial surveys for wild turkeys may be incorporated into similar midwinter waterfowl surveys. Thus, if fiscal restrains permit, managers should use fixed-wing surveys to monitor wild turkey populations in the Southern Great Plains.

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Gene Flow and Dispersal in Rio Grande Wild Turkeys

Richard Phillips, Warren Ballard, Mark Wallace, Robert Baker, Texas Tech University; Stephen DeMaso, TPWD

Dispersal is a one-way permanent movement from one population to another. Such movements among populations have long been important to effective management of wildlife populations. Continued habitat fragmentation increases the importance of dispersal estimates to wildlife management, yet it remains a very difficult parameter to estimate. As such, management has increasingly relied upon genetics (gene flow) to estimate dispersal. Based upon differences in specific regions of DNA, genetic studies estimate movement of organisms by comparing similarities among groups of animals. These studies typically report these estimates by generating statistics to estimate the number of dispersers or by the ability to assign individuals to different populations. Despite the increasing prevalence of such studies, few studies have compared estimates of dispersal based upon genetics with those estimates based upon radio telemetry studies.

Using DNA extracted from captured wild turkeys (*Meleagris gallopavo*), genetic data are being generated for 90 animals from three study sites in the Texas Panhandle. These animals will be used to generate genetic estimates of gene flow among winter roost populations both within and among study sites. Using several genetic markers and several genetic analyses, these data will be used to predict movement patterns among populations. These data generated from genetics will then be compared with observed patterns of dispersal generated from radio-marked individuals. It is hoped that such comparisons will provide insight into the relationship between gene flow and dispersal at multiple spatial scales and promote more effective management by identifying each technique's limitations.

Funding provided by TPWD and the National Wild Turkey Federation

Mortality Rate of Rio Grande Turkeys on the King Ranch

Eric Reyes, William Kuvlesky, David Hewitt, Alfonso Ortega, Texas A&M University–Kingsville; Stephen DeMaso, TPWD; Mick Hellickson, King Ranch Inc.

Few studies have quantified the survival of wild turkey hens (*Meleagris gallopavo*) in south Texas. Therefore, we initiated a three-year research project during fall 2003 to quantify wild turkey survival on the King Ranch. Radio transmitters were attached to 51 wild turkey hens on three study sites during the winters of 2003–2004 and 2004–2005. During the first year, survival for 16 radioed hens was highest on the Encino Division, ranging from 100% during the first-month post capture (February) to 87% one year post-capture ($\bar{x}$ = 89%). Survival declined to 57% during seven months in 2004–2005 ($\bar{x}$ = 60%). Survival for 19 radioed hen on the Laureles Division ranged from 100% during the first month post-capture (January) to 41% one year post-capture ($\bar{x}$ = 66%). Survival declined during the next 11 months to 28% ($\bar{x}$ = 35%). Survival for 16 radioed hens on the Norias Division ranged from 100% during the first month post-capture (January) to 55% one year post-capture ($\bar{x}$ = 71%). Survival declined during the next 11 months to 32% during 2004 and 2005 ($\bar{x}$ = 42%). Survival was relatively high until the nesting season began in April and May suggesting that hens are more vulnerable to predation while they are incubating eggs. The higher hen survival rates on the Encino Division could be a reflection of better habitat conditions or fewer predators than what is typical on the Laureles and Encino Divisions.

Funding provided by TPWD, National Wild Turkey Foundation, Texas State Chapter of The National Wild Turkey Foundation and Caesar Kleberg Wildlife Research Institute

Nesting Ecology of Rio Grande Wild Turkeys in South Texas

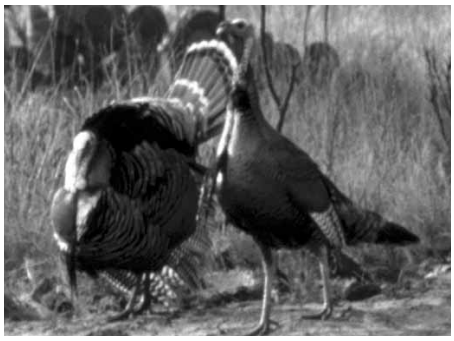
Eric Reyes, William Kuvlesky, David Hewitt, Alfonso Ortega, Texas A&M University–Kingsville; Stephen DeMaso, TPWD; Mick Hellickson, King Ranch Inc.

Few studies have quantified the nesting ecology of wild turkey (*Meleagris gallapavo*) hens in South Texas. Therefore, we initiated a three-year research project during fall 2003 to quantify wild turkey nesting ecology on the King Ranch. Radio transmitters were attached to 139 wild turkey hens on the three study sites during the winters of 2003–3004 and 2004–2005. Compared to other studies conducted elsewhere on Rio Grande wild turkey populations, hens in South Texas experienced lower nesting (35%) and nest success rates (40%), and had smaller average clutch sizes (9.77 eggs) and lower hatching success (9.33 eggs). Spring dispersal distances of hens averaged 3,375 m and hens that nested moved farther from their winter center of activity ($\bar{x}$ = 3,900 m) than hens that dispersed but did not nest successfully ($\bar{x}$ = 2,889 m). Juveniles dispersed almost 2 km farther ($\bar{x}$ = 4,933 m) than adults ($\bar{x}$ = 2,962 m). Nesting season home ranges did not vary significantly among study sites but the average home range was smaller on the Laureles Division ($\bar{x}$ = 275 hectares) than on the Encino ($\bar{x}$ = 545 hectares) and Norias Divisions ($\bar{x}$ = 492 hectares). Nesting season home ranges were smaller during 2004 ($\bar{x}$ = 178 hectares) than in 2005 ($\bar{x}$ = 559 hectares) and juveniles had smaller nesting season home ranges ($\bar{x}$ = 325 hectares) than adults ($\bar{x}$ = 448 hectares). Hens that did not nest had a larger nesting season home ranges ($\bar{x}$ = 423 hectares) than the hens that nested ($\bar{x}$ = 187 hectares).

Funding provided by TPWD, National Wild Turkey Foundation, Texas State Chapter of The National Wild Turkey Foundation and Caesar Kleberg Wildlife Research Institute

Nest-Site Vegetation Characteristics of Rio Grande Wild Turkey Populations

Charles Randel, Nova Silvy, Markus Peterson and Fred Smeins, Texas A&M University; Ray Aguirre, Stephen DeMaso, T. Wayne Schwertner, TPWD



Since 1970, Rio Grande wild turkey (*Meleagris gallapavo intermedia*) numbers in the southern region of the Edwards Plateau have been declining. Lack of nesting cover has been hypothesized as limiting wild turkey numbers in declining regions. Wild turkeys were trapped and fitted with mortality-sensitive radio transmitters on four study areas; two within a region of stable (northern Edwards Plateau) populations, and two within a region of declining populations. Monitoring occurred from February 2001 to August 2003. Nest-site locations were determined via homing during the breeding season.

Following nesting attempts/completions, nest fate, vegetation height, visual obstruction, litter depth, percent cover, and cover scores of forbs, grass, litter, and bare ground at each nest site and surrounding area were sampled. This was done to determine if wild turkey hens selected nest sites with vegetative characteristics differing from surrounding habitat, and if there were differences in vegetative characteristics at nests site in stable and declining regions. Hens from the four study areas selected similar vegetation characteristics at nest sites. Hens also selected nest sites with greater visual obstruction, greater litter depth, and greater litter cover than was available at random locations. Trends in these data were similar for hens in both stable and declining regions, suggesting no behavioral differences between populations.

Funding provided by TPWD and Texas A&M University System

Relationships of Cattle Grazing to Rio Grande Turkey Habitat Use and Nesting Ecology

Galon Hall, Mark Wallace, Warren Ballard, Texas Tech University; Donald Ruthven, TPWD

Interactions between cattle grazing and various wildlife species have been extensively studied throughout the United States, specifically in regards to wild ungulate ecology. However, limited studies on the response of gallinaceous birds to grazing have produced conflicting results, warranting further investigation. The Rio Grande wild turkey (*Meleagris gallopavo intermedia*) occupies plains grasslands, Texas savanna, and southwestern shrub-steppe across its range from Mexico, through Texas, and up to Kansas. In many cases, these same areas are intensively used for grazing. Our objective was to quantify habitat use by female Rio Grande wild turkeys during the nesting period and determine possible relationships between cattle grazing and nest site selection that can be applied to the Rolling Plains ecoregion.

From January 2000 to August 2004, turkeys were trapped at four study sites in the Texas Panhandle and Southwest Kansas. Each turkey was fitted with a radio transmitter in order to obtain estimated locations throughout the year. Over the five-year study, 361 nests were located and vegetative characteristics were recorded. Each nest site was categorized into three different vegetative zones: urban/agriculture, upland and riparian. Initial analysis indicated that urban/agriculture and upland zones were used less than available and riparian zones were used more than available. Grazed and non-grazed pastures were used in proportion to their availability.

At every located nest, vegetation measurements were recorded, including the horizontal screening cover, canopy cover, and percentage of grass, forb, litter, shrub, and bare ground. The measured vegetative characteristics at each nest site were analyzed to determine critical components of nest site selection. Results indicated that visual obstruction is a primary component in site selection. Nest sites were then divided into four categories: upland grazed, upland non-grazed, riparian grazed and riparian non-grazed. We then compared each category to determine if there were differences in vegetative structure and composition of nest sites. Shrub composition at nest sites was lowest in riparian non-grazed (10.2%) and increased progressively in riparian grazed (12.2%), upland non-grazed (19.2%), and upland grazed (21.1%). Rank ordering of nest success (proportion of females that successfully hatched at least one egg) for each category indicated a likely trend: riparian non-grazed (35.6%) had the highest success rate compared to upland grazed (33.3%), upland non-grazed (25.6%) and riparian grazed (24.1%).

These data indicate that grazing has a measurable effect on the selection of vegetative cover by nesting Rio Grande wild turkeys. We concluded that turkeys in grazed situations used areas with increased shrub cover to provide the visual obstruction component. An appropriate grazing plan may include upland grazing in the spring, when it likely has little impact on nest success and controlled riparian grazing after the nesting season is completed.

Funding provided by TPWD and the National Wild Turkey Federation

Rio Grande Wild Turkey Site Occupancy and Abundance Estimation

Bret Collier, Markus Peterson, Nova Silvy, Roel Lopez, Mike Morrison, X. Ben Wu, Texas A&M University; William Kuvlesky, Jr., Alphonso Ortega, Texas A&M University–Kingsville; T. Wayne Schwertner, Steven DeMaso, TPWD

Development of monitoring surveys to estimate wild turkey (*Meleagris* spp.) abundance and detect changes in population size has become a critical issue for the long-term management of wild turkeys in Texas. TPWD has used many techniques to estimate wild turkey population size or trajectory, including road counts, gobble surveys, roost counts, harvest surveys, thermal imaging approaches using aerial surveys, and road based distance estimates. These have had variable success for estimating the size of wild turkey populations. Currently there is an indeterminate relationship between Rio Grande wild turkey survey estimates and population status. Thus, management based on these estimates of population size and/or trend is not feasible.

In order to provide TPWD with an approach to population monitoring of Rio Grande wild turkeys in Texas, a coordinated abundance estimation program is necessary. The focus of our proposed research is the development, testing, and implementation of such methods which will have broad applicability within the range of the RGWT and for management of turkey populations across the United States. We are conducting an occupancy-based Rio Grande wild turkey abundance estimation program to be used for future population management decisions.

We have developed a sampling protocol to focus survey efforts where Rio Grande wild turkey encounters are likely. Over each sample location (e.g., single riparian area), a grid network of sample plots will be overlaid, and a random selection of survey plots will be conducted within those plots. Thus, we will determine the probability that a particular patch (sample plot) is occupied. We used dependent double observers to estimate "site or plot" specific abundance. We have found that patch occupancy rates are currently low (0.05), and that observer variability using point count techniques varies between 20 and 60%.

Additionally, we are developing an adaptive sampling protocol to focus survey efforts where Rio Grande wild turkey encounters are likely. This approach will allow us to incorporate varying degrees of land accessibility over time in an adaptive management framework. Sample locations will be selected with probability proportional to size based on a variety of characteristics collected from data on radio-tagged wild turkeys. Over each sample location (e.g., single riparian area), a grid network of sample plots will be overlaid, and random selection of survey plots will be conducted within those plots.

Funding provided by TPWD

Seasonal Habitat Use by Female Rio Grande Wild Turkeys in South Texas

Cody Lawson, William Kuvlesky, David Hewitt, Texas A&M University–Kingsville; Stephen DeMaso, TPWD

Few studies have quantified the seasonal habitat use of Rio Grande wild turkey hens (*Meleagris gallopavo intermedia*) in South Texas. Therefore, we initiated a three-year research project during fall 2003 to quantify female Rio Grande wild turkey habitat use during the breeding (March–July) and non-breeding (August–February) seasons in South Texas. Vegetation maps were created using GIS and delineated by vegetation community. Microhabitat measurements were taken at random points to characterize the vegetation communities during each season. Bird locations were determined by using radio telemetry and the Location of a Signal program. Results indicate that during the breeding season hens utilized rangeland communities more than woody communities (P <0.001), while during the non-breeding season utilization was opposite that of the breeding season (P <0.001). Results of this data indicate that both rangeland and woody communities are important habitat components to Rio Grande wild turkey in South Texas.

Funding provided by TPWD

Survival of Rio Grande Wild Turkeys on the Edwards Plateau

Bret Collier, Dustin Jones, Jody Schaap, Charles Randel, Beau Willsey, Nova Silvy, Markus Peterson, Texas A&M University; Ray Aguirre, T. Wayne Schwertner, TPWD

The southeastern portion of the Edwards Plateau, historically a stronghold of Rio Grande wild turkeys (*Meleagris gallopavo intermedia*), has seen a decline in turkey numbers since the 1970s. Because adult and juvenile survival are key parameters affecting turkey population dynamics, we used radio-tagged individuals to compare Rio Grande wild turkey survival in areas of suspected decline versus stable portions of the Edwards Plateau during 2001–2003. Reproductive period (breeding or non-breeding) had an impact on survival, but differences in age, sex or region did not influence survival. Model averaged estimates of monthly survival were 0.97 (SE = 0.005) for non-breeding periods and 0.96 (SE = 0.007) for breeding periods. Our results indicate juvenile and adult survival in the declining areas was similar to survival in the stable areas of the Edwards Plateau. This suggests causes of the decline might be associated with differences during other life-history stages, such as nest success or poult survival, although we cannot rule out the possibility juvenile or adult survival contributed to the decline in the past. This situation demonstrates why wildlife managers should be cognizant of the implications of initiating long-term monitoring programs after changes in population status occur, rather than initiating them in expectation of such changes.

Funding provided by TPWD

Use of Geographic Information Systems to Adjust Gobble Count Survey Techniques

James Bass, Warren Conway, Stephen F. Austin State University; Stephen DeMaso, T. Wayne Schwertner, Gary Calkins, TPWD

Eastern wild turkey (*Meleagris gallopavo silvestris*) populations have become re-established throughout portions of the Pineywoods region of East Texas. Because of the long history of reintroductions in the region, hypothesis have been formulated that populations are disjunct and variable in their permanence and habitat use. Such variability in population permanence in a given area, combined with rapid habitat changes, have likely limited the value of current fixed route gobble counts, as they may be performed in areas where (1) birds no longer exist, as that subpopulation has been extirpated or (2) habitat is no longer suitable for wild turkeys.

This research has been developed to refine, modify, and improve the fashion in which gobble counts are performed and physically placed on the landscape. Development of adaptive gobble count survey protocols, where route placement is flexible among years based upon habitat availability on the landscape, should standardize habitat sampling and focus sample efforts in areas where turkeys likely exist within the region. Our goals are to determine and evaluate habitat being utilized during periods of peak gobbling activity and use GIS software to make biannual or triannual adjustments to gobble count routes in response to large-scale habitat changes.

During the first year of field work, trapping efforts were initiated in February 2006 on the southern portion of Angelina National Forest in Angelina and Jasper County, Texas, in areas where current gobble count routes exist. Males were targeted during trapping efforts, which resulted in one juvenile and nine adults captured. Captured individuals were fitted with radio transmitters and were located daily during spring hunting season and at least once weekly for the remainder of the year. Also, individual were located during gobble count surveys to determine if they were within an audible range of detection and if they were actually gobbling. Gobbles were heard on six of 17 surveys performed, but on only three of the five routes. There was only one instance in which a gobble was detected on the approximate azimuth of a radioed bird. This research is being expanded during 2007 to include more radioed males, use of infrared-digital cameras and audio recorders to more closely examine gobbling behavior on old and new gobble count routes.

Funding provided by TPWD

Using Landcover Data to Predict Success of Restocked Eastern Wild Turkeys

T. Wayne Schwertner, TPWD

Between 1978 and 2004, 7,155 eastern wild turkeys (*Meleagris gallopavo silvestris*) were stocked at >300 sites in 58 East Texas counties, as part of an ambitious restoration effort. While much of the region is open for turkey hunting, total harvest remains low, with only 387 birds killed in 2005. Moreover, anecdotal evidence suggests that some local populations established during the restoration efforts have failed to expand or have gone extinct. Finally, current population estimates by TPWD field staff suggest a total population of <10,000 in 2005. This represents little change from the number of birds originally stocked.

I am examining landscape-level habitat attributes acquired from remotely-sensed landcover data (1992 National Land Cover Dataset) to investigate possible relationships between these attributes and the success of individual stockings. I identified 130 sites in East Texas that were stocked with eastern wild turkeys between 1990 and 1995, and delineated a 10 km radius circle around each site. For each site, I calculated 115 landscape metrics using Program FRAGSTATS. I reduced this to a set of 41 variables using Spearman rank correlation to eliminate redundant variables. I then used factor analysis to further reduce the set to the following 11 variables: Interspersion and Juxtaposition Index, Simpson's Evenness Index, Contagion Index, Area-weighted Mean Shape Index, Median Patch Area, Perimeter-Area Fractal Dimension, Range of Euclidean Nearest Neighbor Distances, Range of Perimeter-Area Ratios, Area-weighted Mean Proximity Index, Range of Related Circumscribing Circles and Patch Richness. These 11 variables captured 87% of the variability of landscape metrics.

During summer 2007, TPWD personnel will visit release sites to determine turkey presence or absence. For sites where turkeys are not detected, probability of occupancy will be determined using an occupancy modeling procedure, to ensure a 95% power of detection for occupied sites. Site occupancy will be evaluated against landscape metrics to develop a predictive model of restoration success. The results of this analysis will be used to guide site selection and evaluation for future restoration efforts.

Funding provided by TPWD

Variation in Brood Sex Ratios of Rio Grande Wild Turkeys

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We evaluated brood sex ratio (BSR) variation in Rio Grande wild turkeys (RGWT; *Meleagris gallopavo intermedia*) in the Edwards Plateau and South Texas Plains during 2005–2006. Offspring sex was determined from DNA extracted from tissue biopsies of embryos from unhatched eggs or vascular tissue from eggshells of hatched and depredated eggs. Sex ratio across all eggs was 56.3% male (135/240) and did not differ statistically from parity (x^2 = 3.75, P = 0.053). We found that mean population growth rate based on a population simulation with BSR at unity averaged 1.02 (range = 0.924–1.058), whereas it declined to 0.978 (range = 0.816–1.037) using BSR estimates from our study. Although our statistical analyses did not detect a BSR different from unity, our simulation modeling demonstrated that BSR variation caused

biologically significant differences in mean population growth rates. Even though the biological mechanism controlling primary sex ratio remains unknown, our estimates of BSR should allow managers to more reliably predict population dynamics insuring viable RGWT populations across Texas.

Funding provided by TPWD

Winter Roosting Ecology of Rio Grande Wild Turkeys

Ryan Swearingin, Mark Wallace, Warren Ballard; Texas Tech University; Donald Ruthven, III, TPWD

A crucial time for Rio Grande wild turkeys (*Meleagris gallopavo intermedia*) is during the winter when flocks in excess of 200 birds congregate at traditional winter roosts. Wild turkey home ranges during this time of year are at their smallest, so there is a need for appropriate foraging habitat and security in close proximity to suitable roosting habitat. In addition, it is believed that eastern cottonwood (*Populus deltoides*), the favored roost tree species in the Rolling Plains, may be declining due to altered river flow regimes and the invasion of exotic species such as salt cedar (*Tamarix* spp.) and Russian olive (*Elaeagnus angustifolia*). Consequently, a greater understanding of the critical vegetative characteristics of winter roost sites is needed.

We conducted fieldwork on the Matador WMA, Gene Howe WMA, and a private ranch near Clarendon, Texas, which lie in the western Rolling Plains along the eastern half of the Texas Panhandle. Data collection began in September and continued through flock breakup around early April for the winters of 2004 and 2005. We gathered roost locations via radiotelemetry to identify movement patterns and to detect which roosts were active during the winter. We frequently performed roost counts at each roost to identify the boundaries of the roost and to determine specific trees being utilized. This information aided observers when they returned to measure the habitat. The variables we measured included tree height, tree diameter, canopy cover, tree decay, area of the stand in which the roost occurred (stand area), litter cover and shrub cover. Habitat characteristics were measured at roost sites as well at randomly chosen non-roost sites.

A total of 32 roost sites and 32 non-roost sites were sampled. Using this data, we linked winter roost use (presence-absence) with habitat variables representing forest and vegetation structure at roost sites by creating explicit habitat models. We found that tree height, tree diameter, stand area and percent litter were all important predictors of roost sites. Based on these findings an appropriate management strategy should include the conservation of large stands of riparian trees with open understories. These stands should contain the tallest, largest diameter trees available. Additionally, we suggest that young stands of preferred roost species be protected to provide roost sites when current roosts eventually become unsuitable to turkeys.

Funding provided by TPWD and the National Wild Turkey Federation

Water Birds

Analyses of Least Tern Nest Site Soil Properties

Anna Salinas, Jade Richardson, Jeffrey Kopachena, Derald Harp, Texas A&M University–Commerce; Aron Flanders, TPWD

The interior population of the least tern (*Sterna antillarum*) was federally listed as endangered in 1985. The decline in population was largely the result of losses of breeding habitat: sandy or gravelly bars in rivers that have experienced vegetation encroachment or have become altered due to channelization and reservoir construction. Recently, least terns have utilized inland reservoirs where they have had variable breeding success. One particular problem experienced by least terns is inundation of eggs and eggs sticking to the substrate, both of which can seriously reduce nest success. These factors might be a product of the soil characteristics of the breeding site itself. The purpose of this study was to evaluate soil properties relative to nest success for least tern nest sites at Cooper Lake in northeast Texas.

During the 2005 and 2006 breeding seasons, soil samples were collected to a depth of 2.5 cm within a 15-cm radius centered on a total of 76 nests. Soil texture, defined as the percent sand, silt and clay in the samples, was measured using a Bouyoucos hydrometer. These data were analyzed relative to nest success, the frequency of inundation and the frequency of egg sticking.

The soil composition of nest sites at Cooper Lake averaged 42% sand, 36% silt and 22% clay. We did not find a difference in soil composition among breeding productivity measures, flooding or egg sticking events for nests at Cooper Lake. Drought conditions during our study may have impacted results associated with soil texture and inundation or egg sticking events. For example, precipitation events and amounts were significantly lower than 20-year averages. Relative to available data on soil texture at riparian colony sites in Texas, colonies at this reservoir appeared to have significantly lower amounts of sand and significantly higher amounts of fine particles. Deposition dynamics and subsequent build up of soil on this reservoir yielded one colony site with an estimated 75% silt and another with 26% clay. This is a high amount of fine soil particles even when compared to some dredge islands.

Funding provided by TPWD and U.S. Fish and Wildlife Service

Food Habits and Body Condition of Dabbling Ducks

Daniel Collins, III, Warren Conway, Stephen F. Austin State University; Corey Mason, Jeffrey Gunnels, TPWD

Winter habitat and food quality play a vital role in maintaining winter body condition and subsequent breeding success in waterfowl, such that quality winter habitat should be a common goal of waterfowl managers. TPWD and the Tarrant Regional Water District are managing and constructing moist-soil managed wetlands at the Richland Creek Wildlife Management Area (RCWMA). These wetlands will treat water from the Trinity River and provide suitable habitat to wetland dependent species through management practices that provide quality habitat and food to wintering and migrating waterfowl. In order to estimate food selection and subsequent body condition of waterfowl using these moist-soil managed wetlands, we quantified food item occurrence and developed body condition indices for northern shoveler (*Anas clypeata*), blue-winged teal (*A. discors*) and green-winged teal (*A. crecca*) occurring on the RCWMA.

Initial analyses found that seeds occurred in 100% of digestive tracts examined, while aquatic invertebrates and other plant material occurred in 10% and 2%, respectively. Common species found were barnyard grass (*Echinochloa crusgalli*), curly dock (*Rumex crispus*), flatnut sedge (*Cyperus* spp.), waterprimerose (*Ludwigia peploides*), smartweed (*Polygonum* spp.) and wild millet (*Echinochloa walteri*). Aquatic invertebrates found were aquatic sow bug (*Asellidae*), scuds (*Amphipoda*), snails (*Planorbidae* and *Physidae*), mayflies (*Ephemeroptera*), and midges (*Diptera*). Body condition indices (i.e., BCI1; body mass/wing chord and BCI2; body mass / (wing chord + total body length) were calculated for 357 green-winged teal, 260 blue-winged teal and 98 northern shoveler. Males of both age classes were slightly heavier and both BCIs were generally higher in males than females of both age classes for blue-winged and green-winged teal, although the reverse was observed for northern shovelers. Typically, males exhibit higher BCI values than females due to a larger overall body size and mass, but female northern shovelers had slightly higher BCI values, indicating they were in better condition. Combined, it appears that these three species follow typical food item selection and body condition patterns of dabbling ducks. As such, moist-soil managed wetlands at RCWMA are providing both high quality and quantity food for wintering waterfowl.

Funding provided by TPWD

Nest Site Selection, Breeding Productivity and Management of Least Terns

Anna Salinas, Jeffrey Kopachena, Texas A&M University–Commerce; Aron Flanders, TPWD

The interior population of the least tern (ILT; *Sterna antillarum*) was federally designated as endangered primarily due to breeding habitat loss on rivers. Some least terns have adapted to nesting at reservoirs, such as Jim Chapman (Cooper Lake) in northeast Texas. Cooper Lake level fluctuations have caused nest failures for ILT colonies located below conservation pool elevation. Our objectives were to create sustainable nesting habitat above normal lake elevation, examine nest site selection and compare nesting habitat between successful and unsuccessful nests.

In 2005 and 2006, a two-hectare nest site was established on two peninsulas near historical breeding areas at Cooper Lake by disking, harrowing and applying herbicide. Driftwood, gravel and decoys were distributed on a 930-m^2 area on each site. Surveys were conducted biweekly throughout available nesting habitat. After nest fate was determined, visual obstruction, objects >5 cm long and <15 cm from the edge of scrapes and the percent cover of vegetation, wood, gravel and bare ground was quantified at nest sites and random locations.

Courtship behavior was observed within the created nest sites; however, only one breeding pair nested within a created site. This created site had significantly higher coverage of rock and less bare ground compared to other colony sites. Fifteen nests were located on shoreline adjacent to created nest sites and 81 nests were located on islands exposed due to drought. Fragmentary material appeared to be a factor in nest site selection because nest sites (n = 90) were initiated within 15 cm of objects (e.g., driftwood, bones, rock, metal) more frequently than random sites. Also, the percent cover of wood was higher at nest sites compared to random sites. However, all habitat variables were similar between successful and unsuccessful nests. Breeding productivity exhibited high annual variability. Overall, nest success (nests hatching >1 egg) and fledging rate (fledglings/pair) were 74% and 0.65, respectively. A significant drought lowered reservoir elevations, exposing 804–3,300 hectares of soil on shorelines and islands during this study. With severe drought conditions, Cooper Lake appears to provide suitable breeding habitat for ILT without the aforementioned habitat enhancement activities.

Funding provided by TPWD and U.S. Fish and Wildlife Service

Wading Bird Behavior in Moist-Soil Managed Wetlands

Angela Mangiameli, Warren Conway, Stephen F. Austin State University; Corey Mason, Jeffrey Gunnels, TPWD

Concerns over continental declines of wading birds and shorebirds have prompted their inclusion in wetland conservation and management plans. Moist-soil management techniques used to manipulate water levels, seed banks, and invertebrate production are known to provide quality foods and habitats for wintering waterfowl. However, few data exist on the success of such techniques to attract wading birds during spring and summer, when such wetlands are typically being drawn down or dry. A series of moist-soil managed wetlands have been operating at the Richland Creek Wildlife Management Area (RCWMA) since January 2003, and to address how wading birds are responding to these wetlands, we (1) quantified occurrence, (2) developed time activity budgets and (3) measured habitat use of wading birds using moist-soil managed wetlands at RCWMA from April–September, 2004 and 2005.

A total of 41 and 46 water bird species, representing six orders and 14 families, were observed in 2004 and 2005, respectively. Wading birds were most abundant, accounting for 81% and 55% of all observations in 2004 and 2005, respectively. More than 4,000 focal samples were collected in 2004 and

2005 for cattle egrets (*Bubulcus ibis, n* = 935), great egrets (*Ardea alba, n* = 1250), snowy egrets (*Egretta thula, n* = 736), white ibis (*Eudocimus albus, n* = 826), wood storks (*Mycteria americana, n* = 255), great blue heron (*Ardea herodias, n* = 129, 2005 only) and little blue heron (*Egretta caerulea, n* = 207, 2005 only). White ibis and snowy egrets spent the most time feeding, great egrets spent the most time standing, while cattle egrets and wood storks spent the most time resting. Time activity budgets fell into two dominant categories: feeding and feeding related behaviors, and resting and body maintenance behaviors. However, this generalization masks interspecific differences in time spent in food acquisition behaviors and size and/or morphology-related foraging strategies among herons, egrets and ibis. Focal species tended to either feed more upon arrival (i.e., April–May), or feed more prior to departure (late August). In general, focal species used microhabitats in water approximately 50 m from a hard edge, with nearly 50% cover of emergent vegetation, approximately 25% open water, with <5% mudflat.

Funding provided by TPWD

Winter Ecology of Diving Ducks in East Texas

Shaun Crook, Warren Conway, Stephen F. Austin State University; Kevin Kraai, Corey Mason, TPWD

Diving ducks, particularly canvasback (*Aythya valisineria*) and lesser scaup (*A. affinis*), have been experiencing long-term population declines in North America, and neither species has attained population goals set by the North American Waterfowl Management Plan. Although Texas winters a majority of the Central Flyway's diving ducks, few data exist on canvasback, lesser scaup, and ring-necked duck (*A. collaris*) body condition and behavior during winter. As past studies indicate that habitat quality and body condition during winter will impact future reproductive success, our objectives were to (1) quantify diurnal time-activity budgets, (2) estimate lipid content, and (3) develop species specific lipid prediction models of canvasback, lesser scaup, and ring-necked ducks wintering on Sam Rayburn, Toledo Bend, and B.A. Steinhagen Reservoirs in East Texas.

During 2003–2004 and 2004–2005, five-minute focal samples were collected for canvasback (n = 640), lesser scaup (n = 313), and ring-necked duck (n = 271). Behaviors varied among species (P <0.001) in proportion of time spent feeding and locomoting. Ring-necked ducks spent almost 30% of the time feeding, whereas canvasbacks spent only 19% of the time feeding, and nearly 40% locomoting. Lesser scaup tended to spend intermediate amounts of time in both behaviors. Nearly 250 individuals were collected among the three species (73 canvasback, 89 lesser scaup, and 86 ring-necked ducks). Lipid content ranged between 19% and 35%, depending upon species, sex and age. Several lipid prediction models were successful (P <0.001), although model variables varied among species, sex and age. Skin mass was a consistent variable in most models, and alone accounted for 69–86% of the variation in percent lipid content. Collectively, our data indicate that these reservoirs provide adequate winter habitat for diving ducks, as lipid content and feeding rates are similar to other published studies. Although canvasbacks spend a disproportionate amount of time locomoting, neither body condition nor activity budget data indicate that they are compensating for poor habitat. However, future research should focus upon diets, food and habitat quality, to more closely examine habitat quality on these reservoirs.

Funding provided by TPWD

Other Birds

Bird Community Surveys: A Comparison of Distance Sampling and Point Counts

Wilynn Zickler, Thomas Simpson, Texas State University; Kelly Bender, TPWD

Wildlife surveys are often used to gather critical information on overall ecosystem health. Because birds can be considered indicators of changes in terrestrial habitats, assessing bird populations is a popular method of evaluating the effects of changes in habitat on wildlife. This is especially true in urban areas where habitat fragmentation and invasive woody vegetation appear to be impacting remaining habitat.

There are many methods of surveying bird populations. The point count method is a generally accepted method to provide an index of bird populations. It is a relatively simple way to document a variety of different species of birds at randomly generated points throughout a virtually unlimited area. However, in urban areas it is especially important to document not only indices such as abundance, species richness, and species diversity, but also populations' community structure. It has been postulated that distance sampling methodology would solve the limitations inherent in the point-count method.

In this study, density estimates calculated from the distance sampling method resulted in a more accurate estimate of populations than density estimates by point count data. However, to definitively state that distance sampling methods are superior to point count methods in urban wildlife management studies, study methodology must be refined.

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Detection, Occupancy and Survey Effort of Golden-Cheeked Warblers

Cyndee Watson, Butch Weckerly, Paula Williamson, Texas State University; Jeff Hatfield, USGS Patuxent Wildlife Research Center; Craig Farquhar, TPWD

Surveys to detect the presence and absence of endangered species may not consistently cover an area, nor account for imperfect detection. We evaluated a revised detection-nondetection survey method of the federally endangered golden-cheeked warbler (GCWA, *Dendroica chrysoparia*). The methodology allows a surveyor to survey consistently among sites and allowed us to estimate probability of detection (the extent of imperfect detection) and occupancy (proportion of sample units occupied) using newly developed mark-recapture techniques in the program PRESENCE. From this information we then determined the survey effort required to estimate occupancy with a specified precision (CV <0.2). Three sites were selected across the breeding range of GCWA in central Texas. At each site, 28 to 36 detection stations were placed 200 m apart. Each detection station was surveyed nine times during the breeding season in two consecutive years. Surveyors stayed up to eight minutes at detection stations recording GCWA detected by sight or sound. We built models to assess the potential influence of environmental covariates (e.g. slope, aspect, canopy cover) on detection and occupancy and possible change in occupancy and detection probabilities within a breeding season, between years and among sites. Using information-theoretic model selection procedures we found that detection probabilities and occupancy varied among sites, between years and within a breeding season. Detection probabilities ranged from 0.19 to 0.79 and occupancy ranged from 0.52 to 1.0.

These estimates were, in turn, used to determine that nine surveys of 32 stations at a site will be needed to have estimates of occupancy with coefficients of variation of 0.2. These findings assume no further surveys are needed in that breeding year after detection of GCWA at detection stations.

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Dynamics of Avian Migration Along the Lower Texas Coast

Suzanne Contreras, Arlene Arnold, Bart Ballard, William Kuvlesky, Leonard Brennan, Texas A&M University–Kingsville; Michael Morrison, Texas A&M University; Kathy Boydston, TPWD

The Texas Gulf Coast is one of the most important bird migration areas in the western hemisphere, supporting over 400 species that breed, migrate through, and/or winter within it. Within this highly developed coastline, the pristine lower Texas coast remains relatively undisturbed and retains much of the historical migratory habitat that many species have evolved to rely on during migration. Because of the long-distance movements and large energy demands on these birds, migration and wintering habitat is critical to their success in reaching wintering and breeding destinations. For some species, the energy obtained during spring migration determines their reproductive potential for that season and thus has large influences on annual recruitment.

Recently proposed development projects have large potential for impacting the rich avifauna that migrate, winter and breed in this region. Gaps in information about spatial and temporal dynamics in avian migration prevent us from providing sound advice as to best options for development projects in order to minimize impacts on migration and key migratory habitat in this region. We propose to provide critically needed information on the chronology, magnitude, dispersion and altitude of bird migration in this region, as well as delineate important stopover habitats used by neotropical migrants. This information will be needed to provide informed recommendations for best management practices to future development projects.

We classified plant communities along the Lower Texas Coast based on physiognomic characters, then subclassed them into 10 habitats based on dominant plant species. Ten, 500-meter discontinuous line transects have been established in each habitat type. We have been investigating stopover habitat use and migration chronology using line transect methodology to sample bird use within each habitat. Two transects within each habitat type were sampled each week from early March through May and mid-August through October in 2006 to document chronological changes in bird community composition. Each of 10 transects within each habitat were surveyed once each season during peak migration (Spring: mid- to late April, and fall: late September to early October) in 2006 to document habitat use within the 10 habitats. Habitats will continue to be surveyed during spring and fall 2007. Richness and density of bird species will be calculated for each habitat category using Program DISTANCE.

We will also use mobile marine radar to monitor bird migration along the Lower Texas Coast during 2007–2009. The use of radar to monitor bird migration will allow sampling at night and at altitudes beyond optical capabilities.

Funding provided by TPWD

Ecological and Economic Impacts of the Texas Coastal Prairie Conservation Initiative

Alejandro Lozano-Cavazos, Leonard Brennan, William Kuvlesky, Jr., Fidel Hernandez; Texas A&M University–Kingsville; Wade Harrell, The Nature Conservancy; Tim Anderson, U. S. Fish & Wildlife Service; Stephen DeMaso, TPWD; Stan Reineke, Natural Resources Conservation Service

Ecologically sound habitat management will be essential to reverse the current decline of grassland birds. The objective of this study is to evaluate the effects of two habitat management practices: (1) summer prescribed fire [SF], (2) a combined treatment of roller chopper, summer prescribed fire, and chemical application [CT], and (3) an open grassland [C] as "control" on wintering and breeding grassland-shrub bird community composition and relative abundance of single species. Line transects of variable lengths were run at least three times in winter and breeding seasons on SF, CT and C treatments to assess bird community. Wintering bird species richness was greater on SF (31 species) than on CT and C treatments (15 and seven species, respectively). All species found on C were also present also SF or CT and had greatest relative abundance on these treatments. Savanna sparrow (*Passerculus sandwichensis*) and meadowlark (*Sturnella magna*) were the most abundant species across treatments. Northern bobwhite (*Colinus virginianus*) abundance was similar on SF and CT, but was not present in C. Breeding bird species richness on CT and SF treatments was similar with 17 species whereas C supported seven species. The seven species found on C were also present on either or both of the CT and SF. Meadowlark abundance was much greater on C than on CT and SF. Scissor-tailed flycatcher (*Tyrannus forficatus*) and northern bobwhite were the most abundant across CT, and SF. The average number of calling northern bobwhites was greater on the CT than on SF, and C. The CT and SF treatments seem to support the greatest diversity of breeding and wintering birds in the coastal prairie ecological region of Texas.

Funding provided by TPWD

Effects of Nonindigenous Plant Species on Bird Communities

Arlene Kalmbach, Thomas Simpson, Texas State University; Kelly Bender, TPWD

Invasive, nonindigenous plants such as red tipped photinia (*Photinia seratofolia*), wax-leaf ligustrum (*Ligustrum japonicum*), Chinese privet (*L. sinense*), heavenly bamboo (*Nandina domestica*), pyracantha (*Pyracantha coccinea*), Japanese honeysuckle (*Lonicera japonica*), Chinaberry tree (*Melia azedarach*) and Chinese tallow (*Triadica sebifera*) pose a significant threat to natural vegetative communities and by extension, to avian populations dependent upon native flora. In urban areas of Central Texas, nonindigenous plants are widely used for landscaping purposes. Consequently, many have naturalized and become invasive, spreading well beyond the manicured yard to infest the few forested green spaces available to bird communities in this rapidly developing urban area. Previous research indicates that nonindigenous plants do not provide native bird populations with necessary cover, forage (plant and insect), vertical profile, branch structure, predator escape or nesting material. This altered habitat is also viewed as encouraging use by nonindigenous bird species. This research investigated the hypothesis that sites in Austin, Texas, invaded by nonindigenous woody plants species harbor a suite of birds lacking diversity and abundance when compared to areas unaffected by exotic woody vegetation. The avian community was surveyed by point count on six study properties within and near Austin, Texas. Sixty-two species and 1,742 individual bird detections were recorded during the 18-month study. Avian species richness for impacted point count sites was 32 with 448 total detections, while species richness at unimpacted point count sites was 59 with 1,294 total detections. A two-factor nonparametric multivariate analysis of variance (habitat x year) revealed significant differences between impact cover type (P = 0.0002) and year (P = 0.0002). There was also a significant cover x year interaction (P = 0.0156). These results identify differences between cover types and differences between study years to the extent that we can conclude that the presence of nonindigenous plant species has a significant influence on avian populations.

This is the first of a continuing series of investigations seeking to examine the potential impact of nonindigenous vegetation on wildlife habitat. Further studies will examine impact on non-native invasive vegetation on grassland habitat of the Blackland Prairies ecosystem.

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Foraging Perch and Patch Selection by Loggerhead Shrikes

Miles Becker, Peter Bednekoff, Eastern Michigan University; Michael Janis, Donald Ruthven, III, TPWD

Declines in loggerhead shrike (*Lanius ludovicianus*) populations may be partly due to loss of foraging habitat. Shrikes require an elevated perch to scan for prey and attack prey on the ground within a limited distance of the perch. Two important foraging habitat features are therefore availability of suitable perch substrate and ground vegetation structure. Our objectives were to identify the characteristics of trees used as foraging perches and to determine how vegetation height influences prey accessibility.

Shrikes were observed at Matador Wildlife Management Area in North Central Texas. Shrikes in 15 study territories foraged from 352 natural perch trees during 154 one-hour focal watches. Bare or dead honey mesquite (*Prosopis glandulosa*) was the most common type of perch tree (42.3%), followed by mesquite with a partial canopy (35.2%), all other woody species (18.5%), and mesquite with a complete canopy (4.0%). In contrast, mesquite with a complete canopy was the most common available tree type. Tree height and density of woody species within 50 m did not differ between observed foraging perches and available trees. We also introduced three treatments of artificial perches with bare cover, foliated cover, and no cover to eight shrike territories. Shrikes used the "no cover" and "bare cover" artificial perches two to three times more often than the foliated cover treatment.

Vegetation height and insect abundance did not differ between areas around foraging perch trees and areas around available trees. To establish areas with different vegetation heights and insect abundance, we mowed half the usable area on one side of selected perch trees and left the adjacent side as a control tall grass treatment. Shrikes perched on an experimental tree had a 50% chance of making a capture attempt in either vegetation height. In eight experimental territories, capture attempts were significantly higher on the mowed sides than in tall vegetation even though insect abundance was significantly less in mowed plots.

Funding provided by Eastern Michigan University

Winter Survey of Bachman's Sparrow in the Post Oak Savannah

Dan Jones, TPWD; Diane Neudorf, Sam Houston State University

Bachman's Sparrow (*Aimophila aestevalis*) is a weakly migratory grassland resident of the southeastern United States. Its habitat specificity for open pine or oak stands and savannahs has resulted in fluctuations of range and abundance since the 1830s as a result of cultural land uses. This national trend is consistent in Texas where the species is now generally restricted to early seral stages of abandoned fields, young clearcuts and managed open mature pine stands in the Pineywoods ecoregion, and remnant grasslands within the Post Oak Savannah ecoregion.

Due to declining population size and habitat specificity, Bachman's Sparrow is considered as globally vulnerable and a species of concern by federal wildlife agencies and state listed as "threatened" and of high conservation priority in Texas. This species was formerly listed as a Category 2 candidate for Endangered Species Act listing by the U.S. Fish and Wildlife Service, and has also been included as a species of management and conservation concern by the Partners in Flight program and the National Audubon Society.

Little is known about winter demographics and habitat use of this species in eastern Texas due to its secretive nature. Additionally, its use of ephemeral habitat, relatively poor dispersal tendencies and adverse effects of small-scale habitat disturbance on reproductive success may be significant in managing existing populations for long-term viability.

Recent research has shown winter survey for Bachman's sparrow using playback of recorded songs holds promise as a cost and time-effective method for estimating winter populations of this species. This method will be utilized during a two-year study at the Gus Engeling Wildlife Management Area (GEWMA) in northwest Anderson County. This TPWD facility has a small but stable population of Bachman's sparrow. The area is in the early stages of a 1,000-hectare Post Oak Savannah restoration project. This research will establish baseline population data and characterize habitat utilized by the wintering Bachman's Sparrow population on GEWMA, develop a survey method with widespread applicability for eastern Texas, and provide a reference point for avifaunal response to savannah restoration efforts.

Funding provided by TPWD

Invertebrates

Impacts of Management Practices on Aquatic Invertebrates

Daniel Collins, III, Warren Conway, Stephen F. Austin State University; Corey Mason, Jeffrey Gunnels, TPWD

Aquatic invertebrates are important components of natural and moist-soil managed wetlands, as they effect wetland energy transfer, and provide food for waterfowl and other wetland dependent fauna. Although aquatic invertebrates are positively correlated with waterfowl and shorebird abundance and distribution, few data exist on the specific factors that influence invertebrate community structure. Consequently, quantifying and monitoring aquatic invertebrate abundance and community structure is a critical element of evaluating wetland management success. Moist-soil management techniques involving water level manipulations are generally used to encourage increases in aquatic invertebrate abundance and biodiversity for waterfowl and shorebirds. Our objectives were to calculate aquatic and benthic invertebrate diversity, richness, abundance, and biomass in response to moist-soil management practices, related water quality parameters (i.e., water depth, temperature, pH, dissolved oxygen and salinity), and substrate type, in four moist-soil managed wetlands on Richland Creek Wildlife Management Area. During 2004, >19,000 invertebrates, representing 37 species, were collected. Species diversity (Simpson's D) ranged from 0–0.972, with the highest values recorded during January 2004, four months after flooding. To date in 2005, 561 invertebrates of 21 species were collected, and diversity values ranged from 0–0.95. Nearly double the number (i.e., $\bar{x}$ = 5.2 vs. 2.8) and double the biomass (i.e., $\bar{x}$ = 0.10 vs. 0.05) of invertebrates were captured at each sampling point in 2004 than in 2005, respectively. The decline in biomass and invertebrates can be attributed to prolonged flooding and increased water depths. In general, water depth (P <0.001), temperature (P <0.001), conductivity (P <0.001) and dissolved oxygen (P <0.001) varied between years. Preliminary analyses indicate that timing of flooding and drawdown will impact both abundance and biomass of aquatic invertebrates, which will in turn impact waterfowl and water bird carrying capacity. These results emphasize moist-soil managed wetland productivity and the importance of hydrological manipulation for aquatic invertebrate production and potential waterfowl and water bird use.

Funding provided by TPWD

Invertebrate Abundance at Rio Grande Wild Turkey Nest Sites and Brood-Use Areas

Charles Randel, Nova Silvy, Markus Peterson, Fred Smeins, Texas A&M University; Ray Aguirre, Stephen DeMaso, T. Wayne Schwertner, TPWD

Rio Grande wild turkey (*Meleagris gallapavo intermedia*) numbers have been declining in the southern region of the Edwards Plateau since the 1970s. Lack of invertebrates has been hypothesized as limiting wild turkey poult survival in declining regions. Wild turkeys were trapped and fitted with mortality-sensitive radio transmitters on four study areas; two within a region of stable (northern Edwards Plateau) populations, and two within a region of declining populations. Monitoring occurred from February 2001 to August 2003. Nest-site locations were determined via homing during the breeding season.

Following nesting completion, broods were followed for six weeks post-hatch or to brood failure. Brood survival was calculated as >1 poult surviving to two weeks. Invertebrates were collected, via sweep-net and D-vac, at each nest site and at visually confirmed brood location and a paired random site to determine if wild turkey hens elected nest sites and/or brood habitat based on invertebrate abundance. Analyses were preformed to determine if invertebrate abundance differed between regions of stable and declining turkey abundances.

Frequency of Orthoptera was three to five times greater at nest sites on stable regions than declining regions in all three years. Orthoptera is a noted food source for young Galliformes and comprised the majority of dry mass in invertebrate samples, nest sites and brood locations, on both the stable and declining regions. No differences in total invertebrate dry mass were detected between regional brood locations. The greater number of invertebrates found at nest sites in the stable region, possibly gives wild turkey poults from stable regions greater initial chances of survival.

Funding provided by TPWD and Texas A&M University

Reptiles

Composition of Prey Consumed by American Alligators

Amos Cooper, K.J. Lodrigue, Jr., Marc Ealy, Monique Slaughter, TPWD; Tim Scott, Texas A&M University

American alligators (*Alligator mississippiensis*) are a keystone species in the coastal ecosystem; however, higher than desired population densities may result in a reduction of game and non-game prey. Very little is known about waterfowl and amphibian predation by American alligators. Because American alligators are known to vary their diet according to age, size and habitat, it is important to consider size class and collection site in any food study. Further research is required on the Texas coastal populations of American alligators before harvest levels can be established in a management plan that conserves all of the available natural resources at a sustainable level.

Study objectives were to determine (1) the prey base by American alligator size class; (2) the occurrence of mottled ducks (*Anas fulvigula*) and pig frogs (*Lithobates grylio*) in the stomach content of American alligators; and (3) if the prey types consumed by various size classes were correlated with habitat type or other environmental factors.

Stomach content of live juvenile (<1.4 m), sub adult (1.4–1.8 m), and adult (1.8–2.3 m) American alligators are lavaged soon after capture by forcing water into the stomach and applying abdominal compression to stimulate regurgitation. The mouth is held open during this process by inserting and securing PVC tubes of appropriate size. To evaluate the accuracy of our techniques, American alligators that are to be lethally removed by a nuisance control hunter will be lavaged before euthanasia. After euthanasia, the stomach will be removed to determine what, if any, contents were left in the stomach. Additionally, stomach contents from a maximum 105 harvested American alligators from the J.D. Murphree, Mad Island and Guadalupe Delta Wildlife Management Areas will be collected annually.

Stomach contents will be stored until identified, counted and weighed. Final analysis of stomach contents will be based on frequency of occurrence. All captured individuals are permanently marked for identification in case of recapture. Individuals will not be sampled more than once per month.

Funding provided by TPWD and Texas A&M University

Demography and Habitat Selection of the Alligator Snapping Turtle

J. Daren Riedle, Richard Kazmaier, West Texas A&M University; Wes Littrell, Bill Adams, TPWD

The alligator snapping turtle (*Macrochelys temminckii*) is considered a species of concern throughout its range because of overharvest and habitat alteration, but little is actually known about its biology. As such, we initiated a project in the Middle Trinity River Basin to better understand the life history of this highly impacted turtle species.

We are sampling all aquatic habitat types on Gus Engeling Wildlife Management Area (GEWMA), Keechi Creek Wildlife Management Area (KCWMA) and Richland Creek Wildlife Management Area (RCWMA). Sampling is done using a variety of turtle sampling gear including fyke nets, hoop nets and box traps. Traps are baited with sardines or fresh fish, set in the afternoon and checked the next morning. Habitat and water quality data are being collected at each trap site to compare turtle community structure through use of ordination analyses. All turtles are being given a unique mark upon capture. Species, sex, mass and basic morphometric measurements were recorded for all turtles captured, and to allow for abundance estimation and demographic analyses.

Between April and July 2006 we had a total effort of 231 net nights at GEWMA, 10 net nights at KCWMA, and 14 net nights at RCWMA. We captured a total of 206 turtles representing eight species. One alligator snapping turtle was captured in Catfish Creek on GEWMA. These initial results have been puzzling given the fact that alligator snapping turtles have been historically captured on GEWMA. Thus, their presence there might be limited or dependent on water levels. This is an ongoing project and continued sampling efforts on both the Trinity River and its tributaries should allow us to better understand how alligator snapping turtles utilize the various habitat types present in the Middle Trinity River Basin.

Funding provided by TPWD

Distribution and Growth of American Alligators in a Texas Coastal Marsh

Todd Merendino, Matt Nelson, Kevin Kriegel, Marc Early, TPWD

We examined growth rates and movements of American alligators (*Alligator mississippiensis*) in a Texas coastal marsh. Study objectives were to (1) determine growth rates for American alligators, (2) assess movements and habitat use along a salinity gradient, and (3) provide habitat management recommendations.

We captured and marked 1,080 alligators, ranging in size from 0.4-3.4 m. We have recaptured 240 alligators. Overall growth rate of recaptures was 13.3 cm/year. Using data from 58 alligators recaptured at least three growing seasons from initial capture, growth was approximately 15.4 cm/year.

Most alligators were captured at fresher sites along the salinity gradient. In fact, most were captured in two lakes on the study area. Most were recaptured in close proximity to the initial capture site. During times of heavy rainfall or run-off, alligators are seen throughout most of the study area. Of note, one alligator recaptured in 1999 was recaptured within 50 m of the initial 1994 capture site.

The importance of this information is that alligators may be somewhat habitat limited to fresher sites along the Texas Coast. As degradation of coastal marshes continues, most notably due to saltwater intrusion, alligators may be forced into more inland habitats such as creeks and ditches and become further concentrated into shrinking habitats. These high concentrations of alligators may then in turn begin to affect population levels of other organisms such as furbearers and breeding ducks.

Funding provided by TPWD

Growth Rates and Nesting Ecology of American Alligators

David Saalfeld, Warren Conway, Stephen F. Austin State University; Gary Calkins, TPWD

American alligator (*Alligator mississippiensis*), once listed as an endangered species in 1967, has made a dramatic recovery, and is now one of a few crocodilian species which is not currently in danger of extinction. In Texas, alligators were reclassified from Endangered or Threatened to Threatened Due to Similarity of Appearance by 1985, and Texas conducted its first legal hunt for American alligators in 1984. Current harvest management strategies for Texas' inland alligators do not use nest survey data, hatchling survival rates, growth rates or sex ratios collected from inland populations, as harvest management strategies are based upon models and data from coastal populations. In order to fill this information gap, we initiated a three-year project at Angelina Neches/Dam B Wildlife Management Area, Little Sandy National Wildlife Refuge, Kurth Lake, and other private lands in East Texas to examine nesting ecology, diet, and growth rates of inland alligators.

In 2006, 10 nests were discovered and monitored. Preliminary analyses indicate that alligators selected nest sites on elevated levees and islands, with at least 50% open canopy. Of these, 60% of the nests successfully hatched young, with pod sizes ranging from six to 28 hatchlings. Also during 2006, 310 unique alligators ranging from 23–224 cm were captured, measured, marked and released. An additional 75 individuals were recaptured. Yearly growth rates for all size classes and study areas combined was 27.2 cm/year. For individuals <50.0 cm, growth rates ranged from 18.5 to 37.9 cm/year, and for individuals >50 cm, growth rates ranged from 18.2 to 25.6 cm/year. Finally, >80 stomach samples were collected, and preliminary analyses suggest that fish, birds, reptiles, amphibians and crustaceans all play a key role in inland alligator diets. Centrarchids (sunfish) appear to be the dominant food item by percent occurrence.

Over the next several years data collected from these inland alligator populations should shed light on how to better manage this species within East Texas. This project will help fill in an information gap for a region where little is known about a game species that has shown geographic variability in growth rates, diet, nesting ecology, sex ratios and hatchling survival.

Funding for this project was provided by TPWD

Ecology of the Houston Toad

Andrew Price, TPWD

The Houston toad (*Bufo houstonensis*), a small member of the Bufo americanus species group endemic to East Central Texas, has resided longer on state, national and international endangered species lists than most other taxa. This species disappeared from most of its historically known range following its discovery in the Houston, Texas, area after World War II. It was known from only a single locality during the three decades prior to 1990. Surveys by TPWD personnel and associates have resulted in the discovery of new populations in nine counties in Central Texas. This species is restricted to deep sandy soils supporting ephemeral wetlands within native post oak/loblolly pine woodlands and savannahs that have been subjected to minimal landscape-scale disturbance. Except for two sites, nothing is known about the demographics of the newly-discovered populations. The most robust population known still resides in Bastrop County.

More than 3,000 adult Houston Toads have been marked with PIT tags in one watershed within Bastrop State Park from 1990–2006. Breeding choruses of up to 200 individuals form under specific climatic conditions over one to four nights during February and early March, separated by intervals of several days to several weeks. Individual females are rarely recaptured during the same breeding season, where as males have been recaptured as often as 22 times in one year. Maximum longevity appears to be six years for males and five years for females. Individual toads have been recorded traveling distances of up to 1.3 km during the breeding season.

Regional climatic regimes have a profound effect upon Houston Toad recruitment and survivorship, compounded by the current fragmented status of the species' populations. These data provide the scientific foundation for ongoing community efforts to implement a Habitat Conservation Plan for the Houston Toad in Bastrop County as provided under the U.S. Endangered Species Act.

These data should provide a basis for making management decisions for the Houston Toad in Bastrop State Park and elsewhere within the range of the species as appropriate.

Funding provided by TPWD

Ecology of Ornate Box Turtles in a Sand Prairie Ecosystem

Richard Kazmaier, Steven Grant, West Texas A&M University; Michael Janis, Donald Ruthven, III, TPWD

In recent years, herpetologists have acknowledged apparent declines in box turtle (*Terrapene* spp.) populations. However, there is a lack of information on demography, particularly age-structured survival and recruitment, and the influence of common land management practices on box turtle populations. Because of these inadequacies, we are initiating a long-term ornate box turtle (*T. ornata*) research project at Matador WMA in Cottle County. Our specific objectives are to evaluate movement and habitat selection in relation to seasonality of fire (winter-burned, summer-burned and unburned plots), and begin assessing demography of the ornate box turtle population.

The primary study site consists of 273 hectares dominated by sand sagebrush (*Artemisia filifolia*)—honey mesquite (*Prosopis glandulosa*) grasslands that have been divided into 15 18-hectare study plots (five blocks x three plots). Within each block, we randomly assigned one of three treatments: winter burn, summer burn, and control. Turtles captured within the plots will be outfitted with radio transmitters to examine the influence of seasonality of burning on movements and habitat selection.

We will use the entire Matador WMA to assess demography of the box turtle population using a mark-recapture approach where demographic and biological data are obtained from each capture. Clutch frequency and the timing of egg laying we be determined by palping females. We will locate nests laid by radiotransmittered females to determine length of incubation, clutch size and hatching success. Survival will be calculated from both age-structured and radiotelemetry data. Chi-square tests will be used to determine if the sex ratio differs from 1:1 or if age structure, size structure or survival differs between the sexes.

This project should provide the nucleus to assess demography, as well as the influence of fire on this species of concern. Information gained will allow for the development of more cohesive and realistic management plans and aid in the delineation of data gaps for further evaluation.

Funding for this project was provided by TPWD and West Texas A&M University

Effects of Fire and Grazing on the Ecology of the Texas Horned Lizard

Richard Kazmaier, Jeremy Lane, West Texas A&M University; Donald Ruthven, III, TPWD; Eric Hellgren, Beth Moeller, Anna Burrow, Oklahoma State University

Little information is available to evaluate ecological effects of land uses such as grazing and burning on herpetofauna in general and the Texas horned lizard in particular. Protected by Texas legislative mandate in 1967, the Texas horned lizard (*Phrynosoma cornutum*) has experienced apparent declines throughout its range, but particularly in Texas. Because of the commonness of controlled burning and grazing as management tools throughout the range of this species, we have been studying the effects of livestock stocking rate and prescribed burning on ecological characteristics of horned lizards (range size, habitat preferences and population parameters) at Chaparral Wildlife Management Area in southern Texas since 1998.

From 1998–2001, our intent was to examine the interaction between heavy or moderate grazing with winter burning. Our more recent focus (2002–2005) shifted to address seasonality of burning (winter, summer, nonburned). This is being accomplished by placing transmitters on individuals in each of four treatments: nongrazed/nonburned, grazed/nonburned, grazed/winter-burned and grazed/summer-burned.

For the entire study, >220 lizards have been monitored for >15,000 radiolocations. Effects of winter and summer burning were similar, resulting in smaller home ranges relative to the control. Home ranges were not affected by grazing treatment. Survival rates were lower in heavily grazed sites, but were similar between nongrazed and moderately-grazed sites. Survival estimates did not differ based on burning treatment. Although data analyses continue, these data suggest that some level of grazing and burning is beneficial for the management of Texas horned lizards in the western Rio Grande Plains.

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Regional Variation in Demography of Texas Horned Lizards

Richard Kazmaier, West Texas A&M University; Donald Ruthven, III, TPWD; James Ray, BWXT Pantex

Demographic variables are useful characteristics of populations to study, because they can provide insight into many of the processes that can cause population growth or decline and provide opportunities to address management needs for any species. Likewise, recommendations developed for the management of a species on one area may not be applicable to another area if regional variation in demography exists. We are beginning to examine variation in demography of the state-threatened Texas horned lizard (*Phrynosoma cornutum*) throughout Texas in an attempt to elucidate the management implications behind this variability.

Sufficient data have been collected from four sites to allow some preliminary comparisons of demography. Samples used in these analyses were obtained from Chaparral Wildlife Management Area (WMA) in Dimmit and La Salle counties (n = 3,367, 1992-2003), Matador WMA in Cottle County (n = 1,206, 2004-2006), the BWXT Pantex Plant in Carson County (n = 123, 2004-2006), and Cross Bar Ranch in Potter County (n = 97, 2005-2006). Size dimorphism indices (SDI) indicated females are larger than males on all sites. Pronounced differences in body size are noted along a latitudinal gradient, with horned lizards on Chaparral WMA being the largest and those at Cross Bar Ranch being the smallest. Clutch size to body size relationships and differences in growing season suggest that clutches will be smaller and clutch frequency will be lower moving north along this gradient. These differences in demography suggest that more southern populations may be better able to respond to perturbations or management practices, but concomitant measures of survival are needed to examine if demographic trade-offs are occurring.

This is intended to be a long-term project and data collection continues. We are also expanding data collection to additional sites in 2007. We also hope that examination of variation in reproduction and survival will also be possible with the expansion of radiotelemetry-based studies on some of these additional sites.

Funding provided by TPWD, the Bureau of Land Management and the U.S. Department of Energy

Texas Nature Trackers: A Citizen-Based Volunteer Monitoring Program

Marsha May, Lee Ann Linam, TPWD

In 1992 TPWD began developing a strategy for monitoring Species of Concern (then Candidate Species) using citizen volunteers. Several statewide and site-specific projects are now offered under the umbrella of Texas Nature Trackers (TNT). Statewide projects include Texas Horned Lizard Watch, Texas Mussel Watch, Texas Hummingbird Round-up, Texas Monarch Watch, Black-tailed Prairie Dog Watch and Texas Amphibian Watch.

In seven years, 175 volunteers have collected data on Texas horned lizards (*Phrynosoma cornutum*) in 164 counties. In 2005, data came in from a total of 43 counties. Data were received for the first time from Anderson, Houston, Howard, Jim Hogg, Kleberg, Lipscomb and Wheeler counties. Positive findings in Potter County in the High Plains and in Brown and Tom Green counties in the Rolling Plains indicate that over 80% of observers found horned lizards in those counties, up from previous years. In addition, positive reports were received for the first time from Blanco and Gillespie counties in the Edwards Plateau and Denton County in the Blackland Prairie region of North Texas. Only negative reports were previously received from those counties. Data have helped to document the current distribution of the species and to show a relationship (χ^2 <= 0.001) between presence of the red imported fire ant (*Solenopsis invicta*) and the absence of horned lizards.

Since its inception in 1997, Texas Mussel Watch, through statewide workshops, trained over 200 volunteer mussel monitors. Data collection by 76 volunteers in 53 counties has documented five new records for mussel species: Texas lilliput (*Toxolasma texasiensis*) and tapered pondhorn (*Uniomerus declivis*) not previously found in Austin County, rare golden orb (*Quadrula aurea*) in the San Marcos River, rare sandbank pocketbook (*Lampsilis satura*) in the Neches and Sulphur rivers, live, rare Texas fawnsfoot (*Truncilla macrodon*) in the Brazos River and a live pigtoe (*Fusconaia* spp.) in Dallas County in the Trinity River. The U.S. Geological Survey collected county records of Asian clams (*Corbicula fluminea*) throughout North America and records of this species were not available in many Texas counties. The presence of Asian clams recorded by Texas Mussel Watch volunteers contributed to this project by adding several county records.

Since 1999, over 300 volunteers have been trained at Texas Amphibian Watch workshops. Volunteers conduct amphibian monitoring at sites they select, or conduct surveys on routes established by the North American Amphibian Monitoring Program. Data have been received from 81 counties. Data were collected at 16 sites using automated frogloggers. Volunteer data have revealed an upward trend for one widely-introduced species, the Rio Grande chirping frog (*Syrrhophus cystignathoides*), while indicating stable trends for most other species of frogs and toads. Significant findings in 2005 included a report of Crawfish frog (*Rana areolata*) calling in Anderson County in April and possibly in Wood County in September. Texas Amphibian Watch has now collected data on 41 of the 42 extant frog species in the state.

Funding provided by TPWD

Status Survey of the Brazos Water Snake

Dustin McBride, James Mueller, Tarleton State University; Michael Miller, TPWD

The Brazos water snake (*Nerodia harteri*) is a Texas endemic species classified as threatened by the state of Texas. It occurs along a 700 km stretch of the upper Brazos River Basin from Deadman Creek, Jones County, to Brazos Point, Bosque County. Within this range the Brazos water snake occupies approximately 300 km of river habitat and two reservoirs (Possum Kingdom Lake and Lake Granbury), giving it one of the smallest ranges of any North American snake species. Along the Brazos River, this snake is most commonly found in shallow, swift-flowing sections typically associated with riffles. Recently, herpetologists have noted an apparent disappearance of the species from parts of its historic range. The last range-wide survey for this snake was concluded 20 years ago; however, searches were primarily conducted at roadway crossings, thereby leaving several stretches of river unsurveyed.

A two-year survey of the Brazos water snake's historic range was initiated in September 2006. We are estimating the extent of potential habitat, determining the species' current distribution and abundance, and investigating the relationship between species occurrence and habitat quality. We are conducting field surveys on the Brazos River by boat (primarily canoe) during September–October and April–May of each year. Time-constrained searches for snakes are conducted and habitat characteristics are measured at suitable sites.

During September–October 2006, approximately 180 km of the Brazos River was surveyed from Morris Sheppard Dam (Possum Kingdom Lake) to Lake Granbury. Seven trips were made, spanning 13 days in which a total of 99 hours were spent searching for snakes. A total of 18 snakes were captured during these surveys; seven Brazos water snakes, three diamondback water snakes (*N. rhombifer*), four blotched water snakes (*N. erythrogaster*), one cottonmouth (*Agkistrodon piscivorus*), and three western ribbon snakes (*Thamnophis proximus*). These surveys and habitat measures should clarify the factors responsible for site occupancy and identify sections of suitable, but unoccupied, habitat. These data will be valuable for future conservation of the species.

Funding provided by TPWD and Texas A&M University

Variation in the Spatial Ecology of Western Diamondback Rattlesnakes

Richard Kazmaier, West Texas A&M University; Michael Janis, Donald Ruthven, III, TPWD

Western diamondback rattlesnakes (*Crotalus atrox*) are the most conspicuous venomous snake within Texas. Indeed, these rattlesnakes are the most common species targeted by the numerous rattlesnake roundups within the state. Despite its familiarity among the public, little information is available on the ecology of this species within Texas. This is particularly true for populations in the Rio Grande Plains of southern Texas. Although rattlesnake roundups remove significant numbers of snakes from various populations each year, our lack of information on the ecology of this species makes it difficult for researchers and managers to predict the possible impacts of these removals on wild populations.

Our broad objective was to establish radiotelemetry-based projects at two sites unimpacted by rattlesnake roundup activity in order to establish baseline datasets for comparisons with impacted sites in the future. We conducted work on Chaparral WMA in Dimmit and La Salle counties from 2001–2005 and began work at Matador WMA in Cottle County in 2005. In order to assess spatial ecology (movements, home range, habitat selection, etc.) we are outfitting individuals with radio transmitters implanted interabdominally. Given that Matador WMA is composed primarily of mesquite-sand sagebrush grasslands and is approximately 650 km north of the thornscrub-dominated Chaparral WMA, we expected individuals in these to populations to vary in their ecology. Preliminary analyses do suggest that there are pronounced differences in home ranges between the two sites with snakes on Chaparral WMA seldom having home ranges >25 hectares, but several individuals at Matador WMA have developed home ranges >200 hectares. Additional data collection at Matador WMA over the next several years should help us better quantify these differences.

Our goal of monitoring western diamondback rattlesnakes over several years via radiotelemetry should allow us to better evaluate movements, home range, habitat selection and other spatial aspects of the ecology of this species. More importantly, we should be able to begin to understand the extent of variation in western diamondback rattlesnakes by comparing habitat selection and other variables between these two sites. Collectively, these data should help us to make wise management decisions for this species.

Funding provided by TPWD and West Texas A&M University

Variation in Texas Horned Lizard Diet: Management Effects

Jeremy Lane, Richard Kazmaier, West Texas A&M University; Donald Ruthven, III, TPWD

Given a general lack of basic ecological data for the state-threatened Texas horned lizard (*Phrynosoma cornutum*), it has been difficult to predict how management treatments might affect this species. As part of our intensive radiotelemetry based project on horned lizards at Chaparral Wildlife Management Area in southern Texas from 1998–2005, we collected fecal samples throughout burning (winter-burned, summer-burned, nonburned) and grazing (moderately grazed, heavy grazed, nongrazed) treatments to characterize the diet of horned lizards in this population and determine if management effects on diet could be detected.

We examined the contents of 225 fecal pellets and identified food items by comparing fragments to voucher specimens from the study site. Food items were counted to determine minimum number of dietary items per sample based on taxonomic family (and on species for ants). Subsequent to counts, we calculated abundance, richness and diversity at the family level for all food items and at the species level for ants. Twenty-five invertebrate families and 27 species of ants were documented from these samples. Overall, percentages of food items were 75% for ants, 24% for termites and <1% for the remaining families.

Patterns of diversity, richness and abundance were similar at both the family level and the ant species level. Dietary richness and diversity did not differ among winter-burned and nonburned sites. Number of food items was higher in the winter-burned than the nonburned treatment. Dietary richness, diversity and abundance of food items were higher for moderately grazed than heavily grazed or nongrazed treatments. Because of considerable annual variation, more samples are needed to help clarify the effects of summer burning and the interaction between all treatment variables. These initial results do indicate that management practices can influence the diet of this protected species.

Funding provided by TPWD, the Bureau of Land Management and the U.S. Department of Energy

Plants

Bracted Twistflower Surveys, Monitoring and Reintroduction

Dana Price, Lee Ann Linam, TPWD; Ross Bee, volunteer; Nancy Wooley, Friends of Bright Leaf; Pat McNeil, McNeil Growers; Bill Carr, The Nature Conservancy; Flo Oxley, the Lady Bird Johnson Wildflower Center; Tim Schumann, U.S. Fish and Wildlife Service; Norma Fowler, UT Austin; Alan Pepper, Texas A&M University

Bracted twistflower (*Streptanthus bracteatus*) is a rare and beautiful annual mustard that is endemic to the Texas Hill Country. Although not yet listed as threatened or endangered, its rarity, proximity to urban development, and palatability to herbivores, particularly white-tailed deer (*Odocoileus virginianus*), make it highly imperiled. Bracted twistflower populations fluctuate dramatically from year to year, making it difficult to track population trends or to understand the species' habitat and management needs.

TPWD staff began monitoring bracted twistflower populations at 10 sites in Travis, Bexar and Medina counties in the mid-1990s as part of a Section 6 project to involve volunteers in monitoring candidate plants. After several years of data collection under this project, staff and volunteers realized that the bracted twistflower was in trouble in Travis County. While some sites or parts of sites were being lost to development, other bracted twistflower populations were in decline and remained without protection from deer. At the urging of volunteers, a group called "Friends of Streptanthus" began meeting in 2001.

"Friends of Streptanthus" is comprised of volunteers, TPWD staff, and representatives from the City of Austin, Travis County, the LCRA, the Lady Bird Johnson Wildflower Center, the U.S. Fish and Wildlife Service, and The Nature Conservancy. In addition to continuing to monitor all previously known and accessible sites, the group has trained new volunteers, conducted searches for new populations on public land, and made contact with landowners. Seed has been collected and banked to safeguard against loss of populations and to use in future reintroduction projects. At least one population on private land has been fenced to prevent browsing by deer.

The group is currently working on a conservation and reintroduction plan for bracted twistflower. To offset the loss of Austin-area populations to development, we plan to reintroduce bracted twistflower to suitable sites on public land and on the properties of interested private landowners. The reintroduction plan, currently being developed, spells out several research needs for the species. Bracted twistflower's habitat requirements are not completely known, so we are seeking funding to determine its light requirements for germination and growth, and for soil testing to aid in identification of sites and methods for reintroduction. Finally, information on the genetic structure of bracted twistflower populations is needed as a basis for creation of new populations. We hope that these efforts will conserve the bracted twistflower into the future without the need for regulatory protection.

Funding provided by TPWD, Friends of Bright Leaf, McNeil Growers, The Nature Conservancy, Ladybird Johnson Wildflower Center, U.S. Fish and Wildlife Service, University of Texas and Texas A&M University

Guide to the Rare Plants of Texas, Including Listed, Candidate and Species of Concern

Jackie Poole, Dana Price, Jason Singhurst, TPWD; William Carr, The Nature Conservancy of Texas

In response to the need for an updated guide to the rare, threatened and endangered plants of Texas, a new field guide has been produced. The last such effort was produced in 1987 by Poole and Riskind. Several plants have been listed or delisted since that time, as well as many changes in both the candidate and species of concern lists. Most of these species are too rare to be found in any of the common field guides, and only a handful of botanists know what these species and their habitats look like. Without more information on these species readily available, their protection and recovery is tenuous. Misidentifications are common as these rare species lack published photographs or easily acquired illustrations.

A reference book with photographs, line drawings, county-level maps, and text on the distribution, habitat, physical description, phenology, federal and state legal status, similar species, selected references and other comments has been produced. The introductory chapters of the book include information on threats, recovery strategies, the history of plant conservation in Texas, an ecological overview of the state, and how to report new information.

The book was submitted to Texas A&M University Press in December 2005. Copyediting was completed, reviewed by the authors, and returned to the press in May 2005. Anticipated publication is in fall 2007.

Funding provided by TPWD and the U.S. Fish and Wildlife Service Endangered Species Program

Lower Rio Grande Valley Plant Candidate Conservation Project

Dana Price, TPWD; Gena Janssen, Janssen Biological; Lisa Williams, The Nature Conservancy of Texas

The Lower Rio Grande Valley (LRGV) of Texas and adjacent Mexico is an area of high biodiversity confronted by rapid human population growth and development. The five-county area along the Lower Rio Grande between Brownsville and Laredo, Texas, contains 12 unlisted, imperiled plant species that are primarily restricted in range to the LRGV and adjacent Mexico. In addition to these potential candidates for listing as threatened or endangered, six federally-listed endangered plant species are restricted to the LRGV. Rapid development in the LRGV makes conservation of rare plant species and communities an urgent priority. The increasing pressures of urbanization and associated introduction of exotic species pose short- and long-term threats to rare species and their habitats as land-use practices change.

In 2002, TPWD received a Section 6 grant to conduct private lands outreach with the goal of conserving the LRGV rare plant species that are potential candidates for listing as threatened or endangered. The Nature Conservancy and Janssen Biological were contracted to conduct landowner outreach and surveys, and when possible, to obtain conservation agreements from landowners.

Initial workshops for botanists on both sides of the border resulted in the sharing of information and collaboration between Texas and Mexican botanists. TNC and Janssen worked with private landowners to conduct surveys for rare plants. Numerous new populations of rare plants, including listed endangered species, have been discovered. Nineteen private landowners and TNC have signed conservation agreements with TPWD, protecting nine rare species and five listed endangered species.

Cooperation with landowners will result in improved continuity of appropriately managed sites along the corridor adjacent to the Lower Rio Grande River. By working with private landowners we are finding a great deal of local interest and involvement in the conservation of native flora and fauna.

Funding provided by TPWD

Research and Recovery of Star Cactus

Gena Janssen, Janssen Biological; Paula Williamson, Anna Strong, Texas State University; Jackie Poole, Sandy Birnbaum, TPWD

Star cactus (*Astrophytum asterias*) is one of the rarest and most imperiled endangered cacti within Texas. Historically the species was known from Cameron, Hidalgo and Starr counties, as well as northern Mexico, but now only three populations exist in Starr County, and six very small populations in adjacent Mexico. Habitat destruction and collection by cactus enthusiasts are the primary threats. Recovery of this species will be accomplished by searches for new populations, monitoring existing populations to learn about life history, documenting habitat characteristics, determining reproductive biology strategies and reintroducing or augmenting populations.

To date, star cactus has been discovered at six additional sites, and the population total now stands at close to 4,000 plants. Seven monitoring plots have been established, and data on various life history aspects have been recorded monthly on approximately 250 individuals. So far little recruitment has been noted. Significant mortality (approximately 75%) due to herbivory has been noted in one plot. Camera traps have been set up, and rabbits (*Sylvilagus* spp.) appear to be the likely consumer. No poaching has been noticed. Size class distribution is fairly even, although there are fewer individuals in the largest size class. Flowering occurs primarily from mid-March to early May, although occasional flowers were observed June through November. Flowering is directly correlated to plant size, with the smallest flowering individual being 3.5 cm in diameter. Slightly less than half of the flowers developed into fruits. Star cactus is an obligate outcrosser. Floral visitors included beetles, halictid and andrenid bees.

Funding provided by TPWD and the U.S. Fish and Wildlife Service Endangered Species Program

Seed Production and Seed Bank Dynamics of Moist-Soil Managed Wetlands

Daniel Collins, III, Warren Conway, Stephen F. Austin State University; Corey Mason, Jeffrey Gunnels, TPWD

Typically, moist-soil management strategies focus upon providing food resources for migrating and wintering waterfowl during critical times of the year. However, to provide these foods, managers need to know what plant species (i.e., desirable and undesirable) exist in managed wetland soil seed banks, and how much seed those species produce per acre, to estimate water bird use days. To address these questions, we determined soil seed bank composition of recently created moist-soil managed wetlands and created seed yield predictive regression models of two common moist-soil plant species.

Greenhouse germination trials documented 27 species, such as barnyard grass (*Echinochloa crusgalli*), nodding smartweed (*Polygonum lapathifolium*), water primrose (*Ludwigia peploides*), delta duck potato (*Sagittaria* spp.), erect burhead (*Echinodurus rostratus*), and redroot flatsedge (*Cyperus erythrorhizos*). More (P <0.001) desirable moist-soil plants germinated in moist treatments, while more (P <0.001) undesirable moist-soil plants germinated in flooded treatments. These results corroborate other work indicating that long term flooding will negatively change plant species composition in moist-soil managed wetlands, while traditional moist-soil management techniques will promote desirable plants. We also tested two seed yield prediction techniques developed by Laubahn and Fredrickson (1992) and Gray et al. (1999). In September 2004, we collected wild millet (*Echinochloa walteri*) and barnyard grass seed heads (n = 90), and measured a suite of phytomorphological variables. Species specific linear regression analyses demonstrate strong relationships (P <0.001) among phytomorphology and seed production. Using the phytomorphological method, it was determined that wild millet had the potential to produce 199 kg/hectare, while barnyard grass was found to have the potential to produce 126 kg/hectare. For wild millet, total number of seed heads, total plant height, mean seed head mass, and inflorescence diameter predicted seed production well (P <0.001). For barnyard grass, total number of seed heads, mean seed head mass, and inflorescence volume predicted seed production well (P <0.001). Combined, these studies demonstrate that when moist-soil managed wetlands are exposed to the proper hydrological manipulations, successful moist-soil seed production can be attained.

Funding provided by TPWD

Texas Snowbell Demography and Reintroduction

David Bamberger, Steven Fulton, Bamberger Ranch Preserve; Jackie Poole, Sandy Birnbaum, TPWD

Texas snowbells (*Styrax platanifolius texanus*) are long-lived, large shrubs that grow in gravelly intermittent streambeds and cracks, crevices, and solution pockets in limestone boulders, ledges, and cliffs along the drainages of the Devil's and upper Nueces rivers in Val Verde, Real, and Edwards counties. At present there are 22 known natural populations, consisting of one to several hundred individuals. The entire natural population is less than 1,000 individuals. A reintroduction program has begun to augment natural populations or introduce new populations in suitable habitat.

The primary threat to Texas snowbells is from browsing animals. Populations along the Nueces River are relegated to inaccessible cliff faces, beyond the browsing reach. Exclosure studies have shown that plants cannot establish in areas easily available to browsers. However, the populations along the Devil's River grow within easy access of browsing animals, yet do not seem to suffer the damage of the Nueces River populations. Camera trapping has shown aoudads (*Ammotraqus lervia*) within the Nueces River populations while only foxes (*Urocyon cinereoargenteus*) and raccoons (*Procyon lotor*) were seen at Devil's River.

Two of the largest populations of Texas snowbells have been monitored for more than 10 years to determine and compare population demographics between browsed and unbrowsed populations. Individual plants are tagged, mapped, and various measurements of vigor (height, stem diameter, number of stems, reproductive output, overall condition, disease, and herbivory) are recorded. Populations between the two sites are similar in age class composition and size, although some of the accessible Nueces River plants remain small in stature due to constant browsing. Both populations produce thousands of flowers and hundreds of seeds (reproductive output is about 50–60%). However, recruitment at the Nueces River site is practically nil outside of the exclosures. Within the exclosures, recruitment rates are similar to those at Devil's River. Recruitment is extremely variable depending on timing and amount of annual precipitation. True recruitment (seedling establishment to reproductive adult) has finally been observed, as three plants at 14 years of age produced their first flowers and fruits. A minimum viable population analysis is being started now that significant life history data has been acquired.

Texas snowbells have been reintroduced on 11 private properties within their historical range. Close to 500 plants have been placed in hog-proof cages. The plants are monitored twice per year as to their growth and vigor. Plantings occur in the late fall, and plants are replaced as needed. Although no plants have yet reproduced, most are growing vigorously.

Funding provided by TPWD

Texas Wild-Rice Monitoring and Management

Jackie Poole, Sandy Birnbaum, TPWD

Texas wild-rice (*Zizania texana*) grows only in the uppermost 3.2 km of the San Marcos River, a uniquely clear and thermally constant river. This listed endangered perennial grass is primarily a submerged aquatic, but will occasionally lift its stalks out of the swiftly flowing water to flower and produce seed. Threatened by depletion of the Edwards Aquifer, altered hydrology (dams, channelization, current, and depth changes), non-native species (both plant and animal), over-enthusiastic recreationists, catastrophic floods and droughts, pollution, and other problems associated with its urban habitat, Texas wild-rice also suffers from the problems of any small population, i.e., reduced genetic resources and loss of individuals to random events.

Historically Texas wild-rice was known from the upper San Marcos River, its irrigation canals, and Spring Lake (an impoundment at the spring headwaters). When the first distribution map was drawn in 1976, Texas wild-rice was only found in the river itself, with an areal coverage of 1,132.5 m^2. During the mid-1980s coverage dropped to a low of 412 m^2. In 1989 Texas Parks and Wildlife Department staff began annual monitoring and mapping of the distribution of the entire population. Individual stands (tangled masses of individual stems) are identified either by GPS or through a system of distance and bearing from witness points. The length, width, and percent areal cover of each stand are calculated, and the total of all stands added together by river segment and entire population. Data has been compiled every summer from 1989 to the present. Coverage has been slowly increasing from 1989, with a high in 2006 of 4,161 m^2. However, coverage is primarily confined to the upper part of the river as the dramatic flood of fall 1998 destroyed most of the stands below I-35. Concentrating the population in an even smaller area makes the species more prone to extinction through chance events.

A recently completed genetic study determined that genetic diversity is spread throughout the Texas wild-rice population, rather than being compartmentalized in distinct segments. This knowledge will make reestablishment of Texas wild-rice easier, as material can be moved from one area of the river to another. Restoration plans are moving forward.

Recent threats include vandalism (plant removal) in a small area, the construction of a new footbridge and completion of Rio Vista Dam (several stands were lost immediately downstream).

In addition to the annual monitoring and mapping, in 2003 Wildlife, Coastal and Inland Fisheries Division biologists began a monthly removal of floating vegetation mats that covered wild-rice, blocking sunlight. The primarily non-native vegetation is removed and composted at Texas State University in San Marcos.

Funding provided by TPWD

Tobusch Fishhook Cactus Annual Monitoring and Assessment of Mortality

Jackie Poole, TPWD

The long-term demographics of Tobusch fishhook cactus (*Sclerocactus brevihamatus var. tobuschii*) are being studied at several sites within the range, to evaluate mortality, particularly the effect of the cactus weevil (*Gerstaeckeria sp. nov.*) on the Tobusch fishhook cactus. Tobusch fishhook cactus is a listed endangered species that occurs in seven counties in the southwestern portion of the Edwards Plateau.

One hundred sixty-five plots (some quite small) tracking approximately 2,500 individuals have been established at eight sites scattered across the range of Tobusch fishhook cactus. Although most plots were established in 1996, several of these plots were established as early as 1991 and 90 new plots (primarily at the Buck Wildlife Management Area) were set up in 2005–2006. Populations are being monitored at five state parks and wildlife management areas, two highway rights-of-way, and one private property. Most sites remained more or less stable, with mortalities balanced by recruitment. A significant population of several hundred plants at Garner State Park suffered over 50% mortality due to herbivory, probably by axis deer (*Axis axis*). A high level of mortality continues at Kickapoo Caverns State Park due to weevils and feral hogs (*Sus scrofa*). The population at Devil's Sinkhole State Natural Area remains low, still not recovering from a weevil infestation that cut the population from 1,100 to 25 individuals in five years.

Funding provided by TPWD

Two Rare Lilies of South Texas: *Echeandia* Surveys and Monitoring

Alice Hempel, Texas A&M University–Kingsville; Dana Price, TPWD; Chris Best, U.S. Fish and Wildlife Service

Lila de los llanos (*Echeandia chandleri*), a rare lily, is one of the showiest wildflowers in South Texas. A former federal candidate, it was dropped from consideration for listing as endangered because several populations on lomas adjacent to the Brownsville Ship Channel were protected by a lease to the Lower Rio Grande Valley National Wildlife Refuge. The status of the species was thrown into doubt in 1999, when a second species of *Echeandia* in the Lower Rio Grande Valley, *E. texensis*, was described. At the time, no extant populations of *E. texensis* were known.

The 2001 rediscovery of extant populations of *Echeandia texensis* requires the examination of its conservation status and reexamination of the status *chandleri*. The *E. texensis* discovery reduces the number of occurrences of *E. chandleri* and puts into doubt the unvouchered species occurrences cited for *E. chandleri* in TPWD's Natural Diversity database. *Echeandia texensis* was described from only four herbarium specimens, the most recent being collected in 1951. Cruden (1999) in his description suggests "this species is rare and probably endangered if not already extirpated." However, living plants were discovered in the nursery trade and traced back to seeds collected on the Lower Rio Grand Valley NWR.

Three years of field surveys conducted by Alice Hempel with assistance from USFWS and TPWD have yielded seven confirmed lomas adjacent to the Brownsville Ship channel with *E. texensis* and one probable population on Green Island. Green Island, the type locality, had less than a dozen vegetative plants, presumably *E. texensis*, when visited. The known populations of viable size are located with in a region of less than 1,036 hectares bounded by the Brownsville ship channel and should be understood to be effectively one meta-population. We have observed several threats to this extremely localized species. Seismic survey stakes were present in a number of both *E. chandleri* and *E. texensis* populations in 2006 and so oil and gas exploration is an immediate threat to these species. Dredge spoil is deposited adjacent to these lomas as well, allowing easier access for both invasive plants and animals and humans. Invasive grass species are heavily impacting many of the sites where these two species occur and several reported *Echeandia* populations in the area could not be relocated and the habitat has been degraded or developed.

Funding is needed to complete the basic status survey, habitat characterization and ecological studies for these two species.

Funding provided by TPWD and Texas A&M University–Kingsville

Zapata Bladderpod Surveys and Monitoring

Dana Price, TPWD; Chris Best, U.S. Fish and Wildlife Service

Zapata bladderpod (*Physaria thamnophila*), a wildflower in the mustard family, is found only in Starr and Zapata counties in the Lower Rio Grande Valley. It was listed as endangered in 1999. Like other species in its genus, Zapata bladderpod is named for its small, round fruits that are inflated like tiny bladders. Zapata bladderpod is a short-lived perennial whose populations fluctuate greatly in response to rainfall, making it difficult to determine population trends and management needs for the species.

TPWD personnel began making observations of Zapata bladderpod in the early 1990s at the six sites to which we had access. Detailed monitoring was initiated at the Cuellar tract of the Lower Rio Grande Valley National Wildlife Refuge (Refuge) in 2002. The previous year, TPWD and Refuge staff had observed a dramatic increase in the bladderpod population in part of this tract where brush was cut with a Woodgator. We established permanent monitoring plots in the area so we could document changes over time following this management practice. We have added a site to the monitoring program each year. Observations at these sites have led to searches in similar areas and two new populations have been discovered. In 2005, with our Mexican partner Pronatura Noreste, we relocated a historical site in Mexico.

Goals for this project are to track population fluctuations at four sites, to characterize the vegetation at each of these sites, and to create GIS maps of Zapata bladderpod distribution. If additional funding and time becomes available we will study the soils and geology of known sites, all of which appear to be underlain by a particular sandstone formation. Another research need is to study the effects of management practices on Zapata bladderpod.

Funding provided by TPWD and USFWS

Wildlife Habitat

Collective Action and Social Capital of Wildlife Management Associations

Matt Wagner, TPWD; Urs Kreuter, Ronald Kaiser, Neal Wilkins, Texas A&M University

In areas with dense landownership patterns, management of white-tailed deer (*Odocoileus virginianus*) depends upon collective decision making of landowners and hunters. To resolve conflicts associated with this commons dilemma, wildlife management associations (WMAs) have become a popular mechanism for coordinating wildlife management decisions in private land states, especially in Texas. Social capital, represented by metrics such as trust, reciprocity and community involvement, has been identified as an important determinant of the success of collaborative institutional arrangements. To determine the influence of social capital on the effectiveness of WMAs, we address two research questions: do WMAs exhibit elements of social capital and what landowner characteristics affect elements of social capital within WMAs? We used a mail survey questionnaire to determine the effect of various factors on the activities and management practices in four WMAs in two regions in Texas: the Lower Post Oak Savannah (LPOS) and the Central Post Oak Savannah (CPOS). LPOS landowners were members of larger associations, had generally acquired their land more recently, held more frequent meetings, and tended to have longer association membership than CPOS landowners, yet they exhibited lower social capital. CPOS landowners owned significantly larger properties, and were predominantly absentee wealthy males that considered relaxation and hunting more important land uses than property ownership for a place to live. The smaller group size of the CPOS associations may be the most important factor in building and maintaining social capital. Intra-association trust, a primary measure of social capital, was positively influenced by the longevity of property ownership, the number of association meetings, the percentage of males in the association and other factors. Conversely, negative influences on trust included absentee ownership and the proportion of woodland habitat present in each WMA. We suggest that deer are a common-pool resource whose populations are dependent upon collective action by stakeholders. Social capital building within landowner associations could facilitate the sustainable harvest of quality deer and possibly lead to cooperative management of other common-pool natural resources.

Funding provided by TPWD and the National Water Research Institute

East Amarillo Complex Wildfires

Sandra Rideout-Hanzak, David Wester, Rodney Weiser, Clint Boal, Carlton Britton, Texas Tech University; Heather Whitlaw, TPWD

In March 2006, two wildfires burned approximately 293,803 hectares in the Texas Panhandle, mostly in Roberts, Gray and Wheeler counties. These fires, which burned over a four-day period, were unprecedented in size. We have begun a three-year study of the effects of these fires on vegetation, soil and bird communities.

We have established study sites on tight, upland soils characterized by buffalograss (*Buchloe dactyloides*) and blue grama (*Bouteloua gracilis*); sandy uplands with sand sage (*Artemisia filifolia*) and little bluestem (*Schizachyrium scoparium*); sandy soils dominated by sand shinnery oak (*Quercus havardii*); and bottomlands with cottonwood (*Populus* spp.), sugarberry (*Celtis laevigata*) and tall grasses. In these ecological types, we have located areas that burned, and we have also been able to locate similar areas nearby that were not affected by the fire to serve as controls in our research. On burned sites, there are plots left available to grazers, while paired plots have exclosures keeping grazers out. We are measuring ground cover, frequency of dead plants, frequency of weeds in burned plots, and forage standing crop in burned as well as non-burned areas to assess potential loss of forage.

Preliminary results suggest the fires removed considerable litter cover from the soil surface. As a result, many areas experienced significant wind erosion. For example, some dead grass plants have had up to 5 cm of soil removed from their bases. In some areas, we have documented a large number of dead plant bases of perennial grasses such as blue grama and little bluestem. However, many plants which show fire effects have recovered. For example, many partially-burned plant bases of blue grama, sideoats grama (*B. curtipendula*) and little bluestem have produced considerable regrowth by replacing burned stems with new tillers. Sand sagebrush, sand plum (*Prunus angustifolia*) and sand shinnery oak are all strong sprouters and important components of upland bird communities. These plants have only been top-killed, changing their structure from large, shrubby plants to smaller plants.

Next year, we will establish additional study sites, and continue to monitor sites established this fall. Results will provide important information, not only on the effects of these fires, but also on the processes involved in ecosystem recovery following wildfire.

Funding provided by TPWD and Natural Resources Conservation Service

Effects of Winter and Summer Fire on Vegetation and Wildlife

Matthew Poole and Richard Kazmaier, West Texas A&M University; Michael Janis, Donald Ruthven, III, TPWD

Prescribed burning has been shown to be an effective tool in suppressing woody vegetation while maintaining woody plant diversity and enhancing herbaceous vegetation preferred by wildlife. As a result of its reported benefits, rangeland managers throughout the Rolling Plains are beginning to utilize prescribed fire to enhance wildlife habitat. However, little data is available on the effects of fire on the flora and fauna of sand sagebrush (*Artemisia filifolia*) grasslands. The objectives of this study are to determine the effects of growing and dormant-season prescribed burning on woody and herbaceous vegetation and a variety of wildlife species.

Research was conducted in sand sagebrush-honey mesquite (*Prosopis glandulosa*) grassland on the Matador WMA in Cottle County. Fifteen 18-hectare plots were randomly assigned one of three treatments: summer-burned, winter-burned and nonburned. Burn treatments were applied in 2005 and sampling of floral and faunal communities was conducted in 2005 and 2006. Herbaceous vegetation species richness was higher in summer burn plots than winter burn plots, but neither treatment was different from the control. Herbaceous vegetation diversity was higher in summer plots relative to winter and control plots. Both burning treatments suppressed sand sagebrush (58% for winter, 86% for summer) and honey mesquite (69% for winter, 66% for summer). Species richness and diversity indices were similar across treatments for herpetofauna and small mammals. Male northern bobwhite (*Colinus virginianus*) whistle counts decreased from 2005 to 2006, but exhibited no treatment effect. Fall covey call counts for northern bobwhite declined in the summer plots relative to the control, but were similar between winter and control plots. Analysis of burning effects on invertebrates is forthcoming.

Our results indicate that summer burning can increase diversity of herbaceous vegetation and both dormant and growing-season fire may be a useful tool in managing woody vegetation in the Rolling Plains. Although few differences occurred across treatments for vertebrates, our data suffered from high variance as a result of an intense drought in 2006 that greatly suppressed captures relative to 2005. Continued sampling should help us clarify the differences between year and treatment effects.

Funding provided by TPWD and Texas Chapter of Quail Unlimited

Hydrogeomorphic Assessment and Evaluation of Andrew's Bog

Carol Thompson, Tarleton State University; Wes Littrell, TPWD

There are numerous examples of bogs in the West Gulf Coastal Plain, but beyond extensive surveys of their botanical composition little is known of their development, geomorphology, hydrology or water chemistry. A study was begun in late 2003 on Andrew's Bog at Gus Engeling WMA in Anderson County, TX. The objectives of study were to define the hydrogeomorphic setting, the age and geologic history, and the hydrology of hillslope bogs in the Gus Engeling area.

Topographic surveys and coring has allowed the stratigraphic setting to be reconstructed. Organic wetland materials range from zero at the upslope and downslope edges to over 3 m in some areas. Radiocarbon results from the bottom of two cores show that organic materials began to accumulate about 19,000–20,000 years before present during the Full Glacial period when it would have been more moist and cooler. The organic material ranges from a good fibric peat to mineralized muck. There are thin layers of sand which may indicate a drier climate at some time in the past with more wind deposited material.

Wells were installed late in 2003 and instrumented for continuous water levels. Water levels in the sands are relatively stable although they showed a large drop through the summer of 2004. The water levels in the peat wells are also very stable. There is a large upward vertical gradient between the sand and peat and a smaller upward vertical gradient in the peat. Hydraulic conductivity for the organic material ranged from 2 x 10-4 to 9 x 10-5 cm/sec.

A detailed reconnaissance was done in the winter of 2004 of bog/wetland sites in close proximity to Andrew's Bog. Seep areas occur around the edges of most sites; in the interior of some of the sites there are mounds present, which represent areas of groundwater upwelling. These mounds range in size from 3–15 m across and 0.6–1.2 m high. Although no distinct mounds occur at Andrew's Bog, there is a relatively large area of increased groundwater pressure.

Funding provided by Tarleton State University

Impacts of Aeration, Warm Season Prescribed Fire, and Drought on Vegetation and Animal Use

James Gallagher, Brandon Sladek, Lyneigh Perez, Cody Zebransky, David Synatzske, TPWD

Aeration and prescribed fire are commonly recommended habitat management tools, but their use is not without risk, particularly in semi-arid regions with unpredictable rainfall. Inadequate rainfall following treatment can result in severe impacts to vegetative communities and subsequent animal use of those communities. We conducted prescribed burns on previously aerated and non-aerated sites during August and September, 2005 (air temperatures $\geq$38° C, relative humidity $\leq$25%) at the Chaparral Wildlife Management Area with the objective of reducing woody plant cover. Precipitation over the next 12 months was below normal (August 2005–July 2006 total 216 mm, 40% of normal for the period). Study plots consisted of control (C, n = 4), aerated only (A, n = 4), burned only (B, n = 4), and aerated and burned (AB, n = 4).

We sampled herbaceous vegetation within 1 m^2 quadrats and woody plant cover along 30 m transects during spring and summer 2006. Animal use was evaluated using drift fence and pitfall arrays, Sherman live traps, and strip census routes. Woody plant canopy cover was lowest on AB sites and greatest on C sites ($P \leq 0.05$). Grass density was greatest on AB sites, but differences were not significant (P = 0.323). Forb density was also greatest on AB sites (P <0.001). No differences were found in small mammal captures (P = 0.248), herpetofauna captures (P = 0.892) or bird sightings (P = 0.083).

These results indicate that the combination of aeration and prescribed fire effectively reduces woody plant canopy cover. The absence of differences in animal use may indicate greater site fidelity, survivorship and/or mobility than is generally appreciated.

Funding provided by TPWD

Long-Term Effects of Root Plowing on Vegetation and Nongame Wildlife

Alejandro Lozano-Cavazos, Timothy Fulbright, Texas A&M University–Kingsville; Donald Ruthven, III, TPWD

Mechanical brush manipulation practices are commonly used to reduce woody plant cover and increase herbaceous vegetation in South Texas. Of the various mechanical treatments developed, root plowing is the most effective at controlling woody vegetation; however, previous research indicated that once treated rangelands are reinvaded by woody species, woody species diversity is dramatically reduced. Little data is available on the response of nongame wildlife to reduction in woody plant diversity as a result of root plowing. A better understanding of the long-term impacts of mechanical brush management practices such as root plowing on nongame wildlife is essential to address future management of previously treated rangelands. The objective of this study is to investigate the long-term effects of root plowing on vegetation and nongame wildlife communities in the western South Texas Plains.

The study area is on Chaparral Wildlife Management Area in Dimmit and La Salle counties, Texas. Vegetation is dominated by mesquite-mixed brush communities characteristic of the South Texas Plains. Five sites root plowed in 1965 and five non-treated control sites were selected for study. Herbaceous and woody vegetation species richness and Shannon's diversity index were similar on control and root plowed areas. Evenness and beta diversity of herbaceous plants were also similar between treatments. Evenness and beta diversity of woody plants were lower on root plowed sites because mesquite and twisted acacia were more abundant relative to other species. Overall woody canopy cover and herbaceous cover was similar on control and root plowed areas. Species richness, Shannon's diversity index and evenness of small mammals were similar on control and root plowed areas. Species richness and diversity of herpetofauna were similar on control and root plowed sites; however, evenness was lower on root plowed sites and population sizes were almost double on root plowed sites compared to control sites.

Our results indicate that root plowed sites on the Chaparral Wildlife Management area support species richness and diversity of vegetation and small mammals similar to that on control sites by 40 years post-treatment. The woody plant communities on root plowed sites are more homogeneous than the communities on control sites. Greater herpetofauna populations exist on root plowed sites; however, numerical abundance is less evenly distributed among herpetofauna species than on control sites.

Funding provided by TPWD

Restoration of Native Grasslands for Wildlife

Michael Morrison, Christopher Lituma, Texas A&M University; Jay Whiteside, TPWD

In Texas, 35% of the original grassland ecosystems have been altered or destroyed. Grassland birds are among the fastest declining bird groups within North America, due in part to a reduction in suitable breeding habitat. Few studies have examined the impact invasive grasses have had on breeding birds.

Our goal is to understand the impacts of invasive grasses and the subsequent restoration of native grasses on the breeding bird community. Restoration has become an increasingly popular management technique, but how these techniques affect the avian communities is unknown. These data are imperative in determining a direction for grassland bird management in the future. We will address this issue by comparing the nesting success of grassland birds between exotic grass sites and restored native grass sites in South Central Texas during the 2007–2008 breeding seasons.

Funding provided by TPWD

Savannah Restoration and the Water Budget

Eric Woolverton, Wes Littrell, TPWD

Savannah communities occur in the South Central U.S., and may be one of the most endangered ecosystems in the U.S. Historically, Texas is estimated to have had approximately 3.44 million hectares of Post Oak Savannah. Today, very little of that habitat is thought to be in good condition due to having been cleared, over-grazed, or choked by encroaching plants and trees as a result of fire suppression. Little research has been done to assess the affects of vegetative change from closed canopy woodland to savannah on the water balance in an area.

The Gus Engeling Wildlife Management Area (GEWMA) is located in northwest Anderson County, Texas, and is currently the largest intact state-owned portion within the Post Oak Savannah ecoregion of Texas. The staff at GEWMA is planning to restore approximately 1,000 hectares of upland post oak woodlands to historic savannah. Through selective timber harvest, approximately 60% of the canopy within the restoration area will be removed, thereby allowing for the growth and expansion of forbs and grasses.

Most of the perennial streams at GEWMA are maintained by spring flow. While there have been no major changes in temperature or precipitation levels in the region around GEWMA in the last 50 years, it does appear that various changes in stream flow and spring discharge have occurred. Maps and old photos of the area show many spring discharges which have dried up and anecdotal accounts from long-time residents mention decreasing spring flow. Vegetation has also changed—canopy cover and overall brush has increased.

The monitoring of spring flows as a part of the savannah restoration will provide information on the benefits of this type of restoration not just for wildlife, but for the water resources of the state. Enhancement of spring flow may lead to a side benefit of wetland enhancement as well since many of these springs drain to wetlands. This study will monitor spring and creek flow using calibrated weirs in both the restoration zone and an unaffected area to determine potential changes in spring flow.

Funding provided by TPWD

Sustainability of Riparian Cottonwoods in the Rolling Plains

Ryan Walker, Mark Wallace, Warren Ballard, A. Faiz Rahman, Texas Tech University; Michael Janis, TPWD

The establishment of the wild turkey (*Meleagris gallopavo*) across the central and western regions of North America has been facilitated by the presence of humans across the continent. Wild turkeys have accustomed themselves to artificial (i.e., electrical poles) and natural trees. Throughout much of the region the majority of these trees are limited to the perimeters of the riparian drainages. As these drainages have been increasingly impounded, declines have been documented. The greatest declines have been documented in cottonwoods and aspens (*Populus* spp.). These declines can have considerable effects on wildlife distributions.

From 2000–2005 we measured 4,256 vegetation plots across three study sites in the Texas Panhandle. A total of 49 cottonwood stems, <6 cm, were found in only 18 of the 4,256 plots (0.4%). In the same 4,256 plots, we measured 2,787 cottonwoods >10 cm in diameter. This suggests there is limited cottonwood recruitment across these study sites in the recent past.

We used a supervised classification in ERDAS IMAGINE to compare riparian areas on LANDSAT satellite images from 1973 and 2005. Our comparisons showed little or no change in the systems surveyed with 0–6% change over the 32-year period. Despite our inability to detect any large changes in these riparian systems, we feel it is important to continue monitoring these areas in the future.

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Water for Texas Demonstration Plots on the Kerr Wildlife Management Area

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Sixty percent of the land surface in Texas is rangeland. Rangeland resources are the basis for many of the state's livestock and outdoor recreation industries, and provide habitat for large numbers of native plant and wildlife species. Rangeland comprises most of the watersheds, is the primary water source for the major rechargeable aquifers, and provides more than 60% of the surface flow to rivers.

"Water for Texas" is a range watershed management program conducted by the Rangeland Ecology and Management Unit, Texas Cooperative Extension. One component of the program is the use of paired watershed results demonstrations, following EPA's "Paired Watershed Study Design" protocol. The objectives of these demonstrations are to identify the amount of runoff and sediment production under current management and following implementation of best management practices (BMP) which include proper grazing, seeding and or brush management (herbicides and prescribed fire).

The Kerr watershed project will compare differences between grassland and brush dominated sites with differences in soils, slopes, and grazing by deer only versus cattle and deer. BMP will involve complete brush removal, except for live oak (*Quercus virginiana*) and shin oak (*Quercus havardii*) . The project will last two years after BMP are installed. During the first year of collection (calibration period of runoff events), all plots received the same treatment (current management by the landowner). After calibration, one catchment out of the pair received a BMP for that situation based on resource needs and landowner objectives. The other catchments continued with landowner management practices.

Sites are monitored for daily rainfall and amount of runoff. Reports and information developed from this site will be prepared by Texas Cooperative Extension for use by the landowner and the County Extension agent for educational programs and handbooks. Continuous monitoring for >10 years is desired to understand the full impact of management and rainfall cycles on the hydrological cycle. This length of time is necessary for normal successional change to occur following treatment and allow "stabilization" before concluding effects.

Funding provided by TPWD

Wildlife Management and Groundwater Associations on Private Lands

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Since nearly all of Texas' rural lands are privately owned, landowner associations for the management of white-tailed deer (*Odocoileus virginianus*) and groundwater have become increasingly popular. Deer are a common-pool resource with trans-boundary characteristics, requiring landowner cooperation for effective management. Sub-surface groundwater reserves are economically important to landowners, but are governed by the "rule of capture" whereby property rights are not defined. One groundwater association and four wildlife management associations were surveyed to characterize their member demographics, land use priorities, attitudes and social capital. Members of the groundwater cooperative were part of a much larger, more heterogeneous, and more recently formed group than members of wildlife management associations. They also placed greater importance on utilitarian aspects of their properties, as opposed to land stewardship for conservation as practiced by members of wildlife management associations. If groundwater association members could be more locally organized with more frequent meetings, social capital and information sharing may be enhanced and lead to land stewardship practices for improved hydrologic functions and sustained groundwater supply. This, coupled with pumping rules assigned by the local groundwater district, could yield an effective strategy that is ecologically and hydrologically sound, and that allows rural provision of water supply to urban consumers.

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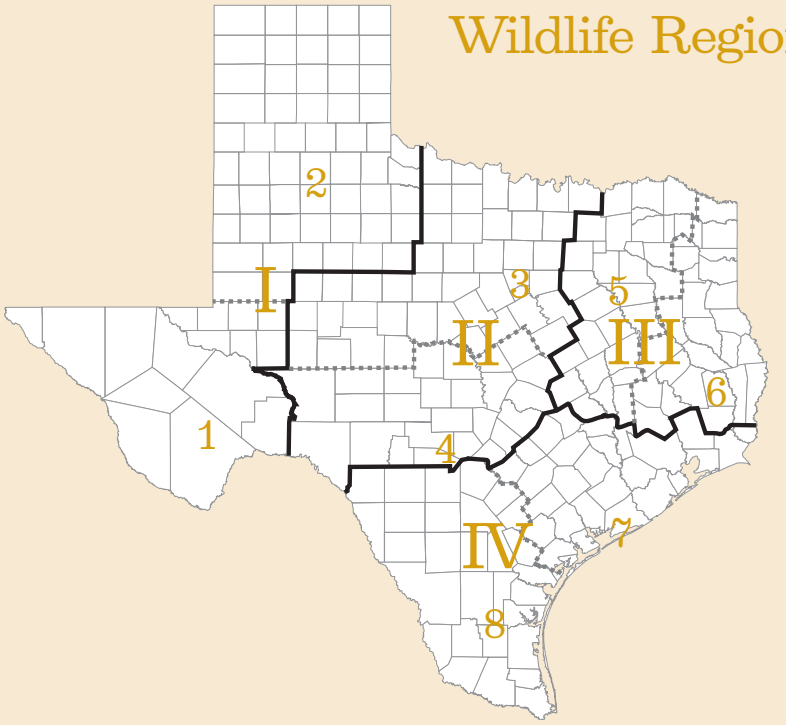

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