TEXAS PARKS AND WILDLIFE

2001 Wildlife Research Highlights

VOLUME 5

EDITED BY XIANGWEN LIU, PHD

TEXAS PARKS AND WILDLIFE

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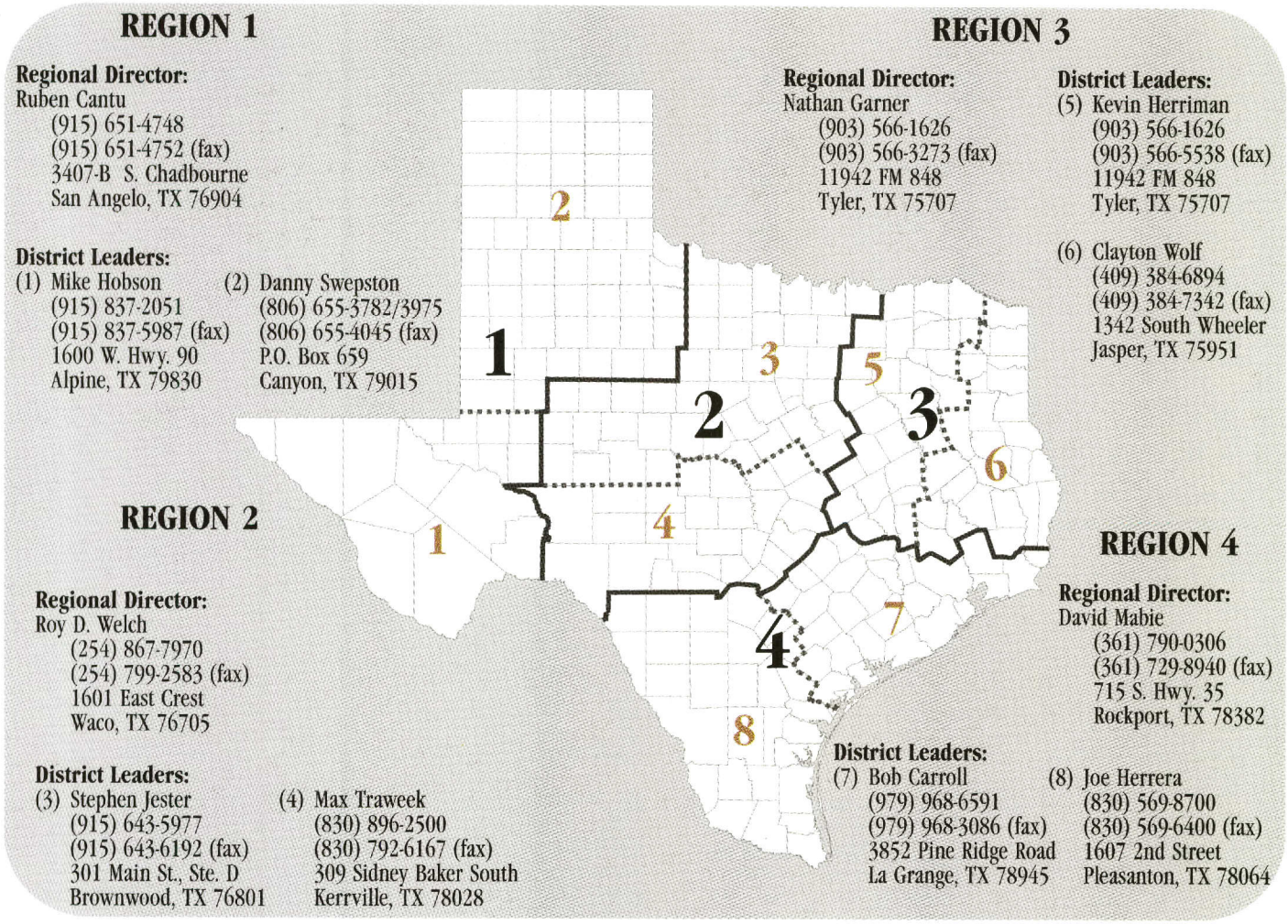


ACKNOWLEDGMENTS

We express our appreciation to those persons who designed these research studies, analyzed data, drafted abstracts, and provided photographs for this publication. We are indebted to Chris Hunt for designing the manuscript and Kathleen Martin, Tim Peterson and Jeannie Swinton for coordinating the production and printing. We appreciate the assistance of all of those individuals, universities, and agencies who cooperated in these studies. We especially thank those persons who donated funds for wildlife research and those private landowners who permitted access to their property for research purposes. This publication is a contribution of the Federal Aid in Wildlife Restoration Act. Printing of this publication was funded, in part, by the **Texas Wildlife Association**.

COVER PHOTOS

Front: Wildlife researcher Bonnie McKinney with tranquilized black bear on Black Gap Wildlife Managment Area in the Trans-Pecos Region. Photo by Billy Pat McKinney.

Back: Golden-ball (or little-leaf) lead tree (*Leucaena retusa*), a preferred deer browse plant in the Edwards Plateau. Photo by Ron George.

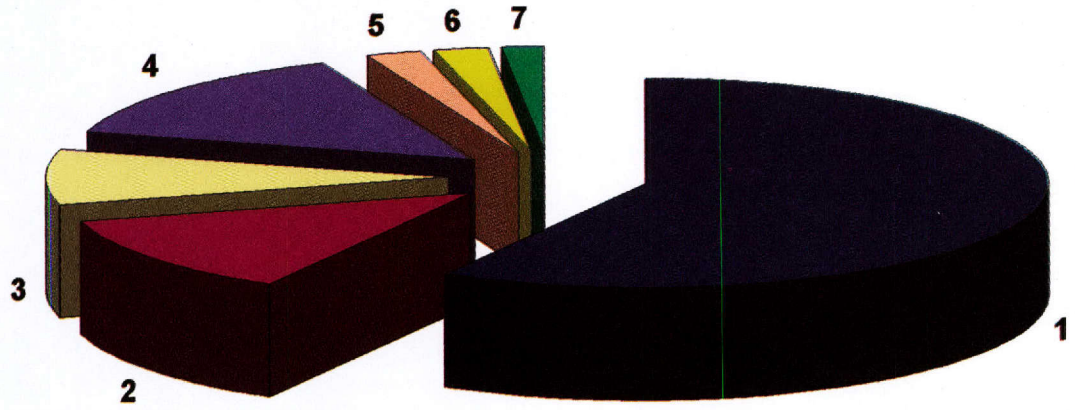
Wildlife Research Highlights
2001

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 biologists are selected to serve as field advisors, graduate committee staff, and publication coauthors.

The Wildlife Division budgeted over $1,795,000 for 76 wildlife research projects during Fiscal Year 01. Funding for this research has come from several sources including: (1) Texas hunting license revenue, (2) grants and donations, (3) federal excise taxes on sporting arms and ammunition (Pittman-Robertson), (4) federal endangered species funds (Section 6), (5) Texas waterfowl, white-winged dove, and wild turkey stamps, and (7) other federal funds.

FUNDING SOURCES



1 Hunting License Revenue
$1,037,000

2 Grants and Donations
$227,000

3 Federal Excise Taxes
(Pittman-Robertson)
$151,000

4 Federal Endangered Species
(Section 6)
$255,000

5 White-winged Dove Stamps
$40,000

6 Waterfowl Stamps
$40,000

7 Other Federal
(COE, USDA, etc.)
$31,000

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UPLAND GAME AND ALLIGATORS

Genetic and Environmental Interaction in White-Tailed Deer

John D. Williams, Texas A&M University
William E. Armstrong, Eugene R. Fuchs, Donnie Frels, and Donnie Harmel (deceased), Texas Parks and Wildlife Department

TPWD PHOTO

Research studies conducted by Texas Parks and Wildlife Department have demonstrated that genetics affect body size and antler characteristics in white-tailed deer (*Odocoileus virginianus*). Further research in penned deer indicated that in the presence of an optimum ad libitum 16% protein diet, some deer consistently produced yearling offspring with spiked antlers while others consistently produced yearling offspring with forked antlers. Departmental check station data indicate that the incidence of spiked antlers increases during extended periods of drought and poor habitat conditions. But even during times of nutritional stress, some yearling bucks were able to produce antlers with 6 or more points. This supports the theory that yearling bucks under natural conditions can generally be categorized into 3 groups based on their genetic potential: 1) bucks able to produce good antler characteristics in the presence of severe nutritional stress; 2) bucks which will produce poor antler characteristics regardless of available nutrition; and 3) the most common group, those bucks which produce good antler characteristics in periods of 'good' nutrition and poor antler characteristics in periods of 'poor' nutrition.

This study was designed to determine the effects of selection or 'culling' based on yearling buck antler development and was conducted at the Donnie E. Harmel White-tailed Deer Research Facility located on the Kerr Wildlife Management Area. From 1991 to 1999, pedigreed yearling bucks were placed with 8-14 pedigreed does to comprise single sire herds. In October of each year, their tagged offspring were removed from their dams, segregated according to sex and placed in 2 separate pens. Beginning each December, all buck fawns were placed on a limited 8% protein diet to simulate nutritional stress conditions. The following October, those 5 or 6 males which exhibited the best antler production and body size under these conditions were used as herd sires. Females producing spike offspring or related to spike yearlings, were removed. Since the study was initiated, 41 single-sire breeding herds have produced 220 yearling males on

Antler Point Classification for 220 Yearling Bucks on a Limited 8% Protein Ration

	Birth Year	No. Bucks @ 1.5 year	Percent Forked	(*n*)	Percent Spiked	(*n*)	Percent with 6 or more points	(*n*)	Percent with 8 or more points	(*n*)
*	1992	27	67%	(18)	33%	(9)	41%	(11)	4%	(1)
*	1993	19	68%	(13)	32%	(6)	37%	(7)	5%	(1)
**	1994	26	69%	(18)	31%	(8)	19%	(5)	4%	(1)
**	1995	34	88%	(30)	12%	(4)	50%	(17)	3%	(1)
**	1996	31	97%	(30)	3%	(1)	77%	(24)	29%	(9)
**	1997	21	100%	(21)	0%	(0)	86%	(18)	43%	(9)
**	1998	33	100%	(33)	0%	(0)	79%	(26)	36%	(12)
**	1999	29	97%	(28)	3%	(1)	97%	(28)	48%	(14)

* Fawns sired by 2.5 year old or older sires; non-stressed diet (16% ad lib)
** Fawns sired by 1.5 year old sires; stressed diet (8% limited)

this restrictive diet. One hundred thirty-six yearling bucks (62%) have produced antlers with 6 or more points while 29 (13%) have produced spiked antlers. The annual percentage of spike antlered yearlings has declined from 33% (in the 1992 cohort) to 3% (in the 99 cohort). These data suggest that antler characteristics can be improved by selecting yearling bucks that perform well under adverse nutritional conditions as opposed to those that perform well under optimal conditions. Furthermore, these data support the opinion that antler characteristics of a deer herd can be improved through selective harvest strategies designed to remove those yearling bucks exhibiting lesser quality antlers.

Molecular Genetic Approaches to Management of White-tailed Deer

Loren C. Skow, Rodney Honeycutt, and John Williams, Texas A&M University
Donnie Harmel (deceased) and E. L. Young, Texas Parks and Wildlife Department

Successful management programs to produce desired phenotypic characteristics in white-tailed deer (*Odocoileus virginianus*) would be enhanced by assessment of the quality of the gene pool. Efforts to improve the genetic stock could be important components in the development of successful management programs to produce quality white-tailed deer herds in Texas. The goal of this study is to develop modern DNA techniques and applied them to white-tailed deer. The closed pedigreed deer herd at the Kerr Wildlife Management Area is being utilized in the study. The identification of DNA genetic markers will be useful in animal identification for forensics purposes. Further, identification of deer through DNA markers can be used as management tools to determine reproductive structure of natural populations, identify biologically distinct stocks, evaluate the effects of deer introductions on the gene pools of existing populations, and determine the genetic fitness (heterogeneity) of free-ranging and closed deer herds.

Genetic markers in deer can be used for individual identification in archeological and post-mortem samples (museum mounts, carcasses, processed meat, antler or hair) as well as identification of fresh or frozen specimens. Samples from herds in major geographical areas of Texas are being analyzed to assess levels of genetic health and determine geographic diversity of Texas white-tailed deer. Studies on high-fenced deer populations will help evaluate historical changes in gene pools, if any, and determine reproductive structure of the herds.

This research is part of the international Deer Genetics program of the International Society for Animal Genetics. Texas A&M is working to develop an internationally accepted panel of genetic markers for use in different species of deer in conjunction with researchers from Europe, Asia, Australia, New Zealand, Japan, and other parts of North America. An article based on this research was accepted by the 64th North American Wildlife and Natural Resources Conference (Skow, L. C., D. Honeycutt, R. L. Galagher, E. L. Young, and R. L. Honeycutt. 1999. Evaluation and use of bovid/ovid microsatellite markers for studies of white-tailed deer).

This study was funded by contributions of the Lee M. Bass Foundation in cooperation with the Texas Parks and Wildlife Foundation and Texas Parks and Wildlife Department.

Non-Invasive Genetic Techniques for Estimating Sex Ratios in Deer

Olin E. Rhodes and Christy C. W. Watson, Purdue University
Nathan P. Garner, E. L. Young, Dale F. Prochaska, Hayden Haucke, and James C. Cathey, Texas Parks and Wildlife Department

TPWD PHOTO

Accurate evaluation of deer population demography has long been a goal of wildlife managers. Reliable data on population size and sex ratio are required to assess various demographic parameters, though such information is often difficult to obtain. Nonetheless, accuracy is paramount when evaluating and implementing management strategies. In the past, many techniques for estimating deer population size have been explored, including track counts, driving surveys, aerial surveys, spotlight surveys, walking surveys, and fecal pellet counts. However, sex-ratio information is calculated primarily through morphological observation data (i.e., presence/absence of antlers)

collected from wildlife managers and hunters. Such data is necessarily subjective. The recent revolution in DNA technology suggests that genetic techniques can be successfully utilized to determine sex ratios in white-tailed deer (*Odocoileus virginianus*) and related cervids.

Recently, a genetic test was developed that is diagnostic for each sex within the family *Cervidae*. A pilot study was conducted to refine DNA extraction protocol, using fecal samples as the source of DNA and then assess the precision of the test. Fecal samples were collected from known individuals (n=15 males and n=15 females) from holding pens located at the Kerr Wildlife Management Area (KWMA). The sex of 5 males and 5 females was made known to laboratory personnel to be used as positive controls. The remaining 10 males and 10 females were used in a blind study, as the sexes were not revealed to laboratory personnel. Using a genetic marker, investigators correctly assigned the sex in 15 of the 20 individuals. Because of insufficient DNA, researchers were unable to assign gender of 3 individuals. The gender of 2 individuals was incorrectly assigned because of poor DNA yields.

To help with the refinement of our methodology, additional samples were collected from 5 male and 5 female white-tailed deer housed within the experimental pens at KWMA. Once again, the experiment was conducted as a blind test. Using a different sex marker, laboratory personnel correctly identified the sex of 8 of 10 samples. Two samples were misidentified, but this was likely due to sample numbers being transposed rather than a failure of the procedure.

We have a potential means to objectively identify the sex of deer, using diagnostic genetic sex markers. We are nearing completion of step 1 in a series of steps to test the efficiency of traditional methods (morphological observations) and genetic methods (DNA sexing) to determine sex ratios in deer. Pending additional funding, step 2, the field scale phase, will test the effectiveness of using sex markers to determine the sex ratio of an experimental deer herd.

Matching funds from Purdue University and Texas Parks and Wildlife Department (Region III and the Upland Wildlife Ecology Program) are being used in this investigation.

White-tailed Deer Subspecies Identification Using Genetic Analysis

Timothy L. Bone, Texas Parks and Wildlife Department

The Carmen Mountains white-tailed deer subspecies *Odocoileus virginianus carminis* was first described in 1940 and was named for the center of its distribution, the Sierra del Carmen range located in Mexico. External dimensions, cranial details, pelage color, and antler tine-size and spread were used to describe the subspecies. Carmen Mountains white-tailed deer are the smallest of the 4 white-tailed deer subspecies found in Texas.

Initial descriptions of Carmen Mountains white-tailed deer in the United States limited their distribution to mountain ranges within the present boundaries of Big Bend National Park (BBNP). Most of the Carmen Mountains white-tailed deer in BBNP are located in the Chisos Mountains.

Small, isolated populations of deer located in mountain ranges outside of BBNP in Presidio, Jeff Davis, and Brewster Counties resemble Carmen Mountains white-tailed deer but have not been studied. The need for a better understanding of the classification of isolated white-tailed deer populations in the Trans-Pecos has become apparent. Texas Parks and Wildlife Department has received requests from private individuals for authorization to transplant white-tailed deer from outside the Trans-Pecos to locations close to possible isolated populations of Carmen Mountains white-tailed deer. The acceptability of such transplants may depend on the taxonomic status of endemic white-tailed deer, which may be exposed to released white-tailed deer.

DNA analysis may be an important tool in classifying Carmen Mountains white-tailed deer, Texas white-tailed deer (*O. v. texanus*), and the possible intergradation between the 2 subspecies. This study will address: 1) the development of DNA analysis to identify Carmen Mountains white-tailed deer, Texas white-tailed deer, and intergrades thereof; and 2) the sampling of isolated white-tailed deer populations in Presidio, Jeff Davis, and Brewster counties to locate Carmen Mountains white-tailed deer or Carmen-Texas intergrade populations outside of BBNP. In addition, Texas white-tailed deer populations from other areas in the Trans-Pecos as well as desert mule deer (*O. hemionus crooki*) will be sampled. Samples will be obtained from Carmen Mountains white-tailed deer in Mexico if possible.

Samples were collected from hunter-harvested deer during the 1997-98 hunting season. Incidental samples from road kills and illegal deer confiscated by game wardens were also collected through the winter to meet sample size goals, especially regarding both white-tailed deer and mule deer does. A variety of material such as flesh, hide, hoof, bone, and antler were collected for testing. Samples were sent to 2 universities for DNA analysis. Mitochondrial DNA sequencing is being conducted at Texas A&M University. Texas Tech University declined to participate in the study.

Funding for this study is being provided by Texas Parks and Wildlife Department.

Guzzler Use, Habitat Selection, and Movement Patterns of Desert Bighorn Sheep at Black Gap Wildlife Management Area

Justin A. Foster and Louis Harveson, Sul Ross State University
Michael T. Pittman, Texas Parks and Wildlife Department

JUSTIN A. FOSTER

Water is often considered as a resource limiting the survival and dispersal of desert bighorn sheep (*Ovis Canadensis*). Some literature indicates that a well-dispersed, adequate supply of water is of primary importance when rating desert bighorn sheep habitat. Development of waters in marginal habitat has been utilized as a method of improving desert bighorn habitat and increasing desert bighorn sheep numbers.

Other research indicates that water is not a limiting factor and that habitat models rate water sources on permanence alone. Some desert bighorn populations have shown preference for areas of lower water availability over areas of greater abundance. Furthermore, desert bighorn have made little use of water developments in some areas where freestanding water was unavailable. Contrasting results regarding the use of watering holes by desert bighorn sheep warrant an intensified study describing the preferred habitat around watering holes and their utilization by desert bighorn sheep.

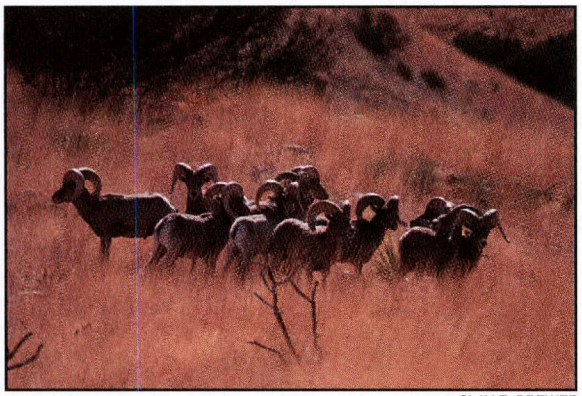
The goal of this research was to evaluate guzzler use by desert bighorn sheep at Black Gap Wildlife Management Area (BGWMA). Special attention is required to ensure the continued success of the desert bighorn restoration project at BGWMA. Data will be used to develop criteria for site selection of future guzzler projects. Proper site selection will facillitate efficient water usage by desert bighorn sheep and will justify allocation of monetary resources on future water development projects. The primary objectives of this study were to: 1) use remote cameras to evaluate guzzler use by desert bighorn sheep and document non-target species use, 2) assess habitat requirements necessary for utilization of guzzlers by desert sheep, and 3) make recommendations on the selection of future guzzler sites. Secondary objectives include: 1) describing desert sheep movement patterns, home ranges, and special use sites using aerial and ground telemetry, 2) document food habits of desert sheep, and 3) estimate production, survivability, and sex and age structure of desert bighorn at BGWMA.

Data collection began in January 2000 and will continue through March 2001. Guzzler use was monitored with remote cameras at 7 sites. These sites were selected because they lie within the home ranges of desert bighorn sheep as estimated by Texas Parks and Wildlife Department (TPWD) bi-monthly aerial-telemetry surveys. As of 31 August 2000, 1,307 photographs documenting guzzler use have been collected. Fourteen species have been positively identified. Turkey vultures (*Cathartes aura*) account for 30% (n=393) of all animals identified. Significant use has been documented by ungulates. Mule deer (*Odocoileus hemionus*) (25%, n=331) and desert bighorn (13%, n=176) account for nearly half of all guzzler use. Aoudad (*Ammotragus lervia*) were documented in 6% (n=80) of photographs. Mesocarnivores have also been photographed using guzzlers. Ringtail cats (*Bassariscus astutus*) appeared in 5% (n=68) of all photos and the gray fox (*Urocyon cinnereoargenteus*) in 3.5% (n=47). Rare or unexpected species have also been documented. Western spotted skunks (*Spilogale gracilis*) have been photographed (n=4) at 1 guzzler site.

Funding Sources: Dallas Ecological Foundation, Texas Bighorn Society, Sul Ross State University, and Texas Parks and Wildlife Department (Grand Slam).

Diets and Seasonal Forage Utilization of Desert Bighorn Sheep at Elephant Mountain Wildlife Management Area

Clay E. Brewer, Robert A. Culpepper, and Scott P. Lerich, Texas Parks and Wildlife Department
Louis A. Harveson, Sul Ross State University



CLAY E. BREWER

The restoration of desert bighorn sheep (*Ovis canadensis* spp.) to Texas is an important long-term project. Recent reintroduction efforts have increased the need for reliable data. Present knowledge regarding forage habits of desert bighorns in Texas is inadequate. Furthermore, diets of desert bighorn at Elephant Mountain WMA have never been documented. The goals of this study are to: 1) establish a base-line of forage habits of bighorn sheep at Elephant Mountain WMA, and 2) assist in developing a habitat suitability index for use in the evaluation of potential release sites. The specific objectives of the study are to determine: 1) seasonal diet and foraging habits, 2) difference in diets between sexes, 3) difference in diets of free-ranging desert bighorn sheep at Elephant Mountain WMA between critical biological periods, and 4) to compare dietary differences between various populations or mountain ranges within Texas including Baylor, Beach, Elephant, and the Sierra Diablo Mountains.

Fresh fecal pellets were collected every 2 weeks randomly from the ground within 4 hours of observed defecation between September 1998 and August 2000. Fecal samples were collected and segregated by sex, with equal numbers of samples collected for each sex (≥ 4) when possible. Diet will be determined through microhistological analysis. Three slides/pellet group and 20 randomly selected microscope fields/slide will be used to determine percent diet composition. Forage preferences will be determined by grouping samples into sexes (male/female), seasons (wet/dry), and critical biological periods (breeding and lambing seasons). Comparisons between sexes, seasons, and critical biological periods will be determined through 2-way log-likelihood analysis. Mountain range comparisons will be determined by performing randomized-block analysis of variance (ANOVA). Existing permanent vegetation transects will be used to determine seasonal forage production and plant species compositions during the study.

Findings of the study will assist biologists in monitoring the population and habitat, and formulating scientifically based decisions regarding management of desert bighorn at Elephant Mountain WMA and other locations.

Funding Sources: TPWD Research Funds and TPWD Grand Slam Funds.

Effects of Selective Harvest on Phenotypic Characteristics of White-tailed Deer on King Ranch, Texas

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Fred C. Bryant, W. Frank Robins, and C. A. De Young, Caesar Kleberg Wildlife Research Institute
Mickey W. Hellickson, King Ranch, Inc.

Although widely practiced in Texas, the system of using legal hunting to cull white-tailed deer (*Odocoileus virginianus*) has not been tested. Many white-tailed deer managers practice selective harvest. However, there is no known comparison of physical characteristics of herds in intensively culled areas and non-culled areas. Currently, age class and males having the least desirable physical characteristics are taken into consideration before they are harvested. There are a number of buck deer harvest strategies available to managers. There can be many variations, but the following are typical management schemes:

1. Harvest any buck;
2. Harvest a few mature large-antlered deer and protect all other bucks;
3. Harvest a few mature large-antlered deer, and protect only spike bucks;
4. Harvest a few mature large-antlered deer, all mature bucks with less desirable antler traits and protect spike bucks;
5. Harvest a few mature large antlered deer, all mature bucks with less desirable antler traits, and immature bucks (1.5-2.5 years old) with less desirable antler traits.

Which of these schemes should be chosen depends on the objectives of deer management. Data from the Kerr

Wildlife Management Area on pen-reared deer suggests that removing undesirable yearlings will help achieve the goal of better mature bucks (Harmel et.al 1989).

The uncertainty over whether culling is advisable, and if so, which method should be used is apparent among hunters and managers. This study is to evaluate which approach to use. The King Ranch offered 2 10,000-acre (4,047-ha) pastures located in Kleberg County to conduct the study, one as a control area and the other as a treatment area. The areas have similar rainfall and vegetation. Attempts will be made to trap all bucks on each study area. During October 1999, 111 deer were captured. On the control area, 25 bucks and 1 doe fawn were marked. On the treatment area, 76 bucks and 9 doe fawns were marked. During October 2000, 148 deer were captured, 79 bucks and 6 doe fawns were marked on the treatment area, and 56 bucks and 7 doe fawns were marked on the control area. Bucks were pit tagged and aged by tooth wear/replacement. Antlers were measured using the standard Boone and Crockett Club scoring system. Girth, nose to tail, and hind foot measurements were taken. After being aged and ear tagged, deer were released.

JOE G. HERRERA

Deer harvest will be achieved by paid and guest hunters on the King Ranch as part of its commercial hunting operation. Data to be collected from harvested deer will include sex, age, weight, antler measurements, girth measurements, hind foot measurements, and total length. A jawbone will be kept from each deer harvested to assist in aging and to provide a sample for possible DNA analysis.

In the treatment area, the objective is to harvest 50% of the bucks, concentrating on those with least desirable characteristics. Bucks of ≥2 1/2 years having >9 points and bucks of any age with <9 points will be selectively harvested in the area. Selective harvest will not be practiced in the control area. Both selective harvest in the treatment area and regular harvest in the control area will be practiced during the hunting seasons of 1999-2000 through 2006-2007.

Comparative Mating Success of Male White-tailed Deer in Relation to Age and Perceived Quality

Donnie Frels, Texas Parks and Wildlife Department
James R. Ott, Southwest Texas State University

Many land mangers in Texas are interested in producing 'superior' quality bucks for the purpose of recreational hunting, economics, and personal interest. Through the years, habitat management has proven to be the key in producing and maintaining healthy deer herds comprised of quality bucks. In recent years, however, many land managers have begun to pursue additional measures that may (or may not) assist them in attaining their goal of producing high quality bucks within a short period of time.

Current interest in 'genetic improvement' of free-ranging white-tailed deer (*Odocoileus virginianus*), through selective harvest of bucks perceived to be of 'low quality' (in relation to body size and antler configuration) and/or the introduction of bucks perceived to be of 'superior quality,' is at an all time high. At present, the effect of selective removal of yearling bucks, and/or the introduction of superior bucks in free-ranging herds on the genetic composition of populations cannot be adequately addressed without detailed information on the breeding success of males in relation to body size, antler characteristics, and age. In addition, much of the controversy surrounding the management and harvest strategy of yearling bucks (spike bucks in particular) is fueled by the lack of information on the breeding success of males of this age class.

The goal of this research project is to provide wildlife managers and deer breeders with baseline information on the relative breeding success of individual males within medium sized captive populations representative of typical high fence conditions. This information can be used to understand the probable effects of selective harvest and management techniques and better design breeding trials.

The project is designed to: 1) estimate the comparative mating success of yearling white-tailed bucks in competition with mature bucks; 2) determine whether variation in relative antler quality and body weight within each age class affects mating success. Mating success will be assessed by performing paternity analyses on all offspring sired within 2 replicate captive herds each housed within 500-acre (202-ha), high-fenced enclosures on Mason Mountain Wildlife Management Area in Mason County, Texas.

The experimental herds were constructed in January and February of 2000 using deer captured throughout the Edwards Plateau and were established at a sex ratio of 1 buck to 3 does and a density of 1 deer/8 acres (1 deer/ 3.2 ha), representative of the Hill Country. A total of 48 does and 16 bucks (4 'high quality' and 4 'low quality' bucks of >4.5 years old and 8 bucks of 1.5 years old) comprise the herd within each enclosure. At the conclusion of the 2000-2001 breeding season, all deer will be collected and tissue samples will be forwarded to Texas A&M University where paternity will be established using DNA sequence analysis.

The results of this experiment, for the first time, will allow deer biologists and managers to understand the ramification of alternative management techniques centered on male white-tailed deer.

Funding for this project is provided by Texas Parks and Wildlife Department.

Antler Development in the Progeny of Nutritionally Stressed Yearling Spike Sires

Eugene R. Fuchs and Donnie Frels, Texas Parks and Wildlife Department

TPWD PHOTO

For many years, biologists, land managers, and sportsmen have discussed the effectiveness of spike buck management in white-tailed deer (*Odocoileus virginianus*) herds. Although there are data that supports the removal of spike-antlered bucks, many landowners choose to allow these deer several years of growth in order to reach their potential, hoping that a few of these animals develop trophy antlers. Researchers associated with the Kerr Wildlife Management Area concede that although a few (<5%) spike-antlered yearlings do produce respectable antlers at maturity, the majority of their resultant male offspring will exhibit less desirable antlers due to the heretibility of heterozygous antler traits.

At the Kerr Wildlife Management Area, intensive selection procedures associated with previous research efforts (Genetic and Environmental Interaction in White-tailed Deer: 1991-2000) has resulted in the development of a female deer herd that has produced non-spike-antlered yearling bucks for 3 consecutive years when fed a limited diet of 8% protein. These females were annually bred to the 5 or 6 yearling males exhibiting the most antler mass (points and circumferences). We hypothesize that when mated to the same females, antler development in the male offspring of nutritionally stressed yearling spike-antlered sires will be inferior to antler development of male offspring from nutritionally stressed yearling sires that produced 6 or more antler points. This study will be conducted in 2 phases. Phase 1 (year 1) will involve mating 3 nutritionally stressed yearling spike sires that exhibited a gross Boone and Crockett Score (GBC) >130 at maturity. The 3 sires will be placed in individual breeding pens with 9-12 pedigreed females that have produced non-spike-antlered yearling males for 3 consecutive years. Phase 2 (year 2) will again utilize 3 sires that were nutritionally stressed spike-antlered yearlings which also produced GBC scores >130 at maturity. However, these bucks represent the largest male offspring resulting from the mating of a large-antlered male (205 GBC) and females from 'spike line' sires. The male progeny from these 2 mating systems will be compared to the final mating associated with the Genetic and Environmental Interaction Study.

All male offspring from the matings of the select group of females to 1) the 'best' antlered nutritionally stressed yearling sires, 2) Phase 1 sires, and 3) Phase 2 sires will be fed a nutritionally stressed, limited diet of 8% protein during the development of their yearling set of antlers. Antler development (number of points, beam length, beam spread, beam circumference, gross Boone and Crockett score, and antler weights) will be compared among the 3 cohorts until 4.5 years of age.

This study is being funded by Texas Parks and Wildlife Department.

A Comparison of Deer Census Techniques for Bottomland Forest Habitats

John C. Jones and Kevin J. Kraai, Texas Parks and Wildlife Department

TPWD PHOTO

Managers of bottomland forest habitats face many challenges specific to this highly valuable and productive ecosystem. One issue very important to managers of white-tailed deer (*Odocoileus virginianus*) is the ability to provide reliable estimates of the size and composition of a deer population.

This project was initiated to compare several commonly used census techniques in forest environments where visibility and road infrastructure are limited. Our objective was to determine the most reliable and cost effective technique for use in habitats of this type.

A manned, walking deer drive was used to determine the actual size and composition of a deer population within a 500-acre (202-ha) area under high fence. Four census techniques were selected to provide estimates for comparison: spotlight survey, Hahn line, track-count, and infrared motion triggered (IMT) cameras.

A 2400-yard (2194.56-m) route was designated through a ranch that comprised a 58.31-acre (23.6-ha) census line. This line was used for the spotlight census and Hahn census. A 1200-yard (1097.28-m) line was prepared to utilize the track-count census. Four IMT cameras were set up as part of the camera census technique. Each camera represented a 125-acre (50.58-ha) sample area. Thus, a census of 500 acres (202.32 ha) could be undertaken.

The deer drive resulted in a total of 23 deer being observed. Sixteen antlerless deer and 7 bucks (1 buck: 2.29 does) were observed. These figures were consistent with information provided by the ranch foreman. The spotlight and Hahn techniques were each averaged for a total population representative of each technique. The population estimates were 57.14 deer for the spotlight survey and 40 deer for the Hahn survey. Hard and rocky soil conditions prevented sufficient deer tracks and thus no data was produced from the track-count method.

Two sets of photos were produced with the IMT cameras. Set 1, taken in March, identified 4 individual bucks. By applying the known buck:doe ratio (1:2.29), a total population of 13.16 deer was determined. Set 2, taken in June, identified all 7 individual bucks and resulted in a total population estimate of 23.03 deer.

The infrared motion triggered camera system seems to be a viable deer survey technique for use in densely forested habitats. Further testing and use may prove its applicability in other habitats as well. The determination of herd composition from photographs will continue to be evaluated as more experience is gained with the IMT camera system.

Ecological Relationships between Desert Mule Deer and White-tailed Deer in Southwest Texas

Kristina J. Brunjes, Warren B. Ballard, Josh Avey, Mark Wallace, and Ernest Fish, Texas Tech University
Mary H. Humphrey, Fielding Harwell, and Doug Humphreys, Texas Parks and Wildlife Department

In West Texas, ranges of desert mule deer (*Odocoileus hemionus eremicus*) and white-tailed deer (*O. virginianus texanus*) overlap in the Panhandle region and along the eastern edge of the Trans-Pecos region. Although ecology of both species in sympatric habitat has been of interest for decades, few investigative studies have been conducted. Habitat requirements of each species are poorly understood in West Texas, particularly in sympatric areas. Past research indicated that woody cover was the only vegetative parameter significantly different between areas of high mule deer densities versus high white-tailed deer densities in the Trans-Pecos region.

Several researchers have suggested that coexistence of mule deer and white-tailed deer is dependent on habitat differences and preferences that vary according to geographic location. In 1998, a pilot study was initiated to investigate differences in habitat selection by sympatric mule deer and white-tailed deer in Crockett County, Texas. Results from that study indicated that slope, amount of forbs, and amount of grass could explain only a portion of the differences in microhabitat selection by the 2 species, indicating that further research was needed. A second study was initiated to further explore the differences in

habitat selection, as well as to investigate spatial and temporal relationships between these sympatric deer species.

The objectives of this study are: 1) to determine and compare distribution, habitat selection, movement patterns, and home ranges of sympatric desert mule deer and white-tailed deer, 2) to examine and compare survival rates and cause-specific mortality rates of adult deer, and 3) to evaluate the role of various habitat features in micro-habitat selection and spatial/temporal segregation between the 2 species.

The study area consists of 5 contiguous ranches (32,331 ha in total area) in the northwest corner of Crockett County, Texas. In February 2000, 40 mule deer and 40 white-tailed deer were captured with net-guns from a helicopter. All animals were fitted with radio-collars that also contained mortality sensors. Radio tracking has been conducted with a truck-mounted null-peak system. As of August 2000, over 700 locations have been collected for 69 deer, with number of locations per animal varied from 1 to 40. All animals have been monitored weekly for mortality signals. When a mortality signal is detected, the animal is located as quickly as possible in order to determine cause of death. As of September 2000, 5 deer were confirmed dead and 1 slipped its collar. An additional 10 female mule deer and 10 female white-tailed deer will be captured and fitted with radio-collars during Winter 2001.

Data collected via radio-telemetry will be used to calculate home ranges for individuals of each species. In addition, animal locations and calculated home ranges will be input into GIS software (ArcView) and overlaid with layers of landscape and vegetative features and land-use practices to examine differences in spatial and temporal use patterns between the species. Study area macro-habitat availability will be determined by creating GIS habitat and vegetative cover maps using digital data from topographic maps, satellite imagery, and other sources.

Population estimates for both deer species will be obtained using 3 survey methods (spotlight surveys, aerial censuses, and remotely-triggered cameras). Because Texas Parks and Wildlife Department is interested in determining the best method for surveying desert mule deer, the efficacy of the methods for estimating mule deer numbers will be compared.

Funding and support for this project is provided by Texas Parks and Wildlife Department, the Welder Wildlife Foundation, the Texas Tech University system, and landowners and managers within the study site. This study will continue through 2003.

Spatial and Temporal Relationships of Mule deer and White-tailed deer in the Northwestern Portion of Crockett County

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Mary H. Humphrey, Fielding Harwell, and Doug Humphreys, Texas Parks and Wildlife Department

Recently, desert mule deer (*Odocoileus hemionus eremicus*) distribution has been expanding in the Trans-Pecos region of Texas. Managed private lands that once maintained populations of white-tailed deer (*O. virginianus texanus*) are now dealing with overlapping distributions of both deer species. Both landowners and the Texas Parks and Wildlife Department need additional information on the segregation and habitat use differences between desert mule deer and white-tailed deer.

The objectives of this study were: 1) to compare landscape differences between locations of desert mule deer and white tailed deer based on site variability, 2) to compare the density and composition of woody vegetation used by mule deer to that used by white-tailed deer, and 3) to compare areas used by mule deer to those used by white-tailed deer, using GIS (Geographic Information Systems). These maps (or coverages) were then overlaid on a satellite image to determine landscape associations selected by each species.

FIELDING HARWELL

In 1999 and 2000, 389 deer locations and 42 different habitat types were recorded using GPS (Global Positioning System). Significant differences between the 2 deer species were detected in 4 landscape parameters that were measured. In order of importance slope, percent shrubs, forbs and grass explained 19% of the total variation in habitats used by the 2 deer species. Elevation

and density of woody cover (the most important parameters in other studies) were not significant parameters separating deer species for this study. GIS coverages, incorporating 42 different vegetation classes, did not explain differences between the 2 species.

This study was the first phase of a long-term effort to further investigate the expanding distribution of desert mule deer, document habitat differences between desert mule deer and white-tailed deer, and develop census techniques. Identification of parameters that can classify mule deer versus white-tailed deer habitats will provide the potential for using satellite imagery to predict deer species distribution across large scales and direct management efforts accordingly.

Funding and support for this project was provided by the Texas Parks and Wildlife Department, the Texas Tech University system, and the landowners and managers within the study site.

Improving Utility of White-tailed Deer Spotlight Surveys in the Cross Timbers and Prairies Ecological Region of North Texas

Steve Jester and Wildlife District 3, Texas Parks and Wildlife Department

The spotlight survey technique is used in many parts of Texas to monitor white-tailed deer (*Odocoileus virginianus*) density trends and estimate minimum deer densities. This is the primary density estimation technique among both resource agencies and private land managers in the Cross Timbers and Prairies ecological region. This ecological area is typified by highly variable deer densities, deer habitat quality, soil types, and land uses which may confound estimation of deer density. Any improvements in data collection, data analysis or remediation may enhance the utility of the technique for deer management in this region.

Selected regulatory spotlight survey routes will be georeferenced using GPS technology prior to the annual survey. Average transect width will be estimated at 0.1 mile (0.16 km) intervals using laser rangefinders. Spotlight surveys will be replicated twice during the annual survey period. Data will be recorded by observation and will include: GPS location of vehicle, range to observation (deer or group of deer), compass bearing to observation, number of bucks, does, fawns, and unidentified deer in each observation, and classification of habitat for the observation.

Accumulated density estimates will be calculated in standardized format and remediated. The impact of different interval lengths, average spacing of observations, group size, and composition will also be examined.

Funding for this study is being provided by Texas Parks and Wildlife Department.

Comparison of Helicopter and Fixed-wing Surveys of White-tailed Deer in the Northwestern Edwards Plateau

Lee Miller, Texas Parks and Wildlife Department

MARY HUMPHREY

During August 1999 and 2000 complete helicopter census of pronghorn (*Antilocapra americana*) and white-tailed deer (*Odocoileus virginianus*) were conducted simultaneously on a 172,000-acre (69,606-ha) ranch in Irion and Reagan counties. Immediately after these complete surveys were conducted, established white-tailed deer aerial strip transects (143.5 linear miles or 143.9 km in 1999 and 104.0 linear miles or 167.4 km in 2000) that sampled the primary study site (Irion-Reagan counties) were surveyed from a helicopter for both species. Approximately 1 week after the end of this activity, established transects were surveyed again with fixed-wing aircraft on the primary study site as well as the 3 satellite sites. On the primary study site, these transects represented a 6% sample in 1999 and a 4% sample in 2000. The same observers were utilized for all 3 survey methods.

In 1999 the deer density resulting from the fixed-wing survey was 41% higher than that from the total helicopter census, and the deer density resulting from the helicopter transects was 82% higher than that from the total helicopter census.

In 2000 the deer density resulting from the fixed-wing survey was 1% higher than that from the total heli-

copter census, and the deer density resulting from the helicopter transects was 37% higher than that from the total helicopter census.

It is possible that differences in estimates could be caused by observer bias. A complete count of 2 species with different habitat preferences and behaviors could result in an undercounting of 1 or both species. Defined-width transects may be more effective than an attempt at census when surveying multiple species.

Project staff will also examine various data remediation options, line transect methodology, or other techniques that may explain some of the differences found in the techniques. A GIS database of the primary study site will be established to include soils, rainfall patterns, land use, and other factors that may further refine habitat quality for both species. All observations on transects and during complete counts were geo-referenced in real-time using automated data collection technology and GPS units in 2000 and will also be geo-referenced in 2001. This additional data should greatly enhance the ability to analyze and manipulate the data set.

Eastern Turkey Restoration in the Pineywoods of East Texas: Phase II - Supplemental Stocking

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John D. Burk, Texas Parks and Wildlife Department

Research in the early 1980s indicated that wild-trapped eastern wild turkeys (*Meleagris gallopavo silvestris*) could be used to successfully rehabilitate wild turkey populations in eastern Texas. In 1987, Texas Parks and Wildlife Department (TPWD) began an intensive program to restock the Pineywoods and Post Oak Regions of eastern Texas using wild-trapped eastern turkeys. In 1994, research was initiated to evaluate the success of the restocking programs. In February of that year, 60 wild-trapped turkeys, 30 from Georgia and 30 from Iowa, were radio-tagged and released at 4 sites in Tyler County in the Pineywoods; each site received 12 hens and 3 gobblers. Those birds were radio tracked for 28 months, and survival, reproduction, and habitat preferences were compared between broodstocks. Survival of the Georgia birds was better than that of the Iowa birds; for gobblers, the difference was significant. However, reproductive success was poor during the 3 springs, with only 11 poults fledged.

In some areas of eastern Texas, restocked populations became established and flourished; spring hunting was allowed in 24 Pineywoods counties in 2000. However, efforts to restock other sites, including the Tyler County study areas, were classified as unsuccessful. In 1997, TPWD began supplementally stocking some release sites. The objective of this research project was to determine if the supplementally stocked birds associated with those released in 1994 and if such associations improved survival and reproduction.

In February 1997, 83 radio-tagged eastern wild turkeys were supplementally stocked in Tyler County with each of the 4 original release sites receiving 5 gobblers and 14-18 hens. At each site, approximately half the birds were from southeastern states and half from midwestern states. At that time, 21 of the original 1994 birds were being radio-tracked, 3 gobblers and 9 hens from Georgia and 9 Iowa hens. Therefore, when the supplemental stocking was completed in Tyler County, we were tracking 104 turkeys, 13 gobblers and 40 hens from the Southeast and 10 gobblers and 41 hens from the Midwest. Additionally, in Trinity County on the Boggy Slough study area, we were tracking 2 resident hens radio-tagged in March 1995 and 11 Iowa hens released in February 1996; thus, as of 1 March 1997, we were tracking 117 turkeys.

When data collection ended on 30 June 1999, 20 turkeys from the 1997 supplemental stocking were being actively tracked, 14 were missing, and 49 were known dead. Three 1994 Tyler County hens were being tracked, 4 were missing, and 14 were dead. Two Boggy Slough hens were being tracked, 5 were missing, and 6 were dead.

Seasonal Kaplan-Meier survival probabilities were calculated for all turkeys released in Tyler County in 1997; we used 3 seasons per year, namely spring (1 March-30 June), summer (1 July-31 October), and winter (1 November-28 February). We found no differences in cumulative survival probabilities of southeastern and midwestern hens, gobblers, or with sexes pooled ($p>0.05$). These results contradict those of the 1994 study where southeastern males survived better ($p<0.05$) than midwestern males (George 1997).

We constructed home ranges of all 1994 and 1997 turkeys in Tyler County for the first spring, summer, and winter seasons (1 March 1994-28 Feb. 1995). We overlaid the seasonal home range of each 1997 turkey with those of the 1994 turkeys. If 68% of a 1997 bird's home range was within the home range of a 1994 bird, we assumed that the 2 birds were associating. During the spring, summer, and fall seasons, 25, 30, and 26 of the 1997 birds, respectively, were associating with at least 10, 9, and 7 of the 1994 turkeys, respectively, and 38, 29, and 23 of the 1997 birds, respectively, were not associating with 1994

birds. Although 1997 southeastern and midwestern turkeys that associated had higher survival values than non-associating birds, the differences were not significant ($p>0.05$).

We found no differences ($p>0.05$) in survival of southeastern hens released in 1994 and 1997 or in survival of midwestern hens released in those 2 years. However, southeastern males released in 1994 survived better ($p<0.05$) than those released in 1997, whereas midwestern males released in 1994 had poorer survival than did those released in 1997 ($p<0.05$). It is noteworthy that during the first spring and summer, 4 and 5 midwestern males, respectively, associated with 1994 turkeys whereas no southeastern males associated with 1994 birds during the first spring, and only 2 did so during the first summer. We found southeastern broodstock had a larger ($p<0.05$) home range than did midwestern broodstock during the first summer. Otherwise, there were no differences ($p>0.05$) in home range sizes of southeastern and midwestern broodstocks, males, or females during the first spring, summer, or winter after release. Likewise, there were no differences in home range sizes of 1997 turkeys that associated with 1994 birds and 1997 birds that did not so associate.

As with George's (1997) study, bobcats were the primary cause of mortality, taking 30 of the 49 documented dead turkeys. Poachers apparently killed 5 of the 1997 birds, 8 died of unknown causes, and 1 each died of avian predation, disease, and automobile.

During the 3 springs, 1997 females produced 56 confirmed nests of which only 4 were successful; 2 hens probably fledged 6 poults. The 1994 females produced 10 confirmed nests, and at least 3 produced poults. However, 2 of these hens were killed by bobcats within 4 days of the hatch, and the third was poached when the poults were about 5 weeks old. If suspected but unconfirmed nesting is included, nesting rate approached 50% for 1997 hens during the first spring and 100% during the 1998 and 1999 springs; assumed nesting rates of the 1994 hens was almost 100% each spring. Of the confirmed nests that failed, raccoons depredated approximately 67%.

In summary, we found few differences in survival and reproduction of the turkeys, regardless of whether they were from the Southeast or Midwest. Although association with previously restocked turkeys did slightly improve survival of supplementally stocked turkeys, it did not improve reproduction. Throughout both this study and the 1994 study, reproduction failed to replace adult mortality on both the Tyler County site and Boggy Slough. However, the population in Tyler County appears to be growing, and that on Boggy Slough is at least stable. These results suggest that the radio transmitter on a nesting hen might increase the possibility of nest depredation.

Maximizing Efficiency of Wild Turkey Restoration Efforts in the Post Oak Savannah of Texas

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J. D. Burk, Texas Parks and Wildlife Department

The overall objective of this study was to summarize the cumulative results of 5 studies focusing on efforts to reestablish eastern wild turkeys (*Meleagris gallopavo silvestris*) into the Post Oak Savannah of Texas and to evaluate the effectiveness of this program. Specifically, we evaluated relocated eastern wild turkey survival and reproduction in respect to initially and supplementally stocked populations, source of broodstock, year of release, and area of release. From 1994 to 2000, 233 eastern wild turkeys were live-trapped, radio-tagged, and released on 8 separate study sites representative of conditions in the northern, central, and southern Post Oak Savannah. Birds were monitored using radio-telemetry and survival and reproduction were evaluated for each study site, as well as for the ecoregion as a whole.

First-year survival for initially and supplementally relocated males was 55%, and no significant ($p>0.05$) differences were found for male survival between broodstocks, years of release, or area of release. We found no differences in first-year survival of females between initially and supplementally stocked populations, broodstock, area of release, or in comparison to survival in subsequent years. First-year annual survival for initially and supplementally stocked females was 50% and 69%, respectively. We found no difference in first-year survival between sex or when combining all initially and supplementally stocked birds. Overall survival for initially and supplementally stocked birds were 51% and 64%, respectively. We found no differences in survival for both sexes between first, second, third, or fourth-year following release (57%, 71%, 68%, and 67%, respectively). Reproduction in relocated eastern wild turkeys occurred in only 1 study site. Differences were found in comparisons of hen success between study sites (Chi-square=8.139, $p=0.004$). However, we found no difference in reproduction in the first, second, third, or fourth year following release for females in all study sites nor for females in the reproductively successful study site. In reality, only 4 of the 171 females relocated were reproductively successful, and 14 poults survived beyond 2 weeks post-hatch. Such low recruitment is most likely limiting the success of these relocated eastern wild turkeys.

Home Ranges, Movements, and Mortalities of Desert Bighorn Sheep at Elephant Mountain Wildlife Management Area

Clay E. Brewer, Scott P. Lerich, and Robert A. Culpepper, Texas Parks and Wildlife Department

Elephant Mountain Wildlife Management Area (EMWMA) was acquired through private gift deed in July 1985, for the purpose of restoration, conservation, and management of desert bighorn sheep (*Ovis canadensis* spp.). Restoration efforts were initiated in February 1987 with the release of 20 bighorns, followed by a supplemental release of 3 yearling rams in April 1988. The herd has grown steadily with the current population estimated at 160 animals.

Home ranges of free ranging desert bighorn in Texas have never been documented. Furthermore, information regarding movements of free ranging desert bighorn in Texas is limited. The fragmented nature of bighorn habitat in the EMWMA leads biologists to believe that spatial use patterns may not fit the norm. In addition, periodic reports of desert bighorn on adjacent property indicate that small populations may exist outside the area.

The objectives of the study are to: determine home ranges and movements (both on and off-site); determine causes of mortality of desert bighorn at the EMWMA; document the presence or absence of bighorn populations within suitable habitat adjacent to the area; and improve the Department's knowledge regarding the delineation of desert bighorn home ranges in Texas. Information gained from this study will assist biologists in monitoring populations, providing recommendations to private landowners in the event that outside populations do in fact exist, and in management of detrimental impacts to desert bighorn.

In December 2000, 20 desert bighorn sheep (10 M, 10 F) were captured by helicopter netgun and fitted with standard radio collars and mortality sensors. Radio-collared animals are monitored weekly by ground and aerial telemetry. Spatial data will be incorporated in the Geographical Information System developed for EMWMA.

Funding for this study is being provided by Texas Parks and Wildlife Department.

Landscape Changes as Related to Rio Grande Wild Turkey Production and Survival in the Edwards Plateau of Texas

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The Edwards Plateau of Texas is one of the few places in the United States where wild turkey (*Meleagris gallopavo*) numbers were not decimated by the early 1900s. This physiographic region served as the major source of Rio Grande wild turkey (*M. g. intermedia*) brood stock for restoration efforts elsewhere in Texas, other states, and Mexico. Since the late 1970s, however, turkey abundance appears to have declined in the southern portion of the Edwards Plateau (e.g., at least in Bandera, Real, and part of Kerr counties), while declines were not observed elsewhere. The cause of this broad-scale decline is unclear, but is probably a landscape-scale phenomenon. Unfortunately, surprisingly few studies of Rio Grande turkey ecology have been conducted in the Edwards Plateau – perhaps reflecting this area's status as the heart of Rio Grande turkey range. No research has addressed declining turkey populations in this region. Reliable knowledge regarding what precipitated this decline in abundance is needed to help inform management plans designed to reverse this trend.

This study will be conducted in 3 phases:

1. A regional-scale, spatially explicit comparison of ecological and anthropogenic changes (late 1970s to present) that could impact turkey habitat and populations between a zone of declining Rio Grande wild turkey abundance in the southern Edwards Plateau and a similar zone of stable turkey abundance elsewhere in the Edwards Plateau. These data will be used to determine whether regional-scale factors can account for declining turkey abundance in the southern Edwards Plateau. This phase will rely on analysis of satellite imagery and turkey populations data.

2. An intensive study of 2 sites in the southern Edwards Plateau where wild turkey abundance has declined, and 2 sites elsewhere in the Edwards Plateau where abundance shows no trend over time. Data from these study sites will be used to determine which life-history phases and micro- and macro-habitat characteristics account for observed differences in productivity between declining and stable populations. Additionally, we will determine if fine-scale changes in habitat (late 1970s to

present) can account for decreases in productivity in the 2 southern study sites. This phase of the project will use turkey data collected by radio telemetry and other methods and evaluation of aerial photography.

Data from Phases 1 and 2 will be used to parameterize a spatially explicit computer simulation of Rio Grande wild turkey metapopulations in the Edwards Plateau of Texas. This model will be used to predict the dynamics of populations in the 4 intensive study sites both with and without management intervention.

Funding and support for this project was provided by Texas Parks and Wildlife Turkey Stamp Fund, Federal Aid in Wildlife Restoration Grant W-126-R, and the Texas Agricul-tural Experiment Station, Texas A&M University System.

Evaluation of a New Survey Technique for Eastern Wild Turkeys

Greg P. Creacy, Chris Gregory, and John D. Burk, Texas Parks and Wildlife Department

GREG P. CREACY

A successful restoration program implemented by Texas Parks and Wildlife (TPW) and the National Wild Turkey Federation has resulted in the re-establishment of eastern wild turkeys (*Meleagris gallopavo silvestris*) in East Texas. Turkey populations within many parts of this region appear to be stable or increasing. However, a persistent problem regarding wild turkey management is the lack of dependable methods to accurately estimate population densities, monitor population trends, or gather flock composition data. Numerous techniques such as gobble counts, roadside surveys, bait site observations, or mark-recapture studies have been shown to be either ineffective or impractical for gathering population data over large areas.

Recently, researchers have begun using cameras with infrared sensors to survey wildlife populations. Preliminary results from research conducted in Florida suggest that infrared camera systems may be used as a more reliable and economical method to survey wild turkeys.

Previous research has only been conducted in areas of relatively high turkey population densities in the southeastern United States. The purpose of this study is to validate the survey technique in the East Texas Pineywoods, which has a relatively low density of wild turkeys. Also, the distribution and abundance data that is gathered with this technique could help area managers identify huntable turkey populations and efficiently distribute hunters, thereby expanding recreational hunting opportunity. Ultimately, data from this survey could yield reliable indices to long-term population trends (number of turkeys, annual recruitment, etc.) within the Pineywoods.

Study sites will be selected in various habitats throughout the 168,000-acre (67,200-ha) Sam Houston National Forest Wildlife Management Area (SHNFWMA). The SHNFWMA will be divided into 4 compartments, each with 10 bait sites equipped with infrared camera systems. Sites will be pre-baited for at least 7 days before cameras systems are activated. Each site will be monitored with cameras at least 7 days following the pre-baiting period. Camera systems will be configured to reduce observations of non-target animals, and cracked corn will be utilized at bait sites to reduce bait consumption by deer and feral hogs.

Sites will be visited daily in order to replace film and to check for turkey sign (tracks, feathers, scat, etc.). Survey data will be evaluated to determine the efficiency of camera systems to detect turkeys (based on presence/absence of turkey sign), optimal pre-baiting duration, optimal survey duration, preferred camera system settings for surveying low-density turkey populations, and the differential effects of various pre-baiting strategies. Population indices derived from this study will include number of turkeys/survey-day, number of turkeys/observation (group size), poults/hen, and hens/gobbler.

Changes in Land Use Patterns and Their Effects on Rio Grande Turkeys in the Texas Rolling Plains and Kansas

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Rio Grande wild turkeys (*Meleagris gallopavo intermedia*) are distributed through Central Texas, Oklahoma, and Kansas. A number of studies have been conducted on Rio Grande turkeys throughout their range, particularly in South Texas. However, in recent years few studies have focused on Rio Grande turkeys in the Rolling Plains. Knowledge concerning Rio Grande turkeys has not kept pace with that of other turkey subspecies. Although wild turkeys have been studied intensively across many parts of their range, much remains to be learned about turkey populations in the Rolling Plains of Texas and Kansas.

Declining turkey poult-hen counts indicated Rio Grande turkeys have been declining in portions of the High Plains and Rolling Plains of Texas and Kansas since the late 1970s. Approximately 50% of this area is used for agriculture and 50% for cattle grazing; turkey habitat is limited to rangeland-agricultural borders and riparian habitats. Historically, Texas Parks and Wildlife Department (TPWD) conducted annual counts at winter roost sites. However, many of these roost sites have been abandoned and such surveys are no longer conducted (Miller, pers. commun.). Declines in turkey populations have not been consistent throughout the plains. Several hypotheses could explain differences among areas. For example, on the Gene Howe Wildlife Management Area (WMA), administered by TPWD, turkey populations appear to have remained stable. Protection from fire and grazing in riparian areas may have resulted in roost tree protection and adequate nesting habitats. In contrast, turkey populations on the Matador WMA have declined precipitously since the late 1970s. Loss of roost trees, advancing vegetative succession, lack of adequate nesting habitat, and/or predation may be responsible for low turkey numbers. Similar patterns on private lands exist throughout the High and Rolling plains.

Texas Parks and Wildlife Department, Texas Tech University, Kansas Department of Wildlife and Parks, and National Wild Turkey Federation have collaborated to make this one of the largest scale studies of wild turkeys to date. This study will attempt to understand the life history of Rio Grande wild turkeys in the Rolling plains. The main objective of the study is to relate the spatial arrangement of habitat types and accompanying land use trends to turkey population performance and distribution. In addition, a population model will be created for Rio Grande wild turkeys and will be linked to a spatial data model. This will allow us to determine the effects of habitat heterogeneity, land use practices, and temporal changes on turkey populations.

Each age cohort of Rio Grande wild turkeys will be intensively studied. We will examine patterns in survival rates of male turkeys: correlations between survival rate and home range size, shrub/tree density, hunting pressure or regime, and presence or absence of supplemental feeding. For adult hens, we will examine survival, home range size, nest site selection, nesting success and habitat use. We will determine survival rates and movement patterns of juveniles among sex and age classes, assess movement patterns in relation to vegetation, assess survival, and determine the relationship among movement, survival, and woody vegetation in the Rolling and High Plains. We will determine poult mortality rates in relation to habitat structure and determine differences in habitat structures between populations of low (<20%) poult survival rates and higher rates.

We have chosen 4 study sites. The sites are the Cimarron National Grassland (Kansas), Gene Howe Wildlife Management Area (Texas), the Matador Wildlife Management Area (Texas), and on private ranches along the Salt Fork of the Red River, northwest of Hedley, Texas.

Between January and March 2000, we captured Rio Grande turkeys at all study sites using a combination of drop- and rocket-netting. We captured >600 turkeys across the sites, and outfitted 334 of these with backpack style radio transmitters (78-92 per site). Fifty-eight adult males, 160 adult females, 50 juvenile males, and 66 juvenile females were fitted with backpack style transmitters. As

of 1 October 2000, 178 of these birds were alive and still outfitted with radio transmitters.

Turkeys have been monitored regularly since capture, with ≥2 locations per week per bird established as a minimum protocol across the 4 sites. Since the first birds received transmitters in January 2000, greater than 10,000 locations have been acquired via radio telemetry. Locations are being gathered during all periods of the day as well as night roost locations.

Periodically, researchers at each site make visual contact with birds to confirm its location and examine its behavior. We have categorized behaviors as roosting, feeding, loafing, displaying, nesting, and brood rearing. At locations with known behaviors, 10- by 20-m quadrats are used to sample the vegetation structure. These quadrats are paired with a systematically chosen quadrat 50 m away. These data will enable us to assess behavior-, sex-, and age-specific habitat selection. To date, we have sampled >600 quadrats across the 4 study sites.

In addition to fine-scale measures of habitat selection, we are also interested in assessing how turkey populations respond to vegetation patterns and land use changes at a landscape scale. To this end, we are assembling extensive raster-based vegetation maps using current Landsat 7 satellite images of each study site. Images are being ground checked and will be included in a Geographic Information System (GIS) database.

The onset of nesting by hens was detected by a change in hen behavior, and subsequent observation of nest sites by researchers. Across all sites, we have 64 nests with known fates. Of these, 22 nests resulted in fledged poults. The majority of nests were depredated by avian or mammalian predators.

We conducted a pen study to evaluate 2 methods of attaching radio transmitters to turkey poults. Glued backpacks and interscapular implants were used to attach 1.8 g transmitters. Attachment method had no detectable effect on the growth or survival of turkey poults. Transmitter retention differed between the methods. Mean retention times were 27.6 ± 0.8 (SE) days for glued backpacks and 30.5 ± 2.1 (SE) days for interscapular implants. Ease of implementation and behavioral differences of birds immediately post-application suggested that glued backpacks are preferred in situations when retention time of 28 days is adequate.

Based on the knowledge gained in our pen study, researchers at each site were able to capture and glue backpack transmitters on wild turkey poults. The method was as follows: surround roosting transmittered hen, flush hen, hand capture poults (being sure to leave at least 1 with the hen), place poults in a cooler, leave site, attach transmitter, relocate hen, flush hen again, replace poults. This method worked very well. We chose to transmitter 3 poults per brood where possible, fewer if broods had <4 poults. We fitted 40 poults from 14 broods with transmitters across the study sites. During the 2000 field season, survival rates of preflight poults were: 25% at the Matador WMA, 15% at the Gene Howe WMA, 66% along the Salt Fork, and 10% on the Cimarron National Grassland.

This study will continue for 2 more field seasons, and will greatly increase our understanding of Rio Grande wild turkeys. This information will then be used to help provide management recommendations so that future generations may enjoy an abundant population of Rio Grande wild turkeys.

Landscape Changes Related to Scaled Quail Habitat in Texas

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Fluctuations of abundance of scaled quail (*Callipepla squamata*) and northern bobwhite (*Colinus virginianus*) in Texas are volatile and their populations tend to have simultaneous peaks and valleys statewide. Recent studies conducted by Texas Parks and Wildlife Department (TPWD) have shown that scaled quail have declined over the last decade in the Edwards Plateau, Trans-Pecos, and the Rolling Plains, whereas no long-term trend is exhibited in the South Texas Plains. Landscape-scale habitat changes, which are changes in composition, abundance, and spatial arrangement of land-cover types, are likely causes for the large-scale decline in quail abundance. Determination of landscape changes and their relationship to the trends in scaled quail abundance, as well as the land use and management practices that contribute significantly to the landscape changes, can provide useful information for TPWD and private landowners. Such information can be used to design and implement management plans to reverse the decline in scaled quail abundance.

The objective of this study is to determine whether scaled quail abundance has declined across much of its range in Texas as a consequence of landscape changes that have occurred over the last 2 decades. We focus our analysis on the Rolling Plains, where the decline of scaled quail has been most apparent, and the South Texas Plains, where there is no apparent decline.

Remote sensing, GIS, and landscape analysis approaches are used to determine whether and how the

composition and spatial pattern of landscapes have changed in the Rolling Plains and the South Texas Plains from the early 1980s to the mid 1990s, to assess how the changes differ in the 2 ecological regions, to determine which components of the landscape change are closely related to trends in abundance of scaled quail and northern bobwhite, and to evaluate what land use or management practices contributed significantly to the landscape changes. Spatial interpolations of quail count distribution in the Rolling Plains and the South Texas Plains were developed using TPWD quail survey data and Breeding Bird Survey data to assess the spatial pattern of population trends. Analyses based on the spatial pattern of population trends and coarse-scale land cover changes derived from Landsat Multispectral Scanner (MSS) data from mid-1980s and mid-1990s are being conducted to evaluate the influence of regional-scale land cover changes on quail populations. Sixteen TPWD quail survey transects, 8 in Rolling Plains and 8 in the South Texas Plains, with different population trends for scaled quail and northern bobwhite were selected as intensive study areas. Each of these areas was 21 square miles (54.4 km^2) in size and included a buffer area of 1 mile (1.6 km) in width along each transect. A total of 108 digital ortho-photo quarter-quadrangles (DOQQ) based on the 1995-96 National Aerial Photography Program (NAPP) photography and 138 frames of positive transparencies of the 1983-85 NAPP or National High Altitude Photography (NHAP) program photography were acquired and geoprocessed for these areas. Land cover and vegetation classifications from these aerial photo images were completed for all transects. Landscape analyses of changes in land cover and vegetation in the intensive study areas are being conducted to assess their relationship to the population trends and the influence of spatial scaling. Although overall changes in land cover and vegetation from 1983-95 in the majority of these areas were moderate, spatial data of land cover and vegetation and corresponding quail counts within these areas provide opportunities to explore spatially explicit assessment of habitat quality and scaling as well as the influence of changes in land cover and vegetation on quail population. Preliminary results from landscape analysis of selected transects show that components of habitat suitability are highly scale-dependent. Analyses performed at different spatial scales can generate different perceptions of habitat quality, which can be different from perceptions of habitat by quail. Analysis is being conducted to explore relevant spatial scale for quail habitat assessment based on spatial data of quail counts along the transects.

Field vegetation/land-cover surveys along 35 transects in the Rolling Plains and 27 transects in the South Texas Plains, approximately 1,240 miles (1,995 km) of transect length, were conducted in July 1998. These data were compared to a historical (1976) survey to determine whether and how scaled quail and northern bobwhite habitat selection have changed in response to landscape changes. Densities of woody land-cover increased significantly in the Rolling Plains while they decreased significantly in South Texas. However, density of woody land-cover was higher in the South Texas Plains than in the Rolling Plains in 1997. The Modified Palmer Drought Severity Index, previously unexplored in quail literature, was found to be more accurate in predicting annual fluctuations in mean quail abundance per survey route than raw precipitation measurements. This study indicated that weather variability and land-cover change were possible influential factors on quail abundance.

Funding for his study is provided by the Cross Timber Chapter of Quail Unlimited, Texas Parks and Wildlife Department, the Rob and Bessie Welder Wildlife Foundation, and Texas A&M University.

Role of Moist-soil Management in Reproductive Ecology of Scaled Quail in the Trans-Pecos Region of Texas

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Scaled quail (*Callipepla squamata*) populations have declined markedly across most of their range in Texas since 1988. The reasons for this decline are unknown. However, there are some notable exceptions where populations remained relatively high. We initiated a project in 1999 on a ranch in Pecos County to test the hypothesis that the ranch's extensive water retention efforts (i.e., moist-soil management) have increased reproductive success and survival in scaled quail. The moist-soil areas (i.e., 'quail oases') supported a 25-fold increase in herbaceous biomass compared to adjacent uplands in August 2000. Hypotheses as to how such herbaceous 'oases' might benefit scaled quail included (a) providing better nesting microhabitats, (b) improved nutritional status (via year-round availability of greens, water, or other nutrients), and (c) better brooding habitats (i.e., insect availability). This study focused on hypothesis (a). The study was conducted on 3 sites. The headquarters of the ranch had a 12-acre (5-ha) irrigated lawn and served as a positive control. Portions of the ranch that had received the

water retention efforts served as the treatment. Leased land that had no water retention efforts served as a negative control. The study was replicated on Elephant Mountain Wildlife Management Area in Brewster County beginning in March 2000, but there was no positive control at this site.

A total of 207 and 72 female scaled quail were radiomarked and monitored through the nesting season at the Pecos and Brewster study sites, respectively. A total of 73 (over 2 years) and 7 (1 year) nests were located at each study site, respectively. There was no trend for scaled quail nesting in 'quail oases.' Nest success was higher (77%) at the Pecos County site than that at Elephant Mountain where 3 of 7 nests hatched. The predominant nesting microhabitat was tobosa (*Hilaria mutica*) which accounted for over 85% of the nests located. Nesting success and hen survival were similar among all sites. Hen survival from March-September averaged 74% across both years in Pecos County and 56% for Brewster County. Mammalian predators accounted for 76% of the mortalities in Pecos County and 32% in Brewster County. Simulated quail nests (i.e., 3 chicken eggs) were monitored to assess mesomammal impact on nest survival. A total of 276 simulated nests was monitored weekly for 28 days and indicated high nest survival (78 and 82% for 1999 and 2000, respectively) in Pecos County.

SCOTT P. LERICH

Rainfall amounts totaling 8 inches (20 cm) at the Pecos County site in June 1999 likely ameliorated any benefits attained from moist-soil management, and thus our ability to discern treatment effects among the 3 sites. The study will be repeated another year at Elephant Mountain WMA. Additional studies on the role that such moist-soil areas may have for arthropod production, i.e., quail brooding habitat, are planned.

A Neural Analysis of the Relation between Quail Populations and Weather Variables in Texas

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Weather and climate are important factors influencing population dynamics of bobwhites (*Colinus virginianus*) in Texas and elsewhere. Using an artificial neural network as a modeling tool, we studied the effects of weather on bobwhite abundance in 6 ecoregions in which the bobwhite occurred. These were Gulf Prairies, Cross Timbers, South Texas Plains, Edwards Plateau, Rolling Plains, and High Plains. Bobwhite abundance data collected by Texas Parks and Wildlife Department biologists between 1978 and 1997 were used. Weather variables considered were June, July, and August mean maximum temperature and winter (December, January, and February), spring (March, April, and May), summer (June, July, and August), and fall (September, October, and November) rainfall. We also included the proportion of county area in cultivation, the number of head of livestock per acre of non-cultivated land, and the previous year's bobwhite count in our analyses. The data were partitioned into training and validation data sets prior to analyses.

The neural network model selected accounted for 87% of the variation in the training data and 63% of the variation in the validation/test data. The most important variables contributing to the network model's predictions were winter and fall rainfall, and the previous year's count. Statewide simulation results indicate that bobwhite abundance decreased with June temperature, summer and fall rainfall, and livestock density. Bobwhite abundance increased with July and August temperature, winter rainfall, and the previous year's bobwhite count. Bobwhite abundance had a hump-shaped relationship with the proportion of county area in cultivation, with maximum counts at 10-20% cultivation. There was little effect of spring rainfall on bobwhite abundance. Although many relationships appeared linear, winter and fall rainfall, proportion of county area in cultivation, and the previous year's count showed strongly curvilinear responses. These results indicate that a potential confounding effect may exist in the survey protocol, resulting in artificially inflated counts during years of excessive July and August tem-

perature and high summer rainfall. The results also provide a better understanding of expected bobwhite responses to variation in weather.

Landscape Change in Lesser Prairie Chicken Habitat in the Texas Panhandle

X. Ben Wu, Nova J. Silvy, Fred E. Smeins, and Markus J. Peterson, Texas A&M University
Robert M. Sullivan and Stephen J. DeMaso, Texas Parks and Wildlife Department

Data collected by Texas Parks and Wildlife Department (TPWD) indicated that habitat occupied by lesser prairie chicken (LPC; *Tympanuchus pallidicinctus*) in the Texas Panhandle has contracted substantially since 1940. Today, in Texas, approximately 5,000-10,000 LPC are found in only 2 separate metapopulations, 1 in the eastern and northeast Panhandle along the Texas-Oklahoma border (~293,800 ha) and the other along the Texas-New Mexico border (~279,400 ha). Habitat loss is suspected as the major factor causing the decline of LPC. The objective of this TPWD-funded project was to determine landscape changes of LPC habitat in the Texas Panhandle on both regional and landscape scales using GIS, remote sensing, and landscape analysis to seek quantifiable explanations for the absence of the LPC from its formerly inhabited range.

For regional-scale study, a GIS database was developed for the 60-county area (~15,000,000 ha) in the Texas Panhandle containing coarse-scale data layers including topography, hydrography, roads, soils, vegetation type, and land use, as well as LPC ranges for 1940 and 1989. Analyses were conducted to characterize the coarse-scale physical and ecological attributes of the current LPC range in the High Plains (HP) and Rolling Plains (RP) portions of the Texas Panhandle. In addition, the analysis compared attributes of occupied (1989 LPC range) vs. unoccupied (apparently suitable but unoccupied in 1989) areas and assessed potential LPC habitat areas in the Texas Panhandle.

Soil texture, land cover, and vegetation type distribution of the current LPC range were distinctly different from those for the study area as a whole. LPC range in the HP differs from that in the RP in soil texture, land cover, and vegetation type composition. Over 95% of the LPC range in the HP was on sand or sandy loam soils, compared to 39% for the HP as a whole. It had larger proportions of rangelands and Havard shin oak (*Quercus havardii*) brush or sandsage (*Artemsia filifolia*)-Havard shin oak brush and grassland vegetation types than the HP as a whole. The LPC range in the RP was mostly (~80%) on sandy soils while fine textured soils dominate more than half of the RP. It had a much larger portions of herbaceous rangeland cover and sandsage/Havard shin oak dominated and mesquite (*Prosopis glandulosa*) shrub/grassland vegetation types than the RP as a whole, and very little mesquite/juniper (*Juniperus* spp.) dominated shrub/brush vegetation types, which is the dominant vegetation types in the RP.

There were considerable differences between unoccupied and occupied areas. The unoccupied areas had more finer textured soils than the occupied areas in both physiographic regions. Unoccupied areas in the HP had more rangelands, largely of the mesquite shrub/grassland vegetation type, than did occupied areas. The composition of the rangelands in unoccupied areas in the RP were dominated by mixed and shrub rangelands, with predominantly mesquite/juniper shrub/brush vegetation types, compared to dominant herbaceous rangeland in the occupied areas, characterized by Havard shin oak brush or sandsage-Havard shin oak brush vegetation types and mesquite shrub/grassland.

Most of the 1940 and 1989 LPC ranges fall within the areas dominated by sand or sandy loam soils. Under the current conditions, areas in the Texas Panhandle dominated by sand or sandy loam soils likely represent the major potential habitat areas for LPC. One area without known LPC range in the northwest corner of the Panhandle appears to have the land cover and vegetation type distributions, as well as a low level of human disturbance, suitable for LPC.

Five intensive study areas, covering 26 USGS 1:24,000 quadrangles in the Texas Panhandle, were selected to assess landscape-scale habitat changes. Historical aerial photographs from 1940 and 1996 covering these areas were acquired, scanned, geo-referenced, and classified into different land cover and vegetation classes. GIS and aerial photo-based landscape analyses were conducted to assess temporal changes in land-use/habitat characteristics of the LPC habitat over the past 5 decades and their possible relationship to the contraction of areas occupied by this species. A moving window analysis approach was used to assess scale-dependent landscape/habitat structure in these areas.

Analyses of landscape changes in stable and lost LPC ranges from 1940 to 1989 suggested that increased cropland cover (especially in the HP) and woody cover (especially in the RP) were major factors contributing to the contraction of LPC range. In areas of stable LPC range in the HP, although cropland cover increased significantly to about 25%, the coverage of woody and non-woody vegetation were still high (both at about 40%) and the spatial

attributes of woody and non-woody patches changed little from 1940 to 1989. In areas of lost LPC range in the HP, however, cropland cover increased from approximately 12% to 75% at the expense of woody cover and especially non-woody cover; both were reduced to 10-15%. The density as well as the mean size of non-woody patches was also reduced. The increase in the shape index for both the woody and non-woody patches also indicate increased mixing between the two, which would be unfavorable to LPC. In areas of lost LPC range in Hall County (HP), woody cover increased from 22% to 36% and non-woody cover decreased from 58% to 37%, while cropland cover remained largely unchanged. Increased numbers of woody patches broke up large non-woody patches as reflected by drastically increased patch density and decreased patch size of non-woody vegetation, as well as by the large increase in edge densities of both woody and non-woody patches. This increase in woody cover, and perhaps more importantly, the spatial spread of woody patches, might have contributed to the loss of LPC habitat in the RP.

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Lesser Prairie Chicken Habitat Use and Survival

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The historic range of lesser prairie chicken (LPC) has decreased significantly in the past century due to numerous human-induced changes to the landscape. Cultivation of native rangeland, control of sand sagebrush and shinnery oak, and fragmentation of existing suitable habitat are hypothesized to be the primary factors responsible for shrinkage of the species range. In Texas, the LPC appears to be declining throughout its range, particularly in the Permian Basin region.

In Texas, LPC have been documented breeding in nontraditional areas such as Conservation Reserve Program (CRP) fields surrounded by intensive agriculture. These areas represent newly 'fragmented habitat' relative to historical 'non-fragmented' range. It is not known if fragmented habitats represent source or sink areas for prairie chickens. Additionally, we know little about microhabitat characteristics and seasonal use of fragmented verses non-fragmented habitats, particularly as they relate to nesting success, brood survival, recruitment rates within metapopulations, and winter survival. Although general habitat requirements for the LPC are well established, the extent to which the species used these non-traditional habitats in Texas is currently unknown. Determination of habitat use patterns is needed in fragmented and non-fragmented landscapes to direct habitat management recommendations for LPC. While LPC nest-site selection and nest success have been well documented, no studies have measured brood survival or recruitment rates. Brood survival and recruitment information for both fragmented and non-fragmented landscapes are needed in order to determine if individual metapopulations are sustaining themselves on a long-term basis.

We are currently starting the first phase of a 5-phase research project. The first phase will be dedicated to gathering information of LPC in the eastern portion (Rolling Plains) of their range. Phase I will consist of identifying why LPC are decreasing in areas comprised primary of shinnery oak, whereas they are maintaining populations in areas of sand sagebrush. Phase II will consist of a second study in the western portion of the LPC range (Permian Basin) that will duplicate Phase I study in the eastern portion of the LPC range. In the western portion of their range, LPC are currently known to use CRP habitats and 'natural' prairie areas. Phase III will consist of a study to determine genetic variability and possible diseases of LPC throughout their range, while Phase IV will consist of a study to develop captive breeding techniques, and Phase V will consist of a study on reintroduction of LPC into their former range.

Funding for his study is provided by Texas Parks and Wildlife Department and Texas A&M University.

Population Parameters of American Alligators in the Gus Engeling Wildlife Management Area

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In spite of their popularity and importance, surprisingly little is known about populations of American alligators (*Alligator mississippiensis*) in Texas, particularly about populations located within inland, forested areas. We have noted interesting characteristics of alligators in inland areas that appear distinct from the more studied coastal populations. For example, while alligators seem to be present in creeks and impoundments within their inland range, we suspect they occur at relatively low population densities, and may persist as isolated family groups.

Consequently, populations of alligators in these areas are probably structured very differently, both demographically and genetically, from coastal alligator populations. Clearly, these differences need to be quantified and understood for proper management of alligators in different parts of their range.

WADE A. RYDBERG

The Gus Engeling Wildlife Management Area (GEWMA) in eastern Texas provides an ideal location and unique opportunity to study alligators living within forested environments. This property, owned by Texas Parks and Wildlife Department (TPWD), is located in the Post Oak Savannah ecological region and encompasses approximately 10,956 acres (4,436 ha). There are 7 major spring-fed creeks within the boundaries of the property, all of which flow into Catfish Creek (a tributary of the Trinity River). Catfish Creek gained positive notoriety in 1983, when the creek and associated riparian corridor was designated a National Natural Landmark by the National Park Service. This honor was bestowed because the near pristine qualities of the creek represented a hardwood bottomland ecosystem that is rapidly vanishing throughout much of the United States.

The purposes of our research are to identify factors influencing population structure and dynamics of the alligators, and to integrate information obtained into management strategies. To begin this work, searches were conducted for alligator nests. Once located, eggshell fragments and/or hatchlings were collected. Additional searches were conducted for larger alligators at night using spotlights. Alligators up to 4 feet (1.2 m) long were captured by hand or with nose poles. Additionally, box traps were used to capture alligators 4 feet (1.2 m) and larger. To date, we have captured and released 87 alligators. Once captured, measurements of total length, snout to vent, hind leg, and nare to eye were recorded. The sex of each animal was determined and recorded. Specific scutes from the tail were removed to permanently mark the animal; this tissue was reserved for future genetic work. Additionally, global positioning system (GPS) units were used to mark the location of each capture site.

Capture/recapture techniques will help determine the population size, demographic structure, and the distribution of alligators in Catfish Creek. Genetic structure of this population will be studied to determine metapopulation structure. We predict that family groups of alligators (i.e., female and her offspring) use individual tributaries or impoundments as breeding and/or nesting locations. By compiling this information, we will then be able to compare the data from this study to what is known about alligators in other environments. This basic study should be used as the starting point for future management decisions regarding inland alligator populations.

Funding was provided by Texas Parks and Wildlife Department, a Reagent's Fellowship, and Texas A&M University.

Distribution and Growth of American Alligators in a Texas Coastal Marsh

M. Todd Merendino, G. Matt Nelson, Kevin. H. Kriegel, and Justin. P. Hurst, Texas Parks and Wildlife Department

American alligators (*Alligator mississippiensis*) are common throughout the coastal marshes and prairies ecological region of Texas, being most abundant on the upper Texas coast. Populations have also spread inland to freshwater reservoirs along the numerous river systems. The alligator has recovered from extremely low population levels in the mid-1900s and is now recreationally and commercially hunted in many southeastern states. The alligator is no longer endangered. However, it is listed as 'threatened by similarity of appearance,' and as such, har-

vest and management is governed by the CITES Treaty (Convention in International Trade in Endangered Species).

The management plan for the American alligator in Texas involves various harvest and management techniques for the species, most of which are based on intensive research conducted in Louisiana. Most research activity to date in Texas has focused on harvest techniques and harvest rates. Little detailed biological data has been collected, especially from the various habitats occupied by alligators in Texas. Determination of growth rates is needed to verify the applicability of population model assumptions. The mark/recapture study we propose, herein, will provide information on growth rates that will improve our understanding of alligator population dynamics in Texas coastal marsh habitats.

There is likely variation in growth rates among the geographic clines, which will subsequently affect the time it takes alligators to enter the breeding population. Given that such differences in populations exist, research is needed in Texas to improve our harvest management and habitat management for American alligators. Without such critical information such as growth rates, habitat use, and movements, attempts at alligator management will be a guessing game, at best.

We propose to test the hypotheses that: 1) growth rates of American alligators do not differ along a salinity gradient, and 2) distribution and movements of American alligators are not affected by water salinity.

Study objectives are to: 1) determine growth rates for American alligators in a Texas coastal marsh, 2) assess movements and habitat use along a salinity gradient in a Texas coastal marsh, and 3) provide habitat management recommendations for coastal Texas.

This long-term capture/recapture study has been ongoing at Mad Island Wildlife Management Area since 1994. Alligators were captured at night from airboats. Searches/surveys were conducted twice monthly. Spotlights were used to search for alligators throughout the marsh ponds along the salinity gradient. Smaller alligators (<4', or <1.2 m, in length) were usually hand-grabbed, whereas alligators >5' (1.5 m) in length were captured with snares. Alligators >5' (1.5 m) were slid into a piece of PVC pipe (10" x 5' or 25 cm x 1.5 m) to allow for safe handling. Captured alligators were tagged with electronic PIT tags that were inserted near the base of the tail. Numbered plastic ear tags, similar to those used to mark cattle, were placed in the tail to provide a secondary tag and to prevent unnecessary re-captures of large alligators. Total length was measured to the nearest millimeter. Sex was determined via cloacal examination. Subsequent capture efforts were used to determine movements and growth of marked alligators.

From 1994 through summer 2000, 425 alligators ranging from 15" to 11' (38 cm to 3.4 m) in size have been captured. Of those, 93 have been recaptured. Overall growth rate of all recaptured alligators was 5.68 inches (14 cm) per year. Using data from 58 alligators re-captured >3 growing seasons from initial capture, growth is about 6.29 inches (16 cm) per year. This growth rate is considerably less than the 8" to 12" (20 cm to 30 cm) a year reported in other regions of the United States (South Carolina, Florida, and Louisiana). The importance of this information is that alligators may require longer to reach sexual maturity, thus making it extremely important to understand how harvest and other survival parameters may affect recruitment into the breeding population.

Most alligators are captured at the fresher sites along the salinity gradient, and in fact, most alligators are captured within 1 or 2 lakes on the study area. During times of heavy rainfall or run-off, alligators are seen throughout most of the study area. Similarly, most alligators are recaptured within close proximity to the initial capture site; 1 alligator recaptured in 1999 was recaptured within about 50 yards of the initial 1994 capture site. The importance of this information is that alligators may be somewhat 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, breeding ducks, etc.

We propose to continue this study through summer 2001.

MIGRATORY GAME BIRDS

USE OF SATELLITE TELEMETRY TO MEASURE KEY PARAMETERS ASSOCIATED WITH MANAGEMENT OF THE MIDCONTINENT SANDHILL CRANE POPULATION

Gary L. Krapu and Dave Brandt, U.S. Geological Survey, Northern Prairie Wildlife Research Center
Jay Roberson, Texas Parks and Wildlife Department

The Midcontinent sandhill crane (*Grus canadensis*) population is the largest crane population in the world with estimates as high as 532,000. This population is a major recreational resource in North America, hunted in 9 of 10 States in the Central Flyway and in Alaska, Canada and Mexico. In addition, it attracts thousands of bird-watchers up and down the Flyway. Cranes have become a significant economic asset to towns and cities located along its migrating and wintering routes.

Cranes require careful monitoring because of they have a low rate of population growth. However, little detailed information exists on many aspects of its life history including breeding and wintering spatial distribution of subspecies or subpopulations, and temporal distribution including chronology of migration. Current population estimates are unreliable because the proportion on the survey area during the survey period is unknown. Wide annual variation in the counts exists for unknown reasons.

There are significant threats to cranes in the Central Platte River Valley in south central Nebraska, the primary spring staging area of this population. Here, habitat loss due to elimination of seasonal flooding and consequent brush encroachment has been significant during the last 50 years. This may be negatively affecting pre-breeding and migrating conditioning. Knowing the spatial and temporal partitioning of available habitat is needed to prioritize habitat restoration and management efforts.

Because of these and other data gaps, the Central Flyway Council has identified this study as a high research priority. Because of the use of state-of-the-art satellite telemetry, this study could enhance techniques for the management of all migratory birds. Satellite tracking allows for efficient recovery of relatively precise locations for species migrating over thousands of miles. Locations are calculated via triangulation of Doppler shifts in radio wave frequency reaching NOAA satellites.

The specific objectives of this study include identifying migration routes, breeding and wintering areas of the various subspecies and subpopulations, determining the temporal and spatial distribution and exposure by subspecies and subpopulation to hunting, and estimating the proportion of this population present on surveyed areas when the annual coordinated population survey is conducted.

Preliminary information indicates that cranes from West Texas have made one way treks to Siberia in excess of 4,200 miles (6762 km). As much as 25% of the population may be missed in some years during the spring survey. In spring on the Platte River, patterns of diet and dependence on waste corn have changed very little over the past 20 years. However, corn availability is declining as is fat storage and cranes are spending more time foraging to meet nutrient requirements. Cranes spent a disproportionate amount of time feeding in grasslands and wet meadows. Protein demands probably partially accounts for why cranes spent so much time foraging for invertebrates despite their scarcity. The need for fat and protein storage by adult cranes may be linked to reproductive success.

This study is entering the fourth year of a total of 6 years. It is a collaborative effort of the USGS - Northern Prairie Wildlife Research Center, U.S. Fish and Wildlife Service, several states in the Central Flyway and the International Crane Foundation. The Texas Parks and Wildlife Department has been a financial contributor to this study by virtue of wintering most of this population and having nearly 50% of the crane harvest and hunters. More information may be obtained from Operation Crane Watch at 701/253-5535 or http://www.npwrc.gov/perm/cranemov/cranemov.htm.

An additional $300,000 for 1000 satellite transmitters is needed over the next 2 years to complete the project from both public and private sources. If you are interested in cooperatively sponsoring this project, please contact one of the authors. Sponsors may obtain recognition in news releases and on Web pages. Name and logo recognition may be provided to schoolchildren through an interactive educational project funded by NASA called "Signals of Spring" (800/707-8519) Web site (http://www.signalsofspring.com).

Refinement and Testing of Surgical Subcutaneous Transmitter Attachment Technique in White-winged Doves in Texas Under Field Conditions

Mark G. Gray and Michael F. Small, Southwest Texas State University
Gary L. Waggerman, Texas Parks and Wildlife Department

White-winged doves (*Zenaida asiatica*) have been moving north of their historical nesting range in South and West Texas for the past 10-15 years. Most of the new areas being used are in urban type habitats. In order to collect information on their daily movements and nesting success, a radio transmitter was surgically implanted subcutaneously into 40 adults during the nesting season in Kingsville. Surgeries were performed at the trap sites and the doves were released upon successfully escaping from a holding box. The initiation of the surgeries was delayed until most of the migratory birds had passed through the area and only local birds remained. As a result, there were many young of the year already flying by the time of the first surgeries.

The objectives were to field test the technique that was used on captive birds the year before. Other data were collected on nesting success, nesting attempts, mortality, and life of the radio signal. Global Positioning System was used to collect point coordinates to evaluate home range.

There were 26 individual birds that nested at least once. Ten of these birds nested a second time and 3 birds nested 3 times. It was found that re-nesting birds did not re-use the nests that they previously occupied. One non-implanted bird was found in a nest that was previously occupied by the implanted doves. Over the course of the summer, 3 birds were predated upon by various causes. The U.T.M. coordinates of the nest locations were obtained. Birds were located to source at least twice every 10 days. Additional points were collected as time allowed. Nesting success (percentage of nests fledging at least one young) will be presented in the final report. The species of tree, height of tree, and height of nest were collected to look for correlation among re-nesting attempts by the doves. It was determined that the life of this type of transmitter was only 2-3 months. Of the 40 birds implanted with a transmitter, 2 individuals died due to the effects of the surgery.

This project is funded by Texas Parks and Wildlife Department's White-winged Dove Stamp.

Development and Evaluation of Mourning Dove Population Models for Optimizing Harvest Management Strategies in the Central Management Unit

David Otis, South Carolina Cooperative Fish and Wildlife Research Unit
John Schulz, Missouri Department of Conservation
Jay Roberson, Texas Parks and Wildlife Department

TPWD PHOTO

The purpose of this nationwide and regional multi-state study is to develop structural population dynamics models of mourning dove (*Zenaida macroura*) populations in the Central U.S. This is a logical first step before we can determine the causes and consequences of long-term declines in the nationwide coordinated call count survey index (CCS). We will synthesize existing population demographic data including banding analysis results from the 1960s and 1970s. We intend to incorporate any harvest age ratio data and subsequent auxiliary local banding recoveries and estimates of survival and recruitment in this analysis. The relationship between survival and harvest rate will be explored using ultrastructure models. Estimated preseason age ratios will be modeled as functions of environmental variables. A range of plausible parameter values, based upon historical literature, will be used to investigate the sensitivity of predicted population trajectories to change in individual parameters, including harvest rates. Predicted population trajectories from different models will be compared to CCS trends, as a course check on model validity. This retrospective study will also evaluate and compare results of the Breeding Bird Survey with the CCS. Models will be used to evaluate harvest management strategies to find out which variables are potentially most important in driving dove populations. Results will guide development of monitoring surveys and research projects in Texas to fill identifiable data gaps.

Late Winter Feeding Habits and Condition of Female Mallards Utilizing Stock Ponds in the Oak Woods/ Blackland Prairie Region of Northeast Texas

Kevin J. Kraai, Texas Parks and Wildlife Department and Texas A&M University-Commerce
Jeff Kopachena, Texas A&M University-Commerce

Texas plays an important role for mallards (*Anas platyrhynchos*) wintering in the Central Flyway, and the Oak Woods/Blackland Prairie Region (OW/BPR) of Northeast Texas is one of the primary wintering areas for mallards in the state. Bottomland hardwood complexes in the OW/BPR have been drastically reduced due to drainage for flood control and clearing for agricultural development. Thus, remaining wetlands have become increasingly important to the perpetuation of waterfowl wintering in this region.

Traditional waterfowl biology suggests that, during the period from January through the completion of the northward migration, bottomland hardwoods play a critical role for mallards. Mallards utilize the sanctuaries and food resources available in forested wetlands to carry out biological functions such as molt, courtship, and nutrient acquisition to prepare for migration and subsequent reproduction.

Most information concerning the wintering ecology of mallards in southern regions pertains to bottomland hardwood habitats in the Mississippi Alluvial Valley and the Playa Lakes Region of the Southern High Plains. However, with the exception of greentree reservoirs, there is little information pertaining to the ecology of mallards wintering in man-made habitats. Yet, informed management decisions require an understanding of what foods are consumed in environments where man-made structures provide the primary habitat.

Stock ponds are becoming the most abundant wetland habitat in Northeast Texas. Stock ponds are small man-made water impoundments that serve as water supply for livestock and aid in soil conservation and flood control. In the OW/BPR stock pond densities are estimated to be as high as 7 ponds per square mile. TPWD annual midwinter waterfowl surveys indicate that an increasing number of mallards are utilizing stock ponds in this region during late winter.

Approximately 35 female mallards will be collected from stock ponds, beginning January through the completion of the northward migration. Collections will take place over two winters. Paring status will be noted prior to collection, as well as waterfowl abundance on the stock ponds. Following collection, each bird will be aged and analyzed for foods consumed, body condition, and molt status.

KEVIN J. KRAAI

This project should provide new information about the ecology and management of mallards in Northeast Texas. It will aid in our understanding of how stock ponds compare to forested wetlands as wintering mallard habitat. If this study indicates that mallards are being adequately served by stock ponds, then TPWD and other conservation agencies should elevate the priority of these wetlands in conservation and management plans. Also, this project may provide the initial understanding of how to enhance and/or develop more of this habitat type.

Texas Parks and Wildlife is providing funding for this project.

The Role of Lesser Snow Geese as Carriers of Avian Cholera in the Playa Lakes Region

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William P. Johnson, Texas Parks and Wildlife Department

Avian cholera, caused by the bacterium *Pasteurella multocida*, is one of the most important diseases affecting North American waterfowl. It is an infectious, introduced disease that was first reported in wild waterfowl in 1944. Avian cholera often occurs as an acute outbreak at waterfowl concentration areas on both breeding and wintering grounds. White-fronted geese (*Anser albifrons*) and lesser snow geese (*Chen c. caerulescens*) appear to suffer disproportionately high mortality. During avian cholera out-

breaks it is not uncommon for thousands of waterfowl to die, and mortality from severe epizootics may exceed 20,000 birds.

MICHAEL D. SAMUEL

Two competing hypotheses have been proposed to explain the recurrence of avian cholera outbreaks: 1) *P. multocida* persists in specific wetlands year-round in water, soil, or other reservoirs, and 2) carriers reintroduce the disease as migratory birds congregate on staging and wintering areas. To date, evidence gathered by the National Wildlife Health Center suggests that wetlands are not a likely reservoir for avian cholera. Conversely, serology samples obtained from snow goose breeding colonies indicated that approximately 3% of birds had been infected with *P. multocida* and survived. Prevalence rates in these breeding colonies increased to >8% following avian cholera outbreaks. Thus, evidence suggests that snow geese serve as a reservoir for *P. multocida*. However, to confirm that carrier birds occur and that they are important in the transmission of avian cholera on wintering areas, research is needed that focuses on isolating live bacteria from tissues of birds and determine how and when it is transmitted to susceptible birds.

The potential role of snow geese as carriers of avian cholera, coupled with the dramatic increase in abundance of mid-continent snow goose populations, amplifies the potential impacts of this species on other waterbird populations. The objective of this study is to determine if snow geese are carriers of *P. multocida* and determine where this bacteria resides in healthy birds. This research targets Western Central Flyway snow geese that winter in the Playa Lakes region.

Current management strategies to control avian cholera outbreaks are reactive, consisting primarily of collecting and disposing of carcasses when outbreaks occur. Uncertainties about the reservoir for avian cholera have probably hindered development of alternative management strategies for this disease. Information from this study will provide a better understanding of the spread of avian cholera transmission among birds. Identification of the reservoir for this disease can help focus future studies and direct management strategies (habitat availability, refuge management practices, bird dispersal, hazing, etc.). Finally, this study will help to determine the importance of snow geese in the avian cholera cycle

Intensive sampling of wintering lesser snow geese from the Playa Lakes region will be conducted to obtain sufficient samples to detect carrier birds. Samples will primarily be collected in Texas, but snow geese will also be collected from New Mexico, Colorado, Kansas, and Oklahoma. Sampling will be conducted during three consecutive years starting during the winter of 2000-2001. *P. multocida* isolated from snow geese will be identified by standard serotyping and selected isolates will be tested for pathogenicity by challenging ducks.

Funding for this study is being provided by the U.S. Fish and Wildlife Service, the Playa Lakes Joint Venture, the Texas Parks and Wildlife Department, and Ducks Unlimited, Inc.

Time Activity Budgets of Wintering American Coots, Gadwall, and American Wigeon in a Texas Coastal Marsh

M. Todd Merendino, G. Matt Nelson, and Kevin H. Kriegel, Texas Parks and Wildlife Department

American coot (*Fulica americana*), gadwall (*Anas strepera*), and American wigeon (*Anas americana*) are three of the most abundant waterbirds using Texas coastal marshes during the winter months (TPWD unpubl. survey data). These species commonly co-inhabit marshy areas which are characterized by large amounts of submergent vegetation. Wigeongrass (*Ruppia maritima*) (Kantrud 1991), a submergent vegetative species, grows throughout a variety of conditions along the Texas coast. Wigeongrass is believed to be an important food component for many waterfowl species, as well as for American coot (Kantrud 1991, Prevost et. al. 1978).

Abundance of coot, gadwall, and wigeon appears to be directly linked with the abundance of wigeon grass. Marsh ponds containing an abundance of wigeongrass are generally better waterfowl hunting sites than those containing little or no wigeongrass (personal observation). Results from hunter check stations at public waterfowl hunting areas generally show that areas of the marsh that contain wigeongrass have higher duck harvests than do areas with little wigeongrass (TPWD unpubl. data).

In Texas coastal marshes large numbers of coots, gadwall, and wigeon co-occur on marsh ponds with an abundance of wigeongrass. Given that all species are utilizing wigeon grass, interspecific competition likely occurs. The study proposed herein, will utilize time activity budget assessment to determine the amount of inter-specific interactions among coot, gadwall, and wigeon as it relates to competition for wigeongrass food resources. Temporal abundance of wigeongrass and vertebrate herbivory will be monitored via the construction of several "exclosures" in the marsh ponds.

We propose to test the hypotheses that: 1) Temporal abundance of widgeongrass is unaffected by vertebrate herbivory, 2) Gadwall, American wigeon, and American coot do not exhibit inter-specific competition relative to foraging activities, and 3) Time activity budgets do not differ among gadwall, American coot, and American wigeon.

Study objectives are to: 1) Determine temporal abundance and herbivory of wigeongrass, 2) Evaluate time activity budgets of wintering American coot, American wigeon, and gadwall, 3) Determine food habits of wintering American coot, American wigeon, and gadwall, and 4) Determine if the abundance of American coot, American wigeon, and gadwall is correlated with the abundance of wigeongrass.

This study will provide important information with which to evaluate current habitat management efforts. If wintering ducks and coots are actively consuming large amounts of wigeongrass, then habitat management should focus on efforts to promote the establishment of wigeongrass. This might include such techniques as salinity reduction, freshwater diversion, etc. Perhaps wigeongrass is a secondary food item of wintering ducks, with invertebrates associated with the wigeongrass being the top food item of wintering ducks. If so, then management might focus primarily on establishing vegetation that provides a substrate for invertebrates, versus focusing on plant species that directly provide food (i.e., tubers, seeds, etc.) for waterfowl. Overall, a lack of data exists on what governs waterfowl use, distribution, and movements within coastal marshes of Texas. Information acquired with this study will help to evaluate current management efforts and provide information with which to improve future management activities.

This was originally proposed as a two-year study, beginning in fall 1998. Results from the first field season indicated that biomass inside the exclosures declined an average of 41% per month. Outside the exclosures, wigeongrass declined an average of 80% per month. Overall, herbivory by coots, gadwall, and wigeon appears to account for about 20% of the loss of wigeongrass biomass. By late December, wigeongrass is nearly completely gone from the marsh as shown by the 93% decline outside the exclosures. During the first segment of the waterfowl season (24 October-30 November), hunters harvested over 2.5 gadwall or wigeon per day, whereas during the second segment (12 December-17 January) hunters harvested less than 1 gadwall or wigeon per day. The decrease directly mirrors the depletion of wigeongrass, as by late December 93% of wigeongrass had either deteriorated or been consumed.

Time activity budgets were conducted once weekly to monitor aggression, locomotion, feeding, preening, and resting. Feeding accounted for 95%, 92%, and 96% of the activity for gadwall, American wigeon, and coots, respectively. There was little inter- or intra-specific aggression.

We attempted to document food habits via an examination of hunter shot gadwall and wigeon. Of the 20 ducks that we examined, no hunter shot ducks contained any food resources. Coots were collected monthly. Nearly 50% of all coots contained food resources, with wigeongrass being the predominate food.

We proposed to repeat the study in fall 1999 and fall 2000. Due to excessive salinities and a lack of rainfall there was no wigeongrass production in the Mad Island WMA area. Thus, field sampling was not conducted. We are proposing to conduct a second field season beginning in fall 2001.

Evaluation of Nest Site Selection and Nest Success of Breeding Wood Ducks in Blue Elbow Swamp

Derrick W. Wolter, Texas Parks and Wildlife Department
R. Douglas Slack, Texas A&M University

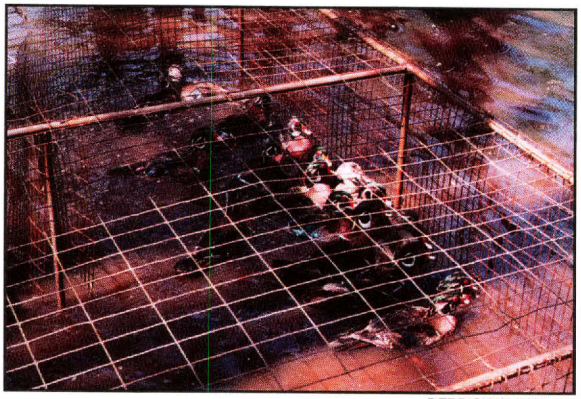
Wood ducks (*Aix sponsa*) are known to use baldcypress/water tupelo (*Taxodium distichum/Nyssa aquatica*) swamps, mixed bottomland hardwoods, and upland tree species for nesting cavities. However, no study has directly examined nesting preference among these various community types. The majority of previous wood duck nesting studies focused on tree species use in single habitat types and was conducted in the midwestern or southeastern United States. Because artificial nest boxes have never existed on Tony Houseman State Park and Wildlife Management Area at Blue Elbow Swamp, a unique opportunity existed to evaluate the true use of natural cavities and forest communities by wood ducks.

The 3,313-acre (1,341-ha) area is located along the Sabine River and includes forested uplands (7%) interspersed within forest wetlands consisting of mixed hard-

woods (11%) and baldcypress/water tupelo (82%). Logging in Blue Elbow Swamp in the 1940s transposed the cypress/tupelo community from a baldcypress to a water tupelo dominated community. Little is known how changes in forest community and habitat structure may have affected wood ducks that use the area. This study proposed to examine the forested habitats present within Blue Elbow Swamp and evaluate wood duck natural cavity preference, nest success, identify ages of preferred tree stands, and determine primary nesting habitat.

Wood ducks were captured during March of each year using grain-baited swim-in traps. Hens were equipped with backpack and implant radio transmitters in 1999 and 2000, respectively, in an attempt to find used natural nesting cavities. A total of 33 wood duck hens were equipped with transmitters (n=13 in 1999 and n=20 in 2000). Seven hens died prior to nesting or leaving the area: 3 predated, 1 stress related, 1 infection, and 2 unknown. No nests were found on the WMA in 1999 or 2000. A nest initiation was identified 1 mile (1.6 km) off the WMA (in upland forest) in 2000, but the hen was predated on the nest prior to incubation. Marked hens were found to leave the area at a steady rate without nesting or prior to nesting elsewhere, with most hens (n=21) having left before June of each year. Wood duck hens on the area were found 93%, 4%, and 3% of the time in cypress/tupelo, bottomland, and upland forest communities, respectively. However, off the management area, hens used cypress/tupelo 55%, bottomland 22%, and upland forest communities 23% of the time.

The density of suitable nesting cavities was estimated for each forested community on the area during November and December 1999. A total of 15, 15, and 23 random plots, 164 feet x 164 feet (50 m x 50 m) in size, were examined by ground searching in the upland, bottomland, and cypress/tupelo forested communities, respectively. Cavity dimensions were examined for suitability by climbing. Estimated minimum cavity density is 0.11, 0, and 0.07 suitable cavities/acre (0.276, 0, 0.174 cavities/ha) for the uplands, bottomlands, and cypress/tupelo communities, respectively. Further analysis of telemetry data will help area managers understand seasonally favorable community characteristics.



DERRICK W. WOLTER

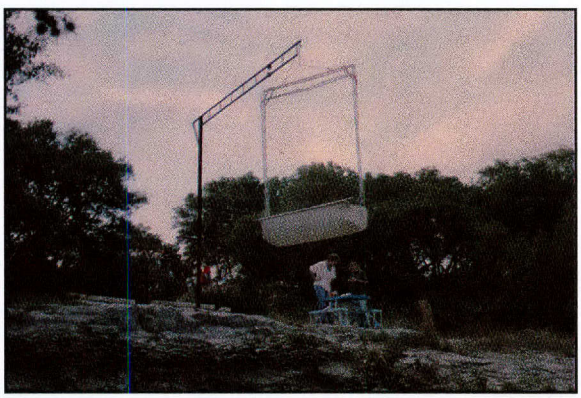
Relatively young tree stands resulted in low cavity densities in the cypress/tupelo forested community. The greater density of cavities in the upland forest community is consistent with prior cavity/forest community research. The absence of nesting wood ducks on the area may have been the results of several reasons. Possible reasons include radio marking young birds which sometimes forgo nesting in the presence of high duck densities, low number of suitable cavities of young forest stands, which would give the effect of high duck densities due to competition for nesting space, late nesting, and young birds exhibiting philopatric behavior.

Funding for this project was provided by Texas Parks and Wildlife Department and Texas Agricultural Experiment Station.

NONGAME WILDLIFE

Visitor Impact on Bat Emergence Behavior at the Old Tunnel Wildlife Management Area

John T. Baccus, Marian Bailey, Max Sears, Kelly Harper, Trevor Tanner, and Cris Hein, Southwest Texas State University
Tim A. Lawyer, Texas Parks and Wildlife Department



TIM A. LAWYER

Texas has 32 bat species, more than any other state, and some exceptionally large colonies that are characteristic of the Southwest. The majority of bats in Texas are insectivorous, and some colonies consume large quantities of insects nightly. Bats are the major predators of night-flying insects and are helpful to farmers and ranchers by controlling certain species of destructive insects.

The Old Tunnel Wildlife Management Area (OTWMA) is a 16-acre (6.6-ha) tract of land owned and operated by the Texas Parks and Wildlife Department. The OTWMA, located in northern Kendall County about 14 miles (22.5 km) north of Comfort, Texas, contains an abandoned railroad tunnel which serves as an annual roosting site for about 1-2 million Brazilian (Mexican) free-tailed bats (*Tadarida brasiliensis*). The OTWMA was purchased for the specific purpose of preserving and protecting this important bat colony. With the dramatic increase in public interest about bats, bat biology and life history, the OTWMA has become an extremely popular and important site in terms of public education and public bat-viewing opportunities. During the 2000 tour season (April-October) at the OTWMA, 11,380 visitors participated in public tours at the OTWMA. As public awareness of the tunnel continues to increase, the potential of detrimental human disturbances to the bat colony also could increase. Little is known about the effects of human disturbance on Brazilian free-tailed bat colonies, but at some point, harassment and roost disturbance causes roost abandonment and a general decline in bat populations. Concern over the effect of visitors watching the emergence of bats has been and will continue to be addressed as part of this research project.

The objectives of this study are to: 1) determine effects of visitors on bat emergence behavior, 2) evaluate the tunnel as a natal site, 3) determine the temporal changes in the composition of the bat population regarding sex and age ratios, 4) estimate bat populations in the tunnel, 5) delineate migratory periodicity, 6) determine crepuscular flight patterns, 7) identify species composition, and 8) evaluate continuous site-use by free-tailed bats.

The nature of the colony composition with respect to age and sex will be studied. This will require bimonthly (May-October) collections of bats using a 'Harp-Type' bat trap. Bats collected will be aged and sexed, marked, and reproductive information will be recorded. Surveys of the tunnel during late June and early July will verify the presence or absence of pups. Data collected will be used to develop a population profile for the resident bat colony. Use of the tunnel by migrating bats will be assessed during February to May and August to November by trapping and surveys of the tunnel.

The results of this on-going research will be used to properly manage the extensive public-use on the OTWMA without impinging upon the integrity of the resource. A major benefit of this research will be the development of a long-term operational policy for the OTWMA. These policy guidelines are necessary for site-specific management of public lands containing important bat colonies.

This is year 9 of the study funded by the Texas Parks and Wildlife Department and Southwest Texas State University.

Colonial Waterbird Survey and Management

Brent Ortego, Texas Parks and Wildlife Department

The Colonial Waterbird Survey is an on-going cooperative effort between Texas Parks and Wildlife Department (TPWD), the U.S. Fish and Wildlife Service, Texas General

Land Office, Texas Colonial Waterbird Society, and other interested organizations and volunteers. TPWD activities have been funded by the Federal Aid in Wildlife Restoration Grant W-125-R and the Department has participated in the annual statewide colonial waterbird survey since 1968. Other activities include bird banding research, managing the data from cooperative surveys and maps of colony locations, conducting aerial and ground surveys of colonial waterbird sites, providing information to the public about colonial waterbirds in the form of pamphlets and signs at colonies and public boat ramps near colonies, and assisting in managing selected colonies along the coast. Today, TPWD participates by conducting aerial surveys of remote colony sites along the Gulf Coast during even numbered years between May 15 and June 1. Data generated are pooled into a common database that frequently is used by participants, consultants, and developers to avoid damaging colonial waterbird nesting sites. Data are also used to monitor coastal population trends of 25 species of colonial waterbirds whose populations are very good biological indicators of the health of the coastal wetlands and estuaries. This Texas cooperative survey is viewed as one of the best of its kind in the nation and is the longest running colonial waterbird survey in the United States.

A total of 19 active colonies and 37,897 nesting pairs were found along the lower reaches of rivers and coastal marshes between the Sabine River in the east and the Guadalupe River in the west during the very dry year 2000. This total represents about one-half of the pairs found during the more typical rainfall years of 1994 and 1998, and about 6000 more pairs than the dry 1996 breeding season. Most fish/crustacean-eating bird nesting populations showed major declines. Cattle egret (*Bubulcus ibis*) and black skimmer (*Rynchops niger*) were the only species showing increases in nesting pairs.

In addition to coastal surveys, colonial waterbirds nesting on 2 islands in Cedar Creek Islands Wildlife Management Area in Henderson County were monitored. A total of 363 individuals of 6 species were found on the Bird Island Unit and 2434 individuals of 7 species on the Telfair Island Unit. Neotropic cormorants (*Thalacrocorax brasilianus*) re-nested at the Bird Island Unit in the fall of 1999. Dr. Ray C. Telfair II banded and color-marked with orange/blue leg tags a total of 93 nestlings on October 2 (50) and October 16 (43). Mortality among the later-banded birds (27.9%) was much higher than that (2%) of the earlier-banded birds. Apparently, the later-nesting birds were subjected to avian predation [probably great-horned owls (*Bubo virginianus*), red-tailed hawks (*Buteo jamaicensis*), and/or bald eagles (*Haliaeetus leucocephalus*)].

The low numbers of small herons and egrets in comparison to previous years at these inland sites reflect the substantial loss of nest-site vegetation due to guanotrophy. Very little nest-site vegetation is left on Bird Island and only 40% is left on Telfair Island. Due to the deterioration of nest-site vegetation and the large number of herons and egrets that, as a result, nested on the ground, no attempt was made to band/color-mark nestlings during the spring/summer season of 2000.

During the late winter/early spring season (1999/2000), local volunteers (Timothy P. Folts and Tomye Folts-Zittner) planted 48 seedling Chinaberries (*Melia azedarach*) on Bird Island as an experiment to determine their survival and growth potential to replace the loss of Chinaberries that have died from guanotrophy.

Determination of the Status of the Louisiana Pine Snake

D. Craig Rudolph, Richard N. Conner, and Richard R. Schaefer, USDA Forest Service, Southern Research Station
Ricky W. Maxey, Texas Parks and Wildlife Department

RICKY W. MAXEY

The Louisiana pine snake (*Pituophis ruthveni*) is one of the rarest vertebrate species in the United States. Its limited distribution in eastern Texas and western Louisiana is closely associated with the distribution of longleaf pine (*Pinus palustris*). Within this region the species is found in upland habitats with abundant herbaceous vegetation on well-drained sandy soils. This habitat restriction is apparently a result of the close association of Louisiana pine snakes with Baird's pocket gophers (*Geomys breviceps*). Louisiana pine snakes prey extensively on pocket gophers and are dependent on pocket gopher burrow systems for nearly all of their underground activity.

Most longleaf pine savannahs have been converted to other land uses, and most of the remaining savannah habitat has been severely degraded due to lack of adequate fire. Consequently, the Louisiana pine snake is now confined to a few limited areas where suitable habitat still exists.

Since 1993 we have been conducting research on Louisiana pine snakes to gain a better understanding of their biology and status. Telemetry studies have provided extensive data on habitat use, home range characteristics, and general natural history of this previously little known species. We are now in the second year of a multiyear effort, funded in part with Section 6 funding provided by Texas Parks and Wildlife Department for work carried out in Texas, to survey additional localities to provide a more complete picture of the current status and distribution of the Louisiana pine snake.

Large, semi-permanent funnel and drift fence traps are currently installed in 24 localities in Texas and Louisiana, and are operated during the active period from March through October. Extensive long-term trapping is required because trap success in areas known to be occupied by Louisiana pine snakes is very low, one capture for each 400-1000 trap days. We are currently accumulating approximately twenty thousand trap days per year in each state.

Results to date, resulting in 40+ additional records, have documented the continued existence of Louisiana pine snakes in 6 counties in Texas and 4 parishes in Louisiana. Examination of all known historical localities also suggests that very little of the original habitat remains in suitable condition for Louisiana pine snakes. Consequently, we are continuing our efforts to locate additional populations of this very rare species and to better understand its biology and habitat requirements.

Demography and Ecology of the Western Diamondback Rattlesnake in South Texas

Donald C. Ruthven III, James F. Gallagher, and David R. Synatzske, Texas Parks and Wildlife Department
Richard T. Kazmaier, Oklahoma State University

Western diamondback rattlesnakes (*Crotalus atrox*) are the most common venomous snakes found throughout much of Texas. South Texas is well known for its high density of diamondback rattlesnakes and exceptionally large specimens. In this region, diamondback rattlesnakes can be encountered during all months of the year. However, the ecology of this species in the South Texas ecosystem is not well documented. The objective of this study is to document activity patterns and demography of diamondback rattlesnakes.

The study site is the Chaparral Wildlife Management Area in Dimmit and LaSalle counties, Texas. Diamondback rattlesnakes were captured when encountered while road cruising during 1996-2000. Upon capture, snakes were measured (snout-vent and total length), sexed, and marked by the subcutaneous insertion of a passive integrated transponder (PIT) tag. Snakes were then released.

JOE MOODY

A total of 354 diamondback rattlesnakes were captured, with 22 individuals being recaptured during the 1996-2000 study period. Males [mean=39 inches (100 cm), total length] were significantly larger than females [mean=32 inches (81 cm), total length]. The largest individual captured measured 59 inches (150 cm) in total length. The observed sex ratio (F:M) of 1:2.7 was skewed towards males. Snakes were encountered during all months of the year. Snakes were most active during mid-spring with 47% of total captures occurring during the months of April and May. Diurnal activity appeared to decrease throughout summer with a slight increase in activity in early fall before decreasing in winter.

The high activity period associated with spring was most likely a result of snakes becoming more active with the onset of warmer temperatures, followed by extensive searches for prey items, and males seeking females. The uneven sex ratio may also be the result of greater activity of males in search of mates. Decreased diurnal activity during the summer months indicates increased nocturnal activity by rattlesnakes to take advantage of optimum temperatures. Too few rattlesnakes were recaptured to estimate population size. However, recapture data indicates that rattlesnakes in South Texas may have relatively small home ranges as most recapture events occurred within 100 yards (92 m) of the original capture site. The greatest movement by an individual snake was 0.93 miles (1.5 km).

Fear of snakes generally leads to their death when human-rattlesnake encounters occur. Most human activity on South Texas rangelands occurs during hunting seasons

(September-May). Our data suggests that rattlesnakes are most vulnerable to harvest by hunters during spring turkey season. A better understanding of rattlesnake ecology combined with greater education efforts may decrease fatal encounters between humans and rattlesnakes. The impacts of hunter harvest on rattlesnakes are unknown and warrant further investigation. To gain further knowledge on rattlesnake ecology, five individuals will be radio tagged in late 2000 and movements monitored to determine home range size, activity patterns, and habitat selection.

Validation of a Technique for Determining the Age of Texas Tortoises

Richard T. Kazmaier and Eric C. Hellgren, Oklahoma State University
Donald C. Ruthven III, Texas Parks and Wildlife Department

DONALD C. RUTHVEN III

Techniques to accurately estimate age are of critical importance for the determination of age related phenomena, such as growth rates and age-specific survival and fecundity rates. Such age-specific information is essential to understanding the demography and population dynamics for any species; it is also needed for the development of functional management plans. We are investigating the utility of aging Texas tortoises (*Gopherus berlandieri*) using growth lines on the shell, because such information is necessary to accurately determine the status of populations of this state threatened species.

The study is being conducted on the Chaparral Wildlife Management Area (WMA) in Dimmit and LaSalle counties. A marking and monitoring program was initiated in 1990 and we began estimating age from scute annuli (shell growth lines) in 1994. Tortoises are captured during intensive searches and whenever they are encountered during routine management activities. Upon capture, scute annuli are counted from 10 different scutes and the modal count is used as an estimate of age. To date, all counts have been made by the same individual, but training of other observers is ongoing. After counting annuli, sex and body size are recorded and the tortoises are released at the site of capture after being given a unique mark by notching the marginal scutes. Upon recapture, ages are re-estimated in a blind fashion, such that previous counts of annuli for the individual are not known. Annuli counts from the first capture can be compared with subsequent captures to determine if Texas tortoises on Chaparral WMA produce one annulus per year. This validation of the one annulus per year hypothesis is necessary for scute annuli to be a useful aging technique.

Over 1880 captures of over 1350 individuals have been aged on Chaparral WMA from 1994-2000. This time period allows comparisons of individuals up to 6 years after initial marking. Counts of annuli beyond 18-20 were difficult. Annuli counts from recaptures corresponded well with expected values, but occasional miscounts did occur. However, 99.7% of recaptures were within ±1 year of expected. Annuli counts on this species are difficult to make because of a large number of false growth lines on many individuals. Distinguishing real from false annuli takes considerable experience, but the time commitment necessary to become proficient with the technique is counterbalanced by the ability to collect extremely valuable demographic data. Despite occasional miscounts of 1 year and an upper cut-off of estimates of 18-20 years, we feel that this technique is useful for estimating age in this species. We are continuing to collect data on Chaparral WMA to determine if the annuli of this population will continue to support the one annulus per year hypothesis. Although all individuals captured on Chaparral WMA had countable annuli, observations suggest that populations in other parts of the state may be more difficult to age because of excessive shell wear. We are currently expanding analyses to other populations to determine if this technique is useful throughout the range of this protected species.

Habitat Characteristics of the Northern Rosebelly Lizard and Texas Banded Gecko in the South Texas Plains

Donald C. Ruthven III and David R. Rios, Texas Parks and Wildlife Department
Richard T. Kazmaier, Oklahoma State University

In southern Texas, mechanical brush management treatments have been applied to large expanses of native brushland to improve livestock grazing and to benefit prominent game species, such as white-tailed deer (*Odocoileus virginianus*) and northern bobwhite quail (*Colinus virginianus*). Little is known on the effects of these management practices on nongame wildlife, especially herpetofauna. To better understand the potential impacts of habitat altering practices on a given species, a clear understanding of its habitat requirements and preferences must be assessed.

DONALD C. RUTHVEN III

The northern rosebelly lizard (*Sceloporus marmoratus*) and Texas banded gecko (*Coleonyx brevis*) reach the northeastern limits of their ranges in the South Texas Plains. Little is known about the habits of these two unique lizards. Anecdotal information suggests that the northern rosebelly lizard is a terrestrial, insectivorous lizard of brushlands, while the Texas banded gecko is characterized as a nocturnal, insectivorous lizard inhabiting rocky areas. Our objective was to compare landscape and vegetation characteristics of sites occupied by the northern rosebelly lizard and Texas banded gecko with nearby sites unoccupied by these lizards.

The study was conducted on the 15,200-acre (6,154-ha) Chaparral Wildlife Management Area (WMA) in the western South Texas Plains. Vegetation is dominated by the mesquite (*Prosopis glandulosa*) and acacia (*Acacia* spp.) brushlands characteristic of the south Texas plains. Vegetation was monitored in association with drift fence arrays where northern rosebelly lizards and Texas banded geckos were encountered and randomly selected arrays where they were absent. Woody vegetation cover, canopy patch characteristics, and edge were estimated by utilizing aerial photographs and GPS and GIS technologies. Woody plant species composition was determined by the line intercept method. Herbaceous vegetation, litter, bare ground, and rock coverage were estimated in 19.6 x 7.9 inch (50 x 20 cm) quadrats.

The northern rosebelly lizard was encountered on sites of dense stands of woody vegetation with little or no herbaceous ground cover. These contiguous stands of woody vegetation have fewer individual patches of woody vegetation, hence resulting in less edge. The Texas banded gecko was found in a wide variety of upland habitats with varying degrees of woody and herbaceous cover. The Texas banded gecko appeared to avoid lowland habitats. Northern rosebelly lizards' affinity for dense stands of woody vegetation may result in it being negatively impacted by brush management activities. Most habitat management activities in south Texas are directed towards game species such as white-tailed deer. As dense stands of woody vegetation that harbor northern rosebelly lizard contain many woody plants preferred by deer as forage, such as guayacan (*Guaiacum angustifolium*) and vine ephedra (*Ephedra antisyphilitica*), maintaining suitable habitat for Northern rosebelly lizard can be compatible with most management programs. The Texas banded geckos' more universal utilization of upland habitats may make it less susceptible to habitat management activities. Further investigations into the amounts of suitable habitat required to sustain viable populations of northern rosebelly lizard and Texas banded gecko are warranted.

Regional Variation in Morphometrics of the Texas Horned Lizard in Texas

Eric C. Hellgren and Richard T. Kazmaier, Oklahoma State University
Donald C. Ruthven III, David R. Synatzske, and Brad Simpson, Texas Parks and Wildlife Department

Populations of wide-ranging species of reptiles, including lizards, vary widely in life-history characteristics. These variations are likely a result of a number of factors, such as resource availability, climate, predation pressure, and genetics. The Texas horned lizard (*Phrynosoma cornutum*) ranges from southeastern

Colorado, central Kansas, and southwestern Missouri south through Oklahoma and Texas to the northern tier of Mexican states (e.g., Sonora, Chihuahua, Coahuila, etc.). This species exhibits geographic variation in clutch size, but other life-history characteristics have not been studied. Our objective was to examine regional variation in morphometric characteristics in 2 populations of Texas horned lizards. These populations occur in southern Texas on the Chaparral Wildlife Management Area (CWMA) and northern Texas on the Matador Wildlife Management Area (MWMA).

Collection of horned lizard data began on the CWMA in 1991 and on the MWMA in 1995. Collections have continued through 2000. We report on data through 1999. Lizards were captured via fortuitous encounters during road cruising and in drift fence arrays. We determined sex, body mass, snout/vent length (SVL) and total length (TL) on captured individuals. We also marked lizards by either a series of toe clippings or the implantation of passive integrated transponder (PIT) tags.

Horned lizards on CWMA (n=2005 captures) were longer and heavier than those on MWMA (n=263). Total lengths averaged 5.3 and 5.3 inches (134.8 and 133.7 mm) for adult females and males, respectively on CWMA, vs. 4.7 and 4.5 inches (119.1 and 115.4 mm) on MWMA. Snout-vent lengths averaged 3.6 and 3.4 inches (92.5 and 85.3 mm) for adult females and males, respectively on CWMA, vs. 3.3 and 3.1 inches (83.5 and 77.9 mm) on MWMA. Adult body mass averaged nearly 0.4 ounces (10.0 g) heavier for each sex on the CWMA, being 1.7 and 1.4 ounces (48.3 and 40.9 g) for females and males vs. 1.4 and 1.1 ounces (38.9 and 31.3 g) on MWMA. The distribution of size classes for SVL shows a larger proportion of hatchlings [<1 inch (25 mm)] on CWMA compared to MWMA, and a shift to larger size classes [>3.9 inches (100 mm)] in the southern population. More intensive capture effort, including use of radiotelemetry to find nests, on CWMA contributes to the larger number of hatchlings in that sample. Because clutch size in many lizards, including the Texas horned lizard, is a function of body size, this variation in body size has implications to geographic variation in reproductive effort. If reproduction is lower in the northern population, higher survival rates must be complementary to sustain viable populations. We presently do not have adequate data to address this question. Untangling the causative factors of such variation would require a 'common garden' experiment in the laboratory to control for environmental factors.

Funding was provided by Texas Parks and Wildlife Department and the Horned Lizard Conservation Society.

Food Habits, Reproduction, Parasites and Diseases of Free-ranging Ratites in the Cross Timbers and Prairies Ecological Area

Misty Sumner and Wildlife District 3, Texas Parks and Wildlife Department

In the late 1980s, emu (*Dromaius novaehollandiae*) farming gained in popularity and large numbers of emu farms sprang up across the United States, including many in Texas. In the mid-1990s, the price of a pair of emus dropped from a high of $50,000 to a low of $20. As a result, emus were released at an alarming rate, particularly in north central Texas. Of particular concern to the Wildlife Division is the recent documentation of production and survival of these free-ranging ratites. The potential of sustaining populations of free-ranging ratites to negatively impact native species of flora and fauna was the stimulus of this study.

The objectives are to describe the seasonal food habits of free-ranging emus in the Cross Timbers and Prairies ecological region of Texas and to identify possible direct and indirect impacts of free-ranging emus on endemic wildlife species and livestock. The possible role of emus as vectors of diseases and parasites will also be explored. District personnel are documenting the number and location of existing free-ranging emu populations in the Cross Timbers and Prairies Ecological area.

WARREN B. BALLARD

Free-ranging emus have been collected seasonally over a 1-year period and digestive, reproductive and respiratory systems removed, blood taken and serum separated. Samples were sent to Texas Tech University to complete the analyses. The ventriculus and stomach contents will be analyzed to determine baseline food habits categorizing contents into vertebrates, invertebrates, vegetative matter, seeds, and mast. Frequency of occurrence by food item

class will also be determined. The other systems and organs are receiving direct gross observation and microscopic examinations to determine the parasites present in the birds. Blood serum toxicology tests are being run to determine the evidence of disease.

This study will provide important information and documentation that may be used to assess possible impacts of free-ranging ratites on endemic species and systems.

Funding is being provided by Texas Parks and Wildlife Department.

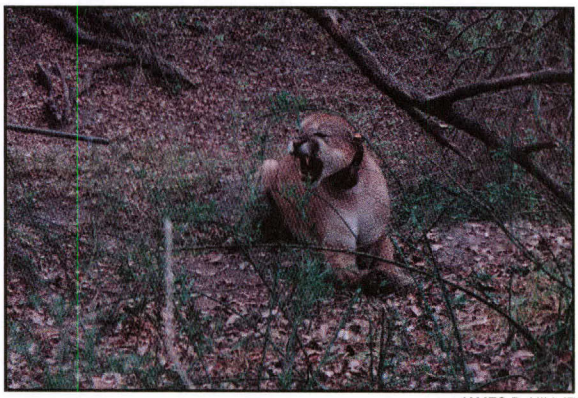
Microhabitat Use, Kill Rates, and a Monitoring Program for Mountain Lions in South Texas

R. Bill Adams and Louis A. Harveson, Sul Ross State University
Paul B. Robertson and James D. Hillje, Texas Parks and Wildlife Department

The goal of this project is to investigate the foraging ecology, microhabitat use, and sign survey information of mountain lions (*Puma concolor*) in South Texas, and to collect supplemental data on food habits, prey-lion interactions, and spatial and habitat relations. Our specific objectives are to: 1) assess kill rates of mountain lions in South Texas, 2) determine microhabitat selection of mountain lions in South Texas, and 3) create a mountain lion-sign survey to determine trends of the mountain lion population in South and West Texas. Our research hypothesis is that mountain lions will select microhabitat for conducting specific behavior such as making and caching kills, and denning. Specifically, we predict that canopy and screening cover will be higher at kill sites and den sites than at random sites.

To date, 94 mountain lion kill sites have been located and microhabitat has been measured. Five and 10-m line transects were placed in each cardinal direction at 13 of the 94 kill sites. Data were collected on plant density, composition, plant frequency, screening cover, and the height of total visual obstruction (HTVO). The mean screening cover at 5 m was 65.6%, at 10 m was 89.0%, and the mean screening cover of both distances was 77.3%. The total mean plant density at each site was 0.72-plants/m. The average HTVO of the total means was 58.02 cm. The 2 most frequent plant species at kill sites were honey mesquite (*Prosopis glandulosa*) and spiny aster (*Aster spinosa*). Data will be collected on the remaining kill sites and all kill site data will be supplemented with a random-point procedure for comparing kill sites and random points. These techniques will also be applied to den sites.

Only kills of 1 female with kittens (2) were found consistently enough to estimate a kill rate. There were 71 telemetry-days on this lion throughout the summer of 1999. In order to determine a kill rate, we used only the number of days that the female was localized as the numerator in the kill rate proportion. The lion was localized a total of 47 telemetry-days, and made 11 total kills. The total kill rate and the kill rate of white-tailed deer (*Odocoileus virginianus*) by this female during the summer of 1999 were 1-kill/4.27 days and 1-kill/5.88 days, respectively. The model that Ackerman et al. (1986) designed proposed kill rates of 1-deer/6.8 days, 1-deer/14-17 days, and 1-deer/8-11 days for females with kittens, females, and males, respectively.



JAMES D. HILLJE

Currently, we are in the beginning stages of creating a mountain lion-sign survey to be employed in South and West Texas. Transects will be established in both areas, and mountain lion sign (i.e. tracks, scats, scrapes, and kills) will be counted on each transect and compared to subsequent counts to determine population trends. This protocol could be implemented by TPWD to bolster current trend data (i.e. harvest records).

Cooperative funding was provided by the Welder Wildlife Foundation, Texas Parks and Wildlife Department, Houston Livestock Show and Rodeo, the Summerlee Foundation, Albert Biedenharn III, and Eddie Knight.

RARE SPECIES

A Status Survey of the Dwarf Pipewort in Texas

Michael MacRoberts and Barbara MacRoberts, Bog Research
Carl Frentress and James C. Cathey, Texas Parks and Wildlife Department

JAMES C. CATHEY

The dwarf pipewort (*Eriocaulon kornickianum*) is a species of concern to both the U.S. Fish and Wildlife Service and the state of Texas. This diminutive plant, the largest of which is only about 6 cm tall, occurs in small disjunct populations in Georgia, Arkansas, Oklahoma, and Texas. This plant occurs in muck bogs, which are wetland communities that are often located near stream heads or slopes whose soils are saturated with groundwater. These bogs, which quake under foot, have a layer of soil rich in organic matter and acidic waters. Bog sites are quite literally treasure troves, whose wealth is measured, in the incredible diversity of plants housed therein.

The number of known populations of dwarf pipewort has declined by over 50% in the last 20 years. A number of biological reasons have been blamed for poor reproduction, (i.e., low seed set, little seed bank, and restricted habitat). These influences reduce the ability of the dwarf pipewort to compete with other plants for a limited amount of resources. Furthermore, this species requires periodic fire to open up habitat by removing standing overtopping vegetation and debris. In recent years, the suppression of fire has further hampered the ability of the dwarf pipewort to compete well with other plants. Other actions by man, such as habitat destruction have negatively impacted this plant.

In Texas, the reported distribution of the dwarf pipewort is confused. Authorities have reported this plant in 8 eastern Texas counties. However, some specimens have been misidentified and mistakes on herbarium labels have been made. Therefore, critical review of all records from the literature, agency records, and herbarium specimens will be researched to clarify the distribution pattern for the dwarf pipewort. Additionally, field surveys for the dwarf pipewort will be conducted at previously reported sites to verify occurrence and new locations will be searched for the presence or absence of this plant. The ultimate goal of this project is to determine if the dwarf pipewort is declining, and if so, this plant would warrant special consideration through sound land management practices.

Funding for this project is currently provided by Section 6 of the United States Endangered Species Act. Monitoring and research on this species will continue for an additional 2 years.

Survey, Monitor and Manage Selected Endangered, Threatened and Rare Plants, Birds and Mammals in the Trans-Pecos Ecoregion of Western Texas

Bonnie R. McKinney, Texas Parks and Wildlife Department

The major objective of this research was to determine the current status of several state and federally listed species found in the Trans-Pecos area of western Texas. Species include 3 cacti, Lloyd's mariposa (*Neolloydia mariposensis*), Davis' green pitaya (*Echinocereus virdiflorus var. davisii*), and Nellie Cory (*Coryphantha minima*), an endemic plant, Terlingua Creek cat's-eye (*Cryptantha crassipes*), and the black-capped vireo (*Vireo atricapillus*).

Lloyd's mariposa cactus was listed as a threatened species by the United States Fish and Wildlife Service (USFWS) on November 6, 1979, and as a threatened species in Texas on April 29, 1983. This species is known from the lower Big Bend Region of western Texas and from several localities in Coahuila and Nuevo Leon, Mexico. The focus of this study was to determine distribution, search for new populations, identify threats, and monitor this species. Lloyd's mariposa cactus has a wide distribution in the lower Big Bend Region, extending into northern Coahuila, and Nuevo Leon, Mexico. Confirmed

locations of populations in western Texas include Brewster and Terrell counties. The plants are found on federal lands in Big Bend National Park (BBNP), state lands on the Black Gap Wildlife Management Area (BGWMA), and private ranches in the aforementioned counties. Lloyd's mariposa cactus occurs in the Chihuahuan Desert scrub biotic community, on hot limestone ridges, slopes, and desert flats. Shrubby plants and perennial xerophytes are dominant vegetation. Study plots were established and monitored for 3 years to determine growth, reproduction, causes of mortality, and to define any threats to the populations. Study results indicate that Lloyd's mariposa cactus occurs in very high densities in suitable habitat. The species does not appear to be threatened by collecting, and large populations occur on state and federal lands. Management recommendations include negotiations with the U.S. Fish and Wildlife Service to start formal delisting process with continued periodic monitoring, and initiating formal surveys in northern Mexico to determine distribution and population size.

BONNIE R. McKINNEY

Davis' green pitaya and Nellie cory cactus were both listed as endangered by the USFWS on November 7, 1979. These miniature cactus are found only in the semi-desert grasslands of the Chihuahuan Desert and are restricted in distribution to the Cabablos-novaculite geological formation in the Marathon Basin area of Brewster County. This Novaculite formation is extensive covering an estimated 60-square mile (155-km^2) area located on private ranches. Landowner permission was granted to survey known populations, establish study plots, and search for new populations in 1998. Study results indicate a very large population of both species scattered widely over the Novaculite area in typical habitat. Study plots have revealed healthy growth and reproduction. Threats identified by the USFWS in the Recovery plan included trampling by cattle and collecting of plants. Because of the steep slopes and the sharp Novaculite, trampling of these cacti by cattle is considered minimal. All ranches are aware of both species and have taken steps to insure that collecting does not take place by posting 'no trespassing' signs, locking gates and not allowing any collecting to take place. Recovery criteria set forth in the USFWS Recovery plan have been met. Recommendations include starting the formal delisting process with continued periodic monitoring.

Terlingua Creek cat's-eye was federally listed as endangered on September 30, 1991. This endemic plant is known only from a small area in Brewster County. The area is geologically unique, composed of silty limestone with dull yellow platelets. Vegetation is scarce and bentonite hills dot the landscape. All known populations ($\geq$5,0000 individuals) are located on private lands in an area with many absentee landowners, unclear land titles, and property development. The biggest threat to Terlingua Creek cat's-eye is habitat destruction. Off road use by trespass vehicles, dune buggies and dirt bikes, and local mining activities all pose threats to the populations. Conservation and management recommendations include: 1) the collection of seeds for propagation, 2) searching for sites with similar geologic features to be evaluated as possible areas where the plants could be established and protected, and 3) continued periodic monitoring of known populations.

The black-capped vireo is listed as a federal and state endangered species and appears to reach the peripheral edge of its western range in the United States in the lower Big Bend Region of western Texas. Two populations have been located in western Texas and monitored for a number of years. One population containing $\geq$35 individuals is located in Big Bend National Park (BBNP) and the second population containing $\leq$10 individuals is located on the Black Gap Wildlife Management Area (BGWMA) east of BBNP. New populations have been searched for in West Texas with no success. Surveys in western Texas on state and private lands follow the protocol set forth by the USFWS. The vireo population in West Texas continues to remain small ($\leq$50 individuals), and appears to be confined to the lower Big Bend Region. These two small populations, which are monitored annually, may represent the edge of a much larger population in Coahuila, Mexico. Both populations in West Texas are located where the Mexican mountains enter the lower Big Bend Region, and form a natural corridor for movement and range expansion. Management recommendations include: 1) continued periodic monitoring, 2) conduct a cooperative project with a Mexican university to survey for presence/absence of black-capped vireos on private lands in Coahuila and Nuevo Leon, Mexico, 3) continue to provide landowners with information on habitat management, and 4) obtain funding to produce an educational brochure on black-capped vireos in Spanish for use in Mexico.

Funding for all projects was provided by Section 6, USFWS and Texas Parks and Wildlife Department.

Bald Eagle Nesting and Wintering Surveys

Brent Ortego, Len Polasek, Kevin Herriman, and Annice Storey, Texas Parks and Wildlife Department

TPWD PHOTO

Nesting bald eagles (*Haliaeetus leucocephalus*) have been monitored in Texas since the 1960s, at which time there were an estimated 3 known active nesting territories. In the 1970s, efforts were increased to find and document active nesting territories. From 1975 to 2000 the number of known active nests increased from 7 to 78, respectively. This increase was due to a combination of an increasing bald eagle population, an increase in agency effort, and an increase in public awareness and reporting of nests.

The nesting population of bald eagles is estimated using aerial and ground surveys of known and newly reported bald eagle nests. Surveys are conducted annually January through April. Data collected includes nest location, general site description, activity status, productivity, and estimated hatching date. These data are used extensively to aid in the preparation of environmental impact assessments for development projects in areas of known nesting activity.

Annual surveys of non-nesting bald eagles are conducted on 22 standardized locations during mid-January. Survey sites include the Laguna Atascosa National Wildlife Refuge, the Attwater Prairie Chicken National Refuge, the Garwood/Eagle Lake Rice Prairies, and 19 reservoirs throughout North, Central, and East Texas. These surveys are coordinated by Texas Parks and Wildlife Department personnel but utilize volunteer labor. Volunteers conducted surveys on 20 of the 22 sites in 2000 and reported 218 bald eagles. During January 2000, the greatest numbers were found on Lake Palestine and Lake Texoma with 39 and 32 eagles, respectively.

These are ongoing annual surveys funded by the Texas Parks and Wildlife Department through Federal Aid in Wildlife Restoration Grant W-125-R-11.

Historical and Local Processes Determining the Current Status of the Alligator Snapping Turtle in Texas

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D. Craig Rudolph and Richard Conner, U.S. Forest Service, Southern Research Station
Ricky W. Maxey, Texas Parks and Wildlife Department

The purpose of this ongoing study is to determine the status and distribution of the alligator snapping turtle (*Macroclemys temminckii*) in Texas and to identify historical and ecological factors associated with the distribution of this species. Historical distributions were obtained by examining museum records and published literature. We also investigated the present distribution of alligator snapping turtles by trapping at various locations in Texas.

RICKY W. MAXEY

When possible, each site was surveyed for alligator snapping turtles for 45 trap nights (15 traps for 3 days) and various habitat parameters were measured at each site. These habitat parameters were measured at individual trap locations and at points 66 feet (20 m) above and below each individual trap location. Alligator snapping turtles were captured using 3.9-foot (1.2-m) diameter hoop nets baited with fresh fish. Bait was changed daily. Once captured, turtles were permanently marked using stainless steel pan-head screws placed in the rear marginals of the carapace. Each marginal corresponded to a specific number and by marking different combinations of marginal scutes; each turtle was assigned a unique identification number. Captured turtles were also sexed, weighed, and various morphological characters measured. Morphological characters measured were straight-line carapace length, maximum carapace length, carapace width, plastron length, maximum depth of shell, and skull width.

We have also created an alligator snapping turtle questionnaire that is being distributed to state natural resource personnel, which may give us additional site records and morphological measurements for alligator snapping turtles. Museum and published records indicate that alligator snapping turtles are known from the Sulphur, Cypress, Sabine, Neches, Neches-Trinity, Trinity, San Jacinto, San Jacinto-Brazos and possibly the Red River drainage. There is a record from Red River County but we do not know if this turtle is from the Red or the Sulphur River drainage. A record from the San Antonio River in the 1800s is probably a mistake. A fossil record of the alligator snapping turtle has been found in the Brazos River. There is a possible Brazos River site record (a photograph) of an alligator snapping turtle. A fisheries biologist from Texas A&M University took the photograph but we have not yet obtained it. This would be significant in that the record would extend the present range of alligator snapping turtles to the Brazos River drainage.

We have surveyed all the major river drainages where alligator snapping turtles historically occurred except for the San Jacinto. Thus far, we have captured 31 alligator snapping turtles (0.65 turtles/10 trap days) and collected 1 road-killed specimen that will be deposited in the Texas Cooperative Wildlife Collection at Texas A&M University. Where surveys have been completed, we have captured alligator snapping turtles in all drainages where they historically occurred except for the Sulphur and possibly the Red River drainages. The Sulphur River drainage (White Oak Creek) was inadequately surveyed due to theft of most of our hoop nets. Also, we did not catch alligator snapping turtles in the Red River drainage and we have not yet determined if a recent record is from the Red or the Sulphur River. There were no turtles caught in the Navasota River, part of the Brazos River drainage, outside the known range of alligator snapping turtles. Also, alligator snapping turtles have been captured at sites above and below Livingston Reservoir, Texas in the Trinity River drainage.

We documented 3 new county records for alligator snapping turtles during the first season of this 3-year survey: Angelina, Nacogdoches, and Leon counties. The Angelina and Nacogdoches County records fill a gap within the known range. Leon County, although a slight westward expansion of the turtle's range, lies within the Trinity River drainage where alligator snapping turtles were historically found. The alligator snapping turtle weights ranged from 1.7 to 102.5 lb (0.8 to 46.5 kg); there were 13 males, 15 females, and 4 juveniles. The smallest turtle was caught in Bingham Lake (an oxbow lake), Tyler County, Texas and the largest turtle was captured in Caddo Lake, Harrison County, Texas. We have also instrumented five alligator snapping turtles with radio transmitters in Bonaldo Creek, Stephen F. Austin Experimental Forest, Texas. Bonaldo Creek is a third order stream with shallow runs and deep pools. The creek's waters eventually enter the Angelina River via Loco Bayou. We are currently collecting data on home range and habitat selection. Thus far, most turtles have moved up stream nocturnally and spend the day in pools or near structure such as logs or bank undercuts.

Funding for this research was provided in part by Section 6 Grant E-1-12 from the U.S. Fish and Wildlife Service Endangered Species Program.

Regional Variation in Ecology and Demography of the Texas Tortoise

Richard T. Kazmaier and Eric C. Hellgren, Oklahoma State University
Donald C. Ruthven III and Sam F. Patten, Texas Parks and Wildlife Department

RICHARD T. KAZMAIER

Assessment of regional variation in demography and ecology is critical for the development and implementation of management plans, particularly for threatened or endangered species. The Texas tortoise (*Gopherus berlandieri*) has a distribution within the United States that is restricted to southern Texas, and the species is currently protected as a threatened species within the state. Additionally, there has been increasing concern about the potential effects of habitat fragmentation on this poorly studied species, particularly in the rapidly changing Lower Rio Grande Valley (LRGV). In light of observations of regional variation in body size across its relatively small geographic range within Texas, we initiated a long-term study in 1999 to investigate variation in demography and ecology of this protected species with respect to geographic location and habitat fragment size.

Texas tortoises have been monitored on Chaparral Wildlife Management Area (WMA) since 1990, with over

3500 captures of over 2350 individuals being recorded. Because of the large, existing database on Texas tortoise demography and ecology from Chaparral WMA, this site serves as our baseline for comparisons with other areas. We have begun selecting additional sites throughout the geographic range of the Texas tortoise for examination of regional variation. To date, data have been collected from 8 units of the Las Palomas WMA in the LRGV, and an additional 4 units of Las Palomas WMA have been chosen for the initiation of data collection in 2001. Ultimately, we hope to gain access to additional sites on Federally and privately owned properties across the range of the tortoise and of various fragment sizes. At each site, tortoises are captured when encountered, and sex, mass, and shell length are recorded. When possible, tortoises are also aged using growth lines on the shell. After recording data, tortoises are marked with a unique code to allow identification of individuals upon recapture.

To date, 333 captures of 267 individuals have been obtained from sites in the LRGV. Examination of body size data confirms that regional variation in body size does occur, with size decreasing as you move northwest from Brownsville. Tortoises on Chaparral WMA have the smallest average body sizes ever reported for Texas tortoises [5.5 inches (139 mm) for females; 5.8 inches (147 mm) for males], while tortoises from Arroyo Colorado Unit of Las Palomas WMA were the largest from our sample [6.4 inches (162 mm) for females; 7.4 inches (188 mm) for males]. Even within Cameron County, body sizes vary greatly among some sites. In terms of body size, tortoises are also more sexually dimorphic in the LRGV relative to Chaparral WMA. Although adult sex ratios on Chaparral WMA do not differ from 1:1, many sites in the LRGV appear to exhibit male biased sex ratios. Sufficient age data is only available for comparisons of Longoria Unit of Las Palomas WMA with Chaparral WMA, but preliminary comparisons of age structures between these 2 sites suggest dramatic differences in age structure between the areas. Tortoises on the Longoria Unit are much older than tortoises on Chaparral WMA, but the age distribution on Longoria is erratic and few young tortoises were found. This suggests that despite reaching old ages on Longoria, recruitment may be sporadic.

Our preliminary data suggests unprecedented variation for a tortoise in demography and ecology across a relatively small geographic area. Data collection continues and casual explanations for these differences will only come after more sites are sampled of varying sizes and across the range of this tortoise. At the vary least, the observed differences in age structure suggest that different management approaches may be needed across its range.

Status of the Peregrine Falcon in Western Texas and Adjacent Northern Mexico

Bonnie R. McKinney, Texas Parks and Wildlife Department

The American peregrine falcon (*Falco peregrinus anatum*) was listed as endangered by the United States Fish and Wildlife Service (USFWS) on October 13, 1970 and officially delisted on August 20, 1999. In the draft addendum to the Recovery Plan, the USFWS recommended the delisting because recovery criteria were being met. Recovery objectives of 1.25 young fledged per occupied site are required to meet recovery criteria. The small population of peregrine falcons breeding in Texas in the Trans-Pecos, and along the Rio Grande corridor in Texas and Mexico have experienced erratic reproductive rates for 26 years.

The research objectives focus on surveying for new breeding areas, potential habitat, surveying wintering areas, monitoring productivity, analyzing eggshells and prey items for pesticide and heavy metal contamination, protecting vulnerable breeding areas, and furthering knowledge on population dynamics. The population has been monitored since 1974, and survey protocol is the same used by other southwestern states, with modifications to fit the unique canyon system in western Texas and northern Mexico.

Reproductive rates of peregrine falcons in the Trans-Pecos area of western Texas, and adjacent northern Mexico, particularly along the Rio Grande corridor continues to be erratic with nest failures, failure of young to fledge, and deserted sites being common occurrences. Numbers of breeding pairs have increased since 1975. However, this may be attributed to the expansion of the survey area. When falcon surveys began in 1975 only the 3 major canyons, Santa Elena, Mariscal, and Boquillas, in Big Bend National Park (BBNP) was surveyed. Today surveys encompass over 300 river miles (482 km), and a vast area distant from the Rio Grande.

Combining data for the 26 years during which falcons have been monitored, there was a decrease in the number of pairs in 1988, and the number of pairs peaked in 1995 with 15 pairs on territories. In 1996, a decline was apparent and the decline continued through the 2000 field season.

The total number of young observed in eyrie scrapes climbed from 0 in 1975 to a high of 17 eyasses in 1997. A sharp decline began in 1998. In 1999, only 7 young were produced from 10 pairs of adults; very low fledging success of 3 young added to the decline. The 2000 field season was somewhat encouraging. A total of 18 sites

were monitored; 9 sites produced 12 young and the young all fledged. Additionally, 2 new breeding sites were located in northern Mexico in the Maderas Del Carmen.

Reproduction is still erratic in this population and recovery criteria set forth by the USFWS are not being met. This geographically isolated population of peregrine falcons should remain on Texas endangered species list, with no take for falconry west of the Pecos River. Other management recommendations include: 1) continued monitoring on an annual basis, 2) eggs should be collected for mercury (Hg) analysis, 3) satellite telemetry should be equipped on 3-4 juveniles to determine dispersal destinations from natal areas, 4) develop cooperative research with Mexico, and 5) continue to work cooperatively with private landowners in Texas and Mexico.

This project received funding from Section 6, Texas Parks and Wildlife and private individuals in Texas and Mexico.

Effects of Coyotes on Distribution, Productivity, and Survival of Swift Foxes in the Texas Panhandle

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Rick Gilliland, USDA-APHIS, Wildlife Services

JAN KEMLER

The objective of this study is to determine how coyotes (*Canis latrans*) affect the distribution of swift fox (*Vulpes velox*), including reproduction, survival, home range size, and spatial and temporal activity patterns in relation to habitat type.

In 1996, TPWD conducted a systematic search of 25 counties in the Texas Panhandle to determine the current minimum distribution of swift fox in Texas. In that effort, swift fox presence was detected in only 2 of the 25 counties (Dallam and Sherman counties). A program was initiated in 1997 to monitor population trends at each site annually. Spotlight surveys were employed along with live trapping and ear-tagging. A cooperative research project was initiated in 1998. Fieldwork (capture and radio-collaring of swift fox) began in mid August of that year.

In August of 1998, a research project was initiated to evaluate the effects of coyotes on swift fox as well as to begin describing the home range habitat characteristics of swifts in Texas. Two 36-square-mile (9-km^2) study sites were established. Both study sites were centered upon each of the Dallam and Sherman sites. The Dallam site is centered on a portion of the Rita Blanca National Grassland and is comprised of open, native short grass prairie rangeland. The Sherman site is comprised of interspersed rangeland, cultivated fields, and mid/tall grass-dominated Conservation Reserve Program acreage on privately owned lands. Preliminary results from radio telemetry data, covering the period between September 1998 and January 1, 2000, show that swift fox on the Sherman site had an average home range size of 3.9 ± 0.4 square miles (10.2 ± 1.1 km^2). Coyotes on the Sherman site had an average home range size of 3.4 ± 0.5 square miles (8.9 ± 1.2 km^2). On the Dallam site Swifts had an average home range of 2.9 ± 0.3 square miles (7.6 ± 0.9 km^2), while coyotes exhibited an average home range of 7.2 ± 0.4 square miles (18.7 ± 1.0 km^2).

The annual survival rate on the Sherman site was 70% for swift fox and 51% for coyotes. On the Dallam site, annual survival rate was 48% for swift fox and 74% for coyotes. In 1998-1999, there were 18 confirmed swift fox mortalities (11 from coyote predation, 4 from vehicle collision, and 3 undetermined). Most coyote predation (8 of 11) occurred at the Dallam site, whereas all vehicle mortalities occurred at the Sherman site. There were 7 confirmed coyote mortalities during the 1998-1999 period, and all were caused by human hunters. Preliminary results show that swift fox had higher survival rates and greater numbers of dispersing juveniles on the Sherman site where there were lower densities of coyotes.

Funding for this research was provided in part by Section 6 Grant E-1-12 from the U.S. Fish and Wildlife Service Endangered Species Program.

Habitat Use, Diet, Home Range and Seasonal Movement of Resident and Relocated Black Bear in Western Texas

Bonnie R. McKinney and Michael T. Pittman, Texas Parks and Wildlife Department

Natural recovery of American black bears (*Ursus americanus*) into historic range in western Texas has occurred. The ecology of the black bear in a lower Chihuahuan Desert habitat has not been studied. Previous research in the southwestern United States and in northern Mexico has focused on pine-oak woodland and upper Sonoran Desert habitats. Research is being conducted on the Black Gap Wildlife Management Area (BGWMA) in southeastern Brewster County, Texas. The area contains roughly 106,000 acres of semi-arid desert shrub. The lowest elevation at 1588 feet (484 m) occurs along the Rio Grande, and the highest elevation at 4,603 feet (1403 m) occurs in an arid canyon complex that runs southward toward the Rio Grande and northern Coahuila, Mexico.

Research began in September 1998 in hopes of obtaining data for the following objectives: 1) determine survival, mortality, dispersal, and reproduction of a newly established black bear population, 2) estimate density, 3) determine parental lineage of transient, resident and relocated black bears by mtDNA and microsatellite analysis, 4) estimate home ranges and seasonal movement, 5) evaluate diet by scat analysis, and 6) improve TPWD knowledge of the technical requirements and support needed to conduct black bear research.

Eleven black bears have been captured 18 times in 798 trap days. Capture occurred in 4 major habitats: riparian desert (18%), yucca slope (6%), oak chaparral (41%), and desert scrub (35%). Capture methods used were barrel traps (58%), Arizona Ez-Catch leghold snares (24%), and culvert trap (18%). Eleven bears have been radio-collared: 5 adult males, 2 adult females with 1 and 2 cubs respectively, 3 yearling males, and 1 yearling female. Recaptures (n=7) included 5 males and 2 females. Captured black bears were immobilized, fitted with radio collars, and ear-tagged. A series of morphological data was collected. Fat levels were estimated and each bear was weighed. One upper pre-molar (UPM1) was extracted for cementum annuli analysis. Breakaway cotton canvas spacers were fitted on radio collars to prevent injury or discomfort to growing bears.

One adult male (G-2) was removed from the study site in 1998 because of private property damage. One adult male was captured in Alpine and relocated to BGWMA; the bear remained in the area for 2 days and moved back to the Alpine area.

No bears slipped collars, and no mortalities have been documented to the present time. Cub survival (n=3) is currently 100%. The heaviest black bear weighed 285 lbs. (129.27 kg) and the lightest weighed 29 lbs. (12.7 kg).

A total of 405 locations for 10 radio-collared bears have been obtained. Among them, 32% were ground locations, 67% were aerial, and 13% were visuals. Home ranges were estimated by calculating inclusive 95% minimum convex polygons (MCPs) using ArcView Animal Extension. Females (n=2) cumulative home ranges averaged 24.3 square miles (63 km^2). A female (F108) was excluded from home range calculation due to late capture date. Cumulative home ranges of adult males (n=4) averaged 64.4 square miles (166.87 km^2). Male yearlings (n=3) cumulative pre-dispersal home ranges averaged 7 square miles (18.3 km^2). Two subadult males dispersed in 1998 and 1999; their dispersal movements averaged 405.9 square miles (1051.5 km^2). The third yearling male dispersed in late September 2000; his dispersal is not complete at this time. Our preliminary data shows that pre-dispersing yearlings have the smallest home ranges, followed by females, with adult males having the largest home ranges.

Preliminary density estimates were obtained using descriptive statistics and 95% MCPs of all radio-collared resident bears (n=8). Bear F-108 and G-2 were excluded from the density estimate for reasons previously mentioned. Eight resident bears used a total of 437.45 square miles (1133 km^2) based on 315 data points, resulting in an estimated density of 1 bear/0.007 km^2 or 142 km^2/bear.

Age classes ranged from <6 months-old cubs to a 16 year-old male. The known resident population was comprised of 30% adult males (n=3), 30% adult females (n=3), 20% yearlings (n=2), and 20% cubs (n=2).

Bear scats were collected year-round (n=452), labeled, air-dried and point frame analyses run on each scat. A total of 24 food items have been identified in the diet. Results indicate several major food items comprise a large portion of the diet. Of all scats collected, 81% contained Texas persimmon (*Disopyros texana*), 71% contained sandpaper oak acorns (*Quercus pungens*), 69% contained Spanish dagger hearts (*Yucca torreyi*), 42% contained several species of insects, 27% contained sotol hearts (*Dasylirion leiophyllum*), and 20% contained mesquite beans (*Prosopis glandulosa*).

Parental lineage of captured bears will be determined using mtDNA and microsatellite analysis. Samples from BGWMA were combined with Big Bend National Park samples to provide a large sample size for genetic typing. Results will be furnished to TPWD upon completion of work

by Dave Onorato, Oklahoma State University. We thank Dave and Dr. Eric Hellgren for conducting the analysis.

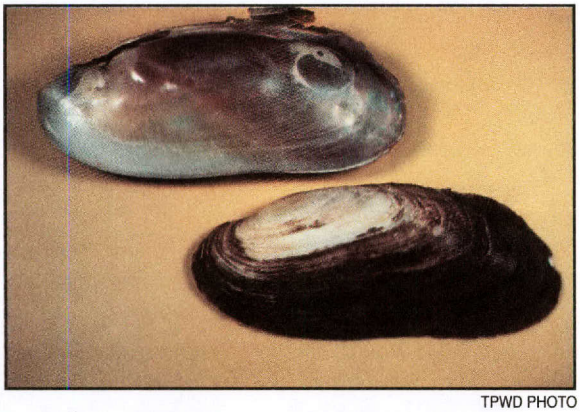
Results from this study have provided the first detailed ecological information on a breeding black bear population in a lower Chihuahuan Desert environment in the United States. Our research also documented the first case of dispersal of black bears from Texas to Mexico, and the first case of black bear dispersal in a West Texas population.

The black bear population in West Texas is slowly expanding northward from the lower Big Bend Region. Landowners are coexisting with the bears while carrying on traditional ranching activities. It is hoped that future research will provide more information that can be used to improve the management of black bears on private lands in West Texas.

Funding for this project is provided by Texas Parks and Wildlife Department.

Abundance, Distribution, and General Biology of Texas Hornshell and Other Unionids in the Rio Grande, Texas

Robert G. Howells, Texas Parks and Wildlife Department



TPWD PHOTO

The purpose of this project was to survey the waters of the Rio Grande, Texas to determine abundance and distribution of Texas hornshell (*Popenaias popei*) and other local unionids and gather data on general biology of these species.

Data from published and unpublished historical literature and museum records were examined and combined with field surveys conducted by TPWD from 1992 through 1999. In the 1999-2000 study segment, fieldwork focused on surveys of the Pecos River. No living bivalves were found in this river. Unidentifiable shell fragments were found on the banks of Pecos River immediately downstream of Red Bluff Reservoir Dam on the Texas-New Mexico border. However, these were subfossil and had probably been dead for many decades. Further downstream on Pecos River, between Pandale and Painted Canyon, several Texas hornshell shells and valves were obtained. Again, all were considered to have been relative-long dead (years, if not decades).

Salinity measured in the upper reaches of the Pecos River, Texas suggests that the area can no longer support unionids due to at least periodical saline waters. Indeed, the absence of Asian clam even in the shallow waters of Red Bluff Reservoir, with little or no salinity at the time of examination, probably reflects inundation by more saline waters during periods of high water levels (e.g., a salt-wedge effect).

From the onset of field work in this study in 1998 through the present, sites have been sampled from the mouth of the Rio Conchos upstream of Presidio to locations below Brownsville including the Pecos River from the New Mexican state line and all of the major Texas tributaries to the Rio Grande. Results have not been encouraging. Texas hornshell and Salina mucket (*Potamilus salinasensis*) shells that had not been dead long were found between Big Bend and the Pecos River, but no living specimens were located. Mexican fawnsfoot (*Truncilla coganta*) has not been documented since 1972 and its continued survival is questionable. False spike (*Quincuncina mitchelli*) and Rio Grande monkeyface (*Quadrula couchiana*) have not been found in many decades and have likely been eliminated from the system. Several more widely ranging unionids were present in Amistad and Falcon reservoirs, but have been dramatically reduced by recent dewatering, and were also found to persist at several sites in canals and other waters in the Lower Rio Grande Valley.

Attempts will be made in early 2001 to access sites below Amistad, Falcon, and Anzalduas dams that have yet to be examined and might be among the remaining places Rio Grande unionids could still endure. However, access, safety, and water-release patterns have proven challenging to sampling efforts from the outset of this research and are likely to remain problematic.

Funding for this research was provided in part by Section 6 Grant E-1-12 from the U.S. Fish and Wildlife Service Endangered Species Program.

Tobusch Fishhook Cactus Annual Monitoring and Assessment of the Impact of Cactus Weevil Herbivory

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T. TURNEY

The goals of this project are to monitor Tobusch fishhook cactus (*Ancistrocactus tobuschii*) populations on several state parks and private ranches, to determine population trends of the species at each site, and to determine the effects of cactus weevil (*Gerstaeckeria* sp. nov.) on Tobusch fishhook cactus.

Monitoring plots were established or revisited at 11 sites in 1996-2000 with a total of over 1000 live individuals. Cactus populations were monitored at Devil's Sinkhole State Natural Area, Kickapoo Caverns State Natural Area, Devil's River State Natural Area, Lost Maples State Natural Area, Garner State Park, Kerr Wildlife Management Area, highway rights-of-way in Kimble County (2 sites), and 3 private properties. A new monitoring site with 1 plot that had 7 individuals was added on a private property near Kickapoo Caverns State Natural Area in 2000 to track the effects of a controlled burn on Tobusch fishhook cactus. A new plot with 2 individuals was also added at Devil's River State Natural Area in 2000.

All species of *Gerstaeckeria* weevils are specialists on cactus. They lay eggs in cactus and pupate inside the crown. Pupal cells are formed and pupae may spend much of the season in diapause. Adults are primarily nocturnal and are especially active immediately after dark. The elytra are fused, and consequently, the insects are flightless.

To check for weevil activity during periods when observers could not be present, selected Tobusch fishhook cacti were shrouded with conical shrouds constructed of aluminum screen. Each shroud was approximately 12 inches (30 cm) high and 6 inches (15 cm) in diameter at the base. Forty-nine cacti were shrouded for a 2-month period during the summer of 1999. Shrouds were placed on 7 July and removed on 8 September. The shrouds were left in place for 2 months and then removed to avoid possible long-term deleterious effects on the cacti. The shrouded plants were visited on a weekly basis, and shrouds and plants were checked for the presence of weevils.

A combination of 2 methods was used to determine whether weevils were present inside a cactus. Sick and dead cacti were collected in the field and placed in ventilated plastic boxes approximately 12 inches x 7 inches (30 cm x 17 cm). A portion of the dead cacti was dissected and examined for presence of weevils. Some dead and sick cacti were kept in the boxes, misted once a week, and periodically checked for weevil emergence. On 1 November 2000 all but 3 cacti were dissected and examined for weevils.

A large terrarium consisting of a ventilated 24 inches x 12 inches (60 cm x 30 cm) plastic box was established on 8 May 2000 to observe adult weevils. Nineteen adults were color-coded with combinations of 2 Testers model paint so that they could be distinguished: 1color was applied to the posterior dorsal abdomen and the other placed slightly anterior to the first. In the terrarium, a living cactus was placed along with several Tobusch fishhook cacti spine masses and pieces of Tobusch fishhook cacti that contained pupa chambers. A living cactus, procured from Desert Botanical Garden, Phoenix, Arizona, was placed in the terrarium with weevils that were allowed free access to it. The terrarium was established on 12 May and shut down on 1 November. Observations were made day and night, approximately once every 3 hours for the first 2 weeks, less regularly thereafter, until terminated in June when no weevil activity was apparent. The terrarium was maintained until the cacti were dissected on 1 November.

Observations of this study and others suggest the following. Emergence of adult weevils during April and early May and lack of activity during the remainder of the year suggest a univoltine pattern. During the summer, the adult weevils ceased feeding on the surface of cacti and were often invisible in the plastic boxes. It is likely that they had mated and the females oviposited within the cacti. This indicates that emergence and mating during April-May are concurrent with active surface feeding. The females lay their eggs in an oviposition hole; the eggs hatch within the cactus and the grubs feed during the summer. At some point they stop feeding and migrate to pupa chambers, mainly in the crown of the cacti. Sometime during the winter, they metamorphose into adults and remain in the pupa chambers until emerging in April. Further observations will be made to confirm weevil activity as a function of season.

Funding for this research was provided in part by Section 6 Grant E-1-12 from the U.S. Fish and Wildlife Service Endangered Species Program.

Census and Monitoring of Black-capped Vireo in Texas

John Maresh, Texas Parks and Wildlife Department

The main purpose of this ongoing study is to determine current population status and distribution of black-capped vireo (*Vireo atricapillus*) in Texas recovery units 1, 4, 5, and 6 (as defined by the USFWS Black-capped Vireo Recovery Plan, 1991) and clarify population status in several counties in recovery units 2 and 3. Another goal is to determine differences in habitat structure and composition and habitat use between the different recovery units.

During the FY2000 season, presence/absence surveys were conducted on 16 localities in various parts of the black-capped vireo range. On 7 properties where vireos were detected, a rough estimate of the population was obtained. Also, several roadside survey routes from Section 6 Project 89, i.e., routes in Hood, Parker, and Somervell counties in North-central Texas, Bandera, Edwards, McCulloch, and Menard counties on the Edwards Plateau, Coke and Tom Green counties in the Concho Valley, and Terrell and Val Verde counties in the Southwest and Trans-Pecos, were re-surveyed.

Eight monitoring sites were established in 4 recovery units: Dinosaur Valley State Park (Somervell County), Fossil Rim Wildlife Center (Somervell County), and a private ranch (Somervell County) in Recovery Unit 1 (North-Central Texas); 2 private ranches (Edwards County) in Recovery Unit 2 (Edwards Plateau); a private ranch (Coke County) and Camp Barkeley National Guard Training Site (Taylor County) in Recovery Unit 4 (Concho Valley); and a private ranch (Terrell County) in Recovery Unit 5 (Southwest). Banding and color-marking efforts were initiated on 4 of the private ranches and at Camp Barkeley Training Site. Nest searching and preliminary determination of parasitism rates from cowbird (*Molothrus* spp.) were also conducted on these properties.

TPWD PHOTO

Funding for this research was provided in part by Section 6 Grant E-1-12 from the U.S. Fish and Wildlife Service Endangered Species Program.

HABITAT MANAGEMENT

Evaluation of Earthen Plugs in Restoring Coastal Marsh on the Lower Neches Wildlife Management Area

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William A. White and Robert A. Morton, Bureau of Economic Geology
Len G. Polasek and Jerry M. Mambretti, Texas Parks and Wildlife Department

The most extensive, contiguous loss of wetlands along the entire Texas coast has occurred along the Lower Neches River. From 1956-78, 9,417 acres (3,811 ha), 395 acres/yr (160 ha/yr), of vegetated open marshes were converted to open water. Loss of these wetlands is attributed to: 1) an aggradation deficit relative to sea level rise and sediment deposition, 2) subsidence associated with active faulting or induced by extraction of groundwater, oil, and gas, and 3) the direct and indirect effects of dredged canals.

Pipeline canals, navigation channels, and borrow ditches change the natural hydrology of coastal marshes by: 1) facilitating rapid drainage of interior marshes during low tides or low precipitation, 2) reducing or interrupting freshwater inflow and associated littoral sediments, and 3) allowing salt water to move farther inland during periods of high tide. Saltwater intrusion into freshwater marsh in turn causes loss of salt intolerant emergent and submergent aquatic plants and erosion and net loss of soil organic matter.

To examine the potential role of saltwater intrusion in marsh degradation, Texas Parks and Wildlife Department will plug 2 borrow ditches connecting the Gulf States Utilities Intake Canal with the Lower Neches Wildlife Management Area. Placed at marsh level, the earthen plugs will prevent daily tides from entering the marsh at this location, but will allow extreme high tides and storm tides to overtop the plug. Four 5-foot by 5-foot (1.5 x 1.5 m) box culverts under State Highway 87 will allow the ingress/egress of marine organisms and tidal waters to enter the 1,483-acre (600-ha) marsh. Specific objectives of this research are to examine: 1) water conductivity, salinity, temperature, and dissolved oxygen using continuous recording instruments, 2) morphology, distribution, and vegetative association of wetland sediments, 3) distribution, density, and cover of emergent and submergent vegetation, and 4) diversity, density, and size of aquatic macro invertebrates and fishes during spring, summer, and fall. Field data will be collected 1 year prior to plug construction and 2 years post-construction. Data will also be collected from a control marsh to compare habitat changes due to earthen plug effects versus habitat changes caused by natural events (storm tides, low or high annual rainfall, etc.). To examine if subsidence is continuing at a rate sufficient to produce marsh loss, the extent of emergent marsh will be compared between the periods of 1956-78 and 1978-1990s. Fieldwork began summer 1996 and will continue through spring 1999.

This project is being funded as a mitigation project by the Port of Beaumont.

Effects of Grazing on Herpetofauna and Small Mammal Diversity and Abundance in the South Texas Plains

Donald C. Ruthven III, David R. Synatzske, and James F. Gallagher, Texas Parks and Wildlife Department
Richard T. Kazmaier, Oklahoma State University
Joe K. Moody, Simpson College, Iowa

TPWD PHOTO

There has been much debate on whether grazing by domestic livestock adversely affects wildlife populations. Furthermore, there is little data on the effects of grazing on wildlife in many ecosystems including the South Texas Plains. Of particular concern, is how grazing may affect threatened and endangered species. Four state-threatened reptile species, the Texas horned lizard (*Phrynosoma cornutum*), Texas tortoise (*Gopherus berlandieri*), Texas indigo snake (*Drymarchon corais*), and reticulate collared

lizard (*Crotaphytus reticulatus*), are found throughout much of South Texas. Our objective is to investigate the effects of grazing by cattle on reptile and amphibian populations.

The study is being conducted on the Chaparral Wildlife Management Area (CWMA), located in the western South Texas Plains. Vegetation consists of mesquite (*Prosopis glandulosa*)-acacia (*Acacia* spp.) thorn woodland/savanna characteristic of South Texas. The CWMA has a long history of cattle grazing to include continuous grazing, as well as various rotational grazing programs. The CWMA was deferred from grazing during the period 1984-89. Cattle grazing resumed in 1990 at low to moderate stocking rates under a high intensity-low frequency rotational system, with stocker animals replacing the previous cow/calf operation and the annual grazing period reduced from 12 to 7 months. In late 1997, stocking densities were increased and are anticipated to remain relatively high through 2003. To monitor grazing effects, 4 drift fence/pitfall arrays were installed in each of two nongrazed pastures and two management units subjected to grazing by cattle. One nongrazed pasture had been deferred from grazing since 1976, the other since 1984. Drift fences were monitored during spring and summer 1997 through 2000.

Eighteen species of reptiles and six species of amphibians were encountered in pitfall traps. Species diversity was greater on grazed sites and total number of amphibians captured was greater on nongrazed areas. The only two species which showed differences between treatments were Great Plains narrowmouth toad (*Gastrophryne olivacea*) and Texas toad (*Bufo speciosus*), with the former being more abundant on nongrazed sites, the latter on grazed areas. The Texas horned lizard was the only threatened reptile, which can be effectively captured in pitfall traps. There was no treatment effect for horned lizard abundance, although total horned lizard captures (38) was relatively low. Merriam's pocket mouse (*Perognathus merriami*) demonstrated a strong interaction being more abundant on nongrazed sites during the first two years of the study and becoming more common on grazed sites during the last two years.

A large number of Great Plains narrowmouth toads encountered in one of the nongrazed pastures accounted for the lower species diversity and higher amphibian numbers on nongrazed treatments. This increase in narrowmouth toads may be a result of habitat differences rather than grazing effects. It appears that rotational grazing may have little effect on herpetofauna populations. However, because of the highly variable weather patterns characteristic of South Texas, monitoring will continue for several more years to accurately assess grazing effects.

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

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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 (*Phrynosoma cornutum*) in particular. Protected by Texas legislative mandate in 1967, the horned lizard has experienced apparent declines throughout its range, but particularly in Texas. Causative factors for this decline may include direct and indirect effects of the red imported fire ant (*Solenopis invicta*), habitat alteration for other land uses (e.g., agriculture, development), highway mortality, and commercial exploitation. The primary objectives of this study are to examine the effects of livestock stocking rate and prescribed burning on ecological characteristics of horned lizards (range size, habitat preferences, and population parameters) and expand a long-term ecological monitoring of horned lizards to include temporal responses of the horned lizard population to anthropogenic (e.g., increased public use, road-building, prescribed burning, disking, fire ant invasion) impacts.

The study area is the Chaparral Wildlife Management Area, a site of relatively high horned lizard abundance in southern Texas. Vegetation on the area is dominated by mesquite (*Prosopis glandulosa*)/mixed-brush communities characteristic of the South Texas Plains. Horned lizards were captured by hand during fortuitous encounters on roads and in the brush and in drift fence arrays. Selected individuals are fitted with radio transmitters. Transmitters were placed on individuals in each of 5 treatment sites: nongrazed/nonburned, grazed at moderate stocking rates/nonburned, grazed at moderate stocking

rates/burned, grazed at heavy stocking rates/nonburned, and grazed at heavy stocking rates/burned. Radio-transmittered individuals are relocated at least twice weekly. Summer was divided into two seasons, active and inactive, corresponding to relative activity of horned lizards. Microhabitat characteristics (e.g., grass, forb, or shrub cover, bare ground, understory height, etc.) for each location were determined. Range size, habitat selection, and survival rates of radioed individuals will be compared among treatments. Surveys were also conducted to determine densities of harvester ants (*Pogonomyrmex* spp.) and other invertebrates between treatments and within lizard home ranges. Harvester ant densities were estimated at activity stations baited with millet and other invertebrates are sampled utilizing pitfall traps.

A total of 78 home ranges from 57 lizards were used in the home range analyses. Total area used by horned lizards ranged from 0.05 to 27.3 acres (0.02-11.05 ha). The effect of burning on home range size interacted with season. In the active season, home ranges in the burned sites were smaller than those in the unburned sites, but were smaller and similar in size in both sites during the inactive season. Grazing did not have an effect on home range size. Male and female home ranges were not significantly different. Survival rates of horned lizards were significantly higher in the moderately grazed sites (60%) than the heavily grazed sites (36%). Burning did not have an effect on survival rates though survival rates tended to be higher in burned sites (52%) than unburned sites (38%). Two predation events were recorded, with a greater roadrunner (*Geococcyx californianus*) and a Texas indigo snake (*Drymarchon corais*) consuming radioed lizards. Suspected predators based on examination of horned lizard remains include northern grasshopper mouse (*Onychomys leucogaster*), avian (hawk/caracara), American badger (*Taxidea taxus*), and coyote (*Canis latrans*). Six lizards were followed through hibernation. Entry dates for hibernation ranged from 30 October to 31 December. Emergence dates ranged from 2 February to 19 March. All lizards completely buried themselves near the edges of shrub clumps at depths of 0.5 to 1 inch (1 to 3 cm) below the soil surface. Analyses indicate that harvester ant densities were highest in both burned treatments. Grazing had a variable effect on harvester ant abundance but was generally higher in heavily grazed sites than moderately grazed sites. Forbs increased with increasing disturbance. Burning and grazing also reduced litter and increased bare ground. Burning and grazing did not affect woody vegetation. Horned lizards utilized bare ground and herbaceous vegetation, as it was available, during the morning and evening for thermoregulation and foraging purposes. During afternoon, lizards selected woody vegetation and litter as a thermal refuge and to escape predators. Lizards were less dependent on herbaceous vegetation and more dependent on woody vegetation and litter during the inactive season compared to the active season. Burning and grazing did not affect habitat selection by horned lizards.

Funding for this project was provided by Texas Parks and Wildlife Department, the Wildlife Diversity Program, and the South Texas Research Fund.

The Effects of Three Range Management Practices (Livestock Grazing, Prescribed Burning, and Juniper Cutting) on the Population Ecology of Tobusch Fishhook Cactus at the Walter Buck Wildlife Management Area

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The Tobusch fishhook cactus (*Ancistrocactus tobuschii*) was federally listed as an endangered species on 7 November 1979 with confirmation action by the state of Texas on 29 April 1983. The cactus was originally described by W.T. Marshall in 1952 from a single plant collected on a private ranch east of Vanderpool, Bandera County, Texas.

Actual and presumed threats to Tobusch fishhook cactus include livestock grazing and trampling, insect parasitism, real estate developments, flooding and erosion of habitat, and collection by cactus fanciers. Most sites inhabited by the species are on private lands with various intensities of land uses that alter the plant community. It has been suggested that limited vegetative disturbances benefited the species by controlling competing grasses.

The control of regrowth Ashe juniper (*Juniperus ashei*) and manipulation of community succession can be accomplished by a combination of livestock grazing, prescribed burning, and juniper cutting. These range management techniques are practiced on thousands of acres of private lands and are in the operational plans of the Edwards Plateau Wildlife Management Areas (WMA) of Texas Parks and Wildlife Department. The objective of this study is to determine the measurable effects (none,

detrimental, or beneficial) of common range management practices on the Tobusch fishhook cactus.

Field work began on this study in September 1995 and will continue for 5 years through August 2001. Eight study sites were selected with 7 of the sites to receive 1 of the 7 possible treatment scenarios (cut, graze, burn, cut-graze, burn-graze, burn-cut, and cut-burn-graze) and site 8 to serve as a control.

A cattle herd was rotated through the grazing plots during winter, spring, and summer 1997. A prescribed burn was conducted on the burn plots in January-February 1997. Juniper was cut in the appropriate study sites during the period 1994-1996.

By the end of this report period, a total of 757 Tobusch fishhook cacti had been located and marked on the Walter Buck WMA. Cacti located within each study site were monitored using 1 m^2 quadrats. Forty-one other species of vegetation were identified occurring within the quadrats. The median number of plant associates per quadrat was 5. Average percent vegetative ground cover was calculated at 33% for the quadrats. The primary vegetative type found in the quadrats was grass, with Bouteloua spp. having the highest composite percent cover. Limestone bedrock and coarse rock fragments were the major physical features identified in the immediate area of Tobusch fishhook cacti habitat.

Overall mortality during the study period September 1995 to December 1999 was 52%, with observed mortality increasing slightly from 20.7% before treatment (September 1995 through December 1996) to a consistent 20% each year after treatments were applied. There was no difference in the annual mortality (20%) between the control population and experimental populations. The before- and after-treatment periods yielded significant differences in overall mortality between the control site and the graze, cut-graze, and cut-burn-graze sites and no significant differences between the control site and the burn, cut, burn-cut, and burn-graze sites. The burn/graze treatment site no longer contains any marked individuals.

The mean flowers/cacti was 1.74 before treatments were applied. There was no significant difference in flower production by cacti based on treatment. The average number of reproductive structures declined from 2.6/plant in February 1999 to 1.5/plant in February 2000. The decline in fruit production was attributed to drought conditions. Comparison of the mean diameter of cacti, measured using a hand-held caliper, at the control site and the treatment sites showed confounding results. Cacti at treatment sites and control sites both increased and decreased in size. Both mortality and size class differences were attributed to drought conditions, which complicated measuring the effects of the various treatments on the plants.

The evidence of predation on cactus plants has increased since 1998. The loss of 21 plants was associated with digging. In addition, six plants showed signs of damage from trampling or grazing. The primary reason for the high mortality is attributed to infestation by insect grubs.

This project is funded by Texas Parks and Wildlife Department.

Comparative Nest Ecology of Urban and Exurban Mississippi Kites in the Rolling Plains of Texas

Scott Sudkamp, Brad Simpson, and Jack Jernigan, Texas Parks and Wildlife Department

The Mississippi kite (*Ictinia mississippiensis*) is a locally common breeding bird in the Rolling Plains of Texas. In addition to traditional nesting areas in rangeland habitat, kites have readily adapted to nesting in urban settings in the past several decades. Nesting studies have been conducted on rural- and urban-nesting kites, but the two habitats have not been compared directly in terms of nest success. Recent research on other raptors has revealed differential success between urban and exurban nest sites. Furthermore, little is known regarding site fidelity and philopatry among kites in either habitat. This study will compare nesting success of kites in urban and exurban settings, and explore the degree to which kites demonstrate site fidelity and philopatry. Kite nests will be located and monitored throughout the breeding season at urban/exurban pairs in 2 disjunct areas of the Rolling Plains. Nest site characteristics will be measured, including nest tree species, DBH, and nest height, and laying cycle data will also be recorded.

During the 2000 nesting season, we observed and monitored nests on the Matador Wildlife Management Area (WMA) (Cottle County) and the Gene Howe WMA (Hemphill County) as our exurban sites. The towns of Childress (Childress County) and Canadian (Hemphill County) served as urban sites. Eleven active nests were discovered on the Matador WMA, while 6 were found on the Gene Howe WMA. In Childress, we observed 5 nests, and 10 nests were found in Canadian. Nests were followed through the incubation and brooding period, until chicks fledged or died. At approximately 3 weeks, chicks were captured by hand and banded with a locking numbered aluminum bands and a unique combination of colored plastic bands. Seventeen rural nesting kite chicks were banded (Matador WMA=13, Gene Howe WMA=4),

while 10 urban nesting chicks were marked (Childress=3, Canadian=7). This unique marking system will facilitate identification of birds in subsequent years and allow determination of site fidelity and philopatry. An attempt was made to capture and mark adult kites, but only 2 were captured, both in Canadian. Local searches will be made each year in an attempt to identify previously banded kites. Understanding nest site characteristics, site fidelity, and philopatry should aid wildlife biologists in reducing human/kite conflicts, as kites' aggressive nest defense behaviors often elicit strong negative reactions from the public.

Funding was provided by Texas Parks and Wildlife research fund.

Cultural Practices for Restoration of Native Plants in Bermudagrass Pastures

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The Post Oak Savannah of Texas extends from the Red River to Victoria, and occupies nearly 7 million hectares of land. Fifty-five percent of this area is pastureland, and most is tame pasture, composed of coastal or common bermudagrass (*Cynodon* sp.). Bermudagrass is an aggressive sod forming perennial that spreads via stolons, rhizomes and/or seed. Due to its rapid growth rate and sodgrass growth form, bermudagrass frequently forms stands with 100% vegetative cover. The conversion of large areas of the Post Oak Savannah to improved forage grasses, such as bermudagrass, has been a major reason for the decline of wildlife species in the region. Bobwhite quail (*Colinus virginianus*) and eastern wild turkey (*Meleagris gallopavo silvestris*) are two important game species that have been impacted by this vegetation conversion.

A minimum amount of bare ground is essential for bobwhite quail mobility and for gaining access to small seed that falls to the ground. For optimum quail habitat, sodgrasses should be replaced by bunchgrasses, which allow the maintenance of some bare ground patches. Young turkey poults also have difficulty moving through heavy herbaceous cover, and require areas with sparse or short vegetation for brood habitat. The lack of native tallgrass cover may limit quail and turkey nesting habitat in the Post Oak Savannah. Native grass and forb seeds provide an important food source for game birds, while the most commonly used forage bermudagrass varieties are sterile.

Bermudagrass requires regular fertilization to maintain high forage and hay production. Many cattle ranchers are currently looking for ways to reduce the financial and labor investment in their operations to maintain a positive cash flow. Native grasses and forbs can provide adequate protein and forage production to meet the needs of livestock without the need for continual fertilization and other cultural practices. A growing number of landowners are also interested in enhancing wildlife habitat on their property. With the passing of Proposition 11 in 1995, landowners can now retain their agricultural property tax valuation if their land use changes to active wildlife management, which can include habitat enhancement or restoration. This relatively new tax advantage provides an incentive for landowners to restore existing bermudagrass pastures back to native grassland.

This study is targeted at determining cost-effective strategies for establishing native grasses and forbs in bermudagrass pasture in the Post Oak Savannah. Two study sites within the Post Oak Savannah have been selected. These sites were chosen because they represent 2 important soil types in the Post Oak Savannah. At both sites, we will use several combinations of glyphosate herbicide rates and/or mechanical practices (mowing, disking) to suppress the bermudagrass and open the dense sod cover. We then will seed the areas with a mixture of native grasses and forbs. These sites will be monitored for 2 successive growing seasons in order to determine which methods will allow successful establishment of native plants. Four repetitions of all treatments will be conducted at both sites. We intend to determine the following: 1) the rate of glyphosate needed to effectively suppress bermudagrass for the purposes of establishing native plants, 2) whether mechanical practices alone will be successful in suppressing bermudagrass long enough to allow the establishment of native grasses, 3) which combinations of glyphosate and mechanical methods will be effective in achieving desired suppression of bermudagrass, 4) native species that can successfully establish and persist in bermudagrass sod.

Funding for this project is provided by the Cross Timbers Chapter of Quail Unlimited, Dow Agrosciences, and Texas Parks and Wildlife Department.

Ecology of Montezuma Quail at Elephant Mountain Wildlife Management Area

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The Montezuma quail (*Cyrtonyx montezumae*) has been studied and is best known from the extreme northern edge of its range in southern Arizona and New Mexico and Chihuahua, Mexico, but is poorly known in Texas. With the exception of a few notable early studies, there is relatively little information on their current status. These peculiar birds have declined in numbers and range over the past century. Most of the literature on their life history (i.e., nest success, recruitment, habitat requirements, food preferences, etc.) is sparse and 20-30 years old. Montezuma quail are habitat specialists (rare among quail) and highly specialized in their feeding behavior, which mainly involves digging for a variety of bulbs and tubers. They shift their diet from plant to animal (insect) food when insects become abundant after summer rains revive the vegetation. However, this shift in diet occurs only for a brief period (June-August). Life history information will be updated with the aid of radio-telemetry. The goal of this project is to establish baseline information on Montezuma quail. Specific objectives of this study include: 1) estimate density on Elephant Mountain Wildlife Management Area (EMWMA), 2) determine breeding season, 3) evaluate nest site selection, 4) estimate recruitment, nest success, and average clutch size, and 5) assess interactions between scaled quail (*Callipepla squamata*) and Montezuma quail (Texas Parks and Wildlife concurrent study). These objectives will be accomplished by capturing ≥30 Montezuma quail (M, F) and ≥10 scaled quail (M, F).

A pilot study was initiated in March 2000 at Elephant Mountain WMA to collect preliminary data on Montezuma quail activities through observations. Montezuma quail have been observed at various locations on the northern canyons and drainages and along the western rim of Elephant Mountain proper, including the surrounding lower table lands (less common). Scaled quail are common throughout the table lands and have been observed on benches and on top of Elephant Mountain proper, suggesting sympatric ranges. Therefore, the possibility for interactions exists.

The Montezuma quail covey size at Elephant Mountain varies from 5-8 individuals. Several coveys consisted of adults and juveniles, which suggest that recruitment is present. Vocalization increased with the onset of the breeding season (June) and continued through the end of July with calls heard primarily during the morning (0630-0900) and the evening hours (1900-2100). Scrapes and ground diggings for a variety of plant roots, including *Allium* sp., are typically found on forage grounds.

Nine bait stations (barrel feeders) baited with sorghum have been set up along the western rim of Elephant Mountain proper in grassy drainages and will be maintained throughout the year. Standard funnel traps have been placed and baited in the vicinity (<100 m) of each bait station. Funnel traps are also set in a drift fence (chicken wire) array setup throughout the mountain top in strategic locations. Captured quail will be radio-collared, released, and located at night while roosting (night netted) to capture surrounding un-collared quail. To supplement trapping efforts, quail will be located using bird dogs and captured using a loop fishing net.

Funding for this project has been provided by Texas Parks and Wildlife Department, Sul Ross State University Research Fund, Quail Unlimited-Houston Chapter, and San Antonio Livestock Exposition.

Vegetation Change Analysis and Floristic Inventory of Four Wildlife Management Areas in the Edwards Plateau Ecoregion

Jason R. Singhurst, Donnie Frels, Bill Armstrong, T. Wayne Schwertner, Gilbert Guzman, Tim Lawyer, and Vivian Ackerson, Texas Parks and Wildlife Department

Wildlife and natural resources management requires accurate and comprehensive information of resources and knowledge of species and communities. Rapid vegetation changes in Central Texas ecosystems over the past decades have been documented but for most part have not been temporally assessed on public lands. To properly assess vegetation change for Edwards Plateau wildlife management areas, a Geographic Information Systems (GIS) database based on Arc/Info and Imagine system is being developed. The GIS and vegetation classification systems in conjunction with remote sensing methodologies and computer-based automated field mapping techniques are being used to create up-to-date vegetation maps. A series of current and historical vegetation maps developed coupled with GIS analysis will provide a means for making informed management decisions for evaluating the extent and nature of vegetation changes between the 1930s and late 1990s. These newly developed vegetation maps will

serve as a baseline data set for monitoring the effects of prescribed burning programs, aid in the evaluation of potential wildlife habitat, and be used to assess the possible impacts of human activities.

The Edwards Plateau Ecosystems Management Project (EPEMP) was developed by TPWD in 1997 to manage and preserve the natural resources of wildlife management areas within the Edwards Plateau and Llano Uplift Ecoregions. This includes management of resources such as vegetation ecotypes, unique hydrologic features, edaphic soil, and karst environments. The EPEMP involves four Central Texas wildlife management areas (Kerr, Mason Mountain, Old Tunnel, and Walter Buck) for a total of 14,381 acres (5820 ha) in Kerr, Kendall, Kimball, and Mason counties.

This ongoing study is year 1 of a 2-year project that was initiated to classify existing vegetation and change over time. The digital data being developed will enable area managers to assess the impacts of land use and increase overall knowledge of wildlife management practices and ecosystem function of the wildlife management areas. This vegetation project reflects the primary importance of "natural/native" vegetation and concerns over the extent to which human activities may have altered the natural vegetation. Throughout time, such activities have included overgrazing, interruption of natural fire, initiation of prescribed burning programs, and a wide range of hunting and recreational uses. The degree and relative influences of some human activities may be adequately ascertained with a detailed map of actual vegetation resources.

In year 1, aerial photography on 10-year intervals from the 1930s to present (late 1990s) was acquired for each of the management areas. A total of 127 black and white aerial photographs were scanned, Ortho-rectified, color balanced, mosaic, and subset to the late 1990s Digital Ortho-photography Quadrangles (DOQ) using Imagine Inc.'s Ortho-base computer software module. In year 1, existing plant community mapping at Mason Mountain, Walter Buck, and Old Tunnel Wildlife Management Areas was conducted. In year 2, plant community mapping at the Kerr Wildlife Management Area and change detection analysis utilizing existing vegetation cover maps will be assessed for each of the 10-year interval aerial photo dates from the1930s to the 1980s. A series of change detection maps will be produced and vegetation classes will be attributed. Change detection analysis will also include a comparison of vegetation class percentage and acreage differences throughout temporal series and published in a technical report for each wildlife management area.

In year 1, the floristic inventories at Mason Mountain and Walter Buck Wildlife Management Areas was conducted. A total of 512 plant species at Mason Mountain and 347 plant species at Walter Buck were collected. These 2 inventories have been drafted into manuscripts to be submitted to Botanical Research Institute of Texas's SIDA Botanical Journal in spring of 2001. In year 2, Kerr and Old Tunnel Wildlife Management Areas will be assessed and manuscripts drafted to be published in spring of 2002.

This is an ongoing project funded by Texas Parks and Wildlife Department. Inceptive data aggregation for this project started in September 1999 and is scheduled for completion in August 2001.

The Impact of Invasive Exotic Grasses on South Texas Bird Communities

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Exotic flora and fauna have become a major threat to the natural resources of the U.S. over the past 50 years. Exotic species invasions rank behind habitat loss as the second greatest threat to endangered species in the United States. Exotic plant invasions often represent habitat loss so the invasion of exotic species may be an even greater threat than previously realized. It is estimated that introduced plants comprise 8-47% of the flora of most states. Many exotic plants were introduced to control erosion, provide timber resources, or as improved pasture grasses for livestock. Buffelgrass (*Pennisetum ciliare*) and Lehmann lovegrass (*Eragrostis lehmanniana*) represent some of the more common exotic African grass species introduced to South Texas. However, the palatability of some exotic grasses such as Lehmann lovegrass are poor compared to many native grass species. South Texas harbors a diverse population of breeding neotropical migrants, as well as resident subtropical species which reach the northern limits of their range in South Texas. The objective of our study is to investigate the effects of range dominance by introduced grasses on breeding bird population. We will test the hypothesis that habitats dominated by exotic grass result in reduced diversity of native herbaceous plants and support lower native bird species diversity and abundance compared to habitats dominated by native grasses.

Study areas include the Chaparral Wildlife Management Area and Piloncillo Ranch in Dimmit, LaSalle, and Webb counties. The vegetation on the study sites is

typical of the mixed brush shrublands found throughout the western Rio Grande Plains. Study sites will be classified into two groups and each group will consist of at least two replicate study sites. One group will be designated as an exotic grass study group dominated by Lehmann lovegrass and the second designated as a native grass study group. Study site replicates will be approximately 500 acres (202 ha) in size. Woody species composition and cover, as well as soil type will be similar on all replicates. Woody vegetation parameters will be estimated by utilizing the line intercept method. Herbaceous plant richness, diversity, densities, and cover will be estimated by utilizing Daubenmire frames. Avian species diversity and abundance will be determined on each replicate using point counts at randomly selected points. At least 5 point counts will be conducted on each replicate twice annually. Reproductive success of a select suite of bird species will be determined by conducting comprehensive nest surveys on each replicate during the breeding season. Every active nest located will be unobtrusively marked using a Global Positioning System (GPS) and then inspected at an appropriate interval in order to monitor the reproductive success of birds inhabiting the 2 study groups. Analysis of variance (ANOVA) will be used to compare vegetation parameters, bird species diversity and abundance, and species-specific reproductive success between replicates and study groups. Linear regression will be utilized to determine the strength of relationships between birds and vegetation attributes from each study group. Fieldwork is anticipated to begin in early 2001.

Funding is provided by Texas Parks and Wildlife Department.

Seasonal Variation in Herpetofauna Abundance and Diversity in the South Texas Plains

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Richard T. Kazmaier, Oklahoma State University

Management and conservation of reptiles and amphibians has generally fallen behind other species. To address the need for research on non-game species, state agencies have increased efforts to inventory flora and fauna and measure their responses to management activities. To insure uniformity in data collection, standardized methodologies to gather and analyze data have been developed. Timing of sampling can be critical to acquiring reliable data and sufficient sample sizes, especially when dealing with exothermic species. Sampling of herpetofauna is generally conducted during the warmer months of the year when activity is greatest. The South Texas Plains has exceptionally mild winters. These extended periods of warm temperatures may allow herpetofauna to remain active throughout most of the year. Currently, there are few data available on the seasonal activity patterns of reptiles and amphibians in southern Texas. The objectives of this study were to investigate seasonal abundance and activity of herpetofauna, determine which seasons might be best for sampling in the South Texas Plains ecosystem, and whether herpetofauna might be susceptible to direct mortality from mechanical and pyric habitat management activities based on their activity patterns.

The study was conducted on the 15,200-acre (6,154-ha) Chaparral Wildlife Management Area (WMA) in the western South Texas Plains. Vegetation is dominated by the mesquite (*Prosopis glandulosa*) and acacia (*Acacia* spp.) shrubland/savannas characteristic of the South Texas Plains. Reptiles and amphibians were monitored in 14 drift fence arrays distributed throughout the study area. Arrays were monitored for 2-week periods each during the 4 seasons from summer 1996 to spring 1997.

Species richness and diversity varied by season with greatest values in spring and summer. Several species demonstrated seasonal differences in abundance. Texas spotted whiptail (*Cnemidophorus gularis*) was most commonly encountered during summer and southern prairie lizard (*Sceloporus undulatus*) was most abundant in fall. Southern prairie lizard was the only species encountered during winter collections. Southern prairie lizards were only captured on days in which the high temperature exceeded 70°F (21°C). Snakes were generally most active during spring. Amphibians were most active during summer. Frequent checks and adequate shelter are essential in minimizing predation and weather -induced mortalities. Immobility during winter may expose reptiles and amphibians to direct harm from vegetation management activities, and research to investigate the effects of habitat management practices on herpetofauna is warranted. For estimating species richness, sampling during spring or summer appears sufficient. Sampling from spring through fall is recommended for acquiring adequate estimations of species diversity, abundance, and fecundity.

Response of Forbs to Various Grazing Intensities by Cattle in the South Texas Plains

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Grazing by domestic livestock is the most common land use practice throughout much of the western United States. Consequently, overgrazing by livestock has been criticized as a major factor leading to woody plant invasion and overall deterioration of rangelands. To improve forage conditions on grazed rangelands and mimic natural grazing pressures, various rotational and high intensity-low frequency grazing strategies have been developed. Most studies investigating the effects of grazing systems have focused on the grass component of herbaceous vegetation communities. In South Texas, forbs are an important dietary component for game species such as white-tailed deer (*Odocoileus virginianus*) and bobwhite quail (*Colinus virginianus*), as well as nongame species including the Texas tortoise (*Gopherus berlandieri*). The objectives of this study are to determine the responses of forbs to various intensities of grazing by cattle in South Texas.

The study is being conducted on the Chaparral Wildlife Management Area in Dimmit and La Salle counties. Vegetation is typical of the mesquite (*Prosopis glandulosa*)-mixed brush communities found throughout the South Texas Plains. Study sites consisted of four moderately grazed plots grazed at an intensity of 10 Animal Unit Days (AUD)/acre/year (25 AUD/ha/year), 4 heavily grazed plots grazed at an intensity of 15 AUD/acre/year (38 AUD/ha/year), and 4 plots excluded from livestock grazing since 1976. Grazing was conducted from 1997-2000 during October through April utilizing stocker class cattle weighing between 500-600 lbs. (227-273 kg). Forb density and frequency was estimated using 1.1 feet^2 (0.1 m^2) frames during spring 2000.

Forb species richness and total forb densities were similar between treatments while diversity was greater on both grazed treatments compared to control plots. Several important forage and seed producing annuls demonstrated treatment effects. Croton (*Croton* spp.), golden dalea (*Dalea aurea*), and tallow weed (*Plantago hookeriana*) were more common on both grazing treatments than the control. Croton densities were greater on the heavily grazed plots than the control, while densities were similar between the grazing treatments. Densities of rough buttonweed (*Diodia teres*) were greater on moderately grazed plots than heavily grazed or grazing excluded plots. Silvery bladderpod (*Lesquerella argyraea*) densities were greater on control plots than moderately grazed areas, while densities were similar between the heavily grazed and control treatments. Monitoring of forbs under these grazing regimes will continue.

Is Use of Aerated and Aerated and Burned Patches by Deer a Response to Forage Availability?

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Cleared patches within shrub-dominated landscapes are more heavily utilized by white-tailed deer (*Odocoileus virginianus*) than are areas with continuous shrub cover. Aerating is widely used to manage shrubland because of the positive response of deer to clearings. Aerators are large, heavy metal cylinders that are pulled by crawler tractors. Metal teeth mounted on the cylinders cut into the soil and chop off the tops of woody plants. Prescribed burning is an effective follow-up treatment to mechanical treatments such as aeration to maintain suppression of woody plants.

It is unclear why deer aggregate in mechanically-created clearings. Removal of the tops of woody plants by mechanical methods or by fire may increase forb abundance and thus attract foraging deer. Resprouting woody plants may also attract deer because sprouts are higher in nutrients than mature growth. Our objective is to determine the effects of burning versus a second aeration as follow-ups to an initial aeration treatment on yield of deer food plants and intensity of utilization of clearings by deer. We will test the hypotheses that use of aerated patches and aerated and burned patches by deer increases as the ratio of forage quality and quantity within the patches versus forage quality and quantity in the surrounding woodland increases.

The study area is on the Chaparral Wildlife Management Area (WMA) in Dimmit and La Salle counties. Vegetation on the area is dominated by mesquite/mixed-brush communities characteristic of the South Texas Plains. Areas of native brush ranging in size from 7-20 acres (2.8-8.1 ha) were aerated during spring 1999. Ten aerated patches were selected as study sites, with patches of similar size being paired. Adjacent untreated areas served as control sites. Monitoring of vegetation includes estimation of woody and herbaceous plant cover and biomass. Analyses to determine nutritive and second-

ary compound content of vegetation will also be conducted. Track count lanes have been established around the perimeters of each site and are monitored on a monthly basis to determine use by white-tailed deer. Maintenance treatments of prescribed burning and an additional aeration treatment were applied to each paired site in late summer 2000.

Monitoring of vegetative response and white-tailed deer utilization of clearings will continue through 2002. Results of the research will help wildlife managers determine proper techniques to use in maintaining clearings and will provide insight into the proper design of clearings.

Cooperative funding is provided by Texas Parks and Wildlife Department and Houston Livestock Show and Rodeo Association.

Effects of Aeration on Vegetation and Nongame Wildlife in the South Texas Plains

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DONALD C. RUTHVEN III

Mechanical brush management techniques such as root plowing and roller chopping are commonly utilized to convert South Texas brushlands back to grasslands to increase forage production for livestock and enhance wildlife habitat. Responses of vegetation and game species such as the white-tailed deer (*Odocoileus virginianus*) to brush management have been the focus of most past studies. An adverse effect of some mechanical brush management practices is that once treated rangelands are revegetated by woody species, woody species diversity is dramatically reduced. Mechanical top growth removal stimulates sprouting of many brush species, while temporarily increasing the nutritional quality, availability, and yield of browse. Herbaceous vegetation usually flourishes following mechanical treatments. Little information is available on the ecological effects of mechanical treatments on nongame wildlife. Nongame wildlife species, especially amphibians, are considered "indicator" species because they are least able to cope with environmental changes associated with habitat loss and fragmentation. Responses of nongame wildlife may be an effective tool in assessing overall ecosystem response to mechanical treatments. The objective of our study was to investigate woody and herbaceous vegetation responses to aeration and the effects of aeration on diversity and relative abundance of herpetofauna and small mammals.

The study area is the Chaparral Wildlife Management Area (CWMA) in Dimmit and LaSalle counties, Texas. Vegetation is dominated by mesquite (*Prosopis glandulosa*)-mixed brush communities characteristic of the South Texas Plains. Aeration treatments were applied to several blocks of native brush during the summer 1998. An aerator differs from a conventional roller chopper in that the blades are intermittent (toothed) rather than one continuous blade across the face of the drum and the blades are angled across the face of the drum rather than parallel. Five aerated sites with paired control sites were randomly selected for monitoring. Individual treatments ranged from 5 to 12 acres (2 to 5 ha) each. Permanent vegetation transects were established on all sites. Woody vegetation cover and density was monitored during summer 1999 and 2000 utilizing the line intercept method. Herbaceous vegetation cover and density was monitored biannually in the spring and fall utilizing the Daubenmire frame method. Herpetofauna was sampled utilizing drift fence arrays (3 on each site) during the late spring and early summer when herpetofauna are most active. Small mammals were sampled utilizing Sherman traps (500 trap nights/treatment/season) set in modified grids during all 4 seasons of the year. Drift fences were also utilized to sample small mammals.

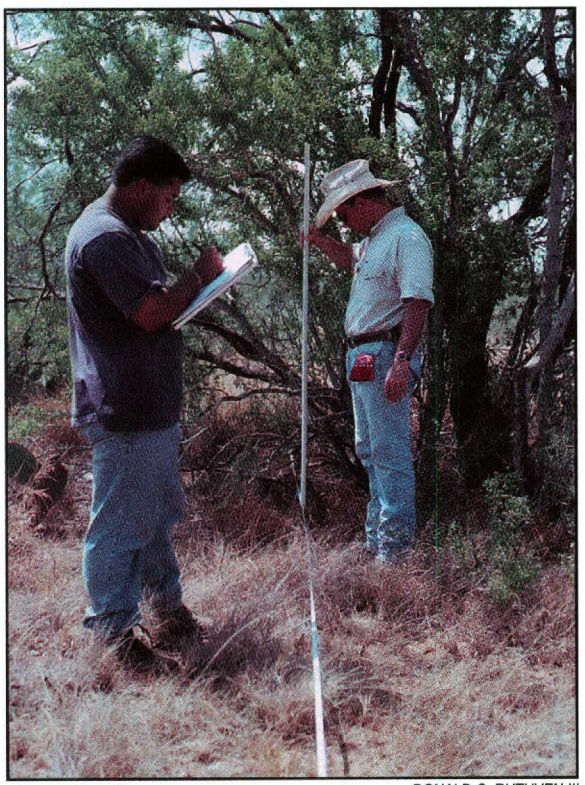
Preliminary analyses indicate that woody plant species richness and diversity was similar between treatments. Tasajillo (*Opuntia leptocaulis*) was dramatically reduced by the aeration treatment. Woody vegetation appears to recover at a rapid rate following aeration, as woody plant canopy coverage doubled from 1999 to 2000 on treated sites. Mesquite and twisted acacia (*Acacia schaffneri*) demonstrated the greatest increases. Herpeto-fauna species richness and diversity was similar between treatments. Texas spotted whiptail (*Cnemidophorus gularis*) and Great Plains narrowmouth toad (*Gastrophryne olivacea*) were more common on control sites. Small mammal species richness and diversity was greater on control sites. Desert shrew (*Notiosorex crawfordi*) was more abundant on control sites.

Preliminary results indicate that aeration treatments can reduce woody plant cover while maintaining diversity. The rapid recovery of woody plants indicates the necessity for follow-up treatments such as prescribed fire to manage woody vegetation and maintain clearings. Aeration may negatively impact small mammal populations. It is unclear whether reductions in small mammal diversity are the result of plant community changes or increased susceptibility to predation by removal of woody cover. Fieldwork will be completed in November 2000. Complete analyses of data are forthcoming.

Funding for this project is provided by Texas Parks and Wildlife Department.

Effects of Summer Burns on Herbaceous Vegetation, Herpetofauna, and Small Mammals in the South Texas Plains

Donald C. Ruthven III, Texas Parks and Wildlife Department



DONALD C. RUTHVEN III

The Rio Grande Plains of southern Texas is the southern most extension of the Great Plains grasslands. As with most grasslands, it is a fire dependent ecosystem. Overgrazing by domestic livestock and fire suppression has lead to the thorn woodlands, which now dominate much of South Texas. Prescribed fire is becoming a more accepted and utilized tool to manage woody vegetation and enhance wildlife habitat. Most prescribed burning is conducted during the winter months when burning conditions are less volatile. Natural fires are predominantly started by lightning strikes, which generally occur during late spring through early fall with the peak of thunderstorm activity. Little data is available on the effects of summer burns on vegetation and wildlife. The objectives of this study are to determine the effects of summer fire on the flora and fauna of South Texas.

The study is being conducted on the Chaparral Wildlife Management Area in Dimmit and La Salle counties. Vegetation is typical of the mesquite (*Prosopis glandulosa*)-mixed brush communities found throughout the South Texas Plains. Study sites consisted of 5 burned plots and 5 nonburned areas. Burns were conducted in late August 1999 following a 10-inch (25.4-cm) rainfall event associated with Hurricane Brett. Herbaceous vegetation density and frequency was estimated by utilizing Daubenmire frames during fall 1999 and spring 2000. Herbaceous plant yields were estimated by clipping vegetation in 0.8 feet^2 (0.25 m^2) plots during late spring 2000. Reptiles and amphibians, as well as small mammals were sampled utilizing drift fence arrays (1 per replicate) during late spring and late summer 2000.

Forb species richness and diversity were greater on control plots and were greater during spring than fall. Total forb densities were greater on burned plots during spring and control plots in fall. Total forb yields were similar between treatments. Croton (*Croton* spp.) was more common and produced greater yields on burned sites during spring. Perennial forbs erect dayflower (*Commelina erecta*) and beach groundcherry (*Physalis cinerascens*) were more common on burned areas during fall and spring. Silvery bladderpod (*Lesquerella argyraea*) was more common on control sites during fall and burn sites in spring. Slender evolvulus (*Evolvulus alsinoides*) was more abundant on control sites in fall and spring. Grass plant densities were greater on control plots in fall, while spring grass yields were similar between treatments. Diversity, evenness, and total numbers of herpetofauna were greater on burned sites. Texas spotted whiptail (*Cnemidophorus gularis*), the most common reptile encountered, showed no treatment effect. Great Plains narrow-mouthed toad (*Gastrophryne olivacea*) was more abundant on control sites. Six-lined racerunner (*Cnemidophorus sexlineatus*) and southern prairie lizard (*Sceloporus undulatus*) tended to be more common on burned sites. Drift fence arrays were effective in capturing three species of small mammal, Merriam's pocket

mouse (*Perognathus merriami*), northern pygmy mouse (*Baiomys taylori*), and desert shrew (*Notiosorex crawfordi*). Of these, northern pygmy mouse was more common on burned areas.

Summer burns appear to enhance annual and perennial forbs, as well as herpetofauna and small mammal populations. Further investigation into the effectiveness of summer burns in managing woody vegetation, as well as determining the effects of repeated summer burns on wildlife are forth coming.

Response of Herbaceous Vegetation to Aeration of a Blackbrush-Guajillo Community

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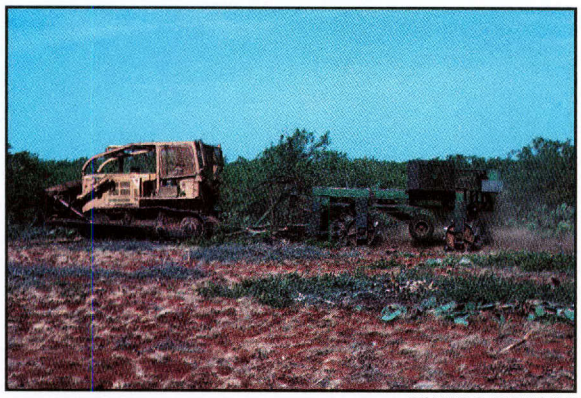
David R. Rios, Texas A&M University-Kingsville
Adan G. Gandaria, Sul Ross State University



DONALD C. RUTHVEN III

With the development of heavy equipment such as the root plow and roller chopper, ranchers have a tool that could be utilized to effectively manage woody vegetation. A major problem with mechanical treatments is that woody vegetation can reinvade treated rangelands in a relatively short time period. Mechanical aeration is a top-removal method that has gained popularity in South Texas. Aerators differ from roller choppers in that the blades along the chopper drum are toothed and set at an angle across the face of the drum. The effects of aeration on vegetation and soil properties are not well documented, especially in xeric environments such as the western Rio Grande Plains.

Vegetation communities in the western Rio Grande Plains are mostly dominated by two woody species, honey mesquite (*Prosopis glandulosa*) and blackbrush (*Acacia rigudula*). Blackbrush dominated communities can form dense stands of woody vegetation with little or no herbaceous vegetation. Under optimum conditions, herbaceous yields can exceed 3,600 lb/acre (4035 kg/ha). Because of potential productivity, dense stands of blackbrush dominated rangeland may be ideal locations to conduct mechanical brush treatments. The objectives of this study were to determine the response of herbaceous vegetation to aeration and determine if any increases in herbaceous yields are substantial enough to permit the use of prescribed burning as a follow-up maintenance treatment.

The study was conducted on the Chaparral Wildlife Management Area (WMA) in the western South Texas Plains. Three sites, ranging in size from 3.0 to 5.7 ac. (1.2 to 2.3 ha), were aerated utilizing a Lawson, double/tandum 12 feet x 30 inches (3.7 m x 0.8 m) drum aerator during early-August 1998. Control plots were established on untreated areas adjacent to aerated sites. All sites were characteristic of blackbrush-guajillo (*Acacia berlandieri*) communities. Woody vegetation canopy cover was >50%. Transects were established through the center of each site in late-June and early-July 1999. Ten 10.8 feet^2 (1 m^2) frames were placed at random locations along each transect during early summer 1999. Current year's growth of grasses and forbs was clipped down to ground level within frames, air-dried, and weighed.

Grass species richness and diversity were greater on aerated sites. Overall grass yields were fourfold greater on aerated sites. When pooled into preference ratings of good, fair, and poor grazing value, grasses of fair grazing value produced greater yields on aerated sites. When preferred native grasses were pooled, natives produced greater biomass on aerated sites. Dominant grasses that were more frequent on aerated areas include Texas bristlegrass (*Setaria texana*) and hooded windmillgrass (*Chloris cuculatta*). Forb species richness and diversity were greater on aerated sites, while forb productivity was similar between treatments. When forbs were pooled into forage groups utilized by white-tailed deer, quail, and cattle, forbs preferred by white-tailed deer and cattle such as erect dayflower (*Commelina erecta*) were more commonly encountered on aerated sites. Herbaceous yield appeared to be sufficient to permit prescribed burning as a follow-up maintenance treatment.

Effects of a Dormant Season Burning Program on Herpetofauna and Small Mammal Diversity and Abundance in the South Texas Plains

Donald C. Ruthven III, Texas Parks and Wildlife Department

DAVID SYNATZSKE

Prescribed burning is a common management technique utilized to enhance rangeland productivity and improve wildlife habitat. In the past, research has mainly focused on vegetation responses to prescribed fire. In addition, little data is available on the effects of fire on wildlife in semi-arid ecosystems such as the western South Texas Plains. There is particular concern that winter burns may adversely affect herpetofauna hibernating just below the soil surface. The objective of this study is to investigate herpetofauna and small mammal diversity and abundance on rangeland sites subjected to multiple burns during the winter season and untreated rangelands under controlled conditions.

Three rangeland sites that were prescribe-burned during winter 1998 and 2000, along with 3 untreated sites were selected on the Chaparral Wildlife Management Area (CWMA). Vegetation on CWMA is typical of South Texas and is dominated by mesquite (*Prosopis glandulosa*)-mixed brush communities. Three drift fence arrays were established on each site. Herpetofauna and small mammals were monitored in arrays during spring and summer of 1998 through 2000. Data from each set of 3 arrays was pooled for analysis.

Seventeen species of reptile and 6 species of amphibian were encountered in the arrays. There were no differences in herpetofauna species richness and diversity between burned and nonburned areas. Texas spotted whiptail (*Cnemidophorus gularis*) and Great Plains narrowmouth toad (*Gastrophryne olivacea*) were the most common species encountered with 183 and 1,169 captures, respectively. Both Texas spotted whiptail and southern prairie lizard (*Sceloporus undulatus*) tended to be more abundant on nonburned sites, while prairie racerunner (*Cnemidophorus sexlineatus*) appeared to be more common on burned sites. Drift fence arrays were effective in capturing 3 species of small mammal, Merriam's pocket mouse (*Perognathus merriami*), northern pygmy mouse (*Baiomys taylori*), and desert shrew (*Notiosorex crawfordi*). Abundance of these 3 species was similar between treatments.

It is not clear whether decreasing trends in abundance of Texas spotted whiptail and southern prairie lizard are related to direct mortality or vegetation changes resulting from burning. It does appear that prairie racerunner responds positively to dormant season burns. It appears that winter burns do not dramatically affect small mammal populations. Because of relatively low capture rates of many herpetofauna species, including the Texas horned lizard (*Phrynosoma cornutum*), a state threatened species, extended monitoring may be required to fully assess the effects of winter burning on many herpetofauna species. Monitoring of the response of nongame wildlife to the prescribed burning program on the CWMA will continue.

Effects of Prescribed Fire on Wintering and Breeding Bird Populations in the South Texas Plains

Brent Ortego and Donald C. Ruthven III, Texas Parks and Wildlife Department

In South Texas, prescribed fire is becoming a more accepted and utilized tool to manage wildlife habitat. Prescribed fire is an economical method of managing woody vegetation and enhancing rangeland productivity. Most prescribed burning is conducted during the winter months when burning conditions are less volatile. Burning during the dormant season has been shown to increase beneficial annual and perennial forbs. In the Edwards Plateau region of Central Texas, winter fire has also been utilized to create and maintain suitable nesting habitat for threatened birds such as the black-capped vireo (*Vireo atricapillus*). With the increasing interest in biodiversity and ecosystem management, more attention is being focused on summer burns, which reflect the timing of natural fires. Little data is available on the effects of summer burns on wildlife. Many tropical birds such as the green jay (*Cyanocorax yncas*) and Audubon's oriole

(*Icterus graduacauda*) reach the northern limits of their ranges in South Texas. The effect of habitat manipulation practices on these unique species is poorly understood. The objective of this study is to determine the effects of winter and summer fire on wintering and breeding birds in the South Texas Plains.

DONALD C. RUTHVEN III

The study area is the Chaparral Wildlife Management Area in Dimmit and LaSalle counties. Vegetation is dominated by the mesquite (*Prosopis glandulosa*)-mixed brush shrublands characteristic of South Texas. Two rangeland sites subjected to 2 burns during the dormant season in 1997-2000, 2 sites burned during winter 1997 and summer 2000, and 2 untreated sites have been selected for study. Wintering birds will be surveyed during January along 2 984 x 264-foot (300 x 80-m) belt-transects per site for a total of 12 transects. Belt-transects will be monitored twice during each sampling period. Breeding birds will be surveyed by point counts in late spring (May-June). Eight point counts will be established on each site for a total of 48 points and monitored twice during each sampling period. Monitoring of the transects and point count stations will continue through 2003. Summer and winter burn sites will be subjected to an additional burn during summer 2001 and winter 2002, respectively.

Managing Invasive Yaupon Holly in the Post Oak Savannah Ecological Region of Texas

Rob Mitchell, Brad Dabbert, Stephanie Dupree, and Brian Pierce, Texas Tech University
Dale F. Prochaska and James C. Cathey, Texas Parks and Wildlife Department

The Post Oak Savannah Ecological Region is a narrow corridor, encompassing over 85 million acres (approx. 34 million ha) of land ranging from Victoria in southern Texas to the Red River in northeastern Texas. This region is bordered by the Pineywoods on the east, the Blackland Prairies on the west, and Coastal Prairies on the south. The Post Oak Savannah has historically been in a constant transition from prairie to savannah to forest, with succession being driven by the presence or absence of wildfires. In the summer and fall of 1854, Parker, a member of the Marcy Expedition, explored this region. His notes state "The timber is short, stunted oak, not growing in a continuous forest, but interspersed with open glades, plateaus, and vistas of prairie scenery, which give a very picturesque and pleasing variety." His notes indicate abundant wildlife, nomadic herds of cattle and horses, and evidence of wildfires.

Recently, dense woodlands with stands of yaupon holly (*Ilex vomitoria*) understory have replaced the historic vegetation due to overgrazing and fire suppression. Yaupon holly, an evergreen plant, is a thicket-forming shrub originating from many basal stems. Usually, this plant has dense crowns that are typically 1 to 3 m in height; however, some noted specimens have reached 8 m in height and measured 30.5 cm at diameter-breast-height (DBH). This plant is not perceived as problematic when present at low levels. The fruits and seeds of yaupon are eaten by a variety of birds and mammals. However, without proper management, it does become a concern to wildlife managers as an invasive plant. In the absence of perturbation, yaupon quickly becomes established. Consequently, quantity and diversity of herbaceous vegetation declines beneath thick yaupon canopies due to competition for sunlight and nutrients.

JAMES C. CATHEY

The overall goal of this investigation is to provide landowners with information necessary to control invasive yaupon holly. Specific objectives will test the effectiveness of yaupon control by utilizing prescribed burning, mechanical manipulation, and herbicide treatment. We intend to make land managers aware of the cost/benefit ratio of each technique and provide landowner tours to demon-

strate treatment responses. Furthermore, we wish to determine if floral species richness can be improved by implementing management schemes described above.

Texas Parks and Wildlife Department and the Department of Range, Wildlife, and Fisheries Management at Texas Tech University provided financial support for this project.

Utilizing Spatial Technologies to Understand and Model Wildlife Species Distributions

Brad E. Daugherty and Rodney Honeycutt, Texas A&M University
Jeffery W. Gunnels, Dale F. Prochaska, and James C. Cathey, Texas Parks and Wildlife Department

The objective of this study was to utilize Geographic Information Systems (GIS), Remote Sensing, and Global Positioning System (GPS) to develop and test an environmental model. The model was designed to predict, based on a combination of environmental elements, the suitability of habitats for the northern pygmy mouse (*Baiomys taylori*), the marsh rice rat (*Oryzomys palustris*), and the hispid cotton rat (*Sigmodon hispidus*). The environmental layers included vegetation types, soils types, and slopes found on Gus Engeling Wildlife Management Area (GEWMA) and Richland Creek Wildlife Management Area (RCWMA). The resulting model output was displayed as a map, depicting the spatial distribution of habitat suitability for each of the 3 species on both wildlife management areas (WMAs).

After the habitat suitability layer was created, it was tested against field data for the target species to determine if the model was predicting significantly different values for locations where the target species was present compared to sampling points where the species was absent. The results showed that the model consistently predicted higher suitability values for locations where the target species was present compared to locations where the species has not been found. This initial verification indicates that this model may prove useful as a management tool for predicting suitability of habitats for multiple wildlife species.

Funding for this study was provided by Texas Parks and Wildlife Department and Texas A&M University.

Changing Patterns of Rangeland Use and Ownership in Texas: The Effects of Fee Hunting in Central and South Texas

Sherry Sultenfuss and Urs Kreuter, Texas A&M University
Kirby Brown, Texas Parks and Wildlife Department

Ranching communities in Texas have been hard hit by numerous problems such as variable or steadily low prices in agricultural markets and in the oil industry, demanding property and inheritance taxes, problems associated with absentee land owners, and high consumptive demands that exceed productive values of the land. As a result, many Texas ranchers have already or, they are now investigating, alternatives in the allocation of their resources in attempts to generate revenue to sustain traditional ranching operations. Among the various alternatives, commercialization of wildlife has become one resource utilized to a considerable extent by the landowner whenever possible.

Fee hunting is believed to generate significant income for those ranchers located in prime hunting areas. Although the number of hunting licenses purchased in Texas has remained reasonably stable over a period of decades, some slight weakening in the number of hunters during the period from 1985 to 1998 has been experienced. As a percent of the state's growing population, a decline of 3.6 percent was documented. Additionally, Texas continues to experience dramatic shifts in demographic makeup and land use practices. How these shifting conditions interact is not yet entirely clear. Also unclear is the degree of influence of hunting operations on rangeland fragmentation/consolidation and enterprises such as fee hunting.

The first of this study's objectives will be to determine the current operational characteristics and economics of fee-based hunting enterprises in Central and South Texas. Data collection within the Edwards Plateau and South Texas Plains ecological regions will be accomplished through means of a mail survey sent to a selected sample of landowners. Further economic, operational and sociological details will be gathered via personal interview conducted on a sub-sample of that population. Information will be analyzed and contrasted to data obtained from previous research completed by Dr. Don Steinbach, Texas A&M University, in 1988. Additionally, a small percentage of landowners from the 1988 study will be re-interviewed. Data collected from this process should allow for a direct

comparison relative to the economic and operational characteristics of those ranches. The subsequent research objective concerning land fragmentation and consolidation will be achieved through a historical data collection and analysis of land ownership and parcel size changes using the sub-sample population determined in both eco-regions.

Funding and support for this project has been provided by Texas Parks and Wildlife Department and Rob & Bessie Welder Wildlife Foundation for Wildlife Research and Education.

Hydrologic Restoration of Historically Logged Bottomlands of Blue Elbow Swamp

Derrick W. Wolter, Texas Parks and Wildlife Department

DERRICK W. WOLTER

Large tracts of baldcypress/water tupelo (*Taxodium distichum/Nyssa aquatica*) forested community within Tony Houseman State Park and Wildlife Management Area (SP/WMA) at Blue Elbow Swamp are significantly degraded due to the alteration of historic hydrologic patterns. Natural drainage has been impacted by spoil banks deposited during logging canal excavation in the early 1940s and construction of Interstate Highway (IH) 10 in the 1950s. The canal banks and highway function as levees, resulting in increased flooding of the swamp into the growing season. As a result, the forest community exhibits signs of stress, such as poor tree health, organic material build up, and low seedling recruitment, from prolonged inundation.

The primary objective of the project is to enhance the vegetative community of the swamp habitat by restoring seasonal hydrologic patterns. Removal of portions of the logging canal spoil banks will allow seasonal flooding to aid in removal of deep organic materials, allow mineral deposition, and encourage drawdown to create favorable conditions for seedling recruitment.

Portions of 3 logging canal spoil banks were excavated in May 1999 in an attempt to return the seasonal hydrologic pattern to approximately 150 acres (62.2 ha) of cypress/tupelo swamp. A total of 18 excavations (6 per canal bank) approximately 20 feet (6.1 m) in width were created. A baseline habitat survey was completed in October 1998 to allow quantification of project impacts. The vegetation survey was repeated in October 2000 and will be repeated again October 2001. A nested plot sampling design was used at 6 control and 9 experimental sites to measure herbaceous vegetation and seedling recruitment and mortality. Water depth recorders were installed in January 1999 to monitor the effect of the excavations on surface hydrology, particularly drainage rates.

Preliminary data suggest that the desired seasonal hydrologic conditions may be obtained after excavations of the spoil banks. During the spring 2000, excavations combined with low precipitation allowed for increased germination of emergent plants such as wild millet (*Echinochloa walteri*), giant cutgrass (*Zizaniopsis miliacea*), and swamp panicum (*Panicum gymnocarpon*). An increase in these plant species was also recorded during the October 2000 vegetation survey.

In addition, recent mitigation allowed for the planting of 2,400 baldcypress and 600 water tupelo saplings on 10 acres (4 ha) of the project site during February 2000. Although the planting of saplings was not initially a part of this project, they will provide a head start to the portion of degraded swamp immediately adjacent to the Texas Travel Information Center on IH 10. Sampling of saplings will be performed in spring 2001 to determine the first year survival rate.

Funding for this project is provided by Gulf Coast Joint Venture (GCJV) and through wetland mitigation by Bomac, Inc.

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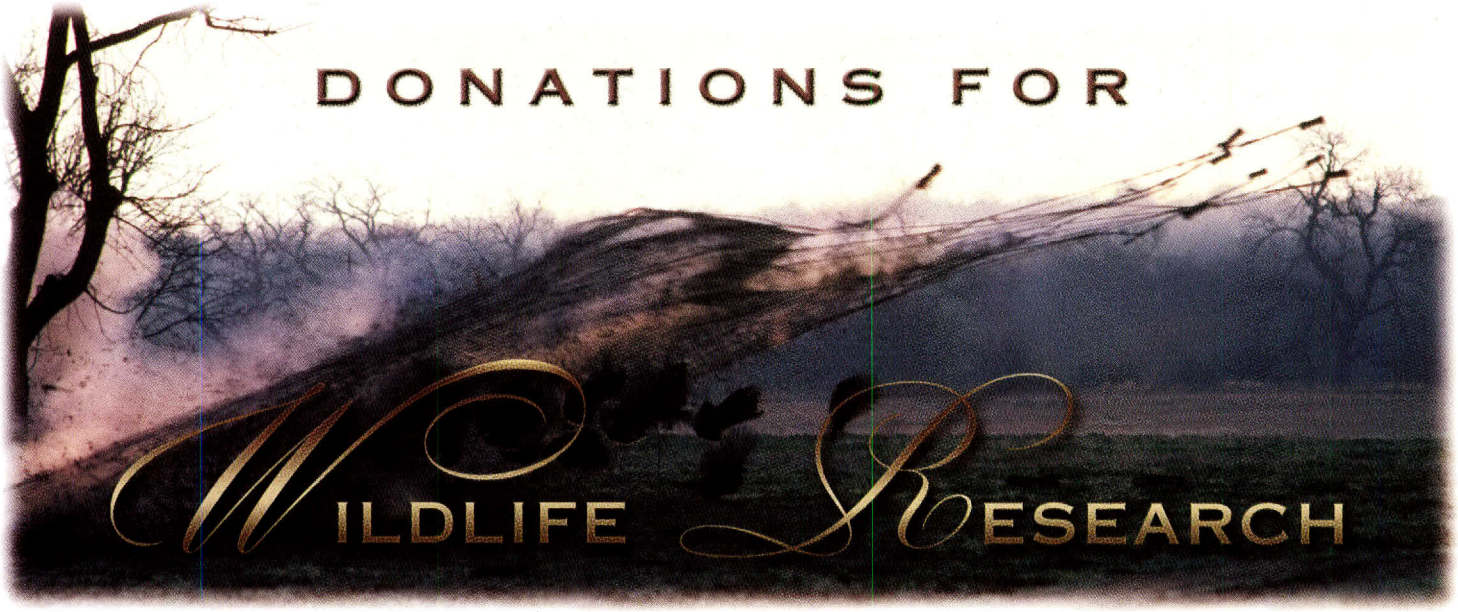

The Wildlife Division of Texas Parks and Wildlife is conducting research studies on Texas horned lizards, white-tailed deer, eastern wild turkeys, desert bighorn sheep, white-winged doves, waterfowl, black bears, mountain lions, neotropical birds, monarch butterflies, elf owls, and other species. Some of this research is funded through private donations. As a means of recognizing private donors, those persons donating $25 to wildlife research will receive a Texas horned lizard shoulder patch. Persons donating $250 will receive the patch and a limited edition art print featuring a mountain lion and 10 other species of Texas wildlife. There is also a color certificate signed by the Texas Parks and Wildlife Executive Director for donations of $1000 or more. Donations in any amount are welcome. Checks or money orders should be payable to "Texas Parks and Wildlife Department" and clearly marked "For Wildlife Research." Contributions should be sent to: Wildlife Research, Texas Parks and Wildlife Department, 4200 Smith School Road, Austin, TX 78744.

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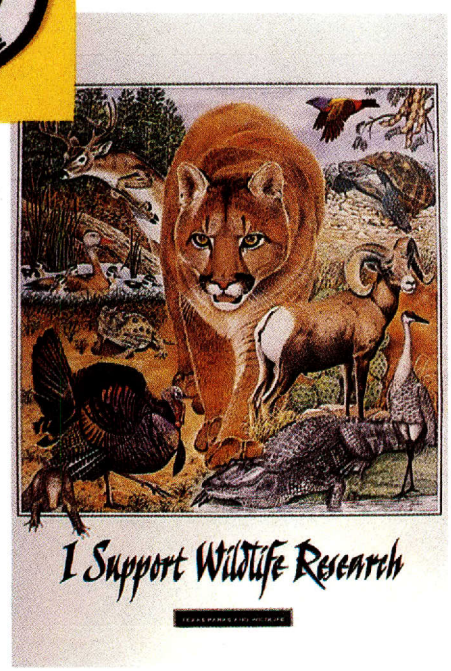

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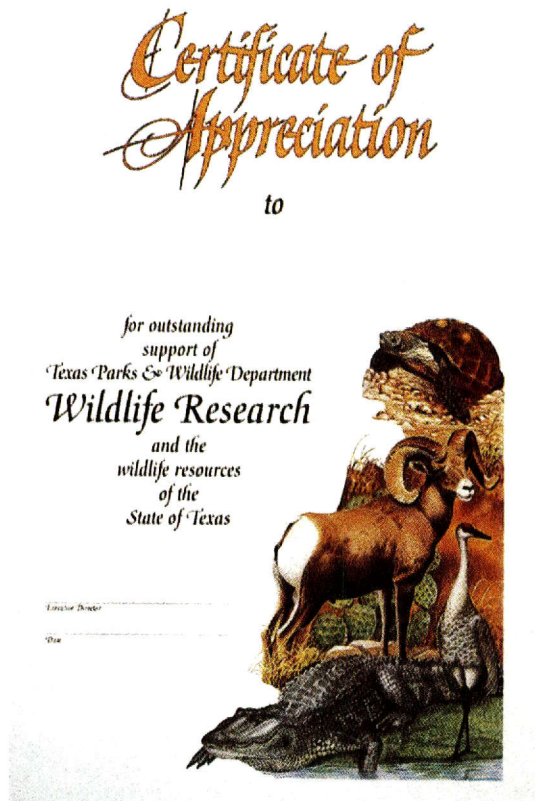

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