



# Wildlife

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## Research Highlights



# Wildlife Division

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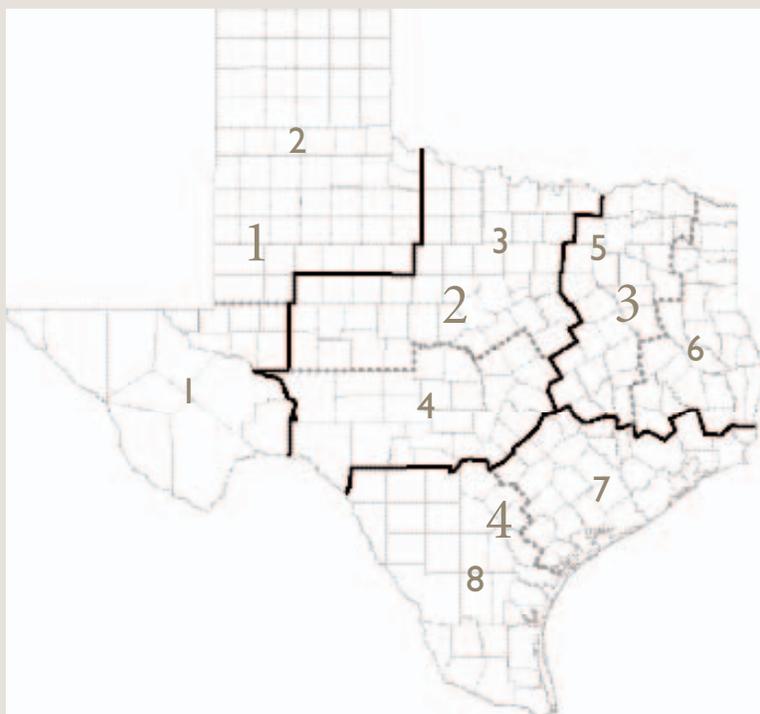
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# Wildlife Research Highlights 2003

Jay A. Roberson, Editor



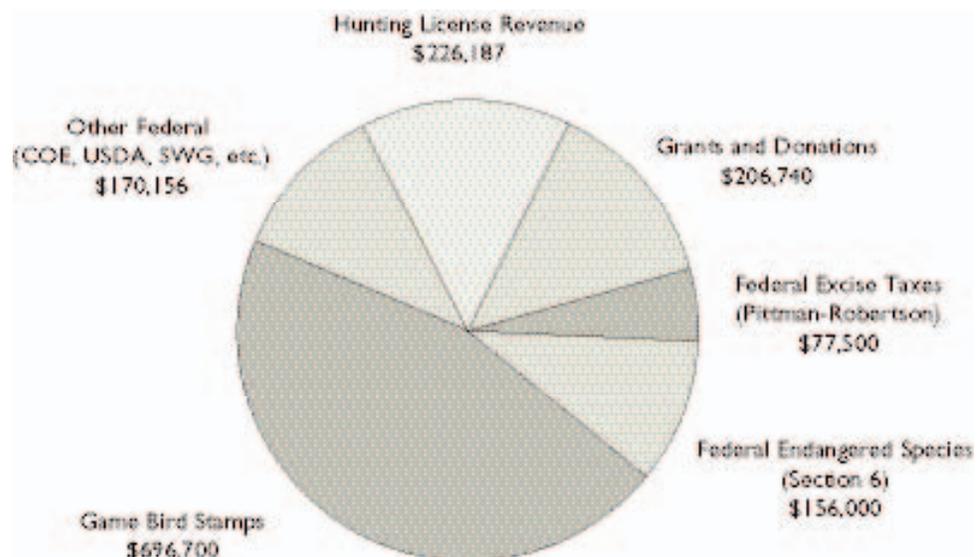
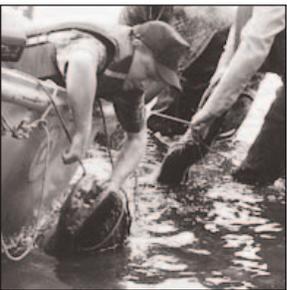
The Wildlife Division of the Texas Parks and Wildlife Department is continuing to develop a more coordinated approach to wildlife research. With ever-expanding responsibilities for wildlife management, the Wildlife Division has recognized the need for additional emphasis on wildlife research. Our primary 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 \$1,533,000 for 70 wildlife research projects during Fiscal Year 03. Funding for this research has come from several sources including: (1) Texas hunting license revenue, (2) grants and donations, (3) federal excise taxes, (4) federal endangered species funds (Section 6), (5) Texas waterfowl, white-winged dove and wild turkey stamps, and (6) other federal funds.



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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 thank Sonia C. Aguirre for designing the manuscript, Carol Otto, Nancy Gallacher and Ron George for editing and Kathleen Martin, Tim Peterson and Kathy Traulsen 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.

## COVER PHOTOS

Front cover, clockwise from top left: Banded mourning dove, photographer unknown; Echinocereus cacti, Jackie Poole photographer; Inland alligator, Gary Calkins photographer; American Badger, Chip Ruthven photographer. Back cover: Streptanthus, Jackie Poole photographer

# Memoriam

The 2003 Research Highlights are dedicated to four colleagues who passed away recently. All were taken in their youth before they developed to their full potential. All were dedicated employees and inquisitive biologists. But most importantly, all were good friends. We will miss them.



## Charles David Altman, Jr.

by Michael Hobson

Charles David Altman, Jr. died suddenly at his home in Van Horn on July 26, 2001 at age 29. He earned his BS (1995) and MS (1997) in Range and Wildlife Management from Sul Ross State University. He worked a year with Sonoran antelope in Arizona before returning to Texas to work as a wildlife biologist on the Trans-Pecos Regulatory District of the Texas Parks and Wildlife Department (TPWD) at Van Horn, Texas.

Wildlife District 1 staff had the pleasure of working with David for almost three years before his death. David was well prepared for the job in West Texas because of his education and professional experience. He was very focused and thoughtful before making comments to his peers or to the landowners to whom he provided technical guidance. David's suggestions and advice about wildlife and habitat management in the Trans-Pecos were appropriate and effective. Most people that worked with him thought that he had a lifetime of experience with wildlife as opposed to just four years. He was a gentleman and a scholar and was liked by everyone that met him. When District 1 staff think of the good things that have happened to them while working with TPWD, they will think of David Altman. David is worth remembering...



## Ski Clark

by Micah Poteet

Ski Clark of Lufkin passed away July 23, 2002. Ski was a native of Houston and received his BS (1988) and MS (1992) in Forestry from Stephen F. Austin State University. He worked five years as a wildlife biologist with the Florida Game and Freshwater Fish Commission. He returned to Texas to work five years for TPWD as the site manager for Alazan Bayou and North Toledo Bend Wildlife Management Areas. Ski accepted a wildlife biologist position with the Davy Crockett National Forest, USFS in early 2002.

Ski's research interests included American woodcock, American alligator, waterfowl, and the effects of prescribed fire. Ski was a productive biologist dedicated to wise management of the resource. Shortly before his death, in an effort to give something back to the community, Ski had become very active in the Big Brothers Big Sisters Program of East Texas. Ski's other hobbies included hunting, fishing, motorcycle riding and martial arts. Ski especially enjoyed training and hunting behind his English pointer. Ski pursued his interests with a dedication, enthusiasm, commitment, and sense of humor that will be missed by his friends and co-workers. Ski left behind a loving wife who enjoyed and was amused by Ski's enthusiasm for life and commitment to their marriage. Ski was a dedicated friend to all that knew him and will be greatly missed.

## Memoriam, continued



### Tim A. Lawyer

by Max Traweek

Tim A. Lawyer passed away November 9, 2001 at age 39 after a courageous battle with cancer. In 1990, he was hired as a wildlife technician assigned to the Neasloney Wildlife Management Area (WMA). In 1992 he assumed the dual positions of area manager at Lake Ray Roberts WMA and regulatory biologist with Wildlife District 3. In 1994, he transferred to the Edwards Plateau Wildlife District, where he once again served as an area manager (Old Tunnel WMA, OTWMA) and regulatory biologist. Tim also was the principle investigator and field coordinator for the Edwards Plateau Rio Grande turkey research project.

Tim was extremely dedicated and hard-working. His dedication and tireless energy resulted in making the OTWMA an extremely well-run, well-maintained, well-equipped, and well-received public use area. With his drive and enthusiasm, OTWMA became a model for handling the numerous visitors who came to see the afternoon flights of Mexican free-tailed bats as they left their roost in the old railroad tunnel. Tim's commitment and "can do" attitude was applied to everything he did. If you requested a short one - two page report, Tim would respond with a five-page highly detailed and well-researched paper. In addition to his devotion to "getting the job done," Tim was also a very dedicated and involved family man. He is survived by his wife, Lucy and two sons, Hunter and Chris.



### Kevin Glen O'Neal

by Max Traweek

Kevin Glen O'Neal died suddenly of a heart condition at his home in Fredericksburg during the last week of October 2002. After receiving his BS and MS at Southwest Texas State University, he held two separate temporary positions with TPWD before becoming a full-time District 4 wildlife regulatory biologist in 1997. He headquartered first in Llano and later Gillespie counties.

Kevin was a firm believer in the value of melding technology with wildlife biology. A self-taught computer expert and experienced GIS and GPS technician, Kevin was always striving to stay current with technical advances in monitoring wildlife populations. He played a key role in initiating and conducting several research projects including technical issues of the mule deer research project in the western Edwards Plateau and pronghorn antelope research on the vast Rocker B Ranch. He was instrumental in obtaining, employing and evaluating several high tech remote sensing devices used in the antelope research. He was quick and eager to share his uncanny technological knowledge and skills with other staff through self-initiated training sessions. He was an active participant in several youth-oriented wildlife camps and regularly volunteered for Wildlife Expo and field projects. He thoroughly enjoyed working with wildlife, experimenting with new technology and, best of all, putting the two together. The Wildlife profession and TPWD lost a very capable employee and a good friend when we lost "Kevin O."

# Birds

## Quail



### Do Radio Transmitters Affect the Bioenergetics of Northern Bobwhite? A Laboratory Study

Juan A. Arrendondo, Fidel Hernandez and David G. Hewitt, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville;  
Stephen J. DeMaso, Texas Parks and Wildlife Department

Northern bobwhite (*Colinus virginianus*) have received considerable research attention

over the past 50 years. The quantity and quality of this research has been aided tremendously through the use of radio telemetry. However, an underlying assumption of radio telemetry research is that radio marked individuals provide unbiased estimates of population parameters. Few studies have tested this assumption. Our objectives were to evaluate the effects of radio collars on bioenergetics by comparing feed consumption and body mass of radio marked and non-radio marked bobwhites in a controlled environment.

We randomly assigned a radio marked or non-radio marked treatment to 32 pen-raised bobwhites and placed them in individual cages [48 x 25 x 13 cm (19x10x6in)] within an

environmental chamber. We provided feed and water ad libitum. Two 21-day trials were conducted to simulate summer and winter conditions, respectively. We recorded feed consumption daily and body mass every three days during both trials.

There was no difference in feed consumption or body mass between radio marked and non-radio marked bobwhites during either trial ( $P > 0.05$ ). A field pilot study also was conducted to assess energy expenditure between radio marked and non-marked bobwhites using doubly labeled water technique. Data analysis is currently being conducted.

Funding for this study was provided by TPWD and Caesar Kleberg Wildlife Research Institute.

### Landscape Changes Related Scale Quail Habitat in Texas

X. Ben Wu, Nova J. Silvy, Fred E. Smeins and Markus J. Peterson, Texas A&M University; Stephen J. DeMaso, TPWD

Abundances of scaled quail (*Callipepla squamata*, SQ) and northern bobwhite (*Colinus virginianus*, NBW) in Texas are volatile. Recent studies conducted by TPWD have shown the abundance of scaled quail has declined in the Rolling Plains (RP) but no long-term trend is exhibited in the South Texas Plains (STP) eco-region. Changes in landscape and the composition, abundance and spatial arrangement of land-cover types are likely causes for large-scale decline in quail abundance.

The objectives of this study were to assess the relationship between landscape changes, land use and management

practices to trends in SQ and NBW abundance in STP and RP. Specifically, we: (1) conducted a regional assessment of landscape pattern and changes in the RP and the STP and their influence on quail habitat using habitat suitability models based on general GIS and remotely sensed data; (2) surveyed field vegetation/land-cover along census transects established by TPWD; (3) compared them to a historical (1976) survey to determine if and how SQ and NBW habitat selection have changed in response to landscape changes; and (4) intensively studied landscape changes based on historical aerial photos of selected transects to assess the pattern and scaling of

landscapes and the effect of those changes on RP and STP abundance. In addition, we examined the spatial and temporal pattern of NBW abundance and the influence of land use over the entire range of NBW using data from the North American Breeding Bird Survey and county-level land use from the U.S. Census of Agriculture.

Five publications, one thesis, one dissertation and six presentations at professional meetings resulted from this study

(see Recent Publications). Results provide useful information to TPWD and private landowners for designing and implementing management plans to reverse the decline in scaled quail abundance.

*Funding for his study was provided by the Cross Timber Chapter of Quail Unlimited, TPWD, the Rob and Bessie Welder Wildlife Foundation and Texas A&M University/Texas Agricultural Experiment Station.*

## Status, Distribution and Ecology of **Gambel's Quail** in Trans-Pecos, Texas

Louis A. Harveson, Sul Ross State University; Michael R. Sullins, TPWD

Abundances of scaled quail (*Callipepla squamata*, SQ) and northern bobwhite (*Colinus virginianus*, NBW) in Texas are volatile. Recent studies conducted by TPWD have shown the abundance of scaled quail has declined in the Rolling Plains (RP) but no long-term trend is exhibited in the South Texas Plains (STP) eco-region. Changes in landscape and the composition, abundance, and spatial arrangement of land-cover types are likely causes for large-scale decline in quail abundance.

The objectives of this study were to assess the relationship between landscape changes, land use and management practices to trends in SQ and NBW abundance in STP and RP. Specifically, we: (1) conducted a regional assessment of landscape pattern and changes in the RP and the STP and their influence on quail habitat using habitat suitability models based on general GIS and remotely sensed data; (2) surveyed field vegetation/land-cover along census transects established by TPWD; (3) compared them to a historical (1976) survey to determine if and how SQ and NBW habitat selection have changed in response to landscape changes; and (4) intensively

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## Characteristics of Foraging Habitat of **Montezuma Quail** at Elephant Mountain WMA

Froylan Hernandez and Louis A. Harveson, Sul Ross State University; Clay Brewer, TPWD

Montezuma quail (*Cyrtonyx montezumae*) are habitat specialists that occur in pine-oak woodlands of the Southwest including the mountainous ranges of West Texas. In Texas, little information exists on the foraging habits, distribution, status or habitats of Montezuma quail. In March 2000, we initiated a

study at Elephant Mountain Wildlife Management Area, Brewster County, Texas to characterize foraging habitats of Montezuma quail. The objectives of the study were to delineate and describe the foraging area used by Montezuma quail at a macro- and micro-habitat level.

Unlike other quail, Montezuma quail dig for their main source of food consisting of a variety of plant bulbs, tubers and other root material. We defined and delineated habitats relative to quail abundance and foraging sites (high use, moderate use, low use) by noting quail abundance and concentrations of diggings. High use areas were noted when  $\geq 3$  diggings or clusters of diggings (e.g., forage sites) were encountered in a 10-minute walking period. The diggings on the outer perimeter were then connected, defining the primary forage area. Forage sites were located within the forage area and micro-habitat measurements were taken at 30 forage sites within the high use area and 30 random locations outside the forage area.

In addition, six 100-m<sup>2</sup> plots were set to describe the macro-habitat. Two plots were set within the forage area (heavy-use area), two in low use, and two in no use (no diggings present). A total count of diggings inside each plot was conducted by walking the entire plot. Two 50-m transects within the plots were set at 25 and 75-m.

Our results suggest that Montezuma quail forage in areas with an adequate supply of bulbs, gentle to steep slopes, and rocky outcrops. Montezuma quail habitat is considered sub-optimal if any of these three variables are missing.

*Funding for this project was provided by TPWD, Quail Unlimited and West Texas Safari Club.*

## Nesting Ecology of Scaled Quail at Elephant Mountain WMA

Scott P. Lerich, TPWD; Dale Rollins, Texas A&M University-San Angelo;  
Louis A. Harveson, Sul Ross State University

We investigated scaled quail (*Callipepla squamata*) nesting ecology and survival relative to small man-made surface water catchments at the Elephant Mountain Wildlife Management Area, Brewster County, Texas. During spring of 2000 and 2001, 179 scaled quail were captured (131 in 2000, 48 in 2001) in funnel traps on two study sites and banded with individually numbered aluminum leg bands. One hundred eighteen (70F, 2M in 2000; 25F, 21M in 2001) were radio marked with neck-loop telemeters. One treatment site contained spreader dams (small lateral or perpendicular dikes or levees of soil and rock) constructed circa 1950s, whereas the control site had no spreader dams. Survival and nest success rates were compared to simulated nest survival. Predator indices were monitored with scent stations and simulated quail nests.

Weekly survival March-September was similar between sites and years (0.64 vs. 0.5 in 2000, 0.56 vs. 0.58 in 2001). We failed to reject the  $H_0$ : spreader dams have no effect on reproduction

and survival of scaled quail. Cause-specific mortality ( $n = 32$ ) included kills by mammals (43%), unknown predators (31%), avian predators (13%) and drowning (9%). Eleven nests were detected in 2000-2001; four hatched; five were depredated; and two were abandoned. Nests were located in bunch grasses ( $n = 5$ ) and under shrubs ( $n = 6$ ). Earliest recorded nesting activity was April 15; latest hatch date was approximately September 7. Forty-four of 96 (46%) simulated quail nests survived in 2000, but only 3 of 96 (3%) of simulated quail nests survived in 2001.

Survival of scaled quail in this study was slightly less than unpublished data for other Texas scaled quail populations and higher than survival reported for northern bobwhites (*Colinus virginianus*) from the southeastern USA.

*Funding for this study was provided by the Texas Agricultural Experiment Station and TPWD.*

## Rare Birds



### Effects of Shinnery Oak Control on the **Lesser Prairie Chicken** in the Rolling Plains of Texas

Nova J. Silvy, Markus J. Peterson and Roel R. Lopez, Texas A&M University; Duane Lucia and Stephen J. DeMaso, TPWD

We initiated a study to determine the effects of herbicide control of shinnery oak (*Quercus havardii*) on lesser prairie chickens (LPC,

*Tympanuchus pallidicinctus*) in fall 2002. In Texas, shinnery oak is an important LPC food and summer cover species. However, oaks compete with other food and cover species and can comprise 90% of annual vegetation production in overgrazed habitat. Decreases in grass and forb production and loss of livestock due to shinnery oak poisoning have prompted ranchers to control it with herbicides.

The effects of herbicide treatment on LPC habitat and food supplies are poorly understood. It has been suggested that a continuing decline in LPC numbers after the 1956 drought was due partially to the use of herbicides to control brush.

Chemical brush control could reduce winter food, but the increased bunchgrass growth created by the treatments might improve winter and nest cover for LPC. LPC have increased on areas treated once with herbicides, but decreased on areas treated for two consecutive years. LPC have been negatively correlated with shinnery oak canopy cover, suggesting control of this plant would improve habitat.

In spring 2003, a graduate student began evaluating survival, reproduction and habitat selection of two LPC populations exposed to different treatments (herbicide treated and non-treated) in the Texas Panhandle. Birds will be trapped with drop nets, fitted with radio transmitters, and monitored an average of 4x/week.

*This study is funded by TPWD and Texas A&M University.*

### Breeding Habitat, Distribution and Population Status of the **Black-Capped Vireo** in Northern Mexico

C. Craig Farquhar, Ph.D., TPWD; Jose Ignacio Gonzalez, Ph.D., Universidad Autónoma de Nuevo Leon, N.L., Mexico

The federally endangered black-capped vireo (BCVI; *Vireo atricapillus*) ranges from central Oklahoma through central and near-western Texas into northern Mexico. In the U.S. portion of its range the breeding biology, habitat, distribution and conservation threats have been intensively investigated. But far less attention has been devoted to it in Mexico. The species was suspected formerly to range widely in northeastern Mexico (Coahuila, Nuevo Leon, Tamaulipas, San Luis Potosi).

To fill this knowledge gap we developed a bi-national cooperative research contract with the Universidad Autónoma de Nuevo Leon. The main objectives were to conduct surveys and censuses, characterize habitat, understand conservation threats and develop management strategies for BCVIs in their suspected historic breeding range. Only extant populations are

known from Coahuila, so we focused our attention on the other three states.

Surveys began in Nuevo Leon in February 2002. In April, using previous observational data provided by S. Breslin, we discovered a small population near the town of Bustamante in north central Nuevo Leon. Three adult males were captured and marked with U.S. Bird Banding Lab leg bands and color-bands. These represented the first records for the state of Nuevo Leon.

Additional work was conducted at 10 sites on a 5,000 ha (12,350ac) private ranch near the town of Villaldama in north central Nuevo Leon. A much larger population was found there. Four adults were captured and banded. Observations

of approximately 30 individuals were recorded. Fledgling BCVIs were observed with attendant parents on two separate occasions. Breeding habitat in this part of their range consists of submontane thornscrub at elevations ranging from 600 – 1,200 m (656-1,312yd).

These data are the first well-documented breeding records for BCVI in Nuevo Leon and further document the known distribution in Mexico. Fieldwork will continue through 2004.

*Funding for this project was provided by Section 6 of the Endangered Species Act.*

## Gene Flow, Colonization Patterns and Phylogeography of the **Black-Capped Vireo**

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Black-capped vireos (*Vireo atricapillus*) breed in arid scrub-type vegetation communities typically associated with rocky limestone-derived soils along slopes and drainages from south-central Oklahoma (34° 50' N) to central Nuevo Leon (26° 30' N), Mexico. This gives them the widest latitudinal breeding range of any endangered songbird. Such geographic isolation may result in genetic isolation. Mitochondrial DNA has been used in many studies of birds to assess genetic isolation. Sometimes populations are not differentiated (e.g., California gnatcatcher, *Poliophtila melanura*) and sometimes they are (cactus wren, *Campylorhynchus brunneicapillus* and verdin, *Auriparus flaviceps*).

It is important to know whether peripheral populations are genetically isolated, because if they are, they merit consideration as distinct units of biodiversity that might require special protection. The objective of this project was to determine how genetically similar BCVI from the northern extreme of their

range were with those from the southern extreme.

In 2002 we captured and removed a few feathers from representatives of their extreme southern (Nuevo Leon, n = 6) and northern (Oklahoma, n = 20) range. Feathers will be analyzed (Dr. R. M. Zink, University of Minnesota) in early 2003. If results indicate genetic differentiation between the two samples then we will proceed to collect more feather samples from populations along a latitudinal gradient from Oklahoma to Nuevo Leon. This will lead to a better understanding of historical rates and geographic patterns of colonization, gene flow among subpopulations and delineation of metapopulation boundaries, which will greatly aid in recovery and management of this endangered songbird.

*Funding for this study was provided by The Bell Museum, University of Minnesota and TPWD.*

## Winter Ecology of the **Black-Capped Vireo**

Robert Powell and R. Douglas Slack, Ph. D., Texas A&M University  
C. Craig Farquhar, Ph. D., TPWD

Black-capped vireos (BCVI; *Vireo atricapillus*) over-wintered in the Pacific slope states of western Mexico. The objective of this study was to improve our understanding of their habitat use, geographic distribution, and conservation threats in this area. Sites were surveyed at 36 locations in Durango, Sinaloa, Nayarit, Jalisco, Colima, Michoacan, Guerrero and Oaxaca January 27 - April 11, 2002. Sites were also surveyed for the dwarf vireo

(DWVI; *Vireo nelsoni*), a little-known Mexican endemic and the BCVI's closest taxonomic relative. Habitat variables were measured at each BCVI and DWVI location and at five random locations along the survey transect at each site. Flock associates were also recorded and later classified as migrants or residents in order to examine trends in different habitat patches.

Nine BCVIs and five DWVIs were recorded from Nayarit, Colima and Jalisco. BCVIs were found at elevations ranging from 64-1,515 m (70 - 1,657yd) [mean = 944 m (1,032yd); SD = 535 m (585yd)]. A variety of habitats were used including shade coffee plantation (tropical deciduous forest and tropical semi-deciduous forest), thorn forest, tropical semi-evergreen forest, riparian forest and within an agricultural matrix adjacent to tropical deciduous forest. DWVIs were found at elevations ranging from 1,445 - 2,372 m (1,580 - 2,594yd) [mean = 1,740 m (1,903yd); SD = 384 m (420yd)] in oak-pine forest, coffee plantation (tropical semi-deciduous forest) and in tropical semi-evergreen forest. Mean avian species richness at BCVI sites was 14.8 (SD = 2.5) and 10 (SD = 5.6) at DWVI sites. The avian community at BCVI sites included 45.5% neotropical migrants while that at

DWVI sites had 36%.

The geographic center of wintering distribution of the BCVI appears to be further south than what is described in the literature. Winter habitat selection includes a wider variety of habitat types than what is utilized by BCVIs during the breeding season. BCVIs and DWVIs seem to be segregating habitats by altitude with BCVIs found at lower altitudes although there is overlap. This investigation will continue through winter 2003-2004 and will include stable isotope analysis from feathers to ascertain over-wintering distribution.

*This project was funded by a Challenge Cost-Share grant from the US Fish & Wildlife Service and a Section 6 grant of the Endangered Species Act.*



## Census and Monitoring of Black-Capped Vireo in Texas

John Maresh, TPWD

The purpose of this ongoing study was to: (1) determine current population status and distribution of black-capped vireo (*Vireo atricapillus*) in recovery units 1, 4, 5 and 6 (as defined by the USFWS Black-capped Vireo Recovery Plan, 1991); and (2) to clarify

population status in recovery units 2 and 3 in Texas. Breeding productivity in these populations as well as rates of parasitism by brown-headed cowbird (*Molothrus ater*) are being monitored and evaluated and other threats are being identified. Another goal is to determine differences in habitat structure and composition and differences in habitat use across different recovery units.

Eight monitoring sites were established during fiscal year 2001 across all recovery units: a private property in Montague County (Recovery Unit 1 - North-Central Texas); a private ranch in Somervell County and Camp Bowie National Guard

Training Site in Brown County (Recovery Unit 2 - Lampasas Cut Plains); two private ranches in Edwards County (Recovery Unit 3- Southeast Edwards Plateau); a private ranch in Coke County and Camp Barkeley National Guard Training Site in Taylor County (Recovery Unit 4 - Concho Valley); a private ranch in Terrell County (Recovery Unit 5 - Stockton Plateau); and Big Bend National Park in Brewster County (Recovery Unit 6 - Trans-Pecos).

All sites are surveyed annually for vireo distribution and abundance. Breeding territories are identified and mapped. Productivity and nest success are monitored on each territory. Rates of cowbird parasitism are noted as is evidence of predation or other threats. Banding and color marking of individuals continues to facilitate territory identification and to determine age structure and return rates within populations. Quantitative characterization of vegetative composition of nesting sites is performed on almost all nests found.

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

# Wild Turkey



## Juvenile Cohort Movement in Rio Grande Wild Turkeys

Richard S. Phillips, Warren B. Ballard and Mark C. Wallace, Texas Tech University; Michael S. Miller, TPWD

Rio Grande wild turkeys (*Meleagris gallopavo intermedia*) generally move greater distances than other subspecies of turkey and often congregate in large numbers at winter roosts. Although some large roosts appear to consistently house a relatively constant number of birds, some landowners report fluctuating numbers of turkeys among years at smaller winter roost sites on their property. The objective of this study was to identify movement patterns that might explain differences in fluctuating numbers at some roosts while others remained relatively stable.

Beginning in January 2000, Rio Grande wild turkeys were outfitted with radio transmitters at three study sites, one each on the Gene Howe Wildlife Management Area (GH), Matador Wildlife Management Area (MA) and the Salt Fork (SF) of the Red River in Donley and Collingsworth Counties.

Movements were classified into three patterns: migration, dispersal and core-use. These types of movement represent three keys to the spatial use of habitat. Migration involved movement from the winter to the summer range; dispersal refers to a one-way permanent movement from one winter roost to another; and core-use was where individual turkeys spend the majority of their time based upon mathematical estimates of locations.

Since beginning the study, > 20,000 locations have been recorded on 562 turkeys indicating variation in distance moved among cohorts as well as study sites. Despite this variation, certain trends are becoming apparent.

At all three Texas study sites, juvenile hens migrated further from their winter range to their summer range. Average juvenile female migratory movements for the three sites were 1.3 km (7.0mi, SF), 2.1 km (1.3mi, MA) and 2.3 km (1.4mi,

GH). Average adult female movements were 1.1 km (0.7mi), 1.0 km (0.6mi) and 0.8 km (0.5mi), respectively.

Average juvenile female dispersal movements for the three study sites were 14.0 km (8.7mi, SF), 1.5 km (0.9mi, MA) and 4.0 km (2.5mi, GH). Average adult female dispersal movements were 1.6 km (1.0mi), 1.8 km (1.1mi) and 1.3 km (0.8mi), respectively.

Core-use areas for juvenile females averaged 220 ha (544ac, SF), 259 ha (640ac, MA) and 241 ha (595ac, GH). Core-use areas for adult females averaged 207 ha (512ac), 259 ha (640ac) and 104 ha (256ac), respectively. Preliminary evidence suggests there might be some relationship between the distance traveled by juvenile females and the size of their core use areas.

Among adult and juvenile males, there was little difference in migration or dispersal distances. Core-use area sizes were also very similar between cohorts and among study sites, except for one study site where adult male core-use areas were twice that of juveniles. Juvenile male core use areas averaged 450 ha (1,111ac, SF), 466 ha (1,152ac, MA) and 130 ha (320ac, GH). Adult males averaged 440 ha (1,088ac), 907 ha (2,240ac) and 181 ha (448ac), respectively.

These findings suggest the juvenile female cohort plays a major role in population expansion and the colonization of winter roosts in the Panhandle. Additional data and landscape analyses will determine the relationships among movement variation, cohort survival and the distribution of trees on study sites.

*Funding for this study was provided by TPWD, Texas Tech University, Kansas Department of Wildlife and Parks, National Wild Turkey Federation and the Texas Chapter of the National Wild Turkey Federation.*



## Population Performance of Rio Grande Wild Turkeys

John H. Brunjes IV, Mark C. Wallace and Warren B. Ballard, Texas Tech University; Michael S. Miller, TPWD

Populations of Rio Grande wild turkeys (*Meleagris gallopavo intermedia*) in the Texas

Panhandle and Kansas are believed to have experienced population declines in recent years. Declining numbers and sizes of winter roosts and reduced poult-hen counts evidenced these declines. Although these methods provide an index of population performance, no population data are available.

The key to understanding population dynamics of any species is the relationship between the per-capita rate of change and population density. Population models provide one method for understanding this relationship. Models have provided wildlife managers with important information on the processes that drive wild turkey populations. This study was undertaken to provide survival data and to create a population model, which predicts future population performance.

To better understand population performance, we choose three study sites in the Texas Panhandle and one site in Kansas. Between January and March 2000, 2001 and 2002, we captured turkeys at the four study sites, using a combination of drop and rocket netting. We captured >1,000 turkeys across all sites and outfitted 724 of these with backpack radio transmitters. Transmitters were used to calculate survival rates and determine nesting success.

We created deterministic and stochastic stage-structured

population models using MATLAB ®. The models were based on the Leslie matrix and used adult, sub-adult, poult, and nest/egg stages to predict population outcome. Survival and reproductive data were input into the model to predict population trends at each site. The model predicted stable to increasing populations for the region as a whole. When considered individually, two study sites had increasing populations, one was stable, and one was declining.

A stochastic form of the model, which randomly varies parameters, was also created to conduct sensitivity analyses to determine which population parameters might be most important to population performance. Our model was found to be most sensitive to reproductive output, specifically nest success. Fall survival of adult females and males also significantly influenced the model.

Previous models were found to be very sensitive to fall hunting; but because fall hunting mortality is so low in the region, it was not found to be a significant factor in our model. Information provided by this model can be used by biologists to better manage turkey populations in the region.

*This study was funded by Texas Tech University, TPWD, Kansas Department of Wildlife and Parks, the National Wild Turkey Federation and the Texas Chapter of the National Wild Turkey Federation.*



## Rio Grande Wild Turkey Poult Habitat Characteristics and Survival

Brian L. Spears, Warren B. Ballard and Mark C. Wallace, Texas Tech University  
Michael Miller, TPWD; Roger Applegate, Kansas Department of Wildlife and Parks

As with all populations, recruitment of young is vital to the subsistence of wild Rio Grande turkey (*Meleagris gallopavo intermedia*) populations.

The period from hatching to approximately two weeks of age has been shown to be the period of highest mortality for turkeys. Survival rates observed range from 4-64%, with predation being the main cause of mortality. As poults reach

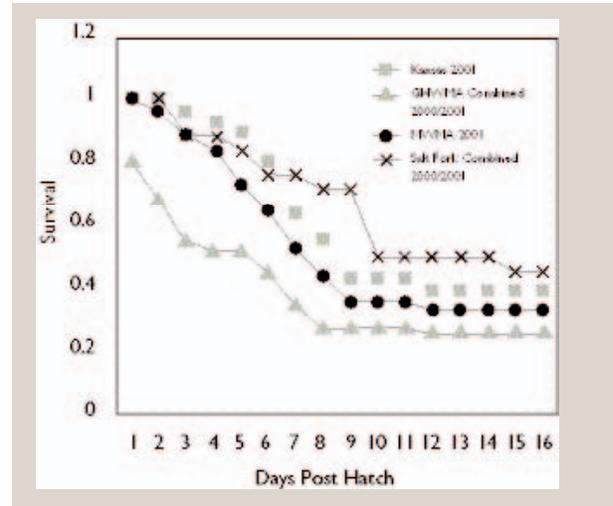
two weeks of age, they are able to fly to trees to escape ground predators. Creating habitat that provides proper nutrition but allows pre-flight poults to avoid predators could allow managers to stabilize or increase declining turkey populations. This study was designed to further examine pre-flight poult daily survival and correlate it with habitat characteristics at four study sites in southwest Kansas and the Texas Panhandle.

In 2000, 42 poult from 15 broods were equipped with miniature radio transmitters on the Cimarron National Grasslands, Kansas and the Gene Howe Wildlife Management Area (GHWMA), Matador Wildlife Management Area (MWMA) and along the Salt Fork of the Red River, Texas. Survival estimates for the 16-day post-hatch period ranged from 10-66%. In 2001, 83 poults were radio-equipped from 25 broods. Survival estimates for the 16-day periods ranged from 33-44%.

While these daily survival rate estimates are within those seen elsewhere, an important trend was uncovered that has rarely been reported in turkey ecology. The majority of studies published regarding poult survival state that mortality rates decrease at approximately two weeks. This study demonstrated that mortality rates in this region increased drastically after nine-ten days. While habitat characteristics may have an effect on this change in survival, it is probably more likely associated with poult flying abilities and brood behavior.

This knowledge will allow managers to focus on increasing the quality of habitat for broods <10 days of age in order to increase poult survival and overall population numbers. Parameters of habitat used by pre-flight broods at each site are being examined to determine if any differences exist between broods of low and high survival and broods < and > nine-ten days of age.

Funding for this project was provided by Texas Tech University, TPWD, Kansas Department of Wildlife and Parks, the National Wild Turkey Federation, and the Texas Chapter of the National Wild Turkey Federation.



Staggered entry design Kaplan-Meier survival function for wild turkey poults on four sites in southwest Kansas and the Texas Panhandle.



## Survival, Movements and Habitat Selection of Male Rio Grande Turkeys in Their Northern Distribution

Derrick Holdstock, Mark C. Wallace and Warren B. Ballard, Texas Tech University; Jack Jernigan, TPWD

Little is known about male Rio Grande turkey (*Meleagris gallopavo intermedia*) survival and habitat use patterns. We initiated a study of male survival, movements, and habitat selection on four study sites located in the Texas Panhandle and southwestern Kansas. From

January 2000 through March 2002, 117 adult male and 106 juvenile male turkeys were captured and equipped with backpack style radio-transmitters at four study sites across the Panhandle and High Plains. Furthermore, 38 juveniles survived to the next capture season and recruited into the adult male age class. These turkeys were located about twice weekly to determine home ranges and survival rates. Turkeys were also approached periodically to determine behavior and habitat use. Vegetation measurements were taken where turkeys were observed. These measurements included indices of visual

obstruction, shrub density, tree density and characteristics, over-story canopy cover and coarse woody debris.

Preliminary data indicate that adult male survival in spring and fall was slightly lower than in summer and winter; but there was no important difference in survival between these seasons. This trend occurred regardless of whether hunting mortality was included. Juveniles had higher survival than adults during autumn. This result was inconsistent with other research suggesting that fall dispersal contributes to low juvenile male survival. Spring survival did not differ between juvenile and adult males. Juvenile survival did not differ among seasons. Study site differences, as well as the contributions of movement and vegetation to the observed patterns of survival are being investigated.

Funding for this study was provided by Texas Tech University, the TPWD, Kansas Department of Wildlife and Parks, the National Wild Turkey Federation and the Texas Chapter of the National Wild Turkey Federation.

## Estimating Rio Grande Wild Turkey Populations in Texas

Warren B. Ballard and Mark C. Wallace, Texas Tech University; William P. Kuvlesky, Jr., Texas A&M University-Kingsville; Roel R. Lopez, Markus J. Peterson and Nova J. Silvy, Texas A&M University; Stephen J. DeMaso, TPWD

We initiated a study to develop a technique to estimate Rio Grande wild turkey (*Meleagris gallopavo intermedia*) numbers over larger areas. The four-year project will be conducted in four phases. First, in 2003 we will review current and past methods used by TPWD for wild turkey surveys. Second, we will review the literature for population density estimation procedures used by others to estimate densities of wild turkey and other wildlife species. Third, we will evaluate potential methods using "known" population data from study sites (various vegetation types) in the Edwards Plateau and Rolling Plains eco-regions of Texas. Last, we will evaluate potential methods over time for their ability to predict change in population densities.

This project will provide: (1) a literature review of potential census methods; (2) an evaluation of historic and present

methods used by TPWD; (3) greater accuracy and precision of potential census methods; and (4) results of tests of additional methods to determine which has the greater accuracy and/or precision to estimate turkey density. If the objectives can be achieved, changes in turkey population densities could be more easily tracked over time and possibly even predicted in advance. This would allow TPWD to more effectively identify parameters influencing turkey populations and better manage the Rio Grande turkey. If the method developed is accurate enough, it could be incorporated into predictive models that measure population response to regulatory adjustments within the existing regulatory framework and expanded hunter opportunity.

*This study is funded by the TPWD, Texas Tech University, Texas A&M University-Kingsville and Texas A&M University-College Station.*



throughout the Trans-Pecos region. In the 1980s, several

## Ecology and Management of Turkey in Trans-Pecos, Texas

J. Shane King and Louis A. Harveson, Sul Ross State University; Michael D. Hobson and Michael T. Pittman, TPWD

Wild turkey (*Meleagris gallopavo*) are one of the many species in the U. S. that have been successfully restored to native habitats throughout their range through partnerships between state wildlife agencies, conservation organizations, university researchers and private landowners. Restoration and restocking of turkey in Texas have primarily been restricted to the Edwards Plateau, Post Oak Savannah and Pineywood eco-regions. However, turkey populations in West Texas do persist in small numbers

restocking/restoration attempts were made with both Merriam's (*M. gallopavo merriami*) and Rio Grande turkeys (*M. gallopavo intermedia*). Despite these efforts, little is known regarding current turkey populations in the Trans-Pecos. We initiated a study in the Davis Mountains in September 2001 to establish baseline information on turkeys in West Texas.

Specifically, our objectives were to: (1) determine the genetic identities of subpopulations; (2) document survival rates; (3) estimate density; (4) evaluate habitat use; and (5) develop management recommendations for turkey in the Trans-Pecos. Twenty-seven turkeys were trapped using walk-in style traps and modified drop nets. Turkeys were aged, sexed, measured, bled and radioed with backpack style transmitters. Turkeys were monitored with radio telemetry 1-4x/week to determine survival, habitat use, home range, nest site selection and roost selection. Blood samples ( $n = 25$  taken from Raton, New Mexico) will serve as a control in assessing genetic identity

(Merriam's vs. Rio Grande). We estimated that 148 turkeys resided in the Davis Mountains in spring 2002. Mammalian predators were the primary source of mortality ( $n = 7$ ) and annual survival rates for turkey was 0.27.

Cooperative funding for this project was provided by the Texas Parks and Wildlife Department (Turkey Stamp Funds). Many generous landowners throughout West Texas, including the Nature Conservancy of Texas, provided access to private lands.

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

Jody N. Schaap, Charles J. Randel, Beau J. Willesey, Dustin A. Jones, Nova J. Silvy, Markus J. Peterson, Fred E. Smeins and X. Ben Wu, Texas A&M University; Tim A. Lawyer (deceased), Kevin G. O'Neal (deceased), T. Wayne Schwertner and Ray Aguirre, TPWD

Historically the Edwards Plateau Region (EP) of Texas was considered the heart of Rio Grande wild turkey (RGWT; *Meleagris gallopavo intermedia*) range. Local ranchers and TPWD biologists have noted a decline in RGWT abundance since the late 1970s in the southern EP. To determine the possible cause of the decline in the southern EP, we conducted research on two sites, one in northern Kerr County (stable turkey population) and one in northern Bandera County (declining turkey population).

In March 2001, 85 birds were trapped (54 on stable site, 31 on declining site), radio-tagged and fitted with leg bands. Blood samples were taken for disease analyses. Radio-tagged birds were intensively monitored to determine survival and reproductive parameters and to identify specific mortality causes. Vegetation characteristics were monitored at each nest and at points 7.5 m (8.2 yd) from the nest in each of the four cardinal directions. In May 2002, 35 additional turkeys were trapped and radio tagged at the original two sites and 49 birds were trapped and radio tagged at two additional sites (22 at a declining site in Bandera County and 27 at a stable site in Real County). Predator abundance was estimated at each site using

scent stations (Carman's Distance Canine Call) consisting of a 0.8-m<sup>2</sup> circle of sifted flour. Survey lines of 10 scent stations approximately 0.4 m apart were placed adjacent to ranch roads. Each avian predator encountered during normal tracking activities also was recorded to determine relative avian predator abundance. The availability of insects was established by collecting (Dietrick vacuum and sweep net) insects at brood sites and paired sites for six weeks post hatch. Insects available will be related to poult production and vegetation type.

In 2001, parameters related to brood survival exhibited the only significant differences between the two sites. The stable site had 100% brood survival, whereas brood survival on the declining site was only 56%. All other vegetative and reproductive parameters showed no conclusive differences. Data are currently being analyzed for the 2002 season.

Funding and support for this project were provided by TPWD's Turkey Stamp Fund, Federal Aid in Wildlife Restoration Grant W-126-R and the Texas Agricultural Experiment Station, Texas A&M University System.

## Waterfowl

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

Michael D. Samuel, Daniel J. Shadduck and Diana R. Goldberg, National Wildlife Health Center, U.S. Geological Survey; William P. Johnson, TPWD

Avian cholera, caused by the bacterium *Pasteurella multocida*, is one of the most important infectious diseases affecting North American waterfowl. Avian cholera often occurs as an acute outbreak at waterfowl concentration areas. White-fronted

geese (*Anser albifrons*) and lesser snow geese (*Chen c. caerulescens*) appear to suffer disproportionately high mortality. Two competing hypotheses have been proposed to explain the recurrence of avian cholera outbreaks: (1) *P. multocida* persists

in specific wetlands year-round; and (2) carriers reintroduce the disease as birds congregate on staging and wintering areas. Evidence gathered by the National Wildlife Health Center, Madison, Wisconsin, suggests that wetlands are not a likely reservoir for avian cholera. Conversely, serology samples obtained from lesser snow geese at Arctic breeding colonies indicated approximately 3% had been infected with *P. multocida*, but survived. To confirm that carrier birds occur, that disease is transmitted year-round, and that carriers are an important reservoir for avian cholera, research is needed that focuses on wintering areas.

This study's objectives are to determine if wintering geese are carriers of *P. multocida* and where the bacterium resides in apparently healthy birds. Swab and blood samples were taken from each snow (n = 266) and Ross' goose (n = 55) collected. Geese were collected January-March, 2001 and 2002, from the Playa Lakes region of Texas, New Mexico, Colorado, Kansas and

Oklahoma. Samples were processed at the National Wildlife Health Center.

*P. multocida* were isolated from cultures of swab samples obtained from four snow geese and one Ross' goose. Estimated prevalence of carriers is 1.5% in snow geese and 1.8% in Ross' geese. Additionally, blood samples indicated that approximately 3% of snow geese and 6% of Ross' geese were recently infected with *P. multocida* and survived the disease. Although prevalence is low, results confirm that apparently healthy geese are carriers of avian cholera and can potentially transmit the bacterium to other birds.

*Funding is being provided by the U.S. Fish and Wildlife Service, the Playa Lakes Joint Venture, the National Wildlife Health Center, the TPWD and Ducks Unlimited.*



## Late Winter Feeding Habits and Condition of Female Mallards Utilizing Livestock Ponds in Northeast Texas

Kevin J. Kraai, TPWD

Texas plays an important role for mallards (*Anas platyrhynchos*) wintering in the Central Flyway. The Oak Woods/Blackland Prairie Region (OW/BPR) of Northeast Texas is one of the primary wintering areas 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 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 green-tree reservoirs, little information describes the ecology of mallards wintering in man-made habitats.

Livestock ponds are becoming the most abundant wetland habitat in Northeast Texas. Livestock ponds are small man-made impoundments that supply water for livestock and aid in soil conservation and flood control. In the OW/BPR livestock pond densities are estimated to be as high as 2.7/km<sup>2</sup> (4.4/mi<sup>2</sup>) and totaling somewhere around 340,000.

Annual mid-winter waterfowl surveys indicate that an increasing number of mallards are utilizing livestock ponds in this region during late winter. Informed management decisions will require an understanding of foods consumed in environments where man-made structures provide the primary habitat. The objective of this study was to determine the importance of livestock ponds to the winter ecology of mallards in Northeast

Texas. This project will provide new information about the ecology and management of mallards in Northeast Texas. It will aid in our understanding of how livestock ponds compare to forested wetlands as wintering habitat for mallards.

From January 1 to the completion of the spring migration during 2001 and 2002, 71 actively feeding female mallards were collected from livestock ponds. Pairing status was noted prior to collection, as well as waterfowl abundance on livestock ponds. Following collection, each bird was aged; foods consumed, body condition and molt status was assessed. Preliminary information suggests how mallards respond to the habitats associated with a regularly changing landscape. All females collected and observed on study sites were paired. Adults comprised 87% of the specimens. Body condition indexes were some of the highest ever recorded for wintering mallards. At the time of collection the average percent of total body feathers being replaced was 6% (range

0–34%). Preliminary analysis of the foods consumed indicates a wide variety of seeds of both upland and wetland plants being used. A high percentage consumed both aquatic and terrestrial invertebrates.

My findings are consistent with this hypothesis that paired adults in good health use late winter and early spring habitats with ample food components. All specimens were in completion stages of pre-basic molt and diets appeared optimal. Therefore, livestock ponds appear to be very important habitats for mallards wintering in the OW/BPR of Texas. Findings from this project are key in conservation planning and habitat delivery associated with the activities of the Lower Mississippi Valley Joint Venture.

*TPWD is provided funding for this project with funds generated by the sale of state waterfowl stamps.*

## White-winged Dove

### Evaluation of Environmental Contaminants in **White-winged Doves** from the Lower Rio Grande Valley of Texas

Timothy B. Fredricks and Alan M. Fedynich, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville; Stephen J. Benn, TPWD

The historical breeding range in Texas for the eastern population of white-winged doves (*Zenaidura macroura*) occurs primarily in the Lower Rio Grande Valley (LRGV). This population has declined over the past 50-70 years, while expanding its range and numbers outside the LRGV in Texas. Decline in the historical breeding range has been attributed to a loss of suitable breeding habitat from conversion to agricultural land. However, recent studies have determined that available breeding habitat is being underutilized, which suggests that other factors could be responsible for the population decline. Research has shown that even though the U. S. and Texas are enforcing stricter environmental contaminant regulations, several wildlife species are still being exposed to a variety of agricultural pesticides and industrial compounds in the LRGV. Although spectacular episodes of morbidity and mortality are highly visible when they occur, the cumulative effects of sublethal and chronic exposures to environmental contaminants may be more harmful to overall productivity, due to subtle influences on fertility, sub-cellular genetic damage and alteration of nesting behavior. Our study was designed to determine if breeding white-winged doves in the LRGV are

being exposed to chlorinated pesticides, industrial contaminants and major and trace elements.

White-winged doves were trapped in Kingsville, Texas during summer 2002 and housed at the TAMUK research aviary to be used as breeding stock. Juveniles captured during summer 2002 and those hatched in captivity during 2003 breeding season will serve as controls. During the 2003 breeding season, 50-60 adults will be collected from pre-selected urban/industrial and agricultural habitats. Wild caught and captive control doves will be tested individually for 24 chlorinated pesticides, Poly-chlorinated biphenyl isomers and 12 major and trace elements. The results of this study will provide baseline data necessary to assess exposure of white-winged doves to environmental contaminants in the LRGV, which may be responsible for negatively impacting productivity of the breeding population.

*This project was funded by sportsmen purchases of the white-winged dove stamp of TPWD and the Caesar Kleberg Wildlife Research Institute.*

## A Model Simulation of **White-winged Dove** Population Dynamics in the Tamaulipan Biotic Province

Cristina A. Martinez, Sallie J. Hejl and William E. Grant, Texas A&M University;  
Alfonso Martinez, Universidad Autonoma de Nuevo Leon, Linares, Nuevo Leon, Mexico;  
Gary Waggenerman, TPWD

Although a wealth of information exists about white-winged dove (*Zenaida asiatica asiatica*; WWDO) biology and ecology, we do not know of any published systems simulation model that synthesizes this information. An objective of this research effort was to create a simulation model of population dynamics for the white-winged dove.

The model we developed simulates the dynamics of nesting and hunting experienced by an average WWDO population in its principal breeding range, the Tamaulipan Biotic Province. It is a discrete-time, deterministic compartment model based on difference equations with a one-week time step. We evaluated the ability of this model to simulate annual productivity and long-term population trends by comparing model predictions to field data. Based on evaluating model simulations, we adjusted annual productivity to correct discrepancies between the database and model results.

Sensitivity analysis showed that hunting pressure and return rates of adults and juveniles had the greatest effect on the spring breeding population size. Further demographic information and quantitative analysis of site fidelity, hunting mortality and survivorship rates would strengthen the model and help in the development of a spatially explicit habitat model. We examined the role of habitat in affecting WWDO distribution and conceptually relate habitat factors to the quantitative model. This should provide the framework for future development of a spatially explicit population dynamics model.

*Financial support was provided by TPWD's white-winged dove stamp fund and a W. K. Kellogg Foundation Grant from the Center for Grazing and Rangeland Management, Texas A&M University.*

## Forage Availability for **White-winged Doves** in the Rio Grande Valley

Karen Bautch and David G. Hewitt, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville; Susan Cooper and Nova J. Silvy, Texas A&M University; Stephen J. Benn, TPWD

A decline of white-winged dove (*Zenaida asiatica*) populations in the lower Rio Grande Valley since the 1920s has been attributed to loss of breeding habitat through clearing of native brushland for agricultural use. Since the 1940s, some breeding habitat has been established through land acquisition and re-vegetation efforts. Because the population has not increased and the current brush available is not supporting as many nesting birds as in the past, other factors influencing reproduction need to be addressed. The objective of this study was to determine if differences in food resources explain changes in white-winged dove nesting success in the LRGV.

An assessment of current and historic forage areas in relation to nesting locations will be conducted. We will determine dove density and reproduction by surveying nest transects in 15 randomly selected brush tracts during the months of May through August 2002 and 2003. GIS software will be used to calculate the area of food source cover types based on aerial photography and land use cover data within 3 km (2 mi) of

each brush tract. Seed and berry samples will be obtained monthly from square quadrats in brush, agricultural crops and forbs and grasses. Dry weight of forage samples from each type of food source landscape at each study site will be extrapolated to the area obtained from the GIS database to determine the total amount of food available at each study site.

Current and historical food available, based on aerial photos, USDA data, farming technology and the types of crops planted, will be associated with three periods: the 1960s, 1980s and 2000s. Nest production estimates obtained from the current nest transects and from historical TPWD nesting data will be related to food availability, and location and size of food cover types for each time period and month of nesting.

*Financial support for this study was provided by the Caesar Kleberg Wildlife Research Institute and sportsmen through the white-winged dove stamp fund of TPWD.*

## Survey Methods for Estimating Breeding Population Numbers of White-winged Doves in Urban Settings

Jeff B. Breeden and Fidel Hernández, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville; Nova J. Silvy, Texas A&M University; Gary Waggerman, TPWD

Auditory point-counts have been used as an index of breeding populations of white-winged dove (*Zenaida asiatica*) for several years in the Lower Rio Grande Valley. Management decisions have been based on these estimates. This method involves counting the number of individuals calling at predetermined stops and correlating that number to a nesting pair density. In the past 20 years, whitewings have been expanding their range throughout Texas and are rapidly increasing in urban areas. It has become necessary to develop a reliable and efficient method for estimating breeding populations in these urban settings. This will allow more certainty in documenting changes in breeding populations within urban areas, which may result from environmental conditions.

A method being tested involves dividing a city into a 1 km (0.62mi) grid and conducting the count near the center of each of a number of the cells. There are biases inherent in this methodology. These include the inability to distinguish individual birds at high densities thus resulting in different counts between different observers and inability to confirm how the index actually relates to breeding population density. Also, a large number of cells must be surveyed requiring a large

effort and manpower.

We are conducting a study to evaluate the current survey method to determine breeding populations trends in urban settings. We will analyze the number of cells being sampled in cities and determine the minimum number that need to be sampled to detect a 20% annual population change. We will also evaluate the method to determine how the numbers of calls heard at each point correlates with total whitewings and the number of nesting pairs present in a 400 m (433yd) radius around the point. We have chosen six cities of varying size in which to conduct this study: San Antonio, Austin, Harlingen, McAllen, Uvalde and Beeville. We will also evaluate the effectiveness of an electronic recording device to eliminate subjectivity. Results should allow us to recommend an efficient and reliable method to conduct breeding population estimates of white-winged doves in urban settings.

*Funding for this study has been provided by the Caesar Kleberg Wildlife Research Institute and white-winged dove hunters through purchase of stamps for TPWD.*



## White-winged Doves Population and Habitat Changes in the Lower Rio Grande Valley

Andrea Felton, William P. Kuvlesky, Jr. and Eric Redeker, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville; Marcus J. Peterson, Nova. J. Silvy and X. Ben WU, Texas A&M University; Gary Waggerman and Mike Frisbie, TPWD

White-winged doves (*Zenaida asiatica*) have been an important natural resource of the Lower Rio Grande Valley of Texas (LRGV) for hundreds of years. However, since 1950, populations have experienced significant declines. This decline may be attributable to habitat loss due to increased agricultural production, a decline in citrus production due to periodic freezes and the recent explosive human development.

Therefore, a five-year research project was initiated during 2002 to determine how habitat changes over the past 50 years have impacted LRGV white-winged dove breeding populations.

Specifically, the objectives of this study included determining if broad-scale landscape elements surrounding breeding areas impacted white-winged dove productivity.

Project personnel selected 15 study sites that represented poor, moderate and good white-winged dove breeding colonies in Cameron, Hidalgo and Willacy Counties. Reproductive rates were monitored via nest transects in each study site. Fine-scale habitat variables as well as coarse scale landscape elements (grain fields, water sources, citrus groves, etc.) were measured surrounding the individual study sites. Vegetation composition and structure was sampled during the 2002 field season. Fruit,

mast and domesticated grain seed sampling was completed in August 2002. Thirteen of 15 study sites have been geo-referenced. A second final field season will begin during April 2003.

*Funding for this study was provided by Caesar Kleberg Wildlife Research Institute and white-winged dove hunters through the White-winged Dove Hunting stamp fund of TPWD.*

## Effects of Food Plots on White-winged Dove Productivity in the Lower Rio Grande Valley

Kenneth D. Pruitt and David G. Hewitt, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville; Nova J. Silvy and Susan Cooper, Texas A&M University; and Stephen J. Benn, TPWD

White-winged dove (*Zenaida asiatica asiatica*) reproductive rates have decreased in the lower Rio Grande Valley of Texas since the mid-1900s. This decrease has been attributed to food availability and underutilization of nesting habitat. Grain availability, foraging strategies, and energy balance may influence nest site selection and productivity. If true, whitewings should prefer nest sites close to high quality food resources that allows for most efficient foraging and minimizing daily energy expenditure. Whitewings should also have higher reproduction in such sites.

Fifteen brush tracts, 5 each in areas with low, medium, and high density of nests, were chosen for study. To test the effects of food plots on nest site selection, private fields were leased and sown with specified grain within 1.6 km (1 mi) of 3 sites from each nesting density level. Nest densities and productivity will be compared between brush tracts with and without food plots to determine their effect on nest density and reproduction.

Subcutaneous radio tags are being implanted to determine foraging strategies. Whitewings will be located during peak

feeding times to determine preferred feeding locations. Factors affecting forage site selection will be examined, including type, quality, spatial distribution of food, and recent history of resource use. Coupled with data on reproduction and energy expenditure, a better understanding of foraging strategies and their implications will be achieved.

Relationships between energy expenditure and the availability and spatial distribution of food resources will be examined using doubly labeled water. Energy expenditure of nesting adult females will be measured soon after young have hatched. Relationships between food resources, productivity, and energy expenditure will be assessed. The study will increase our understanding of the effect of the quality and spatial and temporal distribution of food resources on whitewing nesting in the lower Rio Grande Valley.

*Financial support for this study was provided by the Caesar Kleberg Wildlife Research Institute and the white-winged dove stamp fund of TPWD.*

## White-winged Dove Distribution, Movements and Reproduction in a Recently Colonized Urban Environment

Cynthia Schaefer, John Baccus and Michael Small, Southwest Texas State University; Gary Waggerman and Roy Welch, TPWD

Unlike many game bird species, white-winged doves (*Zenaida asiatica*) have expanded their population size and range over the last few decades. Their breeding range in Texas has expanded from a four-county area in the Lower Rio Grande Valley to well over a third of the state. The largest breeding population (>2 million) is now found within the city of San Antonio. Additionally, many of these once migratory birds are now wintering in urban areas historically used only for breeding.

The objectives of this study were to determine: (1) breeding

population density and size; (2) fall feeding flight patterns; (3) the proportion migrants vs. resident; (4) chronology of migration; (5) distribution of hunter harvested birds; (6) nesting season extent; and (7) number of early and late season nesting attempts and success rates of a recently colonized urban population. Waco was chosen as the study area based on its size, relatively recent arrival of whitewings (1990) and sizeable resident population.

Standard call count surveys were performed over the course of four weekends April - May 2002. Estimated breeding density at

the peak of calling was extrapolated to determine a breeding population for the study area. In addition, we banded whitewings prior to April 15 (resident) and after (migrants) to determine distribution of recoveries and recapture rates. Standard walk-in funnel traps were used with property owner's permission. A sample was implanted subcutaneously in the field with radio transmitters. Most locations were determined from a truck mounted unidirectional and a hand-held directional antenna. Aerial grids were flown by helicopter at 0.15 - 0.31 km (500 - 1000ft) to locate radio marked birds. Feeding flight size and locations were recorded throughout the fall.

We estimated that nearly 70,000 occupied 10,623 ha (26,240ac). January - June 2002, 870 whitewings were banded. The recapture rate was only 3.2%, although banded birds were seen frequently at many trap sites. Only one substantial fall flight (5,160) was located. In June 2002, we implanted 39 whitewings with radio transmitters.

Of these, 28 were located to a perch at least once; 16 were located to a nest. One pair nested successfully and one pair re-nested. The latest nest found was on September 14, and was unsuccessful. One recovery was from a hunter and one was predated.

Multiple problems associated with urban radio telemetry were encountered. Most significant was the reduced range of the radio signal from design specifications [ $\geq 3.2$  km (2mi)] to  $\leq 1$  city block, signal interference, and low nest visibility due to tree height and foliage density. Property access issues affected nest searches. Banding and radio telemetry will continue in January and February 2003. Marked winter residents will be tracked, nests located and monitored. Recovery rates for banded and radio marked birds will be calculated.

*This study was supported by Texas hunter contributions via the Texas white-winged dove stamp and hunting licenses.*

## Evaluating the Coo-Count Survey Method for Estimating Breeding Populations of White-winged Doves in the Lower Rio Grande Valley

Mario Sepulveda and Fidel Hernandez, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville; Gary Waggerman, TPWD

Our objectives were to: (1) evaluate the feasibility and practicality of using an electronic counter to census rural breeding densities of white-winged doves; (2) evaluate the traditional diurnal elapsed time, time of day, and time of year to conduct coo-counts; and (3) determine how weather impacts calling intensity.

An electronic coo-counter was developed by 2 graduate students from the Department of Computer Science and Electrical Engineering, Texas A&M University-Kingsville. The device records total calls heard within the frequency of the white-winged dove call (range: 350 – 750 MHz), which can then be correlated with other parameters (i.e., point count data, nest transect data, and traditional coo-count data). We will develop a conversion factor between number of calls heard and birds/acre or other density measurement (i.e., nest/acre).

Fifteen auditory points were selected from the current TPWD database of historical count locations. These points were selected according to the densities heard at these sites the previous year. Five low density [2-4 pair/ha (5-10 pr/ac)], 5 medium density [4-8 pair/ha (10-20 pr/ac)], and 5 high density [ $> 8$  pair/ha (20 pr/ac)] sites were chosen. Three transects were placed randomly in brush habitat within 400m (366 yd) of each auditory point. Each transect was monitored every 4 days for active nests. Nests were monitored until young were hatched and fledged or the nests were depredated. We

conducted 20m visual point counts at the beginning and ending points of each nest transect.

We partitioned the study period into 3 intervals: peak calling (May to mid-Jun), peak nesting (mid-Jun to mid-Jul), and low calling or nesting (mid-Jul to mid-Aug). During each of these intervals, auditory counts were conducted every 4 days for 10 minutes. We documented the number of individuals heard calling by observer and electronic counter for 2-minute intervals at low density sites. We could distinguish individual doves only at low densities. This will allow us to determine the time segment (0-10 min) when the highest percentage of doves can be detected. We collected temperature ( $^{\circ}$ C), relative humidity (%RH), wind speed (m/sec) and light intensity (lux) for all counts to assess how weather may impact calling intensity.

Some modifications in the research methods will be implemented for the 2003 field season. Mourning dove (*Zenaida macroura*) calling frequency (400-700 MHz) overlaps the frequency of white-winged dove. This represents a significant problem only when mourning doves are present at high-densities. At low and medium densities, species and individuals can be distinguished.

*Financial support for this study was provided by the Caesar Kleberg Wildlife Research Institute and the sportsmen through the purchase of white-winged dove stamps of TPWD.*

## Other

### Ecology of Migrant Shorebirds on Saline Lakes of the Southern High Plains

Adrian Andrei and Loren M. Smith, Dept. of Range, Wildlife and Fisheries Management, Texas Tech University; David A. Haukos, U.S. Fish and Wildlife Service; William P. Johnson, TPWD



In order to complete migration, many species of shorebirds stop at inland wetlands to rest and feed. A select few of these inland sites are used by phenomenal concentrations of migrant shorebirds. Casual observations of large concentrations of migrant shorebirds on saline lakes in the Southern High Plains suggested that these wetlands might be

important. The primary goal of this study was to determine what role saline lakes play in supporting shorebird populations.

The objectives were to: (1) document abundance, species composition and migration chronology of shorebirds using saline lakes during fall and spring migration; (2) determine food habits of four species of representative shorebirds; (3) evaluate habitat characteristics and invertebrate availability at saline lakes used by shorebirds versus lakes not used by shorebirds; (4) evaluate microhabitats used while feeding; and (5) evaluate diurnal and

nocturnal behavior of selected shorebirds through time budget analyses to determine how they are using saline lakes.

During spring 2002, 230 surveys were conducted on a weekly basis on 18 saline lakes. All shorebirds present during surveys were counted. Food availability was sampled using core, water column and pitfall traps.

Twenty-five species were documented. American avocets, Wilson's phalaropes, least sandpipers and lesser yellowlegs were collected for food habits analyses. Preliminary results indicate that all four fed mainly on larvae of Diptera (families Chironomidae, Tipulidae, Heleidae). Analyses of the habitats used suggests that sandpipers fed at areas with <4 cm (1.6 in) of water depth while other shorebirds fed in water depths of 4 -16 cm (1.6-6.1 in). Feeding was the most common activity of shorebirds, accounting for about 70% of their time.

Research is currently in progress for the fall 2002 migration period. Concentrations of up to 7,000 Wilson's phalaropes and 2,000 Baird's sandpipers on these saline lakes have been found.

*Funding and support for this study is being provided by Texas Tech University, the U.S. Fish and Wildlife Service, the Playa Lakes Joint Venture and TPWD.*

### Population Characteristics of Sandhill Cranes Wintering in Texas

Gary Krapu and Dave Brandt, U.S. Geological Survey, Northern Prairie Wildlife Research Center (USGS-BRD, NPWRC); Jay Roberson, TPWD

The mid-continental population (MCP) of sandhill cranes (*Grus canadensis*) contains an estimated 550,000 cranes and is hunted in nine of ten states in the Central Flyway. Sandhill cranes have a low annual recruitment rate (i.e. successful pairs usually produce 1 young/yr), so detailed knowledge of temporal and spatial distribution and abundance are required when setting hunting regulations. Texas is the primary

wintering ground for the MCP and has the largest annual harvest in the nation. Therefore, part of our research has focused on identifying distribution of MCP subspecies and subpopulations during winter in Texas and gaining insight into the relative abundance of subpopulations.

MCP cranes were captured using rocket nets and marked with

Platform Transmitting Terminals (PTTs) on the primary spring staging areas in the Platte and North Platte River valleys in Nebraska. Each 30 gm PTT was attached to a plastic band on the upper leg. PTT-marked cranes were monitored throughout the annual cycle from signals transmitted to orbiting NOAA weather satellites, which relayed locations to ground-tracking stations.

Results from 136 PTT-marked cranes indicate that cranes that winter in Texas are produced over a vast area that extends across parts of four nations (U.S., Canada, Russia and Nunavut). The entire MCP breeding range extends diagonally from northwestern Minnesota northwest to western Alberta, eastern, central and western Alaska, and across the Bering Strait 1,613 km (1,000mi) into Siberia along the Arctic Coast. The primary wintering grounds of the two subspecies in the MCP, the Lesser (*G. c. canadensis*) and Greater (*G. c. tabida*), occur in Texas. A third subspecies, the Canadian (*G. c. rowani*) was dropped as a legitimate taxon after genetic research indicated separation from *G. c. tabida* was not justified.

PTT-marked Lessers that winter in Texas have been found primarily on the High and Rolling Plains between Amarillo and Odessa. In addition, they winter in South Texas, across parts of central and northern Mexico, New Mexico and southeastern Arizona.

The Texas Plains cohort represents the largest wintering concentration of MCP sandhill cranes in existence. Of the 49 PTT-marked Lesser sandhill cranes monitored to their wintering grounds, 76% went to Texas. Of those, 43% were

from the subpopulation that breeds in Northern Canada and Nunavut and 57% were from the subpopulation that breeds in Siberia and Western Alaska.

The northern Canada/Nunavut and Siberian/Western Alaska subpopulations of Lessers stage primarily in fall in central and eastern Saskatchewan and central North Dakota/western Saskatchewan, respectively. The Siberia/Western Alaska subpopulation accounts for about 66% of the Lessers in the MCP with the remainder being from the Northern Canada/Nunavut subpopulation.

Two subpopulations of Greater also winter in Texas (i.e., a Gulf Coast and a Texas Plains subpopulation). Gulf Coast Greater breed primarily in forested regions of Manitoba, Ontario and Minnesota with some from Alberta, Saskatchewan and the Northwest Territories. All PTT-marked Greater that wintered in the Texas Plains were from breeding sites in Alaska, the Northwest Territories, Alberta and Saskatchewan. Preliminary estimates suggest that comparable numbers of Greater winter along the Gulf Coast as on the Plains.

Information gathered on temporal and spatial distributions of subpopulations and their relative abundance will provide managers in the Central Flyway with more insight when making harvest management decisions.

*This study was funded by USGS-BRD, NPWRC, the Webless Migratory Game Bird Research Program of the USFWS, TPWD and other states in the Central Flyway.*

## Bald Eagles Nesting and Wintering Surveys

Brent Ortego, Chris Gregory and Kevin Herriman, TPWD

Nesting bald eagles (*Haliaeetus leucocephalus*) have been monitored in Texas since the 1960s. Initially there were only three known active nesting territories. In the 1970s efforts were increased to find and document more. From 1975-2002 the number of known active nests increased from 7-110, respectively. This increase was due to increasing bald eagle population, agency effort and public awareness and reporting of nests.

The nesting population of bald eagles is estimated using aerial and ground surveys of known and newly reported nests. Surveys are conducted annually January - April. Nest data collected includes location, status, productivity, general site description and estimated hatching date. These data are used extensively 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 18 standardized locations during mid-January. Survey sites include the Attwater's Prairie Chicken National Refuge, the Garwood/Eagle Lake Rice Prairies and 16 reservoirs throughout North, Central and East Texas. These surveys are coordinated by TPWD personnel with the assistance of volunteers.

In the 2002 survey, 228 bald eagles were reported. During January 2002, the greatest numbers were found on Lake Palestine and Lake Texoma with 50 and 41 eagles, respectively.

*These are ongoing annual surveys funded by TPWD and Federal Aid in Wildlife Restoration Grant W-125-R-11.*

## Colonial Waterbird Survey and Management

Brent Ortego, Marc Ealy, Greg Creacy and Larry LeBeau, TPWD

The Colonial Waterbird Survey is an on-going cooperative effort between TPWD, the U.S. Fish and Wildlife Service (USFWS), Texas General Land Office, Texas Colonial Waterbird Society and other interested organizations and volunteers. TPWD has participated in this annual statewide survey since 1968 including: (1) conducting bird banding research; (2) serving as the primary manager of cooperative survey data and maps of colony locations; (3) conducting aerial and ground surveys of inland and Gulf coastal sites; (4) providing information to the public about colonial waterbirds; and (5) assisting in managing selected colonies along the coast.

TPWD has conducted annual aerial surveys along the coast from 1980 - 1992 and during even numbered years thereafter. In 2002, aerial surveys were conducted on remote colonies and for the first time, surveys were conducted over the western Pineywoods and eastern Post Oak Savannah/Blackland Prairie ecological areas. These inland sites were sporadically surveyed from the ground from 1973-1990.

Data obtained from public lands were pooled into a common database summarized by geographic area and managed by the USFWS. Survey participants, consultants and developers frequently use this information to avoid damaging colonial waterbird nesting sites.

In 2002, 28 total active colonies and 62,478 nesting pairs were found along the lower reaches of rivers and coastal marshes between the Trinity and the Guadalupe Rivers. Below average annual precipitation resulted in less runoff in the river bottoms near traditional nesting sites providing colonies with less protection from predators and less forage.

However, sites further inland received more normal rainfall. As a result, the number of breeding pairs was very similar to those reported during the more typical rainfall years of 1994 and 1998 and about twice as high as the dry years of 1996 and 2000. Cattle egrets (*Bubulcus ibis*) and black skimmers (*Rynchops niger*) increased substantially, while white ibis (*Eudocimus albus*) numbers continued to be low. The number of breeding pairs for all species estimated from aircraft in these same drainages in 2002 was very similar to the 1981-1990 average (62,702).

The estimated number of nesting pairs at 13 historic sites in the western Pineywoods during the 2002 aerial survey (11,205) was much higher than the 1981-1990 average (3,237). But, the later were estimated by ground counts by TPWD staff and volunteers.

The 2002 aerial survey of nesting pairs (37,553) at 27 sites in the eastern Post Oak Savannah was much less than the average (102,441) estimated from 1981-1990 ground surveys. Comparisons of estimates between these two survey periods should be done cautiously because the survey methods and effort differed. TPWD's database includes only infrequent population estimates of individual colonies by volunteers and staff since 1973. Thus, there are many gaps among years. Data was gathered most consistently by individual colony from 1981-1990. In addition, the 2002 survey represents only one year's data; the earlier surveys usually represented an average of four surveys during the decade. Thus, comparing nesting pair counts of species with highly variable annual nesting populations with only one year of data is not recommended.

*TPWD colonial waterbird survey activities have been funded by the Federal Aid in Wildlife Restoration Grant W-125-R.*



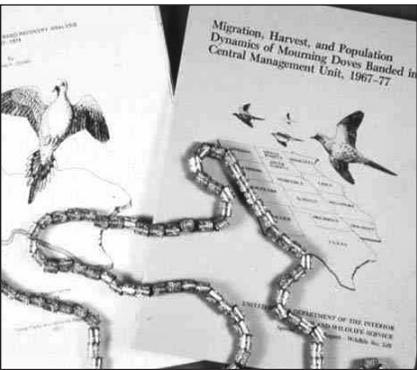
## Development and Evaluation of Population Models and Monitoring Programs for Improved Harvest Management of Mourning Doves

David Otis, Iowa Cooperative Fish and Wildlife Research Unit (ICWR)  
John Schulz, Missouri Department of Conservation; Jay Roberson, TPWD

An informed harvest management process for mourning doves (*Zenaidura macroura*) in the U.S. will require development of one or more

population models that synthesize existing knowledge of basic

life history parameters and how these parameters may be affected by factors such as harvest rate, weather and habitat conditions. Such models can ultimately be used to define decision criteria for implementing alternative harvest strategies. This modeling effort represents an initial step in a process to improve decision-making for hunting regulations. It strives to



place mourning dove harvest management in an objective and quantitative framework.

Re-analysis of 1965-1975 banding studies in the Eastern, Central and Western Management Units resulted in a set of survival models for each unit. The models are distinguished by the functional form of the relationship between annual survival and harvest rate, which ranges from completely

additive to totally compensatory.

No long-term, large-scale monitoring programs of annual reproduction are available to serve as the basis for developing models that predict annual production as a function of weather, habitat, and/or population density. Thus, a predicted range of per-capita reproductive rates has been derived for each of

several large geographical sub-regions based on a review of the scientific literature. These estimates are a function of breeding season length, nest success and length of the nesting cycle. Population models will be developed by integrating the sets of survival and reproductive models. We do not have contemporary and statistically reliable estimates of harvest rates that are fundamental to evaluate of population models and the harvest regulation process.

In cooperation with a consortium of 25 states, the U.S. Fish and Wildlife Service (USFWS), and the U.S. Geological Survey (USGS) Bird Banding Laboratory, a three-year reward banding study has been designed for 2003-2005. Between 25,000-35,000 birds will be banded each year in order to estimate harvest and band reporting rates in a representative sample of sub-regions.

*Funding for this study was provided by the ICWR of the USGS, the Webless Migratory Game Bird Research Program of the USFWS, TPWD and various state wildlife management agencies across the nation.*



## Mourning Dove Count Trends along Call-Count Transects in Texas

Brian L. Pierce, Nova Silvy, Marcus Peterson, Fred Smeins and Ben X Wu, Texas A&M University, College Station; Jay Roberson, TPWD

Significant declines in the mourning dove (*Zenaida macroura*) call-count survey (CCS) index have been reported for the Central Management

Unit (CMU) during the previous 10-year (1992-2001) and 36-year (1966-2001) periods. Texas, which comprises the largest proportional land area and the largest number of CCS routes (133) within the CMU, has reported a significant decline in the statewide population index over the last 10 years. Yet contradictory trends are evident among individual transects within the state. These discrepancies may be important if we are to identify the factors which influence mourning dove populations, and the scale at which these factors operate. Because population trends are likely to correlate with land-use changes associated with human population growth, it is essential that habitat along CCS routes be evaluated in order to: (1) determine how much emphasis to place on habitat improvement; (2) spatially prioritize any foreseeable changes in harvest regulations or habitat improvement efforts; and (3) obtain information that can be used to address public, judicial and legislative inquiries prior to any anticipated changes in harvest regulations.

While it is anticipated that U.S. Fish and Wildlife Service will

consider some form of harvest restriction if the downward trend continues, changes in harvest regulations are not likely to identify or alter the underlying factor(s) affecting long-term population trends. Therefore, our objectives were to: (1) identify declining and stable mourning dove call-count transects in Texas; (2) identify those micro- and macro-habitat variables which correlate with count trends; (3) determine if micro and macro habitat variable changes differ among declining and stable transects; and (4) establish a spatially explicit database that can be used for future data input and the development of predictive models at differing spatial scales.

We have completed data collection for all 133 CCS transects in Texas using a windshield approach. We are currently in the process of compiling the GIS database for the 1976 and 2002 survey results, which will be used to identify spatially congruent sample points from both study periods. Factor reduction will be accomplished using congruence among distance matrices (CADM) and clustering prior to multivariate analysis using canonical correspondence analysis (CCA) and distance-based redundancy analysis (db-RDA) as appropriate. This is the first phase of a multi-year study of mourning dove habitat in Texas.

*Funding for this project was provided by TPWD and the Texas A&M University System.*

# Mammals

## Bighorn Sheep

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

Clay E. Brewer and Scott P. Lerich, TPWD; Louis A. Harveson, Sul Ross State University



We estimated food habits of an introduced population of desert bighorn sheep (*Ovis canadensis spp.*) at Elephant Mountain WMA (Brewster County, Texas) by comparing dietary differences between: (1) sexes; (2) seasons; (3) wet and dry periods; (4) critical biological periods; and (5) bighorn

populations located in the Baylor, Beach, Elephant and Sierra Diablo Mountains. Diet composition was determined through micro-histological analysis of 432 fecal pellet groups (209 M, 209 F, 14 lambs), collected every two weeks September 1998 - August 2000.

Ninety-one dietary items were identified. Diets consisted of 50% browse, 35% forbs, 11% grasses and 4% succulents. Comparison of dietary proportions between sexes indicated a significant difference only for the combined (1998-2000) winter seasons ( $G_3 = 8.772, P = 0.032$ ). Shannon-Wiener diversity indices of the taxa consumed by sex did not differ ( $t = -1.182, P > 0.05$ ). Diet proportions were consistent between years, seasons and critical biological periods.

Mountain range comparisons reflected significant differences in male bighorn diets between Elephant and Beach Mountains

( $G_3 = 10.154, P = 0.017$ ) throughout the study. Seasonal comparisons between mountain ranges indicated no significant differences between sexes. Seasonal differences were indicated among male diet proportions between Elephant and Beach Mountains during fall ( $G_3 = 7.930, P = 0.047$ ) and spring ( $G_3 = 12.752, P = 0.005$ ), Baylor Mountain during winter ( $G_3 = 26.810, P < 0.001$ ) and the Sierra Diablo Mountains during spring ( $G_3 = 13.507, P = 0.004$ ) and summer ( $G_3 = 19.233, P < 0.001$ ). Differences were reflected among female diets between Elephant and Beach Mountains during winter ( $G_3 = 16.559, P = 0.001$ ) and the Sierra Diablo Mountains in fall ( $G_3 = 18.674, P = 0.003$ ), winter ( $G_3 = 30.050, P < 0.001$ ) and summer ( $G_3 = 24.622, P < 0.001$ ). Dietary overlap was greatest between the Elephant Mountain and the Sierra Diablo Mountain populations (57.6%) followed by Baylor Mountain (55.7%) and Beach Mountain (52.0%). The highest average overlap was reflected in the browse component (50%), followed by forbs (22%), grasses (11%) and succulents (3%).

Restoration and management of desert bighorn sheep in Texas must consider the important influence of diet on reproduction and maintenance of viable populations. Management strategies should include: (1) determining diets of all existing free-ranging bighorn populations; (2) evaluating the forage component prior to desert bighorn introductions; and (3) implementing techniques for evaluating habitat manipulations and monitoring forage use, status, condition and trends, including key indicator species.

*Funding for this study was provided by Sul Ross State University and TPWD.*



## Guzzler Use and Habitat Selection by Desert Bighorn Sheep at Black Gap WMA

Justin A. Foster and Louis A. Harveson, Sul Ross State University;  
Michael T. Pittman, TPWD

Water is often considered as a resource limiting the survival and dispersal of desert bighorn sheep (DBS, *Ovis canadensis*). Contrasting results regarding the use of guzzlers by DBS warrant an intensified study describing

microhabitat around guzzlers and their utilization by DBS. The goal of this research was to evaluate guzzler use by DBS at Black Gap Wildlife Management Area (BGWMA). Primary objectives of this study were to: (1) evaluate guzzler use by DBS and document non-target species use; (2) assess habitat requirements of DBS; and (3) make recommendations on the selection of future guzzler sites.

Data was collected from April 1, 2000 - March 31, 2001. Guzzler use was monitored with remote cameras at seven sites within the home ranges of DBS. DBS use (% composition of

photographs) ranked third among 13 species documented and accounted for 29% (n = 412) of all photographs. The majority of guzzler use by DBS (50%, n = 110) occurred between 1000 and 1600 hrs. Guzzler use was affected by precipitation and temperature with the majority of photographs (56%, n = 122) taken during the summer. Twenty percent (n = 87) of DBS guzzler use occurred during August, the summer month with the lowest recorded rainfall (1.7 cm). Steep slopes, distance to other permanent water sources, woody species canopy cover and density affected guzzler use. The results of this study indicate that DBS use artificial waters during critical periods of high temperatures and low rainfall. The construction of guzzlers is an effective means of improving DBS habitat in Trans-Pecos, Texas.

*This project was cooperatively funded by TPWD (Grand Slam Hunting Funds), Texas Bighorn Society, Dallas Ecological Foundation, Sul Ross State University and Houston Safari Club.*



## Habitat Use and Movements of Desert Bighorn Sheep at Elephant Mountain WMA

Shawn L. Locke and Louis A. Harveson, Sul Ross State University;  
Clay E. Brewer, TPWD

Knowledge of habitat use and movements of desert bighorn sheep (*Ovis canadensis* spp.) is critical for proper management of the species. The objectives of

this study were to: (1) estimate home range size, (2) estimate movement rates, (3) determine habitat use, (4) identify key habitat variables and (5) estimate survival of desert bighorn sheep at Elephant Mountain WMA (Brewster County, Texas).

Approximately 930 locations of 20 marked individuals (10F, 10M) were collected February 2001 - March 2002. Rams displayed larger home ranges [mean = 14.71 km<sup>2</sup> (5.7mi<sup>2</sup>)] than ewes [mean = 10.71 km<sup>2</sup> (4.1mi<sup>2</sup>)] and there was a slight difference in mean distance traveled between consecutive locations for rams [mean = 941.32 m/day (1029yds/day)] and ewes [mean = 826.34 m/day (904yds/day)]. Ewes selected slopes  $\geq$  40% while rams selected slopes  $\geq$  20% but both preferred the steepest slope classes available. Bighorns selected elevations  $\geq$  1,500 m (4,921ft), but ewes and rams preferred the higher elevation classes.

Southern aspects of Elephant Mountain were preferred, and desert bighorn sheep selected areas  $\leq$  1 km (0.6mi) of a permanent water source. Approximately, 45.5% and 44.9% of ewe and ram locations respectively, were located within one km of a permanent water source. Seasonal use of habitat variables was similar to annual use of habitat variables although some differences did occur between sexes and between seasons.

During the study period, one mortality of a radio-collared ram was recorded and the overall survival rate for both male and female desert bighorn sheep was 0.91 (CI = 0.69-1.13). Effective management of desert bighorn sheep is dependent upon the knowledge of home range and habitat use. Results of this study can be used to assess current habitat evaluation procedures in order to adequately evaluate potential re-introduction and restoration efforts of desert bighorn sheep in Texas.

*Funding for this project was provided by TPWD (Grand Slam) and the West Texas Chapter of Safari Club International.*

## Bison



### Development of a Genetic Breeding Program for the Texas State Bison Herd

James Derr, Loren Skow, Robert Schnabel and Natalie Halbert,  
Texas A&M University; Danny A. Swepston, TPWD

Charles Goodnight began establishing his bison herd in the Texas Panhandle in 1878. The herd eventually grew to approximately 250 head. After Goodnight's death in 1929 the herd's size gradually declined as the ranch changed ownership several times. The remnants of the herd escaped to the adjacent

JA Ranch in the mid-1930s. They remained there until 1996 when the owners of the ranch donated them to TPWD. It is considered one of five foundation herds that prevented extinction of the plains bison in North America. They have officially become known as the Texas State Bison Herd (TSBH).

Texas A&M University researchers in 1999 found six of 38 Goodnight bison captured in the winter of 1997-98 had traces of cattle DNA. The herd had low genetic diversity and was genetically unique compared to other tested public herds. This study will use detailed analyses of molecular genetic markers to develop a breeding and conservation plan that will support and

strengthen the overall management of the herd.

Significant results to date from this study include: (1) the TSBH is historically and genetically a significant North American bison population and its continued preservation and conservation should be a high priority; (2) reduced heterozygosity in the TSBH as compared with other bison herds is likely due to generations of inbreeding coupled with chronic, long-term small population size; and (3) genetic diversity will continue to be lost as demonstrated by the reduction in the number of alleles per locus among different generations of the TSBH.

Two management options are proposed. If the TSBH is maintained with the current individuals, an intensive breeding program to improve genetic diversity should be implemented based on the degree of relatedness of individuals. The alternative is to introduce genetic diversity into the TSBH from another bison herd. However, any bison brought into the TSBH would have to meet certain health, fertility and historical criteria.

*TPWD provided funding for this project.*

## Deer



### Ecological Relationships Between Desert Mule Deer and White-Tailed Deer

Kristina J. Brunjes, Warren B. Ballard and Mark C. Wallace,  
Texas Tech University; Mary H. Humphrey and Fielding Harwell, TPWD

In West Texas, the distributions of desert mule deer (*Odocoileus hemionus*) and white-tailed deer (*O. virginianus*) overlap along the western edge of the Edwards Plateau, Trans-Pecos and

Panhandle regions. TPWD and private landowners need information on how these two species interact with their

environment in order to manage both effectively in areas of overlap. Our objective was to examine differences in habitat use and causes of mortality of mule and white-tailed deer in a sympatric area.

In 2000 and 2001, 80 and 39 deer, respectively, were captured and radio-collared on five contiguous ranches comprising ~32,389 ha (~80,000 ac) in Crockett County. Forty animals

(eight males and 12 females of each species) were located weekly by triangulation January - August of 2000, 2001 and 2002 to determine survival and causes of mortality.

Causes of death included starvation, bobcats, fence entanglements, hunters, disease, poachers and auto collisions; however, in most cases (69%) cause of death could not be determined. Survival of female mule deer (~90%) was much higher than that of whitetail females (~70%). Survival of adult males of both species was similar to that of whitetail females. Differences in survival were not due to differential hunting pressure; only one collared animal (mule deer buck) has been legally harvested thus far.

Habitat use will be assessed using a geographic information system (GIS). A vegetation coverage has been constructed

using aerial photographs. A digital elevation model will be used to construct a layer depicting topography. Deer locations obtained via telemetry will also be input into the GIS. Use of vegetation classes and different elevations can then be compared between the species.

Preliminary analyses indicate that differences in topography separate the species on the microhabitat level. Mule deer use mesa tops and slopes, while white-tailed deer are largely confined to lower elevations with denser vegetation cover. Additional GIS coverages will be created to examine deer use of habitat in relation to water sources, feeders and roads.

*Funding for this project was provided by Texas Tech University, TPWD and the Rob and Bessie Welder Wildlife Foundation.*

## Vegetation and White-Tailed Deer Response to Aeration and Burning as Maintenance Treatments of Aerated Rangelands

James O. Rogers and Timothy E. Fulbright, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville; Donald C. Ruthven, III, TPWD

Prescribed burning is a recommended maintenance treatment following mechanical treatments of South Texas brushlands, but it is unknown whether additional mechanical treatments such as aeration or prescribed burning are preferable to improve habitat for white-tailed deer (*Odocoileus virginianus*). We tested the hypothesis that prescribed burning of aerated plots during late summer would result in lower protein precipitating tannin concentrations in browse, increased forb biomass, and increased deer utilization compared to a second aeration and that a second aeration would result in greater grass biomass.

The study was conducted on the Chaparral Wildlife Management Area in Dimmit and LaSalle Counties, Texas. Vegetation was dominated by mesquite (*Prosopis glandulosa*)-mixed brush communities characteristic of the South Texas plains. Ten patches of native brush, ranging in size from 2.8-8.1 ha (7-20 ac), were aerated during spring 1999. In late summer 2000, maintenance treatments were applied with five patches burned and five aerated. Standing crop, nutritional quality and tannin concentrations (browse only) of deer forages were

estimated. Tracks crossings across bulldozed lanes surrounding each patch were counted to estimate deer use.

Standing crop of browse, forbs, grasses, succulents, protein precipitating tannin concentrations in browse and track density did not differ between treatments. Below normal rainfall prior to the maintenance treatments appeared to impact vegetation response. Forb biomass increased and grass biomass decreased on both aerated and burned and twice-aerated plots. The influence of abnormal rainfall patterns on the results of this study underscore the importance of long-term research, particularly in regions such as South Texas that have extremely variable rainfall patterns and frequent periods of short-term drought. Based on deer and forage biomass response, burning and a second aeration as follow-up treatments to an initial aeration appear to have similar effects on habitat characteristics and use of cleared patches by white-tailed deer. Because of lower cost, prescribed burning is recommended as a maintenance treatment of aerated shrublands.

*Funding for this project was provided by TPWD.*

# Predators



## Effects of Coyotes on Swift Fox in Northwestern Texas

Jan F. Kamler, Warren B. Ballard, and Patrick R. Lemons, Texas Tech University  
Rickey L. Gilliland, United States Department of Agriculture-Wildlife Services  
Kevin Mote and Robert Sullivan, TPWD

The distribution of swift fox (*Vulpes velox*) in the western Great Plains has been dramatically reduced since historical times. Because coyotes (*Canis latrans*) have been identified as the largest cause of mortality in swift fox populations, we studied the effects of coyotes on swift fox in northwestern Texas. We radio-collared and monitored 88 foxes and 29 coyotes at 2 study sites from 1998 - 2000. On site 1, coyotes had relatively high abundance (6.8 scats/transect, n = 41) and annual survival rate (0.90), whereas foxes had low survival (0.47), low density [0.2 – 0.3/km<sup>2</sup> (0.6-0.8/mi<sup>2</sup>)], and low recruitment (0.25 young/adult). Consequently, swift fox had a sink population due to heavy predation from coyotes.

On site 2, coyotes had low abundance (4.9 scats/transect, n = 19) and annual survival (0.54); whereas, swift foxes had high survival (0.69), high density [0.7 - 0.8/km<sup>2</sup> (1.8 - 2.0/mi<sup>2</sup>)], and high recruitment (1.3 young/adult). Consequently, swift fox had a source population due to low predation by coyotes. These

initial results suggested that lower coyote numbers benefited swift fox.

To test the above hypothesis, we experimentally removed 227 coyotes on site 1 during the final year of the study while not removing coyotes from site 2. Subsequently, coyotes decreased in abundance (4.5 scats/transect, n = 18), and swift fox increased survival (0.63), density [0.7/km<sup>2</sup> (1.8/mi<sup>2</sup>)], and recruitment (1.2 young/adult). It became a source population due to lower predation by coyotes. All parameters remained the same on site 2 during the final year.

Our results indicate that high coyote numbers can suppress swift fox populations due to heavy predation. Reducing coyote numbers can change a sink population of swift fox into a source population. This has important implications for conservation of swift fox.

Funding for this study was provided by Texas Tech University and TPWD.



## Importance of Artificial Escape Cover for Increasing Swift Fox Populations in Northwest Texas

Brady McGee, Kerri Nicholson, Warren B. Ballard and Phillip J. Zwank, Texas Tech University; Heather A. Whitlaw, TPWD

The numbers and distribution of swift foxes (*Vulpes velox*) have dramatically decreased since the expansion of human settlement. Currently, coyotes (*Canis latrans*) are the primary cause of swift fox mortality. Swift foxes are one of the most burrow-dependent canids in North America. Although dens are used year-round for protection from predators, swift fox may shift among several different den sites. Availability of suitable den sites and escape cover may limit swift fox populations in northwestern Texas.

The objectives of this study was to provide information on: (1) utility and applicability of artificial escape cover for swift fox

population enhancement; (2) spatial relationships between sympatric swift foxes and coyotes after installation of artificial escape cover; (3) pup rearing success and litter size after installation of artificial escape cover; and (4) ecological characteristics of natural swift fox den sites. Research for this project began in September 2001 at two study sites: a private ranch in Sherman County, Texas and the Rita Blanca National Grasslands in Dallam County, Texas. Artificial escape dens were installed in April 2002 to determine if they would reduce the effects of coyote related mortalities.

Funding for this study was provided by Texas Tech University and TPWD.

## Modeling Mountain Lion Habitat and Prey Use in South Texas

R. Bill Adams and Louis A. Harveson, Sul Ross State University  
Paul B. Robertson, TPWD

Data was collected on the South Texas mountain lion (*Puma concolor*) population during a 15-month period from May 1999 – August 2001. Our objectives were to: (1) determine mountain lion habitat use; (2) determine cache site characteristics; and (3) predict and model occurrence on South Texas ranches. Using a geographic information system we created a habitat map consisting of four habitat types (or associations) and used compositional analyses to determine if mountain lions in South Texas exhibited habitat preference and home range preference. The Nueces River and its floodplain comprised one habitat type. Creeks/drainages and associated floodplains made up two others. Upland habitat was everything within the study area boundary excluding the other three habitat types.

Mountain lions typically preferred riparian habitats more than upland habitat. Cache sites had higher percentages of canopy cover ( $P = 0.018$ ) and visual obstruction at 5 m ( $P = 0.049$ ) and 10 m, ( $P = 0.014$ ) than random sites. Mountain lion density in the South Texas study area was  $0.005/\text{km}^2$ .

Our model will help managers predict the likelihood of mountain lions occurring on their property and the impacts they may have on resident prey populations based on kill rates.

*Cooperative funding for this project was provided by TPWD, the Welder Wildlife and Summerlee Foundations, Albert Biedenharn III, Rod Lewis and Eddie Knight. Many generous landowners throughout South Texas provided access to private lands.*



## Ecology of the American Badger in the South Texas Plains

Daniel P. Collins and Louis A. Harveson, Sul Ross State University;  
Donald C. Ruthven, III, TPWD

The American badger (*Taxidea taxus*) is found throughout much of the central and western United States and Canada, as well as northern Mexico. Badgers are behaviorally cryptic like many

carnivores, making them a difficult species to monitor. As a result, very little is known about badgers, especially in the southern most portion of their range. Badgers may be an important indicator of the quantity and quality of habitat suitable to prairie wildlife. The objectives of this study were to determine movement patterns, home range size, habitat selection and diet on South Texas rangelands.

The study was 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. Badgers were trapped using padded #3 style foothold traps and fitted with radio transmitters using a harness style backpack. They were monitored 5 –

7x/week. Vegetation at burrow and random sites was measured using the line intercept and Robel pole methods to assess micro-habitat selection. Macro-habitat selection was assessed by comparing daily locations to a current vegetative type map of the study site. Diet was determined from fecal samples of captured individuals and stomach samples of road killed individuals collected throughout the western portion of South Texas.

Five badgers (4M, 1F) were successfully trapped and fitted with radio transmitter backpacks. Two lost their backpacks before ample data could be collected. The remaining three males were monitored spring - fall 2002. Spring home range size ( $n = 1$ ) was 120 ha (296ac). Summer home range size ( $n = 3$ ) was 710 ha (1,754ac), which is significantly larger than home ranges reported from northern populations. Analyses of fall home range size, habitat selection, and diet are forthcoming.

*Funding for this study was provided by Sul Ross State University and TPWD.*

# Rare Plants



## Floral Inventory of Amistad National Recreation Area

Jackie M. Poole, TPWD

The National Park Service (NPS) has initiated a nation-wide inventory and monitoring program of Park resources. The four national parks in West Texas are within the Chihuahuan Desert regional inventory and monitoring network. Of these four only Amistad National Recreation Area (AMIS) lacks an adequate floral inventory. The goal of this project was to develop an

annotated, vouchered plant list for AMIS, complete with locations, frequency and habitat description or site characterization.

A baseline plant list was developed for AMIS by Dr. Richard Worthington using floras from nearby state parks and Nature Conservancy preserves. While this list is an excellent beginning, it may contain many species that do not occur at AMIS. Although AMIS extends from Del Rio to past Langtry along the Rio Grande and north up the Devils River in the Edwards Plateau,

most of the habitat is characteristic of Chihuahuan Desert scrub or Tamaulipan thornscrub. Very little of the habitat is characteristic of the Edwards Plateau portion of the Devils River State Natural Area or the Centex Homes Dolan Falls Preserve.

Although most of AMIS is under water, the NPS actually owns property to the flood pool level, 352 m (1,144 ft). Many areas have never been flooded while many previously inundated areas have become exposed due to continuing low water levels. Also AMIS includes extensive upland areas used primarily for recreation.

The logistics of surveying such a large riparian corridor are challenging. The NPS has offered a boat and driver to access many of the sites. Working with the AMIS Resource Naturalist, 70 sites were selected either as essential for the floral survey or at random. To date 35 have been visited and several hundred plant specimens have been collected. Six additional weeks will be required for fieldwork in the spring of 2003; the project will be completed in December 2003.

*Funding for this project was provided in part by the National Park Service.*



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

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

There is a need for an updated guide to the rare, threatened, and endangered plants of Texas. The last guide was produced in 1987 (Poole and Riskind 1987).

Several plants have been listed (or delisted) since that time. Many changes in both the candidate and 'species of concern' lists have subsequently occurred. Most of these species are too

rare to be found in any of the common field guides and few botanists know these species and their habitats. Misidentifications are common as these rare species lack published photographs or easily acquired illustrations. Without more readily available information on these species, their protection and recovery is tenuous.

The objective of this project was to produce a reference book

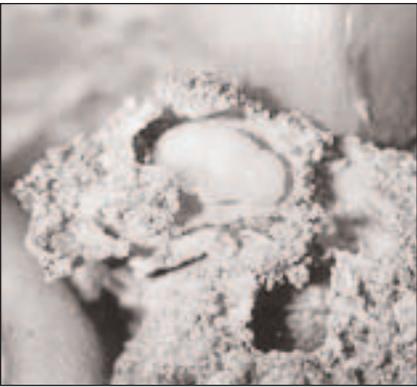
with photographs, line drawings, county-level maps, and text describing the distribution, habitat, physical detail or form, phenology, federal and state legal status, similar species, selected references and other comments. The introductory chapters of this book will include information on threats, recovery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

To date, 219 of 233 species treatments have been completed. The remaining 14 will be completed by January 2003. County distribution maps for each species have been finished. Photographs have been obtained for almost all recently located species. Original illustrations have been produced for those

species that are difficult to identify or for those that have not been photographed or illustrated previously.

Authors have been assigned for each chapter with due dates of July 1, 2003. One introductory chapter on history of rare plant conservation in Texas has been written. Species treatments and introductory chapters will be sent to specialists for review. The draft manuscript will be presented to the publisher on September 1, 2003.

*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 Beetle Larvae Herbivory**

Jackie M. Poole, Dana Price and Jason Singhurst, TPWD;  
William H. Calvert, Entomologist, Austin, Texas

The purpose of this study was to determine the long-term demographics of Tobusch fishhook cactus (TFC - *Sclerocactus breviamatus* var. *tobuschii*) at

several sites within its range and to evaluate the effects of the cactus weevil (*Gerstaeckeria* sp. nov.) on its survival. TFC cactus is a listed endangered species that occurs in seven counties in the southwestern portion of the Edwards Plateau.

Seventy-nine plots tracking 1,664 individuals have been established at 12 sites scattered across the range of TFC. Several plots were established in 1991 but most were established in 1996. Five new plots were set up in 2002. Populations are being monitored at six state parks and wildlife management areas, three highway rights-of-way and three private properties.

TFC populations at most sites remained more or less stable with mortalities balancing recruitment. Only one population located at the Kerr Wildlife Management Area increased significantly (80%), perhaps indicating a recent colonization of the site. Significant decreases (50% mortality and 50% of this caused by weevils) occurred at the Devils River State Natural Area and Devil's Sinkhole State Natural Area. One plot at Kickapoo Caverns State Park had 80% mortality with 60% caused by weevils.

Dr. Horace Burk, a weevil expert at Texas A&M University, has determined that another weevil, *Gerstaeckeria bifasciata*, occurs on TFC. In addition a more common undescribed species of *Gerstaeckeria* and two other insects, *Copestylus* flies and the larva of the Cerambycid beetle (*Moneilema* sp.) have also been found to cause mortality.

Data obtained from weevil rearing boxes suggest that they spend the bulk of the fall and winter months as larvae inside the cacti. Weevils emerge primarily during May, mate and lay eggs. After hatching the larvae develop slowly (typical of root-eating insects) and spend both the hot summer and cold winter months within the moderating environment of the cacti's interior.

Experiments are underway to determine whether the cactus weevil will use other genera. Adult weevils have been color-coded and are observed periodically.

*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.*

# Reptiles



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

Richard T. Kazmaier, West Texas A&M University; Anna L. Burrow, Beth A. Moeller and Eric C. Hellgren, Oklahoma State University; Donald C. Ruthven III, TPWD

Texas horned lizards (*Phrynosoma cornutum*) have declined throughout much of their range for reasons that may be tied to pesticide use, red imported fire ants (*Solenopsis invicta*), habitat alteration (e.g., agriculture, development), highway mortality and commercial exploitation. Reflecting this decline, Texas horned lizards are listed as threatened by the State of Texas. Management of this species is hampered by a lack of information on the effects of land management practices, such as grazing and burning. Our primary research objective was to examine the effects of livestock grazing and prescribed burning on the range size, habitat preferences and demography of horned lizards.

An on-going long-term marking/monitoring and intensive radio telemetry program is being conducted at Chaparral Wildlife Management Area (WMA) in Dimmit and La Salle Counties, Texas. We used radio telemetry to examine reproduction, survival and habitat selection in addition to movements. We used bait stations to measure abundance of harvester ants (*Pogonomyrmex sp.*), the horned lizards' primary prey, within all treatments.

Radio telemetry has been focused on specific pastures representing different management treatments. During 1998-2001, five management treatments were studied (winter burned-heavy grazed, winter burned-moderately grazed, non-burned heavy grazed, non-burned moderately grazed and non-burned non-grazed). Beginning in 2002 we shifted our emphasis away from different grazing intensity treatments to different burning treatments. Thus, the current project focuses on four treatments (grazed non-burned, grazed-winter burned,

grazed-summer burned and non-grazed non-burned). A fifth treatment (non-grazed summer burned) was added in 2003.

Marking and monitoring has resulted in 3,240 captures of 2,918 individuals 1991 - 2002. Radio telemetry through 2002 has resulted in >7,000 locations of 149 individuals. Across all treatments, home ranges have covered 0.02 - 23.4 ha (0.05-57.8 ac). Grazing intensity did not appear to affect home range size, but survival decreased dramatically with heavy grazing. Winter burning increased ant activity and tended to decrease home range size and increase survival; thus, winter burning appears to be beneficial for horned lizards on Chaparral WMA. Our current analyses suggest no effect of grazing or burning on micro-habitat selection by horned lizards. Comparisons between winter and summer burning will be conducted once sufficient data have been obtained.

Of 51 confirmed mortalities, 33% were the result of predation by large mammals, 27% by rodents, 20% by snakes, 18% by avian predators and 2% from anthropogenic causes. Known predators included coyote (*Canis latrans*), badger (*Taxidea taxus*), grasshopper mouse (*Onychomys leucogaster*), Texas indigo snake (*Drymarchon corais*), western coachwhip (*Masticophis flagellum*), glossy snake (*Arizona elegans*) and greater roadrunner (*Geococcyx californianus*). This project has already generated data that will assist in the development of appropriate management plans for this protected species.

Funding was provided by TPWD (Headquarters Research, Wildlife Diversity Program, Region IV, South Texas Research Fund) and the Rob and Bessie Welder Wildlife Foundation.



## Reproduction of Free-ranging Texas Horned Lizards in the Western Rio Grande Plains

Richard T. Kazmaier, West Texas A&M University; Anna A. Burrow and Eric C. Hellgren, Oklahoma State University; Donald C. Ruthven, III, TPWD

Management and conservation strategies for any species should be based on an understanding of that species' demography. Information on reproductive parameters necessary for demographic analyses of many species of reptiles is generally limited to characterization of clutch or litter size with little attention being given to parameters such as hatching success or clutch frequency. The Texas horned lizard (*Phrynosoma cornutum*) is a species of conservation concern that has

declined across many parts of its range. Thus, demographic data are needed for better conservation and management decisions regarding this species. The objective of this study was to characterize reproduction in a population of Texas horned lizards in the western Rio Grande Plains.

Texas horned lizards were monitored via radio-telemetry at the Chaparral Wildlife Management Area in Dimmit and La Salle Counties, Texas. As many as 17 female lizards were monitored concurrently from April 15 to August 15, 1998-2001. Upon locating a female exhibiting nesting activity, we increased radiolocations to at least twice daily for better

assessment of behavior. After a female left a nest, we staked a circular hardware cloth cage over the nest site to document hatching interval. Following hatchling emergence, nests were excavated by carefully digging through the loose soil filling the nesting burrow. Upon complete excavation of the nest, eggshells were counted to indicate clutch size and examined to determine if they successfully hatched.

Seventy female horned lizards were tracked between May 1998 and September 2001 for a total of 7,862 radio-days. Twenty-seven nests were recorded. Females typically made long distance movements outside of home ranges to lay nests, and then returned promptly to old home ranges. Nests tended to be associated with shrub clumps and averaged 43 cm (17 in) deep and 25 cm (10 in) long. Nesting was recorded from April 28 to July 30. Double clutching within the same year was recorded on four occasions. Clutch size averaged 22 and an average of 76% of eggs hatched per clutch. Clutch size tended to decrease with laying date. Hatching interval averaged 45 days and decreased with laying date.

Although this project is ongoing, these data help fill a void in the availability of field-collected reproductive information on Texas horned lizards. This demographic information can be used to develop better population models and management plans.

*Funding was provided by TPWD.*

## Short-Term Effects of Summer Burns on Herpetofauna in the South Texas Plains

Donald C. Ruthven, III, TPWD; Richard T. Kazmaier, West Texas A&M University

The Rio Grande Plains of southern Texas is the southern most extension of the Great Plains grasslands. As with most grassland-savannas, it is a fire dependent ecosystem. Overgrazing of domestic livestock and fire suppression has resulted in the invasion and domination of thorn woodlands. 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, which generally occur during late spring through early fall with the peak of thunderstorm activity. Little data are available on the effects

of summer burns on wildlife. The objective of this study was to determine the short-term effects of summer fire on herpetofauna on South Texas rangelands.

The study was 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 five burned plots and five non-burned areas. Burns were conducted in late August 1999. Reptiles and amphibians were sampled utilizing drift fence arrays (1/replicate) during late spring and late summer 2000 and 2001.

Species diversity and total reptile captures were greater on burned sites. Texas spotted whiptail (*Cnemidophorus gularis*),

the most common reptile encountered, showed no treatment effect. Six-lined racerunner (*Cnemidophorus sexlineatus*) was more abundant on burned sites. Other species that demonstrated trends were Great Plains narrow-mouthed toad (*Gastrophryne olivacea*), which were more abundant on non-burned sites and southern prairie lizard (*Sceloporus undulatus*), which tended to be more common on burned sites.

Summer burns appear to enhance herpetofauna diversity and favor grassland species such as the six-lined racerunner.

Further investigation into the effects of repeated summer burns on wildlife are needed to fully assess the value of summer fire as a management tool.

Funding for this study was provided by TPWD.

## Alligators



### Inland Alligator Habitat Parameters and Growth Rates

Keith Webb and Dr. Jeff Duguay, Stephen F. Austin State University;  
Gary Calkins and Joel Casto, TPWD

Information is lacking regarding the natural history and habitat requirements of inland populations of the American alligator (*Alligator mississippiensis*) throughout their range in North

America. States with inland populations have resorted to management using coastal population information and extrapolations. Florida, Louisiana and Texas all hunt inland populations using a variety of methods to determine harvest quotas with inadequate supporting research.

Texas has several inland populations that are of huntable densities. The Angelina Neches/Dam B Wildlife Management Area (WMA) has conducted hunts for several years using permit issuance criteria developed for coastal populations. Discrepancies exist when comparing harvest quotas on this WMA to those of inland populations in other states. If populations are to be managed and surplus American alligators harvested from these populations, harvest quotas should be based on information derived from inland populations.

Other questions concerning inland American alligators plague Texas biologists such as determining: (1) what constitutes suitable habitat; (2) what is the carrying capacity; (3) what are the reproductive success and dispersal; and (4) what are the growth rates and reproductive ages? Without at least cursory answers to these questions, management of inland alligator populations in Texas is not scientifically based and subject to error in over- or under-harvest.

Management of nuisance American alligators associated with inland populations has also become a concern. Nuisance individuals are currently removed by lethal means, or trapped and relocated. They are usually relocated into areas of known high densities. Dispersal patterns of relocated individuals and their potential impacts to existing populations are unknown. The purpose of this research was to: (1) establish a reliable density estimator for inland populations; (2) determine inland habitat suitability indices; (3) determine growth rate parameters; (4) establish pod dispersal distances and variables; (5) determine dispersal patterns of relocated nuisance individuals; and (6) establish an improved inland American alligator harvest quota formula. Field work for this project will

be initiated in the spring of 2003. Initial work will include the capture and marking of alligators on Dam BWMA for subsequent collection of growth rate and habitat selection data. Concurrently, habitat parameters will be collected and GIS analyses initiated.

Funding for this project was provided through TPWD, State Wildlife Grants and Stephen F. Austin State University.

## Composition of Prey Consumed by American Alligators along the Upper and Central Coasts of Texas

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

American alligators (*Alligator mississippiensis*) are known to play extremely important roles in the ecosystems in which they are abundant. However, higher than desired population densities may result in a reduction of game and non-game prey. Very little conclusive data on waterfowl and amphibian predation by American alligators is present in the literature. Because American alligators are known to vary their diet according to age, size, and habitat, it is important to determine size classes in any particular study. Further research is required on Texas coastal populations before American alligator harvest levels can be established in a management plan that conserves all of the available natural resources at a sustainable level.

Study objectives were to determine: (1) prey base by American alligator size class; (2) frequency of predation on mottled ducks (*Ana fulvigula*) and pig frogs (*Rana grylio*); and (3) if the prey types consumed by various size classes were correlated with habitat type or other environmental factors. Stomach contents of live juveniles [ $\leq 1.2$  m (4 ft)], subadult [1.4 - 1.8 m (4.5 - 6.0 ft)], and adult [1.8 - 2.3 m (6.0 - 7.5 ft)] captured by hand or with a self-locking snare will be lavaged by forcing water and abdominal compression to stimulate regurgitation. The mouth will be held open during this

process by inserting and securing PVC tubes of appropriate size. To evaluate the accuracy of our techniques, American alligators that are to be lethally removed by a nuisance control hunter will be lavaged before euthanasia. After euthanasia, the stomach will be removed to determine what, if any, contents were left in the stomach.

Three areas along the upper and central coasts with important mottled duck molting and nesting presence and three areas with large populations of pig frogs will be sampled during May, June and July of 2003 and 2004. Additionally, stomach contents from a maximum 105 harvested American alligators from the J. D. Murphree, Mad Island and Guadalupe Delta Wildlife Management Areas will be collected annually. Stomach contents will be identified, counted and weighed. Final analysis of stomach contents will be based on frequency and percent by mass. Night counts will be conducted in all areas where stomach samples have been taken to determine population estimates. All captured individuals will be permanently marked for identification in case of recapture. Individuals will not be sampled more than once per month.

This project is funded by TPWD 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 Marc J. Ealy, TPWD

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

management recommendations. From 1994 - 2002, 821 alligators ranging in size from 0.4 - 3.4 m (1.25 - 11.0 ft) were captured and 142 recaptured. Overall growth rate of all recaptures was 13.3 cm/year (5.2 in/yr). Using data from 58 alligators re-captured >3 growing seasons from

initial capture, growth was about 15.4 cm/year (6 in/yr).

Most American alligators were captured at the fresher sites along the salinity gradient; in fact, most were captured within one - two lakes on the study area. Most were recaptured in close proximity to the initial capture site.

The information is important because American alligators may require longer to reach sexual maturity, making it extremely important to understand age structure of harvest and how survival affects recruitment. Also, American alligators may be somewhat limited to fresher sites along the Texas Coast. As

degradation of coastal marshes continues, most notably due to saltwater intrusion, they may be forced into more inland habitats such as creeks and ditches and become further concentrated into shrinking habitats. These high concentrations may then begin to affect population levels of other organisms such as furbearers, breeding ducks, etc. Without such critical information as growth rates, habitat use and movements, our attempts at American alligator management will be a guessing game, at best. This study will be continued through summer 2004.

*Funding is provided by TPWD.*

## Snakes



### 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, TPWD

The Louisiana pine snake (*Pituophis ruthveni*, LPS) is one of the rarest terrestrial vertebrates in the U.S. It is listed as

threatened by the State of Texas (TX) but has received no specific protection in Louisiana (LA) or at the federal level. Previous research and historical records have demonstrated that it is confined to well-drained sandy soils generally associated with longleaf pine (*Pinus palustris*) throughout its limited range in eastern TX and western LA. Although limited data are available on historical distribution and abundance, it is clear that the species' range and abundance has declined in recent decades.

Vacant sites within the historic LPS range suggest that habitat degradation and fragmentation has resulted in the loss of the ability of these sites to support viable populations. LPS currently occupy a highly fragmented mosaic of often-degraded habitat. The original pine savannahs with an abundant herbaceous under-story have succeeded to forests with a dense hardwood mid-story and minimal herbaceous under-story. Information on currently occupied habitat, effects of prescribed fires on vegetation structure and responses of Baird's pocket gopher (*Geomys breviceps*), the primary prey species of LPS, to habitat alteration suggest that alteration of fire regimes have had negative consequences. Fire maintains an open mid-story and abundant herbaceous under-story that supports pocket gopher populations. Wildfire suppression, limitations on prescribed burning and legal challenges from

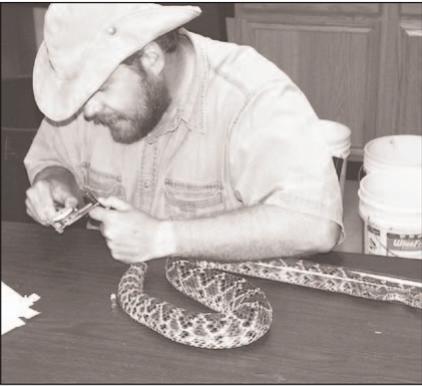
environmental groups have resulted in widespread habitat alteration throughout LPS range.

An extensive trapping survey is underway to refine our knowledge of the current status of LPS. Surveys in TX and LA have documented LPS presence in only six limited areas on federal and private lands. Populations are increasingly confined to federal lands. LPS comprise 1 - 2% of the snakes captured suggesting that they are one of the less abundant species even within the remaining occupied habitats. Numerous additional suitable sites have been surveyed in recent years but no additional occupied habitat has been located.

Predicted future changes in land use patterns and road construction will exacerbate the problems facing LPS. However, significant portions of the historic range still remain in forest and could potentially support LPS. Its continued survival will to a large extent depend on the intensive management of these currently occupied habitats, especially using prescribed fire. It is imperative that the amount of suitable habitat occupied by smaller populations be increased in the near future.

Additional impacts due to road related mortality are also a factor due to the high density of roads in occupied habitat. Management of vehicular traffic, including off-road vehicles would increase the viability of existing populations.

*Funding for this study was provided by the U.S. Forest Service and TPWD.*



## Ecology of the **Western Diamondback Rattlesnake** in a Managed Thornscrub Community

Richard T. Kazmaier, West Texas A&M University; Donald C. Ruthven, III, TPWD; Aaron J. Place, Oklahoma State University

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

impacts of these removals on wild populations.

Our objective was to obtain long-term baseline demographic and movement information from a site not impacted by rattlesnake roundups to compare with impacted sites in the future. Our work was conducted on Chaparral Wildlife Management Area (WMA) in Dimmit and LaSalle Counties. All rattlesnakes encountered were captured and uniquely marked using passive integrated transponders. In addition, individuals were measured, weighed, sexed and rattle measurements taken. Growth rates and shedding frequencies will be determined from recaptures. A subset are

being outfitted with radio transmitters implanted inter-abdominally to study movements and habitat selection.

Since 1996, 643 individuals have been captured a total of 695 times. The observed sex ratio is 2.5M:1F, but male bias may result because males are disproportionately sampled due to larger home ranges and greater movements. As of November 2002, eight have been implanted (5M : 3F). Home ranges have been larger for males [mean = 14.8 ha (36.5 ac)] than females [mean = 4.5 ha (11.1 ac)]. Preliminary rattle and shedding data suggests adults grow slowly and shed only once a year. Although detailed habitat selection analyses are forthcoming, rattlesnakes on Chaparral WMA show a strong propensity to use Southern Plains woodrat (*Neotoma micropus*) middens for cover (650 of 1070 radio locations occurring there).

Long-term monitoring of western diamondback rattlesnakes via both radio telemetry and mark-recapture should allow us to clarify much about the ecology of this poorly understood species including movements, habitat selection, impacts of land management practices, reproductive behavior, growth and demography. Collectively, these data should help us to make wise management decisions for this species.

*Funding for this project was provided by TPWD (Headquarters Research, Wildlife Diversity Program, Region IV, South Texas Research Fund).*



## Food Habits of the **Texas Indigo Snake**

Richard T. Kazmaier and Todd Y. Montandon, West Texas A&M University; W. Frank Robbins and David G. Hewitt, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville; Donald C. Ruthven, III, TPWD

The Texas indigo snake (*Drymarchon corais*) is a large diurnal snake whose geographic range in the U. S. is limited to the South Texas Plains and lower Coastal Prairie and Wetland ecosystems in Texas. Although published food habits data are scarce, indigo snakes are thought to forage opportunistically.

They are well known for their consumption of rattlesnakes and other snakes. Because of their large size and active hunting techniques, predation by indigo snakes could influence populations of other wildlife, particularly species of concern, such as the Texas horned lizard (*Phrynosoma cornutum*). Our objectives were to describe the diet of Texas indigo snakes and

compare diet composition between snakes in the eastern and western portions of the South Texas Plains.

Our research focused on the Chaparral WMA in Dimmit and La Salle Counties and rangelands surrounding Kingsville, Texas. We collected fecal samples and regurgitated foods from indigo snakes caught during research activities. Contents are being identified to the lowest taxonomic order possible.

As of September 2002, we collected 22 samples for the Kingsville area and more than 20 samples from Chaparral WMA. Analyses are ongoing. Preliminary results support the idea that indigo snakes are generalists, but there appears to be strong differences in diets between our 2 study areas. For example, cottontail rabbit (*Sylvilagus sp.*) was found in 30% of samples from Kingsville, but only 5% of samples from Chaparral WMA. Conversely, western diamondback rattlesnake (*Crotalus*

*atrox*) was found in 5% of Kingsville samples, but 75% of Chaparral WMA samples. Overall, Texas horned lizards have been found in about 20% of samples. Some other food items recovered from samples included Southern Plains woodrat (*Neotoma micropus*), hispid cotton rat (*Sigmodon hispidus*), southern prairie lizard (*Sceloporus undulatus*), Texas spiny lizard (*Sceloporus olivaceous*), bullsnake (*Pituophis catenifer*), and a variety of invertebrates, including wolf spiders (family *Lycosidae*).

We are continuing to collect samples and radio telemetry is also providing data on the foraging ecology of this poorly studied species. This project will increase our understanding of Texas indigo snake ecology and help define its interactions with other species on southern Texas rangelands.

Funding is provided by West Texas A&M University, Caesar Kleberg Wildlife Research Institute and TPWD.



## Influences of Land-Use Practices on the Texas Indigo Snake

Todd Y. Montandon and Richard T. Kazmaier, West Texas A&M University; Donald C. Ruthven, III, TPWD; David G. Hewitt, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville

The western Rio Grande Plains is a biologically diverse ecoregion within Texas that has been subjected to extensive manipulation via grazing, burning, and brush manipulation. Knowledge of the impacts of land use practices on populations of rare or protected

taxa is essential for their management. Texas indigo snakes (*Drymarchon corais*) are listed as state threatened. They are large, diurnal snakes that can exceed 2.5m (8ft) in length. Indigo snakes appear to be opportunistic foragers, but their propensity to eat other snakes is well known. Although never critically evaluated, anecdotal observations suggest indigo snakes require ready access to free water or moist conditions.

We are expanding our knowledge of Texas indigo snake ecology by conducting a radio telemetry study at the Chaparral Wildlife Management Area (WMA) in Dimmit and LaSalle Counties, Texas. Our specific objectives are to: (1) measure home range, activity, and movement patterns of indigo snakes; (2) address the relationship between indigo snakes and free water in the semiarid western Rio Grande Plains; and (3) assess habitat selection by Texas indigo snakes in the mosaic of grazed,

burned, and mechanical treatments of brush found on Chaparral WMA.

Beginning in May 2002, we implanted 8 radio transmitters in indigo snakes (4M : 4F) on Chaparral WMA. One female died of unknown causes; 7 others are still being monitored. Preliminary analysis indicates mean home ranges of 126 ha (311ac), with a maximum of 180 ha (445ac). However, as of November 2002, snakes do not appear to have stabilized home ranges, and home range size is likely to increase. It has not been unusual for snakes to move greater than 800 m (875yds) in less than a 24-hr period and movement distances greater than 1 km (0.62 mi) in a 24-hr period have been recorded. Indigo snakes on Chaparral WMA do not appear to be dependent on free water; but detailed analyses of habitat selection related to water and land management treatments are forthcoming.

Our goal with this ongoing project was to increase our understanding of indigo snake ecology and provide information to help land managers understand the influence of land-use practices on this threatened species.

Funding was provided by TPWD (Region IV, South Texas Research Fund, State Wildlife Grant).

## Texas Nature Trackers: A Citizen-based Volunteer Monitoring Program

Lee Ann Linam and Marsha May Reimer, TPWD

In 1992 TPWD began developing a strategy for monitoring Species of Concern (then Candidate Species) using citizen volunteers. Several statewide and site-specific projects are now offered under the umbrella of Texas Nature Trackers (TNT).

Statewide projects include Texas Horned Lizard (*Phrynosoma cornutum*) Watch, Texas Mussel Watch and Texas Amphibian Watch. In five years over 200 volunteers have collected data on Texas Horned Lizards at more than 200 sites in 137 counties. Data have helped to document the current distribution of the species and to show a relationship (Cochran-correct chi-square;  $\alpha \leq 0.001$ ) between presence of the red imported fire ant (*Solenopsis invicta*) and the absence of horned lizards.

Since its inception in 1997, Texas Mussel Watch, through statewide workshops, has trained over 80 volunteer mussel monitors. Volunteers have documented three new records for mussel species, two not previously found in Austin County and one live rare mussel species in the San Marcos River.

Since 1999, about 200 volunteers have been trained at Texas Amphibian Watch workshops. Volunteers conduct amphibian monitoring at sites they select, or conduct surveys on routes established by the North American Amphibian Monitoring Program. Other programs under the TNT umbrella include:

Texas Hummingbird Round-up, Texas Monarch Watch, Project Prairie Birds and Midwinter Bald Eagle Survey.

Site-specific projects have been developed for 17 species at over 25 different sites. Plant species projects include big red sage (*Salvia penstemonoides*), bracted twistflower (*Streptanthus bracteatus*), Rydberg's scurfpea (*Pediomelum humile*), Houston meadowwue (*Thalictrum texanum*), Arkansas meadowwue (*T. arkansanum*), branched gayfeather (*Liatris cymosa*), Southern lady's slipper (*Cypripedium kentuckiense*), Houston daisy (*Rayjacksonia aurea*) and Texas windmill grass (*Chloris texensis*). Invertebrate species projects include horseshoe liptooth snail (*Polygyra hippocrepsis*) and palmetto pill snail (*Euchemotrema cheatumi*). Projects have been developed for five salamander species (*Eurycea spp.*) and one mammal (maritime pocket gopher - *Geomys personatus maritimus*).

Project volunteers are trained on site by TPWD biologists. Volunteers have documented new populations for some species (*Rydberg's scurfpea*), collected the first quantitative data for others (horseshoe liptooth snail) and monitored the results of flood and drought damage to several plant populations (big red sage and bracted twistflower).

*Funding for these projects was provided by TPWD with partial funding from Section 6 of the U.S. Endangered Species Act.*

# Wildlife Habitat

## Managing Invasive Yaupon Holly in the Post Oak

Dan Foley, TPWD

The Post Oak Savannah Ecological Region is a narrow corridor, encompassing approximately 3.5 million hectares (> 8.5 million ac) ranging from Victoria in southern Texas to the Red River in northeastern Texas. This Region has historically been in a constant transition from prairie to savannah to forest, with vegetative succession being driven by the presence or absence of wildfires. Recently, dense woodlands with understory of yaupon holly (*Ilex vomitoria*) have replaced the historic vegetation due to overgrazing and fire suppression. Yaupon holly is a thicket forming evergreen shrub originating from many basal stems. Usually, this plant has dense crowns that are typically one - three meters (3.3-10.0 ft) in height; however, some specimens extend to eight meters (26 ft) and 30.5 centimeters (1.0 ft) in diameter at breast-height. The fruits and seeds are eaten by a variety of birds and mammals.

This plant is not perceived as a problem when present at low levels. However, without proper management, it may aggressively invade and dominate. The quantity and diversity of herbaceous vegetation beneath thick canopies of yaupon holly declines due to competition for sunlight and nutrients.

The goals of this investigation were to determine; (1) which control techniques were most effective; (2) floral species richness; (3) the cost/benefit ratio of each; and (4) provide this information to landowners through demonstrations, tours and other means. At the Gus Engeling Wildlife Management Area, we evaluated three management techniques (herbicide application, mechanical removal + herbicide, and prescribed burning + herbicide).

All treatments including diesel or herbicide effectively killed yaupon. Spraying or cutting and spraying with 5-25% Garlon 4™ resulted in >90% mortality; whereas, spraying or cutting and spraying with diesel only resulted in 68% and 84% mortality, respectively. Burning and spraying with 5-25% Garlon 4™ resulted in >90% mortality except in trees treated 18 months post-fire with 5% Garlon 4™ (76%). Burning and spraying with diesel averaged 62% mortality.

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

## Development of Management Strategies for the Conservation of Wildlife in a Bottomland Forest Ecosystem, Old Sabine Bottom Wildlife Management Area

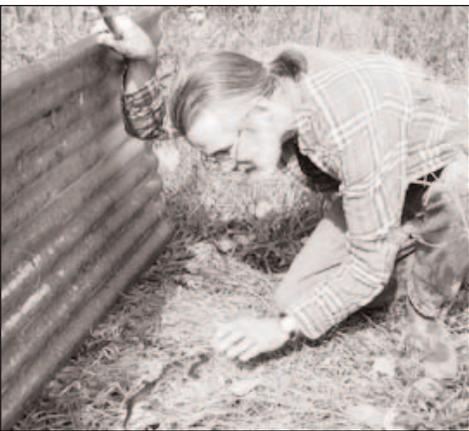
Dr. Neil B Ford and Dr. Darrell W. Pogue, University of Texas-Tyler; Kevin R. Herriman, TPWD

Bottomland hardwood forests are among the most diverse ecosystems in East Texas and are home to approximately 500 vertebrate and 1,150 plant species. However, it is estimated that approximately 75% of these forests originally found in Texas have been lost since the state was settled. Old Sabine Bottom Wildlife Management Area (OSBWMA) is a 2,088 ha (5,158 ac) tract of bottomland hardwood forest along the Sabine River in Smith County. TPWD manages OSBWMA to protect this critical habitat type and provide public recreational opportunities. Effective management strategies for bottomland hardwood forests must be developed to protect these critical

habitats and maintain species diversity.

A three-year study to examine the effects of current management practices and recreational activities on vertebrate communities was initiated in 2003. Specifically, the study will evaluate: (1) community dynamics of herpetofauna at ephemeral pools; and (2) reproductive success of breeding birds in managed areas.

Community dynamics of herpetofauna at ephemeral pools will be evaluated by: (1) comparing species richness, diversity and abundance of an 81.5-ha (220 ac) fire-managed grassland with



about movements, growth and annual natural life history.

comparable forested areas; (2) comparing species richness, diversity and abundance of reclaimed oil pump sites to active oil pump sites and comparable forested areas; (3) comparing species richness, diversity and abundance of forested areas to recreational use areas; and (4) marking selected individuals of various species of snakes with pit tags to obtain information

Data collection methods will include the use of cover boards, minnow traps, drift fences, dip nets and incidental captures. Nesting success of breeding birds in managed areas will be evaluated by: (1) comparing levels of nest predation in contiguous forest, deforested areas utilized for oil production and the fire-managed grassland; (2) comparing levels of brown-headed cowbird (*Molothrus ater*) parasitism in areas with varying degrees of fragmentation; and (3) estimating nesting success of breeding birds in the managed areas. Data collection methods will include the establishment of 10-ha sampling plots in habitats with 3 levels of fragmentation and disturbance. Vegetation in the sampling plots will be searched for nests ( $\leq 12m$ ) during the peak of the breeding season. Information on clutch size, predation and cowbird parasitism will be recorded.

Funding for this study was provided TPWD.

## Effect of Grazing on Forb Diversity and Abundance in a Honey Mesquite Parkland in South Texas

Donald C. Ruthven, III, TPWD

Livestock grazing is the most common use of rangelands, and overgrazing by domestic livestock has stirred much debate concerning the continued use of public rangelands for livestock production. With the increase of wildlife-related enterprises on South Texas rangelands, there is little data available on the compatibility of livestock and wildlife management. In particular, the effects of livestock grazing on plant communities in the semiarid portions of the western South Texas Plains is not well understood. The objective of this study was to compare forb diversity, density and frequency on rangelands subjected to various grazing intensities under a high-intensity, low frequency grazing system and non-grazed rangelands under controlled conditions.

Four rangeland sites that were moderately grazed during the dormant season, four sites subjected to heavy stocking rates, and four sites receiving long-term deferment from grazing were

selected on the Chaparral Wildlife Management Area, Dimmit and La Salle Counties, Texas. Forb density was estimated with 0.1 m<sup>2</sup> (1.1 ft<sup>2</sup>) quadrats during early spring 2000 and 2001. Forb diversity was greatest on grazed sites. Important annuals such as croton (*Croton* spp.) and hooker plantain (*Plantago hookeriana*) were more prevalent on grazed sites. Rough buttonweed (*Diodia teres*) was most common on moderately grazed sites. Lazy daisy (*Aphanostephus* spp.) was more frequently encountered on non-grazed sites. Golden dalea (*Dalea aurea*), a beneficial perennial, increased on grazed sites. Long-term deferment from livestock grazing appears detrimental to forb communities. A high-intensity, low frequency grazing system utilizing moderate stocking rates employed during the dormant season is recommended for enhancing forb diversity and abundance.

Funding for this study was provided by TPWD.



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

Donald C. Ruthven, III and Brent Ortego, TPWD

Encroachment of woody plants into grassland-savanna ecosystems is a growing concern of natural resource managers and a likely factor in the recent decline of grassland bird species. 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. With the increasing interest in biodiversity and ecosystem management, more attention is being focused on summer burns, which reflect the timing of natural fires. The South Texas Plains is a fire-dependent ecosystem; yet, little data are available on the effects of fire on South Texas wildlife. 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.

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 were subjected to two burns during the dormant season in 1997 and 1999; two sites were burned during winter 1997 and summer 1999; and two sites were non-treated controls. Wintering birds were surveyed along belt-transects during January 2001 and 2002. Breeding bird diversity and abundance was estimated with point counts in late spring 2001 and 2002.

Preliminary data analyses indicate higher breeding bird diversity on burned sites. Common ground-dove (*Columbina passerina*), lark sparrow (*Chondestes grammacus*) and northern mockingbird (*Mimus polyglottos*) were more commonly encountered on burned areas, whereas, Bewick's wren (*Thryomanes bewickii*) was more abundant on control sites. Burning appears to have little effect on wintering birds. Additional winter and summer burns will be applied to study plots in 2003 and monitoring will continue through 2004.

Funding for this study was provided by TPWD.

## **Herbaceous Vegetation Diversity and Abundance Beneath Honey Mesquite** in the South Texas Plains

Donald C. Ruthven, III, TPWD

Honey mesquite (*Prosopis glandulosa*) is the dominant woody species on most rangelands in southern Texas and is well known to serve as a nurse plant for many woody species. However, there is little data on how mesquite influences herbaceous plant communities. The objective of this study was to determine herbaceous plant diversity and abundance beneath mesquite canopy and adjacent shrub interspaces on sites with varying degrees of woody plant cover. A better understanding of how mesquite affects herbaceous plants can allow natural resource managers to better manage rangelands to the benefit of livestock and wildlife production.

The study was conducted on the Chaparral Wildlife Management Area in South Texas. Four sites of mesquite-dominated rangeland were selected for study. Woody plant canopy cover on two sites was considered light (20-40%), while

woody plant canopy cover on the remaining two sites was considered dense (60-75%). Herbaceous vegetation cover, density and frequency were estimated under mesquite and adjoining interspaces on rangeland sites with varying degrees of woody plant cover utilizing 0.1 m<sup>2</sup> (1.1ft<sup>2</sup>) quadrats.

Grass diversity was greatest beneath mesquite and on sites with light woody plant cover. Forb richness was greater on sites with light woody plant cover and was not affected by mesquite. Texas bristlegrass (*Setaria texana*) had a positive relationship with mesquite with greater cover, density and frequency of occurrence under mesquite. Other common grasses including Lehman lovegrass (*Eragrostis lehmanniana*) and fringed signalgrass (*Urochloa ciliatissima*) were more common in the herb-dominated interspaces. Erect dayflower (*Commelina erecta*) density was greater within the drip line of mesquite.

Erect dayflower and silky evolvulus (*Evolvulus alsinoides*) were more common on sites with light woody plant cover. The microenvironment created by mesquite may increase availability of beneficial forages to herbivores. As woody plant canopy coverage increases, shading and competition for available

nutrients by woody plants may result in the decrease of herbaceous species.

*Funding was provided by TPWD.*

## Impacts of Invasive Exotic Grasses on Avian Communities During the Breeding Season in South Texas

Aron A. Flanders and William P. Kuvlesky, Jr., Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville; Donald C. Ruthven, III, TPWD

The negative impacts of exotic species on natural resources, economy, and human health in the U. S. are well documented. Exotic grasses have been reported to negatively impact grassland birds in Arizona. Similarly, bird communities could be impacted as exotic grasses occupy millions of acres of South Texas rangelands. The objective of this study was to determine if the abundance and diversity of breeding birds and native flora differed between areas dominated by native grasses and areas dominated by the exotic grasses Lehmann lovegrass (*Eragrostis lehmanniana*) and bufflegass (*Cenchrus ciliaris*).

Research was conducted at the Chaparral Wildlife Management Area and the Piloncillo Ranch in La Salle and Dimmit counties. Vegetation on the study sites was characteristic of mixed brush shrublands of the western Rio Grande Plains. Three native and three exotic grass-dominated sites were selected for study. Point counts were used to sample bird communities during spring 2001 and 2002. Line intercepts, Daubenmire frames and a profile board were used to characterize shrub cover, herbaceous ground cover and vertical structure, respectively.

Native study areas had higher forb and grass species richness and diversity. Percent forb canopy cover was greater on native grass study areas. Important grasses including bristlegrasses

(*Setaria* spp.) and fall witchgrass (*Digitaria cognata*) and beneficial forbs such as slender evolvulus (*Evolvulus alsinoides*), portulaca (*Portulaca pilosa*) and scarlet pea (*Indigofera miniata*) had greater cover on native grass areas.

Bird density and diversity were greater in native grass rangelands than exotic grass dominated rangelands. Lark sparrows (*Chondestes grammacus*), black-throated sparrows (*Amphispiza bilineata*), northern mockingbird (*Mimus polyglottos*) and northern bobwhites (*Colinus virginianus*) consistently had higher densities in native grass areas. Additionally, Cassin's sparrow (*Aimophila cassinii*) was 75% more abundant in native areas, but observations were limited to one year.

Native bird species on our study sites appear to prefer native grass areas and may be exhibiting optimal foraging by selecting patches with a higher abundance and diversity of native vegetative resources. Additionally, exotic grasses may have a negative impact on the abundance and diversity of arthropods, which are a critical resource for birds during the breeding season. Future research should address this in addition to the impacts of exotic grass invasions on wintering birds and avian reproductive success.

*Funding was provided by TPWD.*



## Long-Term Effects of Root Plowing on Vegetation and Nongame Wildlife in the Western South Texas Plains

Donald C. Ruthven, III, TPWD; Timothy E. Fulbright, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville

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

Vegetation on the study area (Chaparral WMA) in Dimmit

and LaSalle Counties, Texas is dominated by mesquite (*Prosopis glandulosa*) mixed brush communities characteristic of the South Texas Plains. Five sites root plowed in 1965, as well as five nontreated sites were selected for study. Horizontal woody plant canopy coverage will be estimated by the line intercept method. Vertical woody plant cover will be estimated utilizing a vegetation profile board. Woody plant density and frequency will be estimated by counting individual plants in 45 m<sup>2</sup> (484 ft<sup>2</sup>) plots. Forbs, grass, litter, and bare ground cover; and forb and grass density and frequency will be estimated in 0.1 m<sup>2</sup> (1.1 ft<sup>2</sup>) quadrats. Herpetofauna, arthropods and small mammals will be sampled in drift fence/pitfall arrays. Small mammals will also be sampled utilizing Sherman traps set in modified grids.

Herpetofauna sampling was initiated in 2001. Preliminary results indicated little variation in diversity or species abundance between root plowed and nontreated sites. Vegetation, small mammal, and arthropod sampling will begin in late spring 2003 and continue through 2004.

Funding was provided by TPWD.

## Response of Herbaceous Vegetation to Summer Fire in the Western South Texas Plains

Donald C. Ruthven, III, TPWD; Keith L. Krakauer, Texas A&M University-Kingsville

With increases in wildlife-related enterprises and ecological restoration efforts in southern Texas, there is an increased interest in utilizing summer fire to achieve management goals; yet, there is little data on the effects of summer burning on vegetation and wildlife. The objective of this study was to determine the effects of summer prescribed fire on the diversity, density, and productivity of herbaceous vegetation during the first and second growing-seasons post-treatment in the western Rio Grande Plains. It is hypothesized that prescribed burning South Texas rangelands during the growing season will result in enhanced germination and establishment of annual and perennial forbs and decreases of perennial grasses.

The study was conducted on the Chaparral Wildlife Management Area in South Texas. Vegetation is dominated by honey mesquite (*Prosopis glandulosa*)- mixed brush. Herbaceous vegetation diversity, productivity, density, and frequency were estimated on five summer burned and five non-treated sites utilizing 0.1 m<sup>2</sup> (1.1 ft<sup>2</sup>) quadrats. Forb density and frequency was monitored for two growing-seasons post-burn. Grass indices were measured three months post-burn. Grass and forb yields were estimated in 0.25 m<sup>2</sup> (0.8 ft<sup>2</sup>) plots during the first growing-season post-burn.

Croton (*Croton spp.*) responded positively to summer burning during the first growing-season post-burn for all indices

measured. During the second growing season post-burn, Croton densities were similar among treatments. Densities of erect dayflower (*Commelina erecta*) and beach groundcherry (*Physalis cinerascens*) were greatest on burned sites throughout the study. Silky evolvulus (*Evolvulus alsinoides*) and hoary blackfoot (*Melampodium cinereum*) were more common on non-treated sites. Grass densities were lowest on burned sites three months post-burn, and yields were similar between treatments by the middle of the first post-burn growing season.

Summer burning does not appear to provide any additional benefits in forb response over dormant-season burning. The long-term effect of a regimented burning regime on vegetation and influence of burn season on wildlife is not clearly understood and warrants further investigation.

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## Response of Woody and Herbaceous Vegetation to Aeration in the South Texas Plains

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Because of its purported benefits, aeration is becoming a popular technique for managing vegetation in South Texas. Aerators differ from conventional roller choppers in that the blades are intermittently spaced (toothed) rather than being continuous laterally across the horizontal face of the drum. In addition, the blades are angled across the face of the drum rather than parallel. Mechanical top removal methods by roller chopping or chaining usually provide short-term control of woody plants and increases in herbaceous vegetation; yet, little data is available on the response of vegetation to aeration. The objective of our study was to investigate woody and herbaceous vegetation responses to aeration.

The study was conducted on honey mesquite (*Prosopis glandulosa*)-mixed brush uplands on the Chaparral Wildlife Management Area. Five sites aerated in summer 1998 and five control sites were randomly selected for monitoring. Permanent vegetation transects were established on all sites. Woody plant cover was estimated using the line intercept method. Stem density was estimated in 37.5 m<sup>2</sup> (403 ft<sup>2</sup>) plots in 1999 and 2000. Forb and grass cover and density were estimated in 0.1 m<sup>2</sup> (1.1 ft<sup>2</sup>) quadrats during spring and fall 1999.

Woody and herbaceous plant diversity did not differ among treatments. On aerated sites percent woody plant cover was 4 x less one-year post treatment and increased 89% from the first to second growing-season post treatment. Canopy

cover of honey mesquite, twisted acacia (*Acacia schaffneri*) and Texas pricklypear (*Opuntia lindheimeri*) was greatest on nontreated sites throughout the study period. By the second growing-season post treatment density of honey mesquite was greatest on aerated sites, whereas Texas pricklypear had declined on aerated sites. Density of spiny hackberry (*Celtis pallida*), hog-plum (*Colubrina texana*), coma (*Bumelia celastrina*) and whitebrush (*Aloysia gratissima*) was greatest on aerated sites. Forb cover was greatest on aerated sites in spring 1999. Fringed signalgrass (*Brachiaria ciliatissima*), fall witchgrass (*Digitaria cognata*), and bristlegrass (*Setaria* spp.) cover was greatest on aerated sites in spring and fall 1999, whereas purple threeawn (*Aristida purpurea*) was greater on nontreated sites.

It is unclear to what degree environmental factors such as pre- and post-treatment climatic conditions and herbivory may have influenced vegetation response to aeration. The rapid recovery of many woody species following aeration may require application of maintenance treatments within a relatively short time period in order to maintain treatment benefits. Aeration was effective in reducing total woody plant cover; increasing the density of desirable woody plants, maintaining woody plant diversity and increasing grass cover. Aeration may be a useful tool in managing South Texas rangelands for white-tailed deer (*Odocoileus virginianus*) and cattle.

Funding provided by TPWD.

## Woody Vegetation Response to Various Burning Regimes in South Texas

Donald C. Ruthven, III, Anthony W. Braden, Haley J. Knutson, James F. Gallagher and David R. Synatzske, TPWD

Following European settlement, suppression of fire combined with heavy livestock grazing led to the current thorn woodlands common throughout South Texas. Mechanical treatments such as root plowing are commonly used to manage woody vegetation; however, once treated rangelands are revegetated by woody species, woody plant diversity can be greatly reduced. Responses of woody plant communities on native rangelands in the western South Texas Plains to fire are not clearly understood. Our objective was to compare woody plant cover, density, and diversity on burned and non-burned rangelands.

The study was conducted on honey mesquite (*Prosopis glandulosa*)-mixed brush uplands on the Chaparral Wildlife Management Area. Treatments included five rangeland sites that received two dormant-season burns, five rangeland sites that received a combination of one dormant-season and 1 growing-season burn, and five non-burned sites. Woody plant cover was estimated using the line intercept method, and stem density and frequency of occurrence was estimated in 37.5 m<sup>2</sup> (403 ft<sup>2</sup>) plots.

Species richness did not differ among treatments. Percent woody plant cover was reduced by 50% and 41% on winter and winter-summer combination burned sites, respectively.

Honey mesquite, twisted acacia (*Acacia schaffneri*), Texas persimmon (*Diospyros texana*), lotebush (*Ziziphus obtusifolia*), wolfberry (*Lycium berlandieri*), and tasajillo (*Opuntia leptocaulis*) canopy cover was greatest on non-treated sites. Woody plant density declined by 29% and 23% on winter and winter-summer combination burned sites, respectively. Density of guayacan (*Guajacum angustifolium*), wolfberry, and tasajillo was less on all burning treatments. Percent cover of spiny hackberry (*Celtis pallida*) and density of Texas pricklypear (*Opuntia engelmannii*) declined on winter burned sites.

Inclusion of summer fire into the burning regime did not accelerate declines in woody plants. Dormant or growing season fire created an environment, which resulted in the decline of many woody plant species. It is unclear to what degree other environmental factors such as herbivory and competition between woody plants and between woody and herbaceous vegetation may have interacted with fire in producing woody plant declines. Fire may be a useful tool in managing woody vegetation on native South Texas rangelands while maintaining woody plant diversity.

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## Maintaining Wildlife Habitat and Groundwater Supply in Texas through Landowner Associations

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

To facilitate effective wildlife management on a large scale while reducing the effects of land fragmentation, wildlife management associations or cooperatives have been formed in over 20 counties in Texas. These multi-landowner associations operate under voluntary TPWD management plans, hold regular meetings to educate and inform the membership on a variety of natural resource issues, and implement various wildlife habitat improvement practices. Over 100 such groups representing nearly 5,000 landowners and approximately 810,000 ha (2 million ac) have been organized in the state.

Wildlife associations may hold promise for the management of other common-pool resources in addition to wildlife, because

the membership represents stakeholders that benefit from collective success. Opportunities for direct landowner involvement in watershed management, protection of groundwater resources, and development of riparian corridors exist within the framework of these associations or similar local public/private partnerships.

We will conduct a landowner survey of wildlife associations in three regions of the state to investigate the feasibility of a cooperative approach to groundwater management. Support for research, monitoring and self-regulation in order to ensure common benefits into the future will be investigated. In addition, we will assess the attitudes of landowners regarding

sustainable groundwater marketing as an indirect economic alternative for ranch viability and habitat protection. Support for protecting the aquifer recharge area, limiting water well placement and production based on sustained yield will be determined. Open space protection through groundwater reallocation is a new paradigm in water management in Texas.

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## **Pastures for Upland Birds: Restoring Native Plants in Bermudagrass Pastures**

Matt Wagner, TPWD; Fred Smeins, Steve Whisenant and Brian Hays, Texas A&M University

The conversion of large areas of the Post Oak Savannah to improved forage grasses, such as bermudagrass (*Cynodon spp.*) and bahiagrass (*Paspalum notatum*), 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. The purposes of the Pastures for Upland Birds (PUB) program includes determining cost-effective strategies for establishing native grasses and forbs in bermudagrass pastures, while providing technical assistance and cost share incentives to private landowners.

Spring - fall 2001, and spring 2002, study sites were established in Falls and Grimes counties. At each site, two rates of Glyphomax Plus<sup>1</sup>, Dow Chemical, herbicide (41% glyphosate) and a combination of different native seed mixes and

planting/seedbed preparation methods were applied. Preliminary results indicate about 98% initial bermudagrass control on sandy soils versus about 43% control on clay soil. Seeding success was low and highly variable in 2001, but much better for 2002. These sites will be monitored for at least two more growing seasons. As a part of PUB, herbicide is being provided free to landowners wishing to convert bermudagrass or bahiagrass pastures back to native vegetation. In addition, the Texas Cooperative Extension Service established six demonstration sites in 2001 and six more in 2002.

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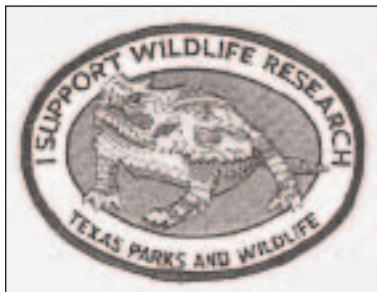
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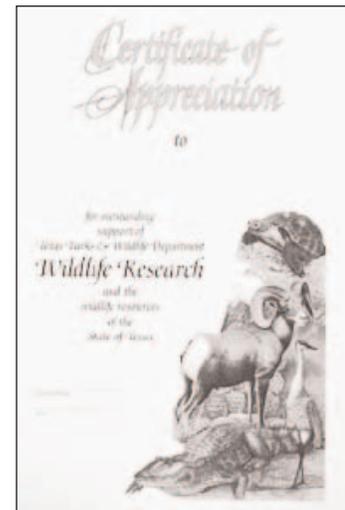
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