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WILDLIFE
RESEARCH INSTITUTE

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Editor Alan M. Fedynich, Ph.D.

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December 2018

Report of *Current Research*

September 1, 2017 to August 31, 2018

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FOREWORD



Dear Friends of the CKWRI,

As in past years, this volume of the CKWRI's *Current Research* report describes the activities of CKWRI students and scientists over the last year. These abstracts summarize the essence of research funded and conducted to further our understanding of wildlife across Texas. The resulting knowledge helps those who care deeply about wildlife to manage and conserve this precious resource.

While the practical value of this knowledge is important, the work described in this annual report has other less tangible values. Knowledge from this research feeds our sense of wonder about nature. For example, how can anyone not be enthralled with the knowledge that the white-fronted goose that flew over them this morning had experienced sunsets in northern Canada a few short months ago, and could have been in Louisiana rice fields or pastures near Hebbronville just a few days ago? Or how can anyone vested in wildlife management in Texas not be proud to know that the thick brush near the Gulf Coast in far South Texas is the only place in the United States where ocelot kittens can be found in the wild? And how do you put a price tag on being able to explain to a wide-eyed youth hunter that the buck seen trotting by the hunting blind in late December has several locations he visits daily to see if any does in that area are ready to breed? And that this same buck has essentially stopped eating so that he can devote all his time to searching for and tending does?

Another unrecognized value of the work reported herein is the training of the next generation of wildlife managers and scientists. Although the abstracts often make it seem as if there is a simple relationship between straight-forward methods and the appearance of data, students and scientists often have to struggle mightily to obtain these data. The students learn to plan projects, manage budgets, deal with unexpected problems, improvise, supervise, collaborate, and communicate. Even more important, the students experience the blessings of working with the landowners and supporters who make their research possible. These are invaluable lessons that cannot be taught in a classroom. These are lessons that will make our students successful wherever their careers take them.

So, as you read these abstracts, use your imagination to peek behind the sterile statements of methods and results. Try to envision students crouching next to a drop net, ready to sprint out and jump on captured turkeys. See sweat hitting dry soil inside a plot where students are recording vegetation on a hot summer day. Envision the face of a student as it lights up after their first look at the plotted locations of a collared mule deer as it moves around the Texas Panhandle. Finally, picture the twinkle in the eye of a major professor or a project donor as they see the newly trained student leaving Texas A&M University-Kingsville on their way to their first job, ready to do the great work of wildlife conservation and management.

As a friend of the CKWRI, you help make all this happen and we are truly grateful. Please enjoy and learn from this year's *Current Research* report, especially now that you know both the tangible and intangible values of these projects.

All the Best,

A handwritten signature in black ink that reads "David Hewitt". The signature is fluid and cursive.

David Hewitt

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Precipitation and Management as Drivers of Northern Bobwhite Populations

Alec D. Ritzell, Fidel Hernández, Eric D. Grahmann, John T. Edwards, Dale Rollins, and Humberto L. Perotto-Baldivieso

Quail populations dramatically increase during wet periods and drastically decrease during droughts. Quail managers have attempted to moderate these boom-and-bust fluctuations using management such as grazing, supplemental feeding, and predator control. However, given that rainfall can account for 70 to 90% of the variability in regional quail populations, the effectiveness of quail management has been questioned. Our objective is to evaluate the effects of rainfall and quail management on bobwhite numbers and to determine whether management can stabilize populations in the face of variable rainfall patterns.

We will build on current research to create a 5-year dataset (2014–2018) of quail density to assess whether management can maintain quail density and reduce its variability on Texas rangelands. Helicopter surveys will be conducted in the Rio Grande Plains and Rolling Plains regions of Texas during the winters of 2017 and 2018 to determine quail numbers on 10 study sites. We will quantify quail management on each site via landowner surveys and document annual rainfall.

We will use quail density, management intensity, and rainfall to evaluate the importance of management in maintaining quail densities on rangelands subject to varying rainfall. Determining the effectiveness of quail management on semiarid rangelands will provide needed guidance for quail conservation and management in Texas.

Cooperative funding provided by Texas A&M AgriLife Extension Service's Reversing the Decline of Quail Initiative in Texas, South Texas Chapter of Quail Coalition, and the Richard M. Kleberg, Jr. Center for Quail Research.

Assessing the Impact of Hunting on a Northern Bobwhite Population

Donal A. Woodard, Leonard A. Brennan, Fidel Hernández, Humberto L. Perotto-Baldivieso, and Neal Wilkins

Despite a century of quail research, there is still ample debate regarding annual harvest rates and the persistence of populations exposed to hunting. Estimating density is the first step required to

implement a harvest prescription. However, whether a sustainable bobwhite harvest prescription can be implemented based on density estimates has not been tested. Our objectives are to (1) test whether a 20% harvest rate is sustainable and (2) determine if hunting influences bobwhite distribution and habitat use.

This study will take place on the East Foundation properties in Jim Hogg County, Texas. Non-hunted control areas have features similar to hunted areas. The harvest prescription will be by pasture, and it represents 20% of late November abundance. This harvest prescription will be distributed evenly across 3 periods: December, January, and February. Line-transect distance sampling using helicopter surveys will be conducted prior to hunting for estimating bobwhite density (November), once a month during the hunting season (December, January, and February), and after the hunting season (March). Hunting-effort data will be collected using GPS units on hunt trucks and hunting dogs, along with demographic data (age and sex ratios) from harvested bobwhites.

Pre-treatment data were collected in 2017–2018 (December–March). Treatment effects will be monitored from autumn 2018 through spring 2021. We will (1) compare variation in abundance estimates between hunted and non-hunted populations and (2) quantify associations between hunting pressure and potential changes in covey distributions. This research will test the hypothesis that quail harvest is a sustainable element of quail management in South Texas.

Cooperative funding provided by the East Foundation, Richard M. Kleberg, Jr. Center for Quail Research, and South Texas Chapter of Quail Coalition.

Influence of Juniper on Montezuma Quail Habitat Use in the Edwards Plateau

Kristyn G. Stewart, Fidel Hernández, Eric D. Grahmann, Leonard A. Brennan, Humberto L. Perotto-Baldivieso, and Robert M. Perez

Montezuma quail in the United States inhabit the pine-oak woodlands of Arizona, New Mexico, and Texas. Although Montezuma quail in Texas are most common in the Davis Mountains, a population once occurred in the Edwards Plateau ecoregion. Years of overgrazing, fire suppression, and juniper encroachment eliminated the species from most of this ecoregion. The recent increase of new landowners and

increased recreational use in the region has resulted in the clearing of large stands of juniper. This has resulted in more favorable habitat for Montezuma quail, and an increase of sightings has occurred.

Very few studies have focused on the population inhabiting the Edwards Plateau, which has resulted in a lack of information for Montezuma quail within this ecoregion. Our study will examine the influence of juniper encroachment on the distribution and habitat use of Montezuma quail in the Edwards Plateau.

Our study is being conducted at Kickapoo Cavern State Park and 3 ranches in Edwards and Kinney counties. Using multiple capture techniques, we will attempt to place GPS transmitters on Montezuma quail to monitor movements, survival, reproduction, and habitat use during spring-summer and into autumn. We will collect vegetation data on juniper (density, percentage cover, and height) and other important habitat variables at both Montezuma quail locations and random locations within the study sites.

Information obtained in this study will allow us to determine the bounds of habitat suitability and thresholds at which juniper cover becomes harmful. Our research will provide critical information to guide juniper management in the Edwards Plateau, which can be beneficial to Montezuma quail.

Cooperative funding provided by the Texas A&M AgriLife Extension Service's Reversing the Decline of Quail Initiative in Texas, Richard M. Kleberg, Jr. Center for Quail Research, and South Texas Chapter of Quail Coalition.

Quail Habitat Restoration in Areas that are Dominated by Non-Native Grasses

Ellart J. Vreugdenhil, Brandon J. Palmer, Geron G. Gowdy, Javier O. Huerta, Benjamin R. Olsen, Alexandra M. Sigg, Timothy E. Fulbright, Eric D. Grahmann, Michael W. Hehman, Fidel Hernández, Keith A. Pawelek, Forrest S. Smith, Tony D. Falk, and David B. Wester

Non-native grasses, such as Old World bluestems and buffelgrass, are a leading cause of quail habitat loss and fragmentation. In 2008, we initiated a pilot study to determine the best methods for restoring quail habitat in areas dominated by non-native grasses. Successful methods included repeat disking and/or glyphosate herbicide application to rid the area of non-native plants and their seed each time the plants emerged. A diverse mix of native plants was sown once non-native plants were no longer found. However, these plots were relatively small. Therefore,

in 2014 we began a study to replicate this success on a large scale (approximately 300 acres).

Our study is on the Hixon Ranch in LaSalle County, Texas. We repeatedly disked and sprayed the site to deplete the seedbank of non-native plants (5 times each). In October 2016, locally adapted native plant seeds were drill-sown onto the site. In addition, woody seedlings were transplanted into the site during April 2017. We sampled vegetation during March, June, and October from 2013 to 2018.

Preliminary analyses show that since the initiation of the restoration, non-native grass cover has dropped to near 0% and native grasses and forbs are becoming established. Our study will ultimately provide guidelines for large-scale restoration of native plants that will be beneficial to quail.

Cooperative funding provided by the Hixon Family, Texas Parks and Wildlife Department, Meadows Professorship in Semiarid Land Ecology, South Texas Chapter of Quail Coalition, San Antonio Chapter of Quail Coalition, San Antonio Chapter of Quail Forever, Hill Country Chapter of Quail Coalition, Coastal Bend Audubon Society, and ExxonMobil Summer Jobs Program.

Understanding Patterns of Gene Expression in the Northern Bobwhite

Damon L. Williford, Randy W. DeYoung, and Leonard A. Brennan

The northern bobwhite displays extensive variation in plumage coloration, body size, and other phenotypic traits across the species' broad geographic distribution.



© Scott Conard

CKWRI quail research is being conducted on a wide array of topics that will benefit quail management strategies.

Some of this phenotypic variation may be correlated with genetic adaptation to specific regional environments. Understanding the genetic basis for regional adaptation may improve conservation and management strategies for the northern bobwhite.

There have been recent advances in genomic sequencing technology, which have made high-throughput analyses of genome-scale genetic data accessible and affordable for wildlife genetics studies. Cells make RNA copies of the DNA sequences that code for proteins and use the RNA transcripts as recipes to make the proteins. We can now determine which genes are turned on in different tissues by isolating RNA from the cells and simultaneously reading the sequence of the RNA template. Our goal is to analyze gene expression in northern bobwhites and use the resulting information to improve our knowledge of gene expression and adaptive variation in bobwhites.

We captured and euthanized 4 male and 4 female bobwhites on the East Foundation's Buena Vista Ranch in Jim Hogg County, Texas. Samples were preserved using liquid nitrogen and RNA extracted from brain, heart, liver, skin, and skeletal muscle tissues. We are sequencing and analyzing the RNA data. Once this step is completed, we will compare the results to the published genomes of the chicken and turkey.

Data obtained will be matched to the northern bobwhite genome to identify the specific location of the genes and coding regions. This will allow us to identify differences in gene sequence between the species. The findings of this study are important in understanding how bobwhites have adapted to local environmental challenges.

Cooperative funding provided by the Rotary Club of Corpus Christi (Harvey Weil Sportsman Conservationist Award Trust) and the South Texas Chapter of Quail Coalition.

Bermudagrass Control and Restoration of Native Prairie for Northern Bobwhites

Anthony D. Falk, Keith A. Pawelek, Forrest S. Smith, James P. Muir, Jamie Foster, Leo Herzberger, Trevor Farthing, and William P. Kuvlesky, Jr.

Bermudagrass is a non-native grass species planted across the southern United States. Bermudagrass often prevents other plant species from growing, and it can limit the movement of ground foraging birds such as northern bobwhites. In an attempt to control bermudagrass and re-establish native plants to benefit



© Anthony Falk

Research is being conducted to determine techniques for restoring native prairie habitat that will benefit bobwhites.

quail, we tested 4 bermudagrass removal techniques, 3 seeding techniques, 3 seed mixes, and 3 post planting management techniques in 4 Texas ecoregions.

The removal techniques included repeat application of glyphosate herbicide, a single application of imazapyr herbicide followed by repeat applications of glyphosate, shredding followed by repeat applications of glyphosate, and the planting of a cool season cover crop. These removal techniques were implemented during summer 2016. Seeding techniques included disk and drill seeding, no till drill, and disked and broadcast, which were implemented during spring 2017. The 3 seed mixes tested included locally harvested native seed, a low diversity commercial native mix, and a high diversity commercial native mix. Post planting management techniques included mob grazing, mowing, and a control, which were implemented during June 2017.

Results of the removal technique experiments were very promising. All herbicide treatments significantly reduced the amount of bermudagrass at all locations. All locations received abundant rainfall following planting, and native plant establishment has been excellent for some treatments. The high diversity commercial seed mix plus repeat glyphosate treatments resulted in a significant reduction in bermudagrass and the best establishment of native plants. Our goal is to provide landowners and managers concise, tested techniques that can be used to remove bermudagrass and successfully establish native prairies to benefit northern bobwhites.

Cooperative funding provided by the Texas Parks and Wildlife Department.

Northern Bobwhite Use of an Area being Restored to Native Vegetation

Brandon J. Palmer, Benjamin R. Olsen, Ellart J. Vreugdenhil, Timothy E. Fulbright, Eric D. Grahmann, Fidel Hernández, Michael W. Hehman, Forrest S. Smith, and David B. Wester

Habitat loss and fragmentation are known as the leading causes in population declines of northern bobwhites. In South Texas, however, populations have remained relatively stable. Unfortunately, non-native grasses, particularly buffelgrass and Old World blue-stems, are invading native plant communities and reducing suitable habitat for bobwhites.

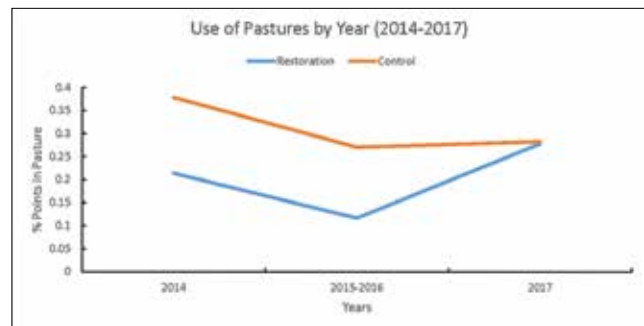
A large area (approximately 300 acres) originally dominated by non-native grasses is being restored to native vegetation on the Hixon Ranch in La Salle County, Texas. In our study, we want to determine if habitat restoration results in increased use by bobwhites. The site is divided into 2 areas, one that is being restored and another that is not receiving treatment (serves as a control site). We radio-collared 40 bobwhites per year during summers 2014–2018 and we located them 2 to 3 times per week using radio telemetry. Before restoration treatments were applied (2014), 21% of bobwhite relocations were in the restoration site. We repeatedly disked the site (2015–2016) to deplete the soil seed bank of non-native grass seeds, resulting in the proportion of bobwhite relocations on the site to decrease to 12%.

The proportion of bobwhite relocations on the restoration site increased to 28% during the first year (2017) after we planted a mixture of locally adapted grasses and forbs. Native vegetation on the restoration site has not become fully established, and we are



© Larry Ditto

Northern bobwhites have declined because of habitat loss and fragmentation.



Northern bobwhite use of an area previously dominated by non-native grasses restored to native vegetation (Restoration) compared to use of an area dominated by non-native grasses (Control) in La Salle County, Texas.

continuing to monitor use of the site by bobwhites. Our results will demonstrate whether restoring native vegetation in sites previously dominated by non-native grasses will increase use of these sites by bobwhites.

Cooperative funding provided by the Hixon Family, Texas Parks and Wildlife Department, Meadows Professorship in Semiarid Land Ecology, South Texas Chapter of Quail Coalition, San Antonio Chapter of Quail Coalition, San Antonio Chapter of Quail Forever, Hill Country Chapter of Quail Coalition, Coastal Bend Audubon Society, Rotary Club of Corpus Christi (Harvey Weil Sportsman Conservationist Award Trust), and ExxonMobil Summer Jobs Program.

Vegetation Attributes Providing Thermal Refugia for Scaled Quail

Ellart J. Vreugdenhil, Brandon J. Palmer, Timothy E. Fulbright, Eric D. Grahmann, Fidel Hernández, and Michael W. Hehman

Scaled quail inhabit environments that can be thermally intolerable. These environments are characterized by hot, dry conditions and are generally lacking in herbaceous vegetation. Because of these harsh habitat conditions, scaled quail must have suitable thermal cover. Previous studies have compared the temperatures between scaled quail locations to available areas. However, studies have not quantified the vegetation structural composition that provides these cooler conditions. Natural resource managers must be able to identify suitable thermal cover to manage these sites appropriately. Our objective is to quantify the structure of suitable thermal cover for scaled quail.

Our study is taking place on the Hixon Ranch in La Salle County, Texas. During spring-summer 2018, we



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CKWRI researchers are studying how scaled quail use habitat features during hot South Texas summers.

will trap, radio-mark, and track 20 scaled quail. Upon locating quail, we will collect data on ground surface temperature, air temperature, black globe temperature, wind speed, and percentage of shade cover. At these same locations, vegetation attributes such as plant species, canopy density, vegetation height, percent woody and herbaceous cover, and canopy overlap will be measured. The same attributes will also be measured at nearby locations for comparison.

This study will provide valuable information to habitat managers for maintaining and restoring suitable thermal cover for scaled quail in southern Texas. If these areas are not maintained and microhabitats are lacking, scaled quail populations could further decline with climate warming.

Cooperative funding provided by the Hixon Family, Texas Parks and Wildlife Department, Meadows Professorship in Semiarid Land Ecology, South Texas Chapter of Quail Coalition, San Antonio Chapter of Quail Coalition, San Antonio Chapter of Quail Forever, Hill Country Chapter of Quail Coalition, Coastal Bend Audubon Society, and ExxonMobil Summer Jobs Program.

Analysis of Adaptive Genetic Variation Among Bobwhite Populations

Damon L. Williford, Randy W. DeYoung, and Leonard A. Brennan

Most previous genetic studies of the northern bobwhite have relied on genetic variation in neutral markers, which are not subject to selection. This approach

is straightforward and highly useful for understanding population history and taxonomy. However, neutral markers provide little insight into the genetic basis of traits that influence fitness. The broad distribution and extensive morphological variation of the northern bobwhite suggest that there may be substantial regional variation in adaptive traits. Technological advances now allow biologists to conduct genome-wide studies of adaptive and neutral variation in wild populations through the identification of thousands of single-nucleotide polymorphisms (SNPs)—a type of genetic marker that is abundant in the genomes of most organisms.

We examined the genetic diversity and population structure of northern bobwhite populations west of the Mississippi River, including masked bobwhites from Sonora, Mexico, using 19,439 SNPs obtained through restriction-site associated DNA sequencing. Masked bobwhites had the lowest genetic diversity and were differentiated from the rest of the bobwhites. Northern bobwhites within the United States were weakly divided between the Midwest and another group composed of birds from Texas. Similar to our previous analyses, this division was not concordant with subspecies taxonomy.

We detected evidence for selection at 59 SNP markers and matched 23 to the chicken genome. Twenty of the identified SNPs overlapped with protein-coding genes that play roles in immunity, metabolism, tissue structure or maintenance, or cell-to-cell communication. Ongoing analyses will help us to understand the function and significance of these genes to bobwhites.

Cooperative funding provided by a Texas A&M University-Kingsville Research Award and the South Texas Chapter of Quail Coalition.

Vegetation Attributes Providing Thermal Refugia for Bobwhites in South Texas

Brandon J. Palmer, Benjamin R. Olsen, Ellart J. Vreugdenhil, Timothy E. Fulbright, Eric D. Grahmann, Fidel Hernández, Michael W. Hehman, and David B. Wester

Northern bobwhites are sensitive to extreme thermal conditions, especially along the western extents of their range. These regions are noted for temperatures that often exceed 104°F, which are potentially fatal to bobwhites. Given these concerns, habitat must be managed to provide adequate thermal refuge. Unfortunately, the structural and compositional

characteristics of these refugia are unknown. Our objective is to determine the vegetation structure and composition of thermal refuge sites used by bobwhites.

Our study site is located on the Hixon Ranch in La Salle County, Texas. We radio-collared 40 bobwhites and located them 2 to 3 times per week from March–August 2017 and 2018. We recorded ground surface temperature, air temperature, operative temperature, wind speed, and percent shade cover. In addition, we documented vegetation attributes such as plant species, canopy density, vegetation height, percent woody and herbaceous cover, and canopy overlap.

Findings indicate that during the middle of the day in summer operative temperature at bobwhite locations averaged 99°F, compared to 108°F at random locations. At bobwhite locations, canopy density and shrub height averaged 97% and 13 feet, whereas at random locations canopy density and shrub height averaged 91% and 11 feet.

We are analyzing our data to determine which plant species bobwhites are selecting. Information obtained in this study will allow us to provide guidelines on minimum woody plant height and cover densities. Based on our preliminary results, it is critical for natural resource managers to maintain taller and denser woody plants on the landscape to provide cooler microsites for bobwhites in South Texas.

Cooperative funding provided by the Hixon Family, Texas Parks and Wildlife Department, Meadows Professorship in Semiarid Land Ecology, South Texas Chapter of Quail Coalition, San Antonio Chapter of Quail Coalition, San Antonio Chapter of Quail Forever, Hill Country Chapter of Quail Coalition, Coastal Bend Audubon Society, Rotary Club of Corpus Christi (Harvey Weil Sportsman Conservationist Award Trust), and ExxonMobil Summer Jobs Program.

Ocelot Resource Selection within a Highly Fragmented Landscape

Amanda M. Veals, AnnMarie Blackburn, Michael E. Tewes, John H. Young, Jr., Humberto L. Perotto-Baldivieso, and Randy W. DeYoung

Wildlife across the globe are faced with landscapes that are becoming more difficult to move through because of habitat loss and degradation. Therefore, conservation of landscape connectivity is essential for preserving wildlife populations, supporting animal movements, and maintaining genetic diversity.

Human-related factors (anthropogenic), such as urban sprawl and roadways are a major cause of habitat loss. Roadway networks are widespread, and these significant influences on the landscape can have profound effects on wildlife populations.

The ocelot is an endangered felid in the United States, with remnant populations of about 80 to 100 individuals occurring in southern Texas. The Lower Rio Grande Valley of southern Texas is one of the fastest growing population centers in the United States. This has led to an increase in ocelot-vehicle collisions and a decrease in available habitat for ocelots.

In this study, we will model the probability of landscape use by ocelots as a function of woody vegetation structure and road permeability using ocelot location data. Our project aims to provide information regarding the placement of future wild cat crossing structures to decrease ocelot-vehicle collisions and increase landscape permeability for this endangered species. Information from this study can be used to assist the Texas Department of Transportation in meeting its ocelot conservation objectives.

Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute and Texas Department of Transportation: Environmental Affairs.

Felid Intraguild Interactions in Sierra de Tamaulipas Biosphere Reserve

Jason V. Lombardi, Michael E. Tewes, Darryl I. MacKenzie, Arturo Caso, Sasha Carajaval-Villareal, and W. Chad Stasey

The Sierra Tamaulipas Mountains National Protected Area is a rugged region in central Tamaulipas, Mexico. It is home to 6 of North America's 7 felid species. This region represents the northeastern distribution

of jaguars, jaguarundis, and margays. In addition, the Sierra Tamaulipas Mountains National Protected Area has robust populations of bobcats, ocelots, and pumas.

Interactions among smaller felids have been studied as well as jaguars, pumas, and ocelots. Over the last 40 years, there has been little research examining the factors that influence co-occurrence of jaguars, pumas, ocelots, jaguarundis, and bobcats. In addition, no studies have examined jaguar-bobcat interactions.

From May–December 2009, we conducted camera-based surveys on Rancho Caracol and Rancho Camotal in the northern Sierra Tamaulipas, Mexico. From the photos, we plan to use a novel multi-species occupancy approach to identify the driving forces of co-occurrence patterns among jaguars, pumas, and lesser felids. In addition, we will determine whether ocelots exhibit top-down forces on jaguarundis and bobcats. Findings from this study will contribute valuable information to understanding the factors influencing felid coexistence in northeastern Mexico.

Cooperative funding provided by the Tim and Karen Hixon Foundation, Caracol and Camotal ranches, Barry Putegnat, Dean Putegnat, Feline Research Program of the Caesar Kleberg Wildlife Research Institute, and Wild Cat Conservation, Inc.

Felid Abundance, Activity Patterns, and Interactions with Ungulates

Shelby B. Carter, Michael E. Tewes, Jason V. Lombardi, Justin P. Wied, John P. Leonard, and Tyler A. Campbell

In southern Texas, ocelots occur in 2 small breeding subpopulations on private and public lands in Willacy and Cameron counties. Ocelot interactions with other carnivores and prey species have been studied across their geographic range. However, interactions with cattle and large game species on private lands have not been examined.

We will use a 7-year photographic dataset (2011–2018) from the East Foundation's El Sauz Ranch in Willacy County to identify differences in abundance, activity patterns, and interactions among ocelots, bobcats, cattle, nilgai, white-tailed deer, feral pigs, and javelinas. We are interested in animal use of trails and dense thornshrub vegetation communities in relation to the occurrence of each species.

Preliminary results indicate that while nilgai have no influence on ocelot abundance or movements, feral pigs and javelinas share similar characteristics. Additionally,

although white-tailed deer are more abundant than nilgai, data suggest that white-tailed deer have no effect on the ocelot population.

This study will provide information that can assist in the management of ungulates and felids as well as help us understand coexistence patterns among species. Our findings can also be used to benefit future ocelot recovery and conservation on private lands in southern Texas.

Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute, East Foundation, Wild Cat Conservation, Inc., Annova LNG and their parent company Exelon Generation, Brown Foundation, Tim and Karen Hixon Foundation, Travis and Bettina Mathis, and Ben F. Vaughan, III.

Using Landscape Features to Determine Placement of Road Crossings for Ocelots

AnnMarie Blackburn, Amanda M. Veals, Michael E. Tewes, John H. Young, Jr., Humberto L. Perotto-Baldivieso, and Randy W. DeYoung

Landscape impermeability is a critical issue for species movement and distribution resulting from the increase of infrastructure in urban areas. Roads have major negative impacts on wildlife populations in the form of animal-vehicle collisions and decreased landscape connectivity. Understanding the landscape features surrounding the areas through which animals move can help to determine why they are crossing roads and what habitat features they are selecting at those crossing locations.

The ocelot is a federally-listed endangered felid whose populations contain about 80 to 100 individuals in the Lower Rio Grande Valley of South Texas. Previous research found that ocelot-vehicle collisions were the highest source of ocelot mortality in this region. Increased development of roads and traffic volume will likely lead to the increase of habitat fragmentation and impermeability, potentially leading to higher rates of ocelot-vehicle collisions.

We will use 35 years of ocelot mortality data and use satellite imagery to compare the landscape features surrounding ocelot-vehicle collision sites. This information will allow us to assess patterns of ocelot habitat selection near roadways.

Our research will help to identify sections of roads with a high potential for constructing ocelot crossings. Information obtained in this study can be used to assist highway transportation personnel in planning

the placement of future wildlife crossing structures designed for ocelot recovery efforts.

Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute and Texas Department of Transportation.

Physiographic and Microhabitat Factors of Ocelot Occupancy

Jason V. Lombardi, Michael E. Tewes, Humberto L. Perotto-Baldivieso, Jose M. Mata, Daniel Kunz, David G. Hewitt, Daniel G. Scognamillo, and Tyler A. Campbell

The ocelot is an endangered small felid occurring in 2 isolated subpopulations in the eastern Lower Rio Grande Valley of South Texas. Ocelots are habitat specialists, occurring primarily in vegetation that has over 95% canopy cover and over 85% vertical cover. However, certain aspects of ocelot ecology are not well understood, including the influence of physiographic, macro- and micro-habitat factors on ocelot occupancy, colonization of new areas, or localized extinction.

From 2011–2018, we conducted a camera-based photo survey at 28 sites on the East Foundation’s El Sauz Ranch in Willacy County. The probability of detecting ocelots was negatively influenced by episodic drought, where detection decreased through the duration of drought. Ocelots were more likely to occur closer to sand dunes, in areas with mesquite and huisache, and areas with sandy soils. Localized colonization was positively influenced by increasing percentage of woody cover, woody patch density, and the presence of thornshrub plants such as lime prickly ash,



© Katy Baldock

Ocelots prefer the very dense thornshrub habitat found in certain areas of South Texas and northern Mexico.

Berlandier’s wolfbender, granjeno, lotebush, and Texas lantana. Localized extinction of ocelots was negatively influenced by sandy soils. The data indicate areas on the western sides of the dunes may act as a refugia for ocelots as these areas include dense vegetation and tree and shrub communities linked to ocelots.

This research provides information on habitat components likely to influence ocelot occupancy, which is essential for future ocelot recovery and habitat restoration in Texas. As woody patch density decreases, there will be less preferred habitat for ocelots to colonize. Information from our study, combined with preferred soil types, should be factored into habitat preservation and restoration efforts.

Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute, East Foundation, Wild Cat Conservation, Inc., Annova LNG and their parent company Exelon Generation, Brown Foundation, Tim and Karen Hixon Foundation, Travis and Bettina Mathis, and Ben F. Vaughan, III.

Accelerating Growth of Ocelot Thornscrub Habitat

Jose G. Cortez, Jr., Sandra Rideout-Hanzak, David B. Wester, Michael E. Tewes, and David E. Ruppert

Loss of habitat is a major issue contributing to the declining number of ocelots in the Lower Rio Grande Valley of Texas. Ocelots within this region are limited to 2 breeding subpopulations located in Willacy and Cameron counties with large urban and agricultural landscapes separating them. Our objectives are to test



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Student researchers photographing a woody plant to estimate its growth using digital software.

various management techniques on both newly planted and established thornscrub plants to identify which treatments are most successful in growing high-quality thornscrub habitat for ocelots as quickly as possible.

The first phase of the project will involve applying treatments to naturally growing thornscrub saplings and recording their effects on growth and plant shape over time. Treatments will simulate mechanical disturbance on individual plants of 3 species by either (1) clipping plants, (2) mulching plants, or (3) both clipping and mulching. Exclosures to prevent access by large herbivores will also be placed around several plants of each species and compared to non-protected plants to determine the impact of browsers.

In the second phase, we will plant seedlings of 7 species that are important components of ocelot habitat. These seedlings will receive the clipping, mulching, or combination treatments at the time of planting.

Results from the 2 phases of this study will allow us to determine effective treatments for enhancing the growth and multi-stemmed habit of young thornscrub plants. It will also help determine when treatments should occur—at the time of planting or a few years later. The information obtained can be used to aid in developing protocols for future ocelot habitat restoration efforts.

Cooperative funding provided by the Texas Parks and Wildlife Department.

Survival Analysis of Ocelots in Relation to Roads in South Texas

AnnMarie Blackburn, Amanda M. Veals, Michael E. Tewes, John H. Young, Jr., Humberto L. Perotto-Baldivieso, and Randy W. DeYoung

The development of roads has had major impacts on wildlife populations in the form of habitat fragmentation, decreased landscape connectivity, and vehicle collisions. These impacts have a greater effect on survival rates of rare and endangered species.

The ocelot is a federally-listed endangered felid found in the Lower Rio Grande Valley (LRGV) of South Texas, whose populations contain about 80 to 100 individuals. The LRGV is a fast-growing metropolitan area with a significant amount of infrastructure and roads. Previous research found that ocelot-vehicle collisions were the highest source of ocelot mortality in the region. Our goal is to analyze the effects of roads on ocelot populations in South Texas.

We will use current and historical VHF and GPS collar data from the past 35 years to determine individual home ranges of ocelots. We will compare survival rates between individuals with home ranges adjacent to roads to those that are more distant. In addition, assessments will be made of ocelot survival rates by sex and social status (i.e., resident or transient). We will also compare landscape features of the surrounding area to those at ocelot-vehicle collision sites to determine if certain landscape features are associated with increased risk of death. With this dataset, we aim to create a model of high- and low-mortality risk zones around roads throughout the LRGV.

Our findings can be used to help mitigate the effects of roads on the ocelot population in the United States by establishing locations of future crossing structures along roadways. These data may help inform transportation planners in the development of new roads where ocelots occur.

Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute and Texas Department of Transportation.

Ocelot, Coyote, and Bobcat Interactions in South Texas

Jason V. Lombardi, Darryl I. MacKenzie, Michael E. Tewes, Humberto L. Perotto-Baldivieso, Jose M. Mata, Matthew Hewitt, Daniel G. Scognamillo, Daniel Kunz, and Tyler A. Campbell

Extreme South Texas is the only location in the world where coyotes, bobcats, and ocelots co-occur without the presence of a larger dominant carnivore species. In other areas of the Americas, coyotes are known to exhibit aggression towards foxes, raccoons, and bobcats. In Central and South America, small felid species often avoid ocelots, known as the “ocelot effect.”

Coyote-bobcat interactions are well known, ocelot-bobcat interactions are less known, and ocelot-coyote interactions have never been studied. Over the last 50 years, ocelots have experienced severe population declines in South Texas, whereas coyote and bobcat numbers have remained stable despite annual harvests. We are examining the driving forces behind this unique carnivore group in South Texas. We are using a 7-year (2011–2018) photo dataset obtained on the East Foundation’s El Sauz Ranch and multiple species occupancy modeling methods.

Our research will provide information into the degree that coyotes may affect ocelots and bobcats (and vice



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We are studying how bobcats and coyotes impact ocelots in South Texas at the East Foundation’s El Sauz Ranch.

versa) in dense thornshrub and oak forests within South Texas. This information can be used by biologists and wildlife managers to develop management strategies for ocelot recovery.

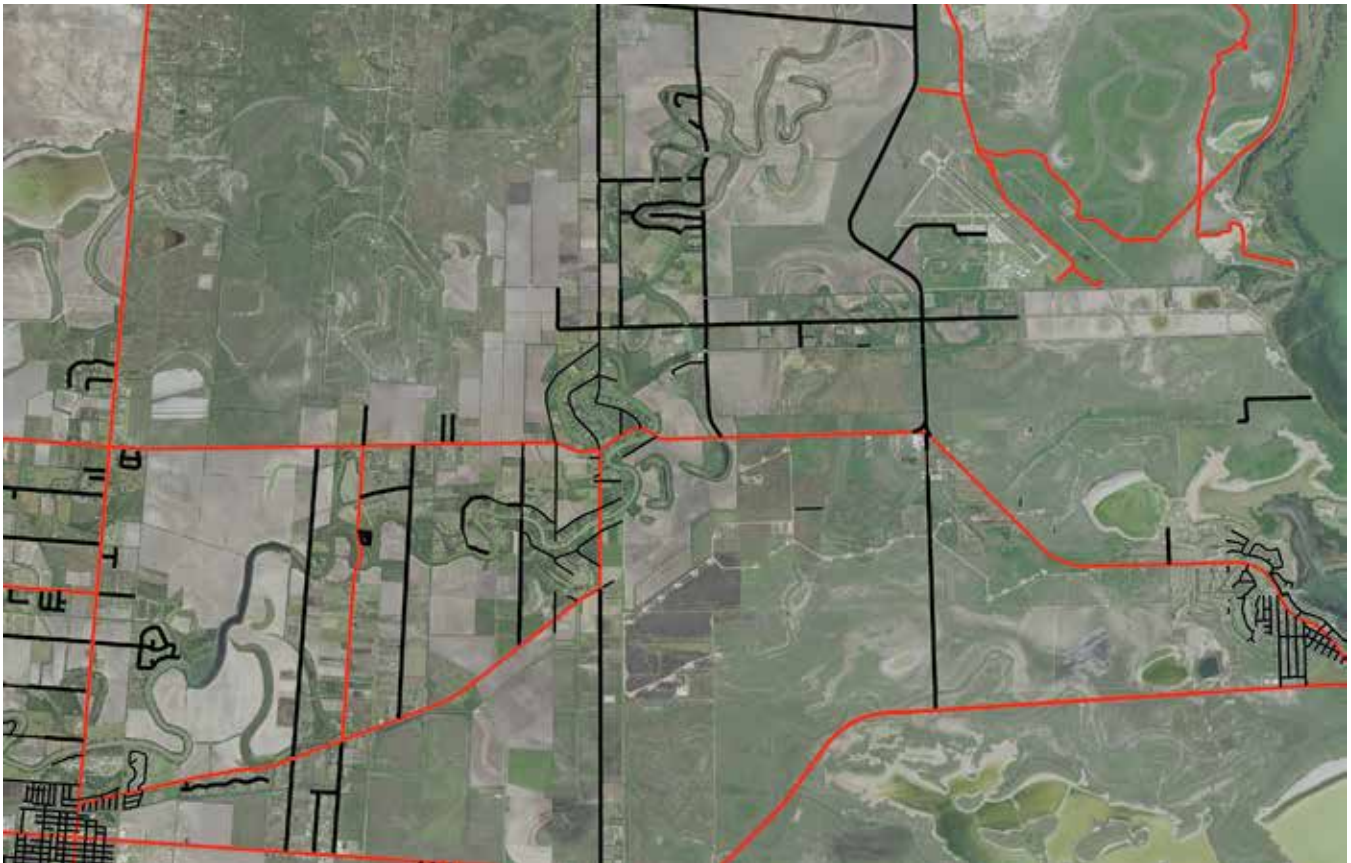
Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute, Wild Cat Conservation, Inc., Annova LNG and their parent company Exelon Generation, Brown Foundation, Tim and Karen Hixon Foundation, Travis and Bettina Mathis, and Ben F. Vaughan, III.

The Impact of Road Matrices on Habitat Connectivity for Ocelots in South Texas

Amanda M. Veals, AnnMarie Blackburn, Michael E. Tewes, John H. Young, Jr., Humberto L. Perotto-Baldivieso, and Randy W. DeYoung

Habitat loss and fragmentation significantly affect carnivores that depend on large tracts of contiguous habitat. Many carnivorous species, especially felids, are sensitive to human activities on the landscape. When planning conservation strategies for species in a highly modified landscape, it is necessary to understand the relationship between spatial distribution of such species and the remaining habitat.

In this study, we will assess potential landscape connectivity thresholds for several habitat fragmentation scenarios based on the extent of road networks. We will use the endangered ocelot in southern Texas as a case study. We will quantify the spatial and temporal distribution of critical habitat for ocelots under different



Aerial image showing human land alterations and road networks (red lines represent highways and black lines represent roads) within portions of South Texas that may negatively affect ocelot movements across the landscape. Image is based on National Agriculture Imagery Program (2016 imagery) underlying Texas Department of Transportation road infrastructure and road network. Data were downloaded from the Texas Natural Resources Information System (TNRIS).

habitat connectivity patterns and road networks within South Texas.

Information obtained in this study can provide insight about which habitat patches are most important for preservation and restoration of ocelot habitat. Future ocelot habitat restoration initiatives should benefit from the findings of this study.

Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute and Texas Department of Transportation: Environmental Affairs.

Assessing Population Dynamics of Ocelots in Northeastern Mexico

Jason V. Lombardi, W. Chad Stasey, Michael E. Tewes, Arturo Caso, and Sasha Carajaval-Villareal

The ocelot is a Neotropical felid and habitat specialist whose geographic range stretches from Argentina to southern Texas. Ocelots occurring in the Sierra

Tamaulipas National Protected Area in northeastern Mexico are genetically similar to those in Texas. They have been identified as a source population to genetically rescue ocelots in Texas from local extinction.

Translocation is a common tool used by biologists to reintroduce species, to restore populations in former ranges, or boost genetic diversity. With the objective of increasing genetic diversity in ocelots in the United States, we conducted field research from May–December 2009 on Rancho Caracol and Rancho Camotal, Tamaulipas, Mexico to quantify ocelot density, population size, and habitat use.

We found ocelots in the northern part of Rancho Caracol occurred in areas of increasing percentage of low spiny forest (1 ocelot per 2.04 mi²). In the southern grid of both ranches, ocelots were more likely to occur in small patches of low spiny forest interspersed with Tamaulipan thornshrub (1 ocelot per 2.05 mi²). Extrapolating the data region-wide, Sierra Tamaulipas National Protected Area potentially has over 870 ocelots with more than 600 occurring in low spiny forest and more than 270 in thornshrub.

Our data indicate that although ocelots were detected in thornshrub, tropical deciduous forests interspersed among thornshrub were the best predictor of occurrence. Given the robust population size, these ocelots could potentially be translocated to the United States. However, researchers and biologists need to be aware of the habitat preferences of ocelots in the Sierra Tamaulipas region to ensure successful translocations into Texas.

Cooperative funding provided by the Tim and Karen Hixon Foundation, Caracol and Camotal ranches, Barry Putegnat, Dean Putegnat, Feline Research Program of the Caesar Kleberg Wildlife Research Institute, and Wild Cat Conservation, Inc.

Circuit Theory to Estimate Road Crossings for the Endangered Ocelot

Amanda M. Veals, AnnMarie Blackburn, Michael E. Tewes, John H. Young, Jr., Humberto L. Perotto-Baldivieso, and Randy W. DeYoung

Roadways are widespread human-caused influences on the landscape. They are a major source of habitat loss. Understanding how animals perceive barriers to movement (landscape resistance) is important for the conservation and management of wildlife populations threatened by habitat fragmentation and habitat loss. In the matrix of habitat patches produced by roadways, barriers have profound impacts on the movement of animals across the landscape.

We will model the probability of landscape use by ocelots as a function of road structure and habitat permeability in southern Texas. Our goal is to identify potential pathways between habitat patches based on landscape resistance scenarios. We will assess which resistance surface best represents the observed movement patterns.

Circuit theory will help us identify locations for potential road crossing structures to reduce vehicle collisions with ocelots. This information may be used to assist Texas Department of Transportation planners with placement of wildlife road crossings for existing and planned roadways.

Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute and Texas Department of Transportation: Environmental Affairs.

Assessment of Ocelot Habitat Suitability in South Texas

Jason V. Lombardi, Michael E. Tewes, Humberto L. Perotto-Baldivieso, John P. Leonard, Matthew Hewitt, Daniel G. Scognamillo, and Tyler A. Campbell

The geographic range of ocelots in Texas once stretched from East Texas along the Louisiana-Arkansas border to Central and South Texas. Hunting, trapping, native habitat conversion for rangeland, agriculture and development, and collisions with vehicles have pushed ocelots to the brink of extinction in Texas.

Currently, 80 to 100 ocelots occur in the eastern edge of the Lower Rio Grande Valley in 2 small isolated subpopulations. Eighty percent of these ocelots occur on private lands. Because Texas is 98% privately owned, any expansion in ocelot range would mean translocating ocelots to privately held land suitable for ocelots. Habitat suitability models have been used by scientists to help gain a better understanding of areas that have a high probability of a species being present.

From 2014–2018, we conducted ocelot trapping and camera-based photo surveys on the East Foundation's El Sauz Ranch and photo surveys on the Frank D. Yturria Ranch. These ranches are in Willacy and Kenedy counties, respectively. We will combine radio telemetry data, photo data, and roadkill data with physiographic, climatic, land cover, and environmental data in program MaxEnt. This will allow us to generate a habitat suitability model for ocelots in their historical range within South Texas. Information can be used by biologists and researchers to identify dispersal areas, new populations, areas for possible habitat restoration, and areas of suitable habitat for establishing a third subpopulation.

Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute, Wild Cat Conservation, Inc., East Foundation, Annova LNG and their parent company Exelon Generation, Brown Foundation, Tim and Karen Hixon Foundation, Travis and Bettina Mathis, and Ben F. Vaughan, III.

The Comanche-Faith Deer Research Project

Charles A. DeYoung, Timothy E. Fulbright, David G. Hewitt, Lindsey M. Phillips, Don A. Draeger, Emily H. Belser, Onalise R. Hill, Ryan M. Rothstein, and Daniel B. Brown

Supplemental feeding of white-tailed deer is a widespread practice in Texas, but the effects of increasing deer densities on deer performance and the vegetation when supplemental feed is available are unclear. In addition, the effects of increasing supplemental feeder density on deer performance and the vegetation are unknown.

The Comanche-Faith Deer Research Project is based in Dimmit County, Texas, and is named after the 2 ranches where the study is replicated. The project's overall objective is to determine the optimal combination of white-tailed deer and supplemental feeder densities for the landscape while maintaining the native habitat.

On each ranch, we are using 6 200-acre high-fenced enclosures, which were constructed in 2003. Phase I of the project began in 2004. Phase II of research began in April 2013 and used the same 6 enclosures on each ranch. Treatments during Phase II for each enclosure on each ranch are outlined in the table below. Numerous projects are being conducted within the overall experimental design. Some projects use all 12 enclosures while others use a subset.

Cooperative funding provided by the Comanche Ranch, T. Dan Friedkin, Faith Ranch, and Stedman West Foundation.

Treatments in enclosures on each of the Comanche and Faith ranches.

	Encl. 1	Encl. 2	Encl. 3	Encl. 4	Encl. 5	Encl. 6
No. of Deer	20	40	60	60	80	0
Actual Acres per Deer	10	5	3.33	3.33	2.5	-
Acres per Deer Adjusted for 33% Count	30	15	10	10	7.5	-
Water and Feeder Sites	1	1	1	3	4	1
Deer per Feeder	20	40	60	20	20	0

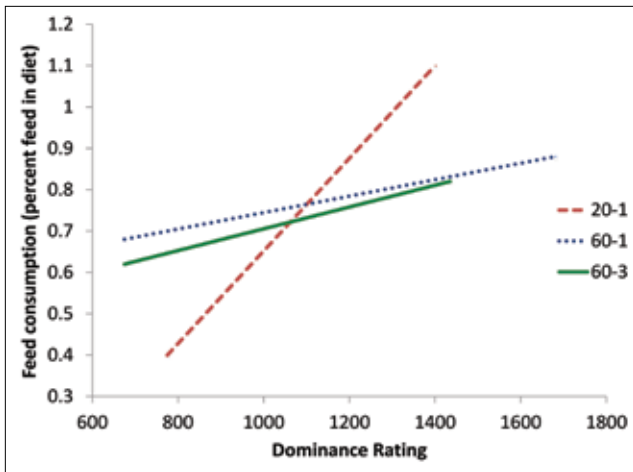
Influence of Deer Density on Dominance Hierarchies and Feed Consumption

Emily H. Belser, David G. Hewitt, Timothy E. Fulbright, Charles A. DeYoung, David B. Wester, Thomas W. Boutton, and Don A. Draeger

Providing pelleted feed for white-tailed deer is a common management practice in Texas. Previous research has shown that not all deer consume the same amount of supplemental feed, suggesting that social interactions at the feeder sites may restrict access for subordinate deer, such as young deer and female deer. Changing deer density and supplemental feeder site density may change the accessibility to feeder sites. To test these hypotheses, pelleted feed was provided year-round, *ad libitum* within the following treatments: 20 deer and 1 feeder site, 60 deer and 1 feeder site, and 60 deer and 3 feeder sites.

We used stable carbon isotope ratios in white-tailed deer serum to estimate usage of supplemental feed in deer diets during March 2015. In addition, social interactions at the feeder sites were analyzed using trail cameras that recorded 30-second videos in March 2015. We recreated the social hierarchy using the video results and determined the effect of a deer's dominance on supplement consumption within the different treatments.

Preliminary findings suggested that as a deer's dominance increased, feed consumption increased. However, the importance of dominance was greatest in the 20 deer and 1 feeder site treatment. These results suggest that during spring, dominance at feeder sites allows those deer to consume more supplemental feed but that the effect of dominance on feed access diminishes at high deer densities. The idea of economic defendability suggests that as the number of deer per



The consumption of supplemental feed increases as a deer’s dominance rating increases but at varying rates depending on the number of deer in the 200-acre enclosures (20 deer or 60 deer). The number of feeder sites (1 or 3) in an enclosure did not have a meaningful impact on the relationship.

feeder site increases, the costlier (in time, energy, and the risk of injury) it is for an individual deer to defend that resource.

Effects of White-tailed Deer Density on Herbaceous Vegetation Communities

Daniel B. Brown, Lindsay D. Roberts, Timothy E. Fulbright, Charles A. DeYoung, David G. Hewitt, David B. Wester, Lindsey M. Phillips, and Don A. Draeger

Many land managers in South Texas use supplemental feeding to maintain higher than normal populations of white-tailed deer on their land for hunting. It is unclear how increasing deer density and providing feeder sites affect abundance of palatable forbs.

We conducted vegetation sampling every June from 2012 until 2017 to determine percent cover of palatable forbs in relation to deer density and feeder sites. We estimated percent canopy cover of each herbaceous plant species. Weather stations on each ranch recorded temperature and rainfall data to determine the impacts of limited rainfall on the herbaceous vegetation communities.

Preliminary analysis shows that canopy cover of palatable forbs, averaged across years of sampling, was 67 to 76% greater in enclosures with no deer than in enclosures with 20, 40, or 60 deer and only 1 feeder site. Percent canopy cover of palatable forbs in enclosures with 60 deer and 3 feeder sites and 80 deer and 4 feeder sites was similar to canopy cover in enclosures with no deer. Forb species richness (number of

species sampled in an enclosure) was 14% and 17% greater with no deer than with 40 or 20 deer and 1 feeder site, respectively. Forb species richness was similar in enclosures with no deer, 60 deer and 1 or 3 feeder sites, and 80 deer and 4 feeder sites. Findings indicate that providing more than 3 feeder sites per 200 acres may reduce the negative impact of increasing deer density on palatable forbs.

Supplemental Feed Consumption by White-tailed Deer in South Texas

Emily H. Belser, David G. Hewitt, Timothy E. Fulbright, Charles A. DeYoung, David B. Wester, and Don A. Draeger

Providing supplemental feed has many benefits for deer, including increasing antler size, body size, and fawn survival. However, supplemental feed may not be accessible to all deer as densities increase due to competition at the feeder site. In addition, supplemental feed consumption may vary as a result of rainfall’s impact on forage and mast production.

We tested the above assumptions by providing supplemental feed year-round, *ad libitum* within each of the enclosures. We measured feed levels when feeders were refilled to determine feed disappearance.

Preliminary results suggest feed wastage averages 14.5 pounds per enclosure per day. Average feed intake by adult deer is 2.1 pounds per deer per day and varies from 0.5 to 4.4 pounds per deer per day, depending on the month. Intake by fawns varies from 0.5 to 2.1 pounds per fawn per day and increases as fawns get bigger. Both rainfall and summer mast (prickly pear fruits and mesquite beans) have a negative effect



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CKWRI researchers are studying the dynamics of actively managed deer populations in South Texas.

on feed disappearance. For example, with a 2 inch rain in the 40 deer and 1 feeder site treatment, per capita feed consumption declines almost 10%. Feed consumption decreases during summer, although the difference between a small and large mast crop was small during July. During June and August, feed consumption declined up to 50% with a large mast crop, depending on deer density.

Findings suggest deer will consume less supplemental feed when forbs, new plant growth, and mast are available. Also, there are indications that per capita feed consumption increases with increasing deer density, as long as the number of feeder sites is increased to maintain 1 feeder site per 20 deer.

Deer and Supplemental Feeder Site Densities Influence on Population Dynamics

Daniel B. Brown, Charles A. DeYoung, Timothy E. Fulbright, David G. Hewitt, Lindsey M. Phillips, and Don A. Draeger

The white-tailed deer is a popular big game species that many people enjoy watching and hunting. In South Texas, some landowners and land managers provide supplemental feed to increase antler size and density of their deer herd.

Our goal is to obtain information that can be used to help landowners and deer managers maintain appropriate deer densities on their land. Our objective is to determine if different deer densities and supplemental feeder site densities affect the growth of yearlings (1–2 years old) and fawns (young of the year), survival of adults, and the ratio of fawns to does. Data were collected at (1) biannual helicopter captures from



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Studies are underway to learn how deer density and feeders affect growth rates and survival within the herd.

April and December 2013–2017 and (2) mark-resight camera surveys completed every January and October 2013–2017. Measurements such as body condition, hind foot length, and weight were collected at each capture to calculate growth rates. Camera survey data will be used in conjunction with known mortality data to determine fawn to doe ratios and adult mortality.

Preliminary analyses have shown a negative relationship between deer density and population growth rates. Data are also being analyzed to determine the effects of other population dynamics variables. This study will indicate ideal densities at which deer populations should be maintained.

** End of In-Progress Comanche-Faith Project Abstracts **

Genetic Differentiation of Captive and Free-Ranging White-tailed Deer

Jordan L. Youngmann, Steve Demarais, Randy W. DeYoung, Bronson K. Strickland, Johnathan Bordelon, Chris Cook, and William McKinley

Restoration of white-tailed deer during the mid-1900s resulted in genetically admixed free-range populations across the southeastern United States. More recently, captive breeding has the potential to add genetic complexity to native populations through mongrelization. However, little is known about the genetic stocks of deer inside breeding facilities and if they are distinct from geographically proximate wild deer populations.

We assessed the genetic variation and differentiation of deer in 6 captive breeding pens in the southeast, and compared captive stocks to nearby free-ranging deer. For 3 of these pens, we also assessed associated enclosures wherein breeding pen deer had been released into native populations.

Most of the white-tailed deer in breeding pens were moderately differentiated from those in enclosures and free-range populations, whereas white-tailed deer in enclosures and free-range populations were more genetically similar. Population assignment tests revealed clear distinctions between deer in each breeding pen and its respective high-fenced enclosure or free-range populations, while there was little difference between deer in high-fence enclosures and associated free-ranging populations.

Though genetic differentiation was low, our findings suggest that captive stocks can be distinguished

from free-ranging deer using genetic assignment methodologies. Mixing of breeding pen and native deer is more difficult to detect because of varying rates of introgression and the historically admixed nature of free-range deer populations in the southeast.

Future research will assess the rate at which genetic differentiation deteriorates between breeding pen populations and free-range deer after successive generations of back-crossing. Our results will be useful in detection of illegal releases of deer, questionable entries in antler contests, and in tracking the origin of diseases, including chronic wasting disease.

Cooperative funding provided by the Mississippi Department of Wildlife, Fisheries, and Parks, Louisiana Department of Wildlife and Fisheries, and Alabama Department of Conservation and Natural Resources via the Federal Aid in Wildlife Restoration Program.

Reproductive Strategies of Male Mule Deer in a Fragmented Landscape

Levi J. Heffelfinger, David G. Hewitt, Aaron M. Foley, Shawn S. Gray, Warren C. Conway, Timothy E. Fulbright, Randy W. DeYoung, and Louis A. Harveson

Most species of deer are highly social, with males and females occupying the same areas, leading to competition for females during the rut. White-tailed deer use a single-female tending strategy in which a male will frequently check females for receptiveness and then court receptive females for less than 36 hours. Conversely, evidence suggests that mule deer use a harem-based strategy in which mature bucks defend a group of females against other males.

We will study the reproductive strategy of mule deer using GPS location data of 74 adult males and 81 adult females across 6 years in the Panhandle of Texas. Male and female mule deer were collared in the same areas. Preliminary observations indicate these deer were associated with each other during the rut. Therefore, we will use spatial analyses to document interaction patterns between sex. Moreover, we will be able to determine mate-search strategies of males throughout the stages of rut and how they differ with age and body size.

We expect that mule deer have a mate search strategy that differs from white-tailed deer. Male mule deer will likely show less roaming and re-visitation of areas that females occupy and show more interaction with GPS-collared females for longer periods. We predict our data will support that mule deer exhibit a



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Placing GPS collars on mule deer provides the data needed to determine the breeding strategies of this species.

harem-based breeding strategy and we will be the first to quantify differences in fine-scale mate search tactics between mule deer and white-tailed deer.

Cooperative funding provided by the Texas Parks and Wildlife Department, Boone and Crockett Club, and Mule Deer Foundation.

DMP Pens Effect on Average White-tailed Deer Antler Size

Stuart W. Stedman, Matthew T. Moore, and Charles A. DeYoung

Ranches obtain Deer Management Permits (DMPs) from the Texas Parks and Wildlife Department for the purpose of confining and breeding a large-antlered buck with up to 20 does. The confined deer and subsequent offspring are then released with the goal of upgrading overall antler size on the permitted property.

Our research is being conducted on the Faith Ranch in Dimmit County, Texas. Two high fenced areas of 1,100 acres were established in 2007 under identical management, including intensive supplemental feeding. Resident deer were removed from the treatment pasture prior to data collection, and the pasture restocked with DMP-sired offspring. The control pasture has resident deer that were present when the high-fence was constructed. DMP pens are stocked with native bucks and does from the Faith Ranch. Fawns are tagged in DMP pens and the control area each year with ear tags specific to year-of-birth. Each fall

marked (known-age) bucks are captured via helicopter and antler size compared within age classes across each pasture.

After 10 years of research, average gross Boone and Crockett (B&C) inches of DMP area bucks differed from control pasture bucks as follows: 1.5-year-olds, -1 B&C inch; 2.5-year-olds, +4 B&C inches; 3.5-year-olds, +9 B&C inches; 4.5-year-olds, +12 B&C inches; 5.5-year-olds, +9 B&C inches; 6.5-year-olds, +10 B&C inches; 7.5-year-olds, +6 B&C inches; 8.5-year-olds, +12 B&C inches; 9.5-year-olds, +19 B&C inches, and 10.5-year-olds, +6 B&C inches. The study is continuing in 2018.

Cooperative funding provided by the Faith Ranch.



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Juniper branches are collected and then ground-up for use as an ingredient in supplemental feed pellets for deer.

Evaluating Ground Juniper in White-tailed Deer Supplemental Pellets

Jessica L. Glasscock, Travis R. Whitney, David G. Hewitt, Fred C. Bryant, and Susan M. Cooper

Throughout North America, rangelands once dominated by perennial grasses are now impacted by the encroachment of native and non-native woody plant species. This can limit rangeland production for livestock and alter habitat for some wildlife species. Recent research has demonstrated that several species of juniper, commonly known as cedar, can be mechanically harvested, ground, and used as a roughage ingredient in sheep and goat feedlot diets.

Goals for this project were to (1) evaluate inclusion of ground blueberry juniper on preference and intake of supplemental pellets by white-tailed deer and (2) determine the potential for inclusion of ground juniper to deter consumption of pelleted supplement by feral pigs. We live-captured 24 feral pigs, assigned individual animals to a pelleted treatment diet and measured pellet consumption for 34 days during a pen trial. Treatment diets only differed by roughage source: 20% cottonseed hulls, 20% juniper, 40% cottonseed hulls, or 40% juniper.

Although no differences in total consumption were determined between treatment groups, decreased intake of diets containing 40% juniper and 40% cottonseed hulls was observed in individual animals during the pen trial. To evaluate consumption by free-ranging feral pigs and white-tailed deer, we used trail-camera video data captured at 4 supplemental feeder sites on the Welder Wildlife Refuge. Data collected from these sites are currently being analyzed. Overall, results

from this research may help reduce non-target species consumption of white-tailed deer supplemental pellets and help to reduce the cost of supplementation.

Cooperative funding provided by Texas A&M AgriLife Research and Extension Service and the Rob and Bessie Welder Wildlife Foundation.

Can Culling Bucks Lead to Genetic Change in Deer Populations on Large Acreages?

Don A. Draeger, T. Dan Friedkin, Charles A. DeYoung, Mitch A. Lockwood, Donnie Frels, Alan Cain, and Bronson K. Strickland

Genetic improvement in antler size is realized with selective breeding in pedigreed white-tailed deer in pens, but data are limited on the effects of culling on antler size for ranch-sized units. We are conducting a study on 3 areas of the Comanche Ranch in Maverick County, Texas to determine results that managers can expect from long-term buck culling.

Bucks are captured annually at random by helicopter and net gun, aged, and measured for Boone and Crockett (B&C) score. During 2006–2012, bucks that met the culling criteria were sacrificed and the meat donated. Bucks that did not meet the culling criteria were released after a microchip was implanted. On one area we culled yearlings with less than 6 points, 2-year-olds with less than 8 points, 3- and 4-year-olds with less than 9 points, and 5-year-olds and older with a gross B&C score of less than 145. On another

area, all yearlings and 2-year-olds were released, and older deer were culled by the same criteria as above. Finally, a third area served as a control and all bucks captured were released.

We saw little response after 7 years of culling, except the intensive cull area had a widening sex ratio and greatly reduced number of bucks. Beginning in year 8 (2013), we ceased culling but continued capturing bucks to determine if there is a lag in the influence of culling.

After 12 years of study, there are no obvious effects of culling. Bucks captured totaled 6,054, including 3,115 new deer and 2,939 recaptures. Bucks culled totaled 1,333. The study will continue for 1 more year.

Cooperative funding provided by the Friedkin Conservation Fund and the Comanche Ranch.

White-tailed Deer-Cattle Interactions on the East Foundation Ranches

Dillan J. Drabek, J. Alfonso Ortega-Santos, Timothy E. Fulbright, David G. Hewitt, and Tyler A. Campbell

Cattle grazing has both cultural and economic value to people in the rangelands of South Texas. Ranchers often wish to consider cattle and deer in managing their property. Although cattle grazing has been used as a tool to improve rangeland habitat, it can also damage valuable habitat for wildlife if incorrectly used. Complications may arise when grazing herbivores consume grasses as well as forbs.

Studies on the effects of grazing in a semiarid climate have had mixed findings. Therefore, our



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Studies are underway to examine the influence of cattle grazing on forbs preferred by white-tailed deer.

objectives are to determine how grazing affects forb standing crop production for white-tailed deer and to determine plant species richness throughout our study sites. We hypothesize that although grazing intensity varies among the study sites, it has no effect on the increase in forb productivity.

Six study sites (6,178 acres each) were selected on the East Foundation ranches in South Texas. The method being used includes 50 grazing exclosures (10.8 ft² each) randomly located within the study sites.

Plant sampling occurred during the peak growing seasons in autumn and spring. Plant composition will be compared within each exclosure to a comparable outside point in the pasture. Forage standing crop will be determined by collecting grasses, preferred forbs, and non-preferred forbs. This study will provide a better understanding of how cattle affect forb standing crop and plant species richness on cattle-deer operations in South Texas.

Cooperative funding provided by the East Foundation.

Examining Crop Use by Mule Deer in the Texas Panhandle

Laura S. Warner, Levi J. Heffelfinger, David G. Hewitt, Randy W. DeYoung, Timothy E. Fulbright, Louis A. Harveson, Warren C. Conway, Shawn S. Gray, and Dana Wright

Mule deer are an important game species in Texas, and many private landowners manage their wildlife habitat with mule deer in mind. However, mule deer behavior is not well understood in the Texas Panhandle. The region is fragmented by row-crop agricultural fields, and mule deer are often observed using crops to supplement their natural diet. We sought to determine (1) which crops mule deer prefer and (2) whether crop growth stage dictates how deer move through the landscape to access crops.

We used GPS collars to track the movements of adult mule deer at 2 study sites in the Texas Panhandle. Mule deer at the Rolling Plains site were collared for 2 years, and deer at the Canadian River Breaks site are currently collared for the second year. The GPS collars recorded a location for each deer every 2 hours. We used radio telemetry to locate collared deer during the data collection period. During this time, we also monitored crop growth stages in both study areas. We used the location data from the collars along with the crop growth information to determine the crop types and growth stages that mule deer preferred.



© Levi Heffelfinger

Even though mule deer are sometimes seen in cotton, they appear to forage more on wheat in the Texas Panhandle.

Preliminary results indicate that winter wheat was used most by collared deer, particularly during the tillering and stem elongation growth stages. Cotton was used minimally in the early leaf development stage. Our findings suggest that mule deer favor certain crop types and growth stages, and landowners or hunters seeking to manage mule deer habitat should account for these factors in their management plans.

Cooperative funding provided by the Texas Parks and Wildlife Department, Mule Deer Foundation, and Boone and Crockett Club.

Behavioral Responses of White-tailed Deer to Heat Stress

Randy W. DeYoung, Timothy E. Fulbright, Charles A. DeYoung, J. Alfonso Ortega-Santos, Aaron M. Foley, David G. Hewitt, and Tyler A. Campbell

In South Texas, the hottest times of the year (June–September) coincide with demands of reproduction and growth for white-tailed deer—physiological activities that also generate body heat. For instance, peak lactation for does occurs July–August, while bucks accumulate fat reserves August–September to sustain them through rut.

Lactation and accumulation of fat require extensive foraging efforts. Ruminants generate heat during fermentation of plant material and may be reliant on shade and water to help reduce heat stress. It is likely that deer also shift feeding activities to night to avoid

heat loads. Furthermore, many ranches support both deer and livestock, and there is potential for competition for shade and water use. Not all shady areas allow access to wind, which can provide extra cooling.

The juxtaposition of foraging areas, shade, and water may have an important influence on how deer can use the landscape during the hottest part of the year. Management that considers heat limitations may avoid the destruction of critical shade resources. Alternatively, managers may be able to target brush control to create refuges from heat once the ideal vegetation composition is understood.

We are using GPS-collared deer to determine how they use shade and water to avoid heat stress. In addition, we will determine if deer and livestock compete for shade resources and, if so, under what conditions. The resulting information on habitat selection in relation to heat stress will have important implications for management of deer and vegetation in South Texas.

Cooperative funding provided by the Zachry Foundation.

Contribution of Northern Stock Sources to the Southeastern United States

Jordan L. Youngmann, Steve Demarais, Randy W. DeYoung, Bronson K. Strickland, Johnathan Bordelon, Chris Cook, and William McKinley

White-tailed deer were nearly extirpated from the southeastern United States by the early 1900s. Deer were restored to the southeast by vigorous translocation programs implemented by state wildlife agencies. As a result, current populations are comprised of an admixture of different genetic stocks. Source stocks included remnant populations of native deer and populations as distant as Michigan, Wisconsin, and New York. The ability of northern deer to withstand the warm, humid climates and novel diseases of the southeast is questionable. However, little is known about the long-term contribution of northern stocks to the current genetic structure of southeastern deer.

We sampled free-ranging deer from Louisiana, Mississippi, and Alabama at sites that received northern stocks, as well as their source populations. These included Iron Mountain, Michigan, Sandhill Wildlife Area, Wisconsin, and the Adirondacks in New York. We used genetic data from 15 microsatellite DNA loci to evaluate ancestry of the southeastern deer.

As expected, the southeastern populations displayed signs of admixture of different genetic stocks.

Sites separated by the Mississippi River were genetically differentiated regardless of which source stocks they received. Sites that received deer from North Carolina and native Alabama populations that received no stocking were genetically differentiated. We found evidence for northern stocks at 1 site—the Black Warrior Wildlife Management Area in Alabama. It received 105 deer from Iron Mountain and represented 74% of the deer released at this site.

Our preliminary data reinforce the importance of choosing suitable source stocks for restoration projects. Our ongoing analyses will further investigate the history of southeastern deer populations.

Cooperative funding provided by the Mississippi Department of Wildlife, Fisheries, and Parks, Louisiana Department of Wildlife and Fisheries, and Alabama Department of Conservation and Natural Resources via the Federal Aid in Wildlife Restoration Program.

Effects of Histocompatibility Complex Variation on Antler Development

David Navarro, Randy W. DeYoung, Charles A. DeYoung, Don A. Draeger, and Masahiro Ohnishi

The handicap theory predicts that development of costly secondary sex characters, such as antlers or horns, can be an honest signal of male quality. Because the traits are physiologically costly to produce, males must be physically mature and in good condition to grow large antlers; there can be no cheating. Antler size is influenced by age, nutrition, and genetics. Therefore, individuals with below-average antler growth may be the result of their condition or pathogens instead of poor genes.

The major histocompatibility complex (MHC) plays a role in immune system response by helping the body recognize pathogens. Genetic diversity at the MHC has been associated with antler growth in white-tailed deer and other species of cervids.

Individuals with MHC alleles from different evolutionary lineages can respond to a wider range of pathogens and parasites, thereby devoting more resources to antler growth. Pathogen resistance may be especially important during rut, when high testosterone levels depress the immune system of bucks. If antlers serve as a signal of male quality, selective harvest may affect the distribution of genetic variation in a population.

We are characterizing MHC diversity and associations between MHC genes and antler size in white-tailed deer. We have collected repeated antler records

for individual bucks and established parent-offspring relationships as part of a long-term study of culling on antler development in white-tailed deer at the Comanche Ranch. The results of this study will improve our understanding of factors that affect antler development in wild deer and will have important implications for harvest programs.

Cooperative funding provided by the Comanche Ranch.

The Influence of Agriculture on Mule Deer Population Parameters

Levi J. Heffelfinger, Laura S. Warner, David G. Hewitt, Shawn S. Gray, Warren C. Conway, Timothy E. Fulbright, Randy W. DeYoung, Aaron M. Foley, Louis A. Harveson, and Dana Wright

Habitat fragmentation is an ever-present and important issue for many wildlife species. Conversion of native rangeland to row crop farming is one of the largest forms of habitat fragmentation. Moreover, as the human population grows, the need will increase for more agricultural land. Understanding how species react to such landscape alterations will prove important for conservation and management.

We seek to evaluate the influence of agriculture on several populations of mule deer in the Texas Panhandle. We are currently evaluating how crop use intensity and duration affects population health parameters such as body fat, body mass, lactation rates, and antler size. Additionally, we will assess how cropland use influences adult and juvenile survival.

We expect that the use of agricultural fields will positively influence body fat and body mass across age classes and sexes. Also, we hypothesize that lactating females will use cropland more than non-lactating females, thereby demonstrating the importance of nutritious forage for lactation. Adult male and female survival will likely be influenced by pre-winter body fat, and adult female survival will be negatively influenced by lactation. We also expect juvenile survival to be primarily driven by autumn body mass. Creating baseline population measures will aid in establishing an adaptive management plan as mule deer population levels in the Panhandle continue to increase and the rangeland-cropland juxtaposition continues to change.

Cooperative funding provided by the Texas Parks and Wildlife Department, Boone and Crockett Club, and Mule Deer Foundation.

HABITAT RESTORATION AND ENHANCEMENT

TxDOT Native Plant Integration Program for South, Central, and West Texas

Forrest S. Smith, Dennis K. Markwardt, Keith A. Pawelek, Anthony D. Falk, Colin S. Shackelford, John R. Bow, James P. Muir, Louis A. Harveson, and Jeff R. Breeden

Collaboration with the Texas Department of Transportation (TxDOT) is a signature function of the *Texas Native Seeds* Program. Since 2001, CKWRI researchers and our partners have had the opportunity to work as part of an extremely beneficial partnership with TxDOT. TxDOT's support enabled the expansion of the *South Texas Natives* Project to other regions of the state, and it is directly responsible for the creation of the *Texas Native Seeds* Program.

A major part of our work with TxDOT has been a focused effort to conduct research on roadside revegetation and to develop and commercialize native seed supplies that can be specified for use in effective roadside revegetation efforts in Texas. This has been accomplished through multi-university and multi-entity collaborative efforts, and it represents a continuous 8-year effort to meet program objectives by the research team and TxDOT.

Because of our efforts, seeding specifications for two-thirds of Texas have been changed to require the use of only native seeds in rural seeding projects. Commercialization or expanded production of over 40 native seed sources has been facilitated by our collaboration with TxDOT and their efforts to write new seeding specifications based on this research.

In 2018, TxDOT began supporting further expansion of this effort to serve the East Texas and the Coastal Prairie regions of the state. TxDOT's participation in and investments toward the *Texas Native Seeds* Program have had a monumental effect on native plant restoration in Texas and continues to directly benefit native seed supply for all consumers.

Cooperative funding provided by the Texas Department of Transportation.

South Texas Natives Project Seed Releases, Restoration Research, and Outreach

Anthony D. Falk, Keith A. Pawelek, and Forrest S. Smith

South Texas Natives (STN) is entering its 18th year of operations and continues to be a leading force in

native plant seed source development, restoration research, and outreach. During the past year, we have accomplished a number of goals toward our mission. STN is completing releases of 2 important grass species specifically for South Texas—Wilson Germplasm Indiangrass and Kenedy Germplasm big bluestem. STN is also leading efforts to release Guadalupe Germplasm white tridens, Menard Germplasm purple threeawn, and a selection of little barley for use in reclamation efforts. These 3 species are critically important for revegetating highway rights of ways. STN will continue its work on making native seed selections in the coming years and plans to release many additional germplasms.

South Texas Natives personnel assisted with 5 new restoration plantings in the last year. These plantings included newly released species to refine seed mix recommendations and test their performance. Each of these plantings has also focused on creating pollinator habitat as part of the restoration goals.

Several recent projects have focused on the South Texas Sand Sheet, particularly on areas affected by energy production and transfer including pipeline and transmission line rights of ways and former oil and gas pads. The success of these plantings and the knowledge generated by these projects are extremely valuable to landowners and land managers in aiding their restoration efforts within South Texas.

Cooperative funding provided by the Robert J. Kleberg, Jr. and Helen C. Kleberg Foundation, Lee and Ramona Bass Foundation, A. E. Leonard Family Giving Council, Joan and Herb Kelleher Charitable Foundation, ConocoPhillips, Brown Foundation, and many generous donors to the South Texas Natives Project.

Statewide Expansion of the Texas Native Seeds Program

Forrest S. Smith, Keith A. Pawelek, Anthony D. Falk, Colin S. Shackelford, John R. Bow, Samuel R. Lufy, and Tyler C. Wayland

The *Texas Native Seeds* Program (TNS) became a statewide effort in 2018 and has made major strides. Native seed development and restoration activities in 3 new regions of Texas were launched last year: the Permian Basin/Panhandle, East Texas, and the Coastal Prairies. TNS is being operated as a network of 6 collaborative native seed and restoration development projects including our original *South Texas Natives*

Project, the *Central Texas Native Seed Project*, and the *West Texas Native Seed Project*.

Significant growth in personnel to undertake this expanded mission was required during 2017–2018. New positions included the addition or creation of assistant director positions in each of the 6 project regions. We also created the position of associate director in Kingsville and stationed the project director in Austin to be more centrally located to manage work in all project regions and to better engage state agencies and new funding sponsors.

Support of the leadership of Texas A&M University-Kingsville and the Dick and Mary Lewis Kleberg College of Agriculture has been essential in accomplishing our ambitious goals. Significant accomplishments will be made by TNS in all regions, including 5 to 10 native seed releases per year.

The program has become heavily involved in providing recommendations for hundreds of restoration projects annually, including the energy sector, highway rights of ways, pollinator projects, rangeland restoration in agency-sponsored conservation programs, and private landowner restoration activities. TNS is poised to have substantial impacts on native plant conservation and restoration for years to come.

Cooperative funding provided by the numerous donors to the Texas Native Seeds Program.

Genomic Analysis of Common Texas Native Grasses

John R. Bow, Jeff A. Brady, James P. Muir, Forrest S. Smith, Keith A. Pawelek, and Anthony D. Falk

Texas Native Seeds personnel collect and evaluate native plant material for releasing seeds adapted to specific regions. Significant variation in plant characteristics and adaptability is clear during the evaluation portion of our field research. However, the basis of that variation and the impact of seed origin in relation to these differences are poorly understood. Our objective is to compare the genetic relationships among native populations from various regions and commercial plant material already available of little bluestem, silver bluestem, and blue grama by examining DNA sequence differences in their genomes.

Plant tissue samples were collected and processed at the Texas A&M AgriLife Research and Extension Center in Stephenville. DNA was extracted from the leaf tissues sent to Texas A&M Genomics and

Bioinformatics Services in College Station for analysis. DNA sequences will be analyzed to identify DNA markers associated with regional variability.

We hope to discover both regional DNA markers and trait-based DNA markers that correspond to our results from field evaluations. This information will give us a better understanding of the population structure of these native grasses. We also hope DNA results will help us confirm and reinforce our plot evaluation data. This information will provide a genomic fingerprint of plant materials that we will be releasing into commercial production, which could be useful in ensuring high-quality native seed supplies are provided to consumers.

Cooperative funding provided by donors to the Texas Native Seeds Program.

Blackland Prairie Restoration at Martindale Army Airfield near San Antonio, Texas

Keith A. Pawelek, Forrest S. Smith, Anthony D. Falk, Roberto Obregon, and Aaron R. Gilfillan

In 2016, *South Texas Natives* and the Texas Military Department began a project to restore 103 acres of blackland prairie at the Martindale Army Airfield near San Antonio. This project is aimed at increasing pollinator habitat and providing long-term vegetation cover on areas not currently used in training activities. Of the 103 acres, 97 acres will be planted with an ecotypic native grass and forb mixture that will provide nectar plants for pollinators. Five acres around the border will be planted with a pollinator forb-only



© Keith Pawelek

Blackland prairie restoration is underway at Martindale Army Airfield near San Antonio, Texas.

blend. This will allow us to see whether adjacent non-native grasses on the perimeter can be controlled using grass-specific herbicides as a management tool.

Herbicides were applied in spring 2017 on the restoration site to purge the seed bank of agriculture weeds and non-native grasses. Following seeding in August 2018, we will monitor site use by pollinators and other wildlife to determine the effects of increased habitat availability and the ecological impact of the restoration effort. We hope this restoration project will serve as a demonstration site to showcase the ability of ecotypic seed sources to restore large tracts of blackland prairie—one of Texas’ most imperiled ecosystems.

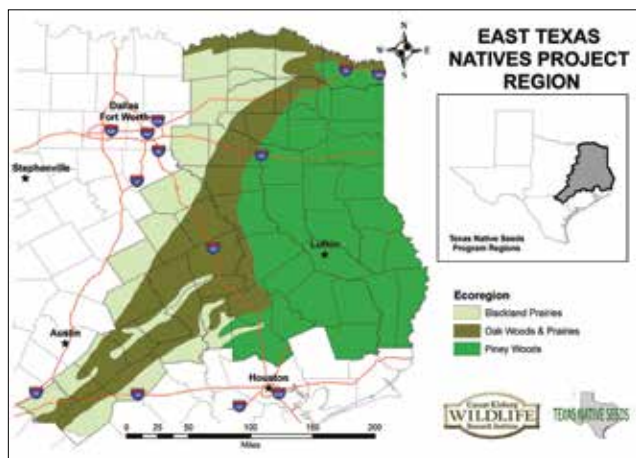
Cooperative funding provided by Texas Military Department.

East Texas Natives Project Native Seed Development and Outreach Efforts

Tyler C. Wayland, Alan Shadow, Robert Sanders, Keith A. Pawelek, and Forrest S. Smith

There is significant demand for locally adapted, commercially available native seed to use in restoration and reclamation projects in East Texas. Success of the *Texas Native Seeds* Program to meet similar demands in South, Central, and West Texas over the last 17 years has paved the way for a new East Texas initiative—*East Texas Natives* (ETN).

East Texas Natives is focusing on the development of ecotypic seed sources of native plant species for the East Texas region. Seed releases of plants native to the region will aid public and private restoration efforts in the pineywoods, oak woods and prairies, and blackland



The *East Texas Natives* Project is working over a large area of East Texas (image provided by CKWRI Geospatial Technologies Laboratory).

prairie ecosystems of East Texas. ETN has partnerships with private landowners, the USDA Natural Resources Conservation Service, Texas Department of Transportation, and U.S. Forest Service.

In February 2018, ETN hired a full time assistant director, who is based out of the Lufkin-Nacogdoches area. A collection list of 81 grass, forb, and legume species was compiled with priority given to those species having growth and development characteristics suited for restoration plantings and commercial scale seed production.

Scouting and seed collection trips have covered 20 counties in East Texas. In addition to our seed collection efforts, ETN personnel are meeting with landowners and conservation groups in East Texas and participating in workshops, field days, and education and outreach efforts to promote native habitat restoration in the region.

Cooperative funding provided by Ellen Temple, the Joan and Rufus Duncan Memorial Fund, Pineywoods Foundation, TransCanada Charitable Fund, Texas Department of Transportation, USDA Natural Resources Conservation Service, U.S. Forest Service, Boggy Slough Conservation Area, T.L.L. Temple Foundation, and Winston 8 Ranch.

Native Seed Ecotype Development by the Central Texas Native Seed Project

John R. Bow, Forrest S. Smith, Keith A. Pawelek, Anthony D. Falk, Colin S. Shackelford, James P. Muir, Chase A. Murphy, and Jeff R. Breeden

The development of locally adapted native seed sources is the goal of *Texas Native Seeds*. This is accomplished through collecting, evaluating, selecting, increasing, and eventually releasing native plant germplasms that can be commercially produced. The *Central Texas Native Seed* Project includes 67 counties that encompass several ecoregions.

Evaluations are being conducted at the Texas A&M AgriLife Research and Extension Center in Stephenville and the USDA Natural Resources Conservation Service James E. “Bud” Smith Plant Materials Center in Knox City. Hairy grama and tall grama evaluation plots were established at both locations during 2017. Data collection includes growth measurements, plant characteristic rankings, seed potential, and seed quality.

Wild seed collections in 2017 were focused on sideoats grama and seep muhly. In June 2018, new evaluation plots were established from greenhouse

transplants that consisted of 23 populations of sideoats grama and 22 populations of seep muhly at Stephenville and Knox City.

Evaluations resulted in 3 grass species selected for seed increase beginning in 2018: little bluestem, silver bluestem, and meadow dropseed. Population selections of each were transplanted into field plots to increase seed production at Stephenville. Seed of each species will be released as a select native germplasm by *Texas Native Seeds*. In addition, seed increases of selections of hooded windmillgrass, sand dropseed, and slim tridens are nearing completion, which will lead to commercially available seed sources of these species for use in Central Texas within 2 years.

Cooperative funding provided by the Texas Department of Transportation, Stillwater Foundation, Horizon Foundation, USDA Natural Resources Conservation Service, and donors to the Texas Native Seeds Program.

Season of Fire Effects on Gulf Cordgrass Rangelands

Jose S. Avila-Sanchez, Victoria L. Haynes, Sandra Rideout-Hanzak, David B. Wester, J. Alfonso Ortega-Santos, Tyler A. Campbell, and Alfonso Ortega-Sanchez, Jr.

Gulf cordgrass is a perennial bunchgrass found along the Gulf Coast of Texas. It is used by wildlife for nesting and escape cover, and as a reserve forage for livestock when other grasses are sparse. Gulf cordgrass often occurs in solid stands and becomes coarse and low in nutritional value when mature. This makes it unattractive as forage for livestock. However, gulf cordgrass is of interest because of its potential nutritive value and accessibility when old growth is removed.

Our objectives are to determine the best season for using prescribed burning of gulf cordgrass to increase accessibility and nutritional value of forage and browse and increase species richness and diversity within the plant community. We are comparing the effects of prescribed burning in summer and winter by applying fire to pastures containing gulf cordgrass.

Two pastures were burned in winter 2016, summer 2016, winter 2017, and summer 2017. We also have 2 control (non-burned) pastures. We have clipped quadrats inside each pasture to determine biomass and forage production. We have also recorded plant composition, recruitment, and mortality.

Our preliminary results show higher mortality of gulf cordgrass in the summer burn pastures (29%) 90 days after burning than in the winter burn pastures



© Alfonso Ortega-Sanchez, Jr.

A prescribed fire burns in gulf cordgrass on the East Foundation's El Sauz Ranch.

(7%) and control pastures (1%). No differences in plant recruitment among burn treatments were found. We used HOBO® data loggers to record ground temperatures in the burn pastures. We found that the odds of gulf cordgrass mortality increased 36% for each 100°F increase in maximum fire temperature regardless of whether the prescribed burns occurred during the summer or winter.

Cooperative funding provided by the East Foundation.

The Valley Crossing Pipeline Restoration Project

Forrest S. Smith, Devin Hotzel, William R. Murphy, Jr., Anthony D. Falk, and Keith A. Pawelek

The Valley Crossing Pipeline was constructed through valuable native habitats of the South Texas Sand Sheet during 2017 and 2018. This provided *South Texas Natives* personnel the opportunity to conduct plant restoration research along the pipeline right of way through Kenedy County.

In autumn 2017, we worked with Enbridge Energy Partners, private landowners, and Douglass W. King Seed Company to develop an ecotypic native plant seed mix for use on the Kenedy County portion of the Valley Crossing Pipeline. This seed mix was specifically designed to include native pollinator plants that would provide beneficial habitat to migrating monarchs and meet revegetation, wildlife habitat, and livestock forage goals of landowners and Enbridge.

In spring 2018, we began sampling the restored right of way, and will continue sampling vegetation and plant use by monarchs for the next several years. Results will be used for pipeline right of way seeding recommendations for the Sand Sheet and other areas.

This project has provided a unique opportunity to study landscape-scale restoration dynamics as well as to implement one of the largest pollinator plantings ever undertaken in this region. Dry conditions since completion of seeding have been a limiting factor, though copious rains received in late June 2018 should provide ample opportunity for successful establishment of native plants. We hope that this project will be successful in providing restored native pollinator plants for migrating monarchs.

Cooperative funding provided by Enbridge Energy Partners, L.P. and King Ranch, Inc.

Locally-Adapted Native Seed Development by the West Texas Native Seed Project

Colin S. Shackelford, Jameson S. Crumpler, Louis A. Harveson, Keith A. Pawelek, Anthony D. Falk, and Forrest S. Smith

Work is continuing in the development of ecotypic native seed sources for the Trans-Pecos region of Texas. Two new plant releases for West Texas have been planted in seed increase plots at Alpine. Two accessions each of cowpen daisy and black grama were established in June 2018. Eleven species for grassland restoration in West Texas are now included in seed increase efforts; 2 of those species (whiplash pappus-grass and silver bluestem) have pending licenses to 3 growers for commercial production. Other plants nearing commercialization are blue grama, Hall's panicum, sand dropseed, sideoats grama, Gregg's mistflower, skeleton-leaf goldeneye, and Tahoka daisy.

A new evaluation planting of hooded windmillgrass for sandy soil restoration in the Trans-Pecos is in the second year of data collection. Thirty-nine accessions were installed at both the Sierra la Rana evaluation site in Alpine and the Railway Ranch evaluation site near Odessa in 2017. Data collection for this species will continue through 2018, after which selected accessions will be planted for seed increase and eventual commercial release. In total, evaluations of 20 species have now been completed in West Texas.

Seed collections throughout West Texas are ongoing to support additional native plant evaluations and future ecotypic seed releases for the Trans-Pecos. As



© Colin Shackelford

Skeleton-leaf goldeneye is a pollinator and wildlife plant being developed for commercial production in West Texas.

of summer 2018, more than 1,200 native seed collections have been made. Construction of a new project greenhouse is underway in Alpine, which should greatly increase future capacity. This much-needed infrastructure was made possible by a generous contribution from Concho Resources.

Cooperative funding provided by the Texas Department of Transportation, USDA Natural Resources Conservation Service, Concho Resources, Inc., Caesar Kleberg Foundation for Wildlife Conservation, CF Properties and the Sierra la Rana Development, Stan Smith, and the Railway Ranch.

The Effects of Thrips on Native Grass Seed Production

Tyler C. Wayland, Anthony D. Falk, Keith A. Pawelek, and Forrest S. Smith

Flower thrips are a significant insect pest affecting field, nursery, and greenhouse crop production. Many species of thrips cause damage to crops by directly feeding on plants and spreading plant viruses, causing a reduction of quality in crop yields.

To evaluate the effects of thrips on seed production, malathion insecticide was applied to half of the little bluestem, big bluestem, and Indiangrass plants in seed production plots at the *South Texas Natives* research complex in Kingsville, Texas. Seed was harvested by hand when ripe from both the treated and untreated portions of the plots for comparison using both germination and tetrazolium testing.

Results from the seed tests are available for the Indiangrass samples and indicate a modest increase in seed purity (+1.5%) in the treated plants compared to the untreated plants. We found a 5% increase in Indiangrass germination, from 30% in the untreated portion to 35% in the plants treated with the insecticide. Seed samples from little bluestem and big bluestem are being tested.

The goal of this study is to determine if future investments in insecticide application to combat thrips are warranted for commercial seed production of these plant species. Upon completion of seed testing, we will analyze yield and treatment cost to provide recommendations to commercial seed growers.

Cooperative funding provided by the numerous donors to the South Texas Natives Project.

Development and Release of Kenedy Germplasm Big Bluestem

Forrest S. Smith, Anthony D. Falk, Keith A. Pawelek, Dean N. Williams, John Reilley, and Shelly D. Maher

Big bluestem is an important native grass found in high quality grasslands of the Coastal Prairie and South Texas Sand Sheet. Big bluestem is considered one of the “big 4” native grasses of the true tallgrass prairies of North America and reaches its southernmost extent in South Texas.

Big bluestem is an excellent forage for cattle and it provides habitat to a variety of wildlife. It is a charismatic vegetation component of native prairies. However, it is currently restricted to lightly grazed



© Forrest Smith

Kenedy Germplasm big bluestem is nearing release by South Texas Natives and Douglass W. King Seed Company.

or deferred pastures or road rights of ways in South Texas. Historically, big bluestem was likely more abundant than today.

An ecotypic seed source of big bluestem has long been desired for use in South Texas. Commercial seed supplies for revegetation projects originated from the Great Plains. The plants were poorly adapted to conditions found in South Texas. Therefore, in 2001, we began collecting seed of big bluestem from South Texas for evaluation. From 2002–2007, we evaluated populations at various locations to select a germplasm with traits necessary for restoration efforts and commercial seed production.

Following extensive research to determine adequate seed production methods from 2007–2016, we began a cooperative effort with the Douglass W. King Seed Company to produce large amounts of seed of a blend of big bluestem populations originating from the La Paloma Ranch and Encino Division of the King Ranch. Upon completing these increases and obtaining large quantities of seed of this selection, we have initiated release procedures for Kenedy Germplasm big bluestem. Large quantities of seed should be available for purchase by consumers in spring 2019.

Cooperative funding provided by the Robert J. Kleberg, Jr. and Helen C. Kleberg Foundation, Lee and Ramona Bass Foundation, Douglass W. King Seed Company, and donors to the South Texas Natives Project.

Commercial Production of Seed Releases Made by the Texas Native Seeds Program

Keith A. Pawelek, Forrest S. Smith, Anthony D. Falk, Dean N. Williams, and Nick Bamert

Commercial production and sale of *Texas Native Seeds* (TNS) releases are important measures of program performance and the impact on restoration activities. Seed sales were slightly rising in 2017–2018 and seed produced exceeded 45,000 pounds. Seed sales often track demand from the energy sector. Last year, use of native seeds in pipeline reclamation had a notable effect on seed sales. Also, commercial growers reported increased interest in native pollinator species for restoration and reclamation efforts and greater use of native seed mixes as specified by the Texas Department of Transportation.

Additional seed production efforts are underway by growers, including new releases of Santiago Germplasm silver bluestem and Permian Germplasm



© Anthony Falk

Large scale restoration seedings are increasingly being undertaken because of the *Texas Native Seeds Program*.

whiplash pappusgrass. Both show potential for restoration projects in West Texas and the Permian Basin. In addition, commercial seed production of zizotes milkweed was achieved during 2017, which provided an important seed supply for monarch habitat restoration plantings.

Efforts to encourage additional increases in commercial seed production continue. In March 2018, we began negotiating license agreements for 9 TNS releases with 3 commercial seed growers. These licenses will ensure high quality Texas Department of Agriculture-certified native seeds are made available to consumers. In addition, it will provide a mechanism for the collection of royalties from seed sales and will help support TNS’ foundation seed production and provision of technical assistance to seed producers.

Cooperative funding provided by the numerous donors to the Texas Native Seeds Program.

Development and Release of Wilson Germplasm Indiangrass

Forrest S. Smith, Anthony D. Falk, Keith A. Pawelek, Dean N. Williams, John Reilley, and Shelly D. Maher

Indiangrass is a common native species in the prairie region of North America. It is an excellent livestock forage and provides good cover for wildlife. Indiangrass is an indicator of good range management. Pastures containing this grass are usually well-managed or receive periodic deferment from livestock. It

is also common on road rights of ways and other protected areas. As a charismatic native grass species, it is often desired for use in native prairie and rangeland restoration seed mixes.

In South Texas, Indiangrass is found in the Sand Sheet, Coastal Prairie, Blackland Prairies, and Post Oak Savannah ecological regions. Prior to our efforts, commercial seed of Indiangrass originated from areas far north of these regions, but this Indiangrass was not adapted to South Texas.

In 2001, we obtained collections of Indiangrass from South Texas. After several years of evaluation, we selected and began producing seed of Indiangrass collected from a road right of way in Wilson County. Following over a decade of seed production research and efforts to produce economically sustainable yields of this selection, we made substantial breakthroughs in seed production with Douglass W. King Seed Company’s collaboration in 2016. Subsequently, we began efforts to make a formal release of Wilson Germplasm Indiangrass, which should be available to consumers in spring 2019. This seed selection should be a valuable addition to restoration seed mixes throughout the eastern portions of South Texas.

Cooperative funding provided by the Robert J. Kleberg, Jr. and Helen C. Kleberg Foundation, Lee and Ramona Bass Foundation, Douglass W. King Seed Company, and donors to the South Texas Natives Project.

Pollinator Plant Seed Increase to Enable Restoration

Anthony D. Falk, Forrest S. Smith, Keith A. Pawelek, Colin S. Shackelford, John R. Bow, Dennis K. Markwardt, Chris Best, John Reilley, and Shelly D. Maher

The loss of pollinators is a growing global concern. Consequently, the ability to restore pollinator habitat by planting native flowering plants is desired by many agencies and landowners. To help meet the need for pollinator seed sources, *Texas Native Seeds* and our partners are working to develop seed releases of plant species beneficial to pollinators in Texas.

In South Texas, we have successfully increased seed selections of tropical sage, frostweed, cowpen daisy, and zizotes milkweed. In West Texas, we have made successful seed increases of Tahoka daisy, skeleton-leaf goldeneye, and Gregg’s mistflower. In Central Texas, golden dalea and Illinois bundleflower have been successfully increased. Seed of these species will be provided to commercial seed companies

for large scale seed production and, ultimately, provision of seed to consumers and agencies for use in pollinator habitat restoration efforts.

We are working with commercial seed dealers to ensure that the seeds being produced are becoming commercially available. Through these efforts, several pollinator species are available in commercial quantities. Species include awnless bushsunflower, orange zexmenia, prairie acacia, prostrate bundleflower, Rio Grande clammyweed, Indian blanket, purple prairie clover, velvet bundleflower, and zizotes milkweed.

Cooperative funding provided by the numerous donors to the Texas Native Seeds Program, Texas Department of Transportation, USDA Natural Resources Conservation Service, and the U.S. Fish and Wildlife Service.

Testing Efficacy of Stock-piling Topsoil for Ecological Restoration

Nelissa N. Guerra, Sandra Rideout-Hanzak, David E. Ruppert, Veronica Acosta-Martínez, and David B. Wester

Stock-piling topsoil derived from areas disturbed during oil and gas extraction is a common recommendation to enhance future restoration using the saved topsoil. We began a study in 2012 on a stock-pile that was created when a fracking pond was constructed in Dimmit County, Texas. This site was retired in 2017 and we are now evaluating the use of different layers of stock-piled topsoil as substrates for restoration.

Three newly-created surfaces from the stock-pile were defined and segregated by layers of 4.5 feet and distributed over the pond. Two additional surfaces included fresh topsoil and a non-amended surface. Each of the 5 surfaces was seeded with (1) a mixture of 13 native grasses, (2) 13 native grasses plus an annual warm-season grass cover crop, or (3) non-seeded.

We are assessing initial restoration success by taking plant density measurements and determining plant species composition. Seed bank trials and assessments of soil microbial community size and structure will also be studied with soil samples collected prior to reseeding in 2017 as well as 1- and 2-years post-restoration. These assessments will be compared to similar data collected from this stock-pile between 2012 and 2015. Our goal in this research is to quantitatively assess the common recommendation of stock-piling topsoil following soil disturbance in semiarid regions.

Cooperative funding provided by Alston and Holly Beinhorn.

Permian Basin Native Seed Project Ecotype Development and Outreach Efforts

Samuel R. Lutfy, Jesse Wood, Colin S. Shackelford, Anthony D. Falk, Keith A. Pawelek, and Forrest S. Smith

The Permian Basin Native Seed Project (PBNSP) began operations in November 2017. PBNSP's mission is to develop commercially available native seed sources for the Permian Basin and Panhandle regions and to engage the energy industry in the use of native seeds for land restoration and reclamation. Our primary objective is to obtain wild seed collections from native species of interest that will allow the evaluation and increase of desired species in the region.

Over 50 seed collections have been made since November. These and other collections obtained will be planted for evaluation at the Railway Ranch evaluation site near Odessa, the USDA Natural Resources Conservation Service Plant Materials Center in Knox City, and a third evaluation site to be identified.

Our secondary objective is fostering partnerships with the oil and gas industry and local landowners in the Permian Basin. As of spring 2018, we have given 7 presentations to various audiences in the region. Through these events, we aim to encourage greater restoration efforts using native plants.

Concho Resources, Inc. is cooperating closely with the PBNSP on 2 research and demonstration plantings. At the first site, we have 2, 10-acre sites that were planted in spring 2018 with ectopically suitable native seed mixtures. Our restoration efforts will be valuable for determining the limitations in current seed supply for the Permian Basin. The second site is in downtown Midland. It is a native plant demonstration garden



© Samuel Lutfy

A native plant demonstration site developed in collaboration with Concho Resources in Midland, Texas.

that showcases a variety of commercially available species and includes a trial restoration seeding plot. Through our efforts, we hope to encourage the use of native plant species adapted to the Permian Basin and Panhandle regions of Texas.

Cooperative funding provided by Concho Resources, Inc.

Assessing Landscape Impacts of Energy Sprawl in the Trans-Pecos Region of Texas

Michael H. Young, Forrest S. Smith, and Dale A. Devitt

We are assessing the potential land impacts from energy sources (utility-scale solar to wind to oil and gas exploration) and identifying techniques to reduce the effects of energy sprawl in the Trans-Pecos ecoregion of West Texas. Researchers have begun to consider multi-energy source impacts on landscapes—termed “energy sprawl.” There is some urgency in understanding these impacts in the Trans-Pecos region of Texas because of the substantial interest and activity related to energy development.

Our objectives include assessment of baseline landscape conditions in the eastern Trans-Pecos region, including areas near Pecos, Balmorhea, Fort Davis, and Fort Stockton. We plan to use current imagery to locate and measure the severity of impacts. The research team will identify field sites based on current and potential future construction of solar facilities, oil and gas infrastructure, wind farms, etc. In addition, we will obtain information from landowners and other organizations involved in land management.



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Energy sprawl is affecting wildlife habitats within the Trans-Pecos ecoregion of Texas.

Working with stakeholders, we will assess ways to monitor landscape impacts related to energy development, and to consider actions for mitigation. As part of this project, we hope to develop technical papers and best management practices for the conservation and restoration of native habitats affected by energy sprawl in West Texas.

Cooperative funding provided by the Cynthia and George Mitchell Foundation and the University of Texas Bureau of Economic Geology.

The Sandbrock Ranch Native Grassland Restoration and Demonstration Project

John R. Bow, Forrest S. Smith, Anthony D. Falk, and Keith A. Pawelek

Texas Native Seeds (TNS) personnel have begun a collaborative project with the Sandbrock Ranch near Aubrey, Texas. This project will be used to demonstrate and encourage grassland restoration in north-central Texas. The primary objective of this project is to restore 100 acres of native prairie per year for the next 3 years, while also evaluating available native seed varieties for use in this region. Additionally, we are working to establish demonstration and evaluation plots of native plants at the ranch as part of our *Central Texas Native Seed* Project. TNS personnel are collecting data on species performance and evaluating several native grassland seed mix strategies. Those results will be used to refine restoration recommendations for the north-central Texas region.

Expansion of our research into the Blackland Prairie ecoregion is providing a much-needed native seed source evaluation opportunity and provides an opportunity to identify the most suitable native seed sources for use in this area. Data on plant performance will be collected monthly and will be compared to that obtained at existing evaluation sites located in Knox City and in Stephenville. TNS and Sandbrock Ranch personnel hope to use these projects for education and outreach efforts to stimulate greater awareness of the importance of restoration and conservation in this area of rapid human population growth.

The first 100 acres of restoration planting was seeded in spring 2018. Findings of this research should enable more successful restoration by landowners, agencies, and the public in north-central Texas.

Cooperative funding provided by the Horizon Foundation and the Sandbrock Ranch.

Native Grassland Restoration: Diversity and Stability of Wildlife

Geron G. Gowdy, Brandon J. Palmer, Ellart J. Vreugdenhil, Javier O. Huerta, Fidel Hernández, Eric D. Grahmann, Timothy E. Fulbright, and Michael W. Hehman

Throughout the world non-native invasive species of plants and animals are degrading community diversity. One species that has a significant ecological effect in southwestern rangelands is buffelgrass, which was introduced from Africa. Since its introduction into the United States in the early 1900s, millions of acres have been planted or invaded by buffelgrass.

Buffelgrass is a prolific seed disperser that displaces native vegetation and creates dense monocultures. These monocultures have been shown to reduce diversity of birds, small mammals, and butterflies. Diversity is important for ecosystem function given that biodiversity generally correlates with community stability, and stability influences an ecosystem's ability to respond to environmental changes. Native plant community restoration may mitigate the challenges that non-native grasses have created.

Our objective is to document changes in the diversity and stability of bird, small mammal, and butterfly communities in an area originally dominated by buffelgrass that is being restored to a native plant community. We will conduct surveys for breeding birds (June), wintering birds (December), small mammals (March), and butterflies (October) on 3 study sites (restoration site, a non-native grassland site, and a native thornscrub site) and compare how diversity and stability changes through time. This study will provide important information regarding how wildlife communities change and stabilize in response to the establishment of a native plant community.

Cooperative funding provided by the Hixon Ranch and Texas Parks and Wildlife Department.

Developing Ecotypic Native Seed Supplies for the Coastal Prairie Region of Texas

Keith A. Pawelek, Forrest S. Smith, Anthony D. Falk, Gary Stephens, Aaron Tjelmeland, Jim Willis, and Sonia Najera

Locally adapted native seed supplies for restoration in the Coastal Prairie region of Texas are increasingly desired by agencies, municipalities, and private landowners. The interest in using native prairies to lessen



© Anthony Falk

Evaluations of little bluestem and knotroot bristlegrass are being conducted in the Coastal Prairie region of Texas.

flooding concerns in the wake of Hurricane Harvey has also been high in the last year. The *Coastal Prairies Native Seed Project* was initiated in spring 2018 to help meet native seed supply needs and enable successful restoration of prairies. It is modeled after the successful *South Texas Natives Project* and will focus on developing and promoting the use of locally adapted native seed.

Thanks to partnerships with the Wildlife Habitat Federation and The Nature Conservancy-Texas City Prairie Preserve, we were able to establish initial evaluation plots near Cat Springs and Texas City in the spring of 2018. The development of these research areas, and access to previously collected plant material from the region, has allowed evaluations to begin on little bluestem and knotroot bristlegrass. Both grasses are common throughout the region and could be widely used in restoration plantings.

A full-time assistant director for the region has been hired to coordinate the project. In addition to ongoing evaluations, making new seed collections of regionally important native plant species and engaging regional constituents that need locally adapted native seeds will be priorities for the project.

Cooperative funding provided by the Texas Department of Transportation, USDA Natural Resources Conservation Service, Steve Lindley, Don and Cynthia Stevenson, Rotary Club of Corpus Christi (Harvey Weil Sportsman Conservationist Award Trust), Wildlife Habitat Federation, and The Nature Conservancy-Texas City Prairie Preserve.

Developing a Survey Methodology for Wild Turkeys in Northeast Texas

Darrion M. Crowley, William P. Kuvlesky, Jr., Humberto L. Perotto-Baldivieso, J. Alfonso Ortega-Santos, Leonard A. Brennan, and Nicholas R. Kolbe

Rio Grande and Eastern wild turkeys are popular gamebirds in Texas, but their populations are declining. There is very little research on survey methodologies for wild turkeys.

Identifying the optimal survey methodology to determine accurate population densities is a key factor needed for proper management of wild turkeys. Therefore, this project will compare and contrast the dependability of popular survey methods for wild turkeys. The objectives of this project are to (1) identify common and useful surveys for wild turkeys, (2) compare survey methods, and (3) propose a method or set of methods that can reliably estimate abundance.

Eastern wild turkeys are being surveyed at Camp Maxey Training Center near Paris, Texas while Rio Grande wild turkeys are being surveyed at Fort Wolters Training Center near Mineral Wells, Texas. The survey methods being tested are road surveys, point count surveys, and roost count surveys. To accomplish this, study sites will be visited multiple times a year in which the survey methods being tested will be conducted. The number of turkeys observed during each of the surveys will be recorded; statistical analysis will be performed to determine if there are any differences among the survey estimates. Data collection will take place in 2018 and 2019 between the months of January and March. This project will help us to identify the best survey methods for population abundance estimates of wild turkeys in North Texas.

Cooperative funding provided by the Texas Military Department.

Spring Migration Stopover Decisions by Greater White-fronted Geese

Jay A. VonBank, Bart M. Ballard, Mitch D. Weegman, and Kevin J. Kraai

Spring migration is a critical period for Arctic-nesting geese as their performance during migration influences their subsequent survival and reproductive success. Thus, availability and quality of habitat on

spring staging areas are important. In recent years, white-fronted geese have shifted their migration routes, as well as migration timing, which complicates their management during this period. Understanding locations of staging areas and how successful individuals use these areas can aid in developing better management strategies.

We captured 72 adult greater white-fronted geese along the lower Texas coast, Rolling Plains, and South Texas Brushlands regions during winters 2015–2017. We attached tracking devices equipped with accelerometers to track movements and behaviors throughout migration and breeding.

Our marked geese used several important stop-over areas during spring migration, including the Missouri River area of northwestern Iowa, north of the Kindersley area in western Saskatchewan, and west of Red Deer, Alberta. White-fronted geese used breeding areas in the interior and North Slope of Alaska and in the Northwest Territories and Nunavut, Canada. Timing of arrival to breeding areas varied greatly among individuals, ranging from April 20th to June 2nd. We will investigate the relationship between landscape use (habitats, landscape variables, etc.) by migrating geese and their subsequent reproductive success. Information obtained in this study can help conservation planners manage the habitat on staging areas that will benefit white-fronted geese.

Cooperative funding provided by the Texas Parks and Wildlife Department.

Forecasting Sandhill Crane Habitat Suitability Along the Texas Coast

Emily D. Wells, Bart M. Ballard, Shaun L. Oldenburger, Daniel P. Collins, and Humberto L. Perotto-Baldivieso

Sandhill cranes wintering along the Texas coast depend heavily on grasslands, agricultural land, and wetlands to meet their daily and seasonal needs. As human development within the Texas coast continues to expand rapidly, it becomes more important to incorporate predictions of future habitat suitability into conservation and management strategies.

To help address the concern over future sandhill crane habitat availability along the Texas coast, we predicted land change to the year 2050 using a spatially explicit land change modeling program. Rates of change are being modeled using known rates of

change between 2006 and 2010, and 2010 and 2016. We also are integrating several variables into our modeling framework known to be related to landscape change, particularly in coastal areas. We are using this modeling process to estimate future suitability and distributions of habitats to predict potential impacts on wintering sandhill cranes.

Our results will identify areas along the Texas coast most likely to change in suitability and allow us to predict associated changes in sandhill crane distribution. This information can aid natural resource managers in creating conservation strategies targeted at areas where land change will have the most impact on cranes wintering along the Texas coast.

Cooperative funding provided by the Texas Parks and Wildlife Department and U.S. Fish and Wildlife Service.

Spatial Analysis of Wild Turkey Habitat in South Texas

Alison R. Menefee, Humberto L. Perotto-Baldivieso, William P. Kuvlesky, Jr., J. Alfonso Ortega-Santos, Leonard A. Brennan, Michael T. Page, Jaclyn D. Robles, and Darrion M. Crowley

Radio telemetry is a common tool used to locate and track wild turkeys. However, little is known about the error resulting from telemetry triangulations. To counteract these errors, error ellipses are used, which assume that the animal is somewhere within that ellipsoid and is using landscape resources only within that ellipsoid. Error ellipsoids can provide a unique opportunity to explore landscape-level features used by a particular species.

Wild turkeys use landscape structures and resources, such as ground cover and distance from water, differently depending on the season. Error ellipsoids derived from telemetry data combined with features that describe landscape structure could aid in understanding how wild turkeys use breeding and wintering habitat.

Our goal is to identify trends in landscape structure that can be used to provide habitat recommendations for wild turkeys. Our objectives are to (1) quantify landscape structure within error ellipses during breeding and wintering seasons and (2) develop models that quantify suitable areas for wild turkeys in South Texas.

We will use error ellipsoids derived from telemetry triangulation data collected during 2004 and 2005 to obtain estimated wild turkey locations. We will then download and classify National Agriculture Imagery

Program imagery to assess landscape structure. Classified imagery combined with error ellipsoids and statistical analyses will be used to determine specific landscape structures and resources wild turkeys are using most frequently. Our results will provide insight for wildlife managers to ensure habitat is available, which may increase wild turkey populations.

Cooperative funding provided by the Las Huellas Association of South Texas, Hoffman HC 30 Ranch, El Veleno Ranch, and the Bass ranches.

Modeling Foraging Habitat for Shorebirds in the Laguna Madre

Mikayla M. House, Bart M. Ballard, Selma N. Glasscock, Humberto L. Perotto-Baldivieso, and Mitch D. Weegman

Landscape development activities along the Texas coast have been increasing over the years. Thus, understanding how wildlife use habitats along the coast is critically important for successful management and conservation.

The Laguna Madre is a large lagoon located along the lower Texas coast that supports large numbers of shorebirds during migration. It is likely the most important stopover site for these migrants in the Western Hemisphere. Wind farms, bridge construction, and dredging operations are among the types of development potentially impacting habitats used by migratory shorebirds. We plan to identify characteristics of foraging habitat for migratory shorebirds and develop a spatial model that predicts habitat availability throughout the Laguna Madre.



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Graduate student Mikayla House measuring water levels to delineate shorebird foraging habitat in the Laguna Madre.

We will use geospatial datasets that provide information on landscape features (aquatic bottom type, water depth, etc.) to help in model development. We will sample habitat characteristics at sites used by foraging shorebirds. Tidal fluctuations within the Laguna Madre are primarily wind driven, so we will use information on wind direction, wind speed, and wind duration. In addition, we will measure water depths at random locations and during varying weather conditions to initially train the model and provide an independent dataset to later assess performance of the model. Our final spatial dataset can be used by natural resource managers to (1) identify important shorebird foraging areas within the Laguna Madre, (2) prioritize areas based on size and availability, and (3) be better informed about the potential impacts of human development on shorebird foraging habitat in and around the Laguna Madre.

Cooperative funding provided by the Coastal Bend Audubon Society.

Autumn Migration Characteristics of Mid-Continent Greater White-fronted Geese

Jay A. VonBank, Bart M. Ballard, Kevin J. Kraai, and Daniel P. Collins

The greater white-fronted goose breeds in a wide range of tundra and boreal forest habitats across northern Canada and Alaska and migrates during autumn to the southern United States and Mexico. There is limited information on migration chronology and factors influencing the speed and duration of migration.



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Graduate student Jay VonBank releasing a greater white-fronted goose equipped with a tracking device.

Our objectives are to determine migration chronology, migration routes, important stopover areas, stopover duration, and the effects of environmental conditions on autumn migration characteristics. We deployed solar powered, automated (transmit through the cell phone network) tracking devices on adult greater white-fronted geese during winters 2015–2017 in the Rolling Plains ecoregion, South Texas Brushlands ecoregion, and the Texas coast. This will allow us to monitor their movements during autumn when they are returning to the wintering areas.

We have collected autumn migration data for 12 white-fronted geese for 2016 and 2017. Preliminary results suggest that individuals nesting in boreal forest regions begin autumn migration before those nesting in tundra regions. This has potential implications on exposure to hunting and probability of being in the fall survey area when surveys are being conducted.

We will continue to investigate relationships between movements and several potential explanatory variables (habitat, weather, disturbance, etc.) at autumn staging areas. Information obtained in this study will help us understand the factors driving movements by white-fronted geese during autumn migration.

Cooperative funding provided by the Texas Parks and Wildlife Department.

Use of Constructed Roosts by Wild Turkeys in South Texas

Alison R. Menefee, Humberto L. Perotto-Baldivieso, William P. Kuvlesky, Jr., J. Alfonso Ortega-Santos, Leonard A. Brennan, Brandon S. Mitchell, and Darrion M. Crowley

Constructed roost structures are an important aspect of restoring wild turkey populations. There is concern about the lack of suitable roosting cover, which may be a limiting factor in wild turkey populations. It is believed that constructed roosts may be the reason for the wild turkey’s quick expansion into West Texas. Constructed roosts are critical to fulfilling the roost habitat requirement of wild turkeys in areas with limited roosting structures.

In South Texas’ arid and semiarid regions, lack of rainfall, high temperatures, and infertile soils have resulted in a lack of tree roosting structures. Limited roosting structures can impact turkey populations and their interactions with the landscape. Spatial analysis allows us to identify resources wild turkeys are using on the landscape.

The objectives of this project are to (1) assess the spatial structure of constructed roosts in South Texas and (2) analyze landscape features to identify resources wild turkeys are using. Our goal, upon completion of this research, is to provide recommendations for roost locations based on landscape structure and the surrounding resources.

This study will evaluate vegetation composition and landscape structure at 29 constructed roosts in South Texas. We will measure canopy cover, visual obstruction, and identify plant species around the roosts. We will also analyze satellite imagery to quantify landscape structure in areas where wild turkey roosts are in place. We will use this information to compare data between used versus unused constructed roost sites. This will allow us to identify roost site characteristics preferred by wild turkeys, which can then be used to guide future constructed roost placement.

Cooperative funding provided by the Las Huellas Association of South Texas, Hoffman HC 30 Ranch, El Veleno Ranch, and the Bass ranches.

Autumn Migration Ecology of Sandhill Cranes

Emily D. Wells, Bart M. Ballard, Shaun L. Oldenburger, Daniel P. Collins, David A. Brandt, Aaron T. Pearse, and David W. Wolfson

Sandhill cranes wintering along the Texas coast belong to the Gulf Coast subpopulation of the mid-continent population. This subpopulation breeds throughout Alaska, Canada, and into Minnesota. Little research has been conducted to investigate the ecology of this subpopulation, particularly during autumn migration. We are investigating several aspects of autumn migration including chronology, use of stopover areas, and exposure to hunting.

We deployed 40 tracking-by-satellite devices on adult sandhill cranes wintering along the Texas coast during 2015–2016 and 2016–2017. Average initiation of autumn migration from breeding areas was September 3rd. Stopover areas with the most use during autumn migration were in southern Manitoba, northwestern Minnesota, northern Oklahoma, and northern Texas. We found most exposure to hunting occurred in southern Saskatchewan and Manitoba, where cranes staged for long periods after leaving breeding areas and prior to large movements southward. Average date of arrival on wintering areas was November 14th.



© Emily Wells

Graduate student Emily Wells getting ready to release a sandhill crane after attaching a tracking device.

We also plan to explore landscape composition (habitat availability) within stopover areas to better understand habitat requirements during migration. Our findings can be used to shape hunting regulations and identify regions of conservation interest along the migratory corridor where maintaining quality roosting and foraging habitat should be a priority.

Cooperative funding provided by the Texas Parks and Wildlife Department, U.S. Fish and Wildlife Service, and U.S. Geological Survey.

Developing Wild Turkey Wintering Habitat Suitability Models in Northeast Texas

Darrion M. Crowley, William P. Kuvlesky, Jr., Humberto L. Perotto-Baldovieso, J. Alfonso Ortega-Santos, Leonard A. Brennan, Nicholas R. Kolbe, and Michael T. Page

Developing habitat suitability models can be useful for estimating population abundance of Rio Grande and Eastern wild turkeys as well as highlighting optimal habitat for their wintering sites. Integrating survey methods with these habitat suitability models may increase reliability of population estimates.

Our objectives are to (1) develop habitat suitability models that will enable Texas Military Department staff to determine optimal habitats for wild turkeys and (2) integrate survey methods with the habitat suitability models. Our study sites are located at Fort Wolters Training Center in Mineral Wells, Texas and Camp Maxey Training Center in Paris, Texas.



© Humberto Perotto-Baldivieso

Habitat suitability models are being developed to identify essential wintering habitat for wild turkeys.

To develop these models, we focused on 3 main factors: food, water, and cover. We reviewed the existing literature on wild turkeys. Based on this information, we decided on optimal components for each of the factors pertaining to wild turkey wintering habitat. We then classified high resolution satellite imagery and quantified landscape structure using class level metrics. We will use these metrics and abiotic factors (soils, elevation) to develop suitability indices models for both subspecies of turkeys.

The models developed in this study can be used to assess areas with a higher probability of observing wild turkeys to optimize population abundance estimates. This will also help reduce time and money allotted for survey efforts.

Cooperative funding provided by the Texas Military Department.

Winter Movements and Habitat Selection by Greater White-fronted Geese

Jay A. VonBank, Bart M. Ballard, Kevin J. Kraai, Daniel P. Collins, and Humberto L. Perotto-Baldivieso

Historically, the state of Texas wintered a large portion of the midcontinent population of greater white-fronted geese. Recently, however, the distribution of the greater white-fronted goose has shifted northeasterly with a larger proportion of the population now wintering in Arkansas and the Mississippi Alluvial Valley. Large changes in the distribution

of white-fronted geese have occurred within Texas. Changes in climate, land use, and resource availability are likely drivers of the shift in distribution.

Our research aims to further understand winter habitat use and movement ecology of greater white-fronted geese. We captured and attached tracking devices to 72 adult white-fronted geese during winters 2015–2017. These devices have collected more than 300,000 GPS locations on monitored geese throughout the annual cycle.

Preliminary habitat selection analysis revealed that white-fronted geese relied strongly on agricultural crops throughout winter. They selected peanut, rice, corn, and sorghum fields and vegetated wetland habitats and they avoided developed areas, grassland/pasture, soybeans, and cotton fields. We also found white-fronted geese made movements during winter throughout the states of Texas, Louisiana, Arkansas, Mississippi, and Nuevo Leon, Tamaulipas, Durango, and Jalisco, Mexico.

An understanding of the use and selection of habitats by white-fronted geese during winter will help identify the causes of the distributional shift. This information can be used by natural resource managers to ensure that adequate habitat is available for wintering populations.

Cooperative funding provided by the Texas Parks and Wildlife Department.

The Impacts of Red Imported Fire Ants on Gamebirds

Kelly M. Redmond, Nicole A. Hansen, William L. Lutz, Jr., Andrew P. Nicholson, Taylor R. Shirley, Eric D. Grahmann, Fidel Hernández, Leonard A. Brennan, Timothy Anderson, Michael E. Morrow, Kirk Feuerbacher, and Jay Kelso

Population declines of northern bobwhites and Attwater's prairie-chickens within the Texas Gulf Prairie region can be attributed to habitat loss and possibly invasion by the red imported fire ant. Our objectives are to (1) determine the impact of fire ant density on nest success, adult survival, and brood survival for bobwhites and Attwater's prairie-chickens and (2) determine the effectiveness of using an aerially applied insecticide to reduce fire ant densities and assess how insecticide treatment affects individual and population performance of these gamebirds.

Our study is located on 3 ranches in Goliad and Refugio counties, Texas. Each ranch contains 2 paired

experimental units that consist of a treatment and control site (1,235 acres each).

The treatment unit received an aerial application of fire ant bait (Extinguish Plus) during April 2018, while the other unit remained untreated (control site). Pasture-wide estimates of fire ant abundance and mound density will be determined using baited cup traps and counting fire ant mounds using the distance sampling method. Bobwhite densities will be estimated using distance sampling via helicopter surveys. Adult bobwhite and prairie-chicken survival, brood survival, and nest success will be monitored using radio-telemetry methods. We will also calculate fire ant mound density at each nest site and at the locations of the radio-marked birds.

Preliminary analyses of pre-treatment data indicate that fire ants had no effect on the 2017 demographic performance of individual bobwhites or population density of bobwhites. However, these findings may be affected by the unusual weather that occurred during 2017, which included a direct hit by Hurricane Harvey. We are planning to measure post-treatment effects and further analyze the data.

Cooperative funding provided by the Coastal Bend Bays and Estuaries Program, U.S. Fish and Wildlife Service, Steve and Jon Lindley, D Bar J Ranch, Dunn O'Connor River Ranch, and JF Welder Heirs' Vidaurri Ranch.

Survey Techniques to Count Reptiles with Emphasis on Drone Technology

Victoria M. Cavazos, Javier O. Huerta, Scott E. Henke, Humberto L. Perotto-Baldivieso, and Ellart J. Vreugdenhil

Determining species presence and abundance is critical to the ecology and conservation of reptiles. Too often reptiles are excluded from wildlife surveys and inventories because of their camouflage, cryptic behavior, or nocturnal activity.

Various techniques have been developed to capture reptiles to determine their presence. Active capture methods include road cruising, systematic searches, lizard noosing, cover boards, and stunning with rubber bands or cold-water squirt guns. Passive capture methods include pitfall traps, funnel traps with drift fences, remote camera-based photos, and sticky traps.

Aerial surveys using drone technology might be a method to investigate the presence and abundance of reptiles. However, this technology has yet to be evaluated for such a method. Drones have the advantage of being able to take photographs and video, which can be reviewed multiple times, rather than an instantaneous glimpse of a reptile as it runs into cover during a road cruising survey or systematic search survey.

We will compare the 'tried-and-true' methods of road cruising, funnel traps, cover boards, remote camera-based photos, and systematic searches to evaluate the presence of reptile species and their abundances, and compare our data to aerial photos taken by drones. Drones will be flown at 30-foot intervals in altitude and in various habitat cover types to determine the point where reptiles are no longer visible in photographs. If successful, our method can be used to assist future herpetologists who wish to count reptiles.

Patterns in Autumn and Winter Surveys of Large Mammals in South Texas

Aaron M. Foley, David G. Hewitt, Randy W. DeYoung, and Tyler A. Campbell

Population parameters of large mammals in South Texas are often monitored using helicopter surveys. Some ranches conduct surveys during autumn because of the need to establish harvest quotas prior to the hunting season. Other ranches conduct surveys during winter because of the increased visibility after leaf-fall.

Little is known about the potential differences in observation patterns as it relates to surveys conducted prior to and after leaf-fall. For instance, preliminary results indicate that fawn to doe ratios when the 9th group of females is observed during an autumn survey are a good indicator of ranch-wide fawn to doe ratios. Is this pattern similar during winter surveys when fawns are larger and potentially more likely to be misclassified as does? Further, male to female ratios of white-tailed deer may be more variable during autumn surveys than winter surveys because of the foliage obscuring antlers.

We will compare and contrast long-term trends in helicopter surveys from the King Ranch (September surveys) and the East Foundation (February surveys). Specifically, we will examine seasonal variation in running totals of observation rates and sex ratios within a survey. We will focus on native wildlife such as white-tailed deer and collared peccaries and non-native species such as nilgai and feral pigs.

Information obtained in this study will aid in our understanding of the potential causes of variation in surveys during pre- and post- leaf-fall. Our findings will have application for many landowners that use helicopters to conduct large mammal surveys on South Texas rangelands.

Cooperative funding provided by the East Foundation.

Competition for Space between Harvester Ants and Red Imported Fire Ants

Javier O. Huerta, Victoria M. Cavazos, and Scott E. Henke

Red imported fire ants were introduced into the United States near Mobile, Alabama approximately 75 years ago. Since that time, fire ants have expanded their range to encompass nearly the entire southeastern portion of the United States.

It is believed that red imported fire ants are successful invaders because they (1) prefer heavily disturbed habitats associated with human activity, (2) tolerate a large variety of climates, (3) use a wide array of food resources, (4) can sustain populations of high densities, (5) have workers that vary in size enabling broader feeding strategies, (6) have aggressive foraging behavior, (7) have a high reproductive capacity, (8) have mated queens that can quickly establish new colonies, and (9) lack predators and competitors in their introduced range.

Red imported fire ants reportedly alter insect communities by direct and indirect competition; however, past studies have varied greatly in their findings. Some studies concluded that fire ants had little to no effect on insect abundance and diversity, while other studies claimed that fire ants substantially changed the insect community. However, most studies that suggest minor effects by fire ants examined monogyne or single-queen colonies. Today, most fire ant colonies are polygyne, of which nest densities often are 10 times greater than monogyne nest densities. Therefore, ecological impacts of polygynous red imported fire ants are expected to be greater.

Our objective is to determine if fire ants compete for space with harvester ants—the main prey item of Texas horned lizards. Such research will aid in our knowledge of the life history of the threatened Texas horned lizard.

Cooperative funding provided by the Hixon Family.

Vertebrate Response to Experimental Burn Treatments in South Texas

Jeremy A. Baumgardt, Leonard A. Brennan, Sandra Rideout-Hanzak, David B. Wester, and Michael L. Morrison

We are developing a long-term monitoring program for the plants and animals across the East Foundation ranches, as well as monitoring the response of birds and mammals to a burn experiment being conducted on the Foundation’s El Sauz Ranch. After completing our 4th field season, we have analyzed data and provided the East Foundation with a comprehensive report of our findings, which also included monitoring recommendations for small mammals, birds, and bats. We have 2 manuscripts based on these efforts submitted for publication and will have at least 2 more submitted in the following months.

In spring 2018, we trapped small mammals at 12 sites associated with the experimental burn treatments on El Sauz and conducted point counts along 15 transects. Each transect consisted of 10-point count locations where we conducted 10-minute counts, repeating this effort 4 times throughout the breeding season. We also conducted surveys for locating breeding territories of birds in the burn treatment plots and monitored these for signs of reproduction. With this effort, we have monitored over 190 birds that appear to have established breeding territories and have confirmed successful fledging of young for 13 of these.

The data we are collecting will be analyzed to detect impacts of burn treatments on populations of small mammals and breeding birds on the East Foundation ranches. We are continuing to analyze data collected in previous years to complete monitoring recommendations for reptiles, amphibians, and vegetation for the East Foundation.

Cooperative funding provided by the East Foundation and the Richard M. Kleberg, Jr. Center for Quail Research.

The Human Dimensions of Conservation Photographers in Wildlife Management

William C. Colson, April A. Torres Conkey, Scott E. Henke, Richard L. Miller, Glenn Perrigo, and La Vonne Fedynich

Conservation photography has developed over the past 150 years from a simple medium to allow people to see the wonders of the natural world using magazines, postcards, or books to a digital medium of thought-provoking images of endangered or threatened species and vanishing habitats. In recent times, various state, local, and private organizations have attempted to “advertise” notable regional species in a bid to educate the public about conservation and the importance of biodiversity using outdoor or conservation photography contests.

This study strived to understand why photographers and landowners participate in contests using a 102-question online survey. Additionally, a written survey was administered to a photography organization. Basic demographics, participation in photography contests, conservation habits, and viewpoints



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Photograph of a northern cardinal taken during a photography workshop given by Dr. Brian Loflin.

about the environment were obtained from survey participants. Most participants self-identified as white with less than 25% claiming Latino ancestry. Additionally, the most notable question of this study attempted to identify changes in 8 outdoor activities. These included hunting, fishing, beach or roadside cleanups, overall desire to be outdoors, birding, hiking, recycling, and habitat restoration projects.

Participants seemed less likely to spend more time outdoors doing things that improve the environment, such as habitat restoration or beach and roadside cleanups. But, as participants reported spending more time outdoors, their participation level increased more than 50% in 3 of the 8 activities: birding, an increased desire to spend more time outdoors, and hiking.

Generalist Versus Specialist: A Dilemma for Texas Horned Lizards

Javier O. Huerta, Victoria M. Cavazos, and Scott E. Henke

Animal species live on a dietary scale with generalists and specialists at each end of the spectrum. A dietary generalist can survive on a variety of foods while a specialist is very limited. Ecological theory states that generalists respond much better to environmental changes because they can switch diets if one food item becomes unavailable; whereas, a specialist must relocate if diet items become too sparse. Generalists usually survive better because they are capable of dealing with unanticipated events.

We hypothesize that Texas horned lizards are dietary generalists in their first year of life but evolve into specialists as they become adults. Hatchlings and juveniles appear to consume a variety of prey (ants, beetles, termites), while adults restrict their diet to ants, typically harvester ants of the genera *Pogonomyrmex*.

Based on anecdotal information, once red imported fire ants become established, they out-compete many insect species, including harvester ants. If true, then the Texas horned lizard provides an exception to ecological theory, but does create a problem for the viability of the Texas horned lizard population. In the presence of fire ants, juvenile generalists may be at risk resulting from a lack of food. This would reduce recruitment of the horned lizard population and lower their abundance over time.

Our objectives will be to determine the diets of juvenile and adult Texas horned lizards, and to determine if red imported fire ants alter horned lizard diets through competition with the insect community



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CKWRI scientists are examining how the diet of Texas horned lizards ultimately impacts their survival.

in southern Texas. Findings from our study can be used to enhance management strategies for this iconic Texas reptile.

Cooperative funding provided by the Hixon Family.

Flattened Fauna: Roadkill Patterns in Kleberg County, Texas

Delanie Slifka, Zayda Flores, and April A. Torres Conkey

Roads can have negative impacts on wildlife, such as habitat fragmentation and animal death due to collision with vehicles (roadkill). In addition, there are negative impacts on humans, such as vehicle damage and even injury and death resulting from a collision with a wild animal.

We initiated a roadkill observation survey as part of an Honors Senior Project (Slifka) that will continue as a McNair Scholar project (Flores). The survey was conducted twice a week for the month of March 2018 along 20 miles of FM 772 in Kleberg County to determine trends in roadkill patterns. In addition, animal roadkill data from the City of Kingsville/Kleberg County Animal Control for January–March for the years 2016–2018 were obtained. Weather data were collected from online records from the Naval Air Station-Kingsville weather station.

Nine types of animals were documented in the rural road survey (goat, opossum, bird, feral pig, skunk, deer, dog, cat, and fish), and 16 species were documented in Animal Control records with cats, dogs, and

opossums being the most common. Although January and February consistently had more roadkills than March for the 3 years, there was no statistical difference between the number of carcasses and the month. Other studies have reported trends in increased roadkill numbers and temperature (particularly in winter). Documentation of animal carcasses in Animal Control data did increase once ambient temperatures reached 50°F or higher. Identifying and understanding trends in roadkill patterns can help us identify locations where mitigation measures can be implemented to reduce animal-vehicle collisions.

Wildlife Use of Fence Crossings in South Texas Rangelands

Lisa D. Zoromski, Randy W. DeYoung, John A. Goolsby, Aaron M. Foley, J. Alfonso Ortega-Santos, David G. Hewitt, and Tyler A. Campbell

Fences are known to affect wildlife movements, especially long-distance migrations. However, less is known about how livestock fencing impacts non-migratory species. Wildlife often cross fences at defined locations, and often prefer to go underneath rather than over fences. We define fence crossings as areas where the bottom fence wires are pushed up or missing, often with a depression of bare soil beneath.

Fence type, height, and crossing size influence the ease and method by which different species will cross. Large animals, such as feral pigs and nilgai, create fence crossings; deer and javelinas are known to cross at these sites as well. However, there is little



© Lisa Zoromski

Large animals, such as this nilgai, seem to prefer going under a fence than jumping over it.

information on the frequency of animal crossings or what additional species use these sites.

We are assessing the seasonal frequency of species using fence crossings in relation to time, placement, and fence height. We are using cameras to monitor 20 fence crossings at 2 ranches with different crossing densities: 1 crossing per 700 yards with 14 total crossings and 1 crossing per 75 yards with 29 crossings. We are also monitoring how animals respond when an existing crossing site is patched or obstructed.

This information will help us understand movement rates between ranches and identify characteristics of highly used fence crossings. Our findings could lead to insight regarding how fence crossings are created and their importance to wildlife movements. To our knowledge, this is the first intensive study to quantify fence-crossing use by wildlife in South Texas. Information obtained will provide new insights regarding the ecology and management of multiple wildlife species.

Cooperative funding provided by the Las Huellas Association of South Texas.

Comparison of Intestinal Tracts Among Rodents Occupying Similar Niches

Sarah D. Garza, Ashton V. Crocker, Scott E. Henke, and Richard C. Laughlin

The microbes that live within animal intestines participate in important functions such as digestion, pathogen exclusion, and the generation of vitamins and amino acid precursors. Current work has provided numerous insights, but often relies on comparisons within a single animal species, or between numerous distantly related animal species.

While intestinal microbe populations are generally conserved between animals of the same species, the population is variable and sensitive to the animal's diet, geographic location, and immune system. Along with their microbial populations, an animal's morphometrics, such as body length and weight, intestinal length, or caecum size, provide insight to the specialized diet of the species and a suggestive link to the expected microbiota population.

We will assess intestinal morphology and microbial populations of 4 rodent species (cotton rats, hispid pocket mice, grasshopper mice, and deer mice) found in similar ecological niches within southern Texas. We hypothesize that the microbe populations will be

unique for each rodent species given their unique natural histories and diet preferences, despite occupying similar ecological niches. We will use sub-regions of rRNA to quantify morphometric differences and microbiologic populations.

The intestinal microbiota are expected to vary significantly as diet has a strong influence on microbiota populations and diversity. This study will allow us to gain insight regarding niche separation of rodent species and provide a better understanding of our ecological environment.

Cooperative funding provided by a Texas A&M University-Kingsville Research Award.

Texas Tortoise Movements and Habitat Use in South Texas

Victoria M. Cavazos, Javier O. Huerta, Scott E. Henke, Ellart J. Vreugdenhil, Geron G. Gowdy, and Brandon J. Palmer

The Texas tortoise is 1 of 6 species of tortoise that is native to North America and is classified as a threatened species in Texas. Their geographic range is from southern Texas to northern Mexico. Texas tortoises appear to prefer dry scrub and grassland habitats that contain succulent plants such as the fruit of prickly pear cactus. Little is known about the life history of Texas tortoises. For instance, they are presumed to live about 60 years, but do not begin breeding until about 15 years old. It is believed that the Texas tortoise has a low reproductive output and use the burrows of other species.



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CKWRI researchers are studying the ecology of the Texas tortoise—a threatened species in Texas.

Because of the lack of information about Texas tortoises, we plan to monitor their populations at multiple sites in southern Texas. Specifically, we will estimate population size and survivability, as well as determine age distribution, sex ratios, diet composition, and habitat use. Information obtained from this study can be used to aid in the management of this little-studied, threatened species.

Pronghorn Land Cover Selection Versus Availability in the Texas Panhandle

Anthony P. Opatz, Gary Mizer, Timothy E. Fulbright, Randy W. DeYoung, Humberto L. Perotto-Baldivieso, Warren C. Conway, and Shawn S. Gray

The North American prairie ecosystem is rapidly being replaced by urban expansion and agricultural activities. Native shortgrass and mixed-grass prairie provide habitat for pronghorns. The effects of expanding agriculture development on pronghorns in the Texas Panhandle are unclear.

In February 2017, we attached satellite-linked GPS collars to 64 pronghorns in study areas near Dalhart and Pampa, Texas, with 32 collars evenly distributed between sexes. We paired a pronghorn-used location with a random location for comparison of habitat usage. We used the Texas Ecological Mapping System (TEMS) land cover map to determine the land cover class for each pronghorn-used and random location.

Pronghorns in the Dalhart study area selected mixed grass prairies and improved Conservation Reserve Program grasslands over other land cover classes such as agricultural fields (30%) and sand prairies (25%) that were proportionally more available. Pronghorns in the Pampa study area selected agricultural fields and sandy shrubland land cover types while mixed grass prairie (33%) and shortgrass prairie (18%) were proportionally more available. Selection for land cover classes varied among seasons and between sexes. Females, for example, selected areas with more cover than males during the fawning season.

We are continuing our monitoring and remote sensing efforts to identify agricultural crop type and land coverage. Identification of seasonal land cover usage in relation to agricultural area usage can help wildlife managers protect key areas needed by pronghorns for forage and cover.

Cooperative funding provided by the Texas Parks and Wildlife Department.

Evaluating Welder Wildlife Foundation's Rangeland Curriculum

Angelica F. Arredondo, April A. Torres Conkey, Selma N. Glasscock, and La Vonne Fedynich

The Millennial generation is perceived to be less in touch with the outdoors. Thus, it is essential to provide educational resources to address this disconnect in the classroom. *Rangelands, A Conservation Education Guide* is a curriculum created by the Rob and Bessie Welder Wildlife Foundation to teach basic natural resource concepts about Texas rangelands for grades K-6. Our objective is to evaluate the use and effectiveness of this curriculum as reported by teachers.

Curriculum training workshops have been presented to approximately 1,350 teachers from 2012 to 2016. Pre- and post-tests were administered at workshops to 898 participants to test their knowledge of the material. In 2017, post-workshop online surveys were emailed to over 800 teachers, but only 163 of those emails were opened (29% response rate) and only 59 surveys were completed.

Analysis of the pre-tests and post-tests showed that teachers significantly improved their knowledge of basic rangeland concepts that were taught in the training workshops. As reported by teachers in the online survey, teachers in rural or suburban communities (42%) used the rangeland curriculum most frequently. Of these, 67% implemented the curriculum in their classroom and 27% used the curriculum at least once a semester or at least twice a year.

Additional analyses of the survey dataset are underway. Based on our findings, use of this curriculum can enhance the next generation's knowledge of the importance of rangelands and help build the desire to be good land stewards.

Cooperative funding provided by the Rob and Bessie Welder Wildlife Foundation.

Vertebrate Response to Grazing Treatments on the East Foundation

Jeremy A. Baumgardt, Leonard A. Brennan, and Michael L. Morrison

We are monitoring the response of birds and mammals to a grazing experiment on the 18,000-acre Coloraditas Grazing Research and Demonstration Area (CGRDA) for the East Foundation. In spring



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Breeding birds are surveyed on the East Foundation to learn more about their responses to livestock grazing.

2018, we trapped small mammals at 20 sites in the CGRDA and at 10 control sites. Additionally, we conducted point counts for breeding birds with 10 transects in the CGRDA and 15 transects on the San Antonio Viejo Ranch outside of the CGRDA. Each transect consisted of 12 points, and we resampled each transect 4 times through the breeding season.

In the previous 3 years, we collected similar data for the CGRDA project on small mammals and birds, as well as for reptiles, amphibians, and vegetation. These data will be analyzed to detect impacts of various grazing regimes on populations of vertebrates and vegetation on the East Foundation ranches.

Cooperative funding provided by the East Foundation and the Richard M. Kleberg, Jr. Center for Quail Research.

Efficacy of Baits Used to Trap Feral Pigs in Texas

Chancie Whitaker and Scott E. Henke

The feral pig is an opportunistic invasive species that has established populations in a wide range of habitats across the southern United States. In addition, the distribution of feral pigs appears to be expanding. Reasons cited for this expansion include high reproductive rates, changes in land use, development of agriculture and irrigation in arid environments, eradication of screwworm for livestock health, and increased illegal relocation of feral pigs into new regions for sport hunting.



© Randy DeYoung

The invasive feral pig is known to damage wildlife habitat, transmit disease agents, and consume supplemental feed.

Interest in feral pig research exists because of the habitat damage they cause and because they are a reservoir of domestic swine diseases. Research relies on trapping feral pigs to obtain blood samples for disease testing or to apply radio collars to gain knowledge about their movements and habitat use. However, many scientific papers focusing on feral pigs do not elaborate on specific trapping methods. In conducting previous studies on feral pigs, we discovered that trapping feral pigs was not easy. One should not expect to open a trap and presume feral pigs will enter.

Our objectives are to determine (1) the ability of various baits and odor attractants to aid in capturing feral pigs and (2) determine the relationship between weather and habitat variables and capture rates. This project’s findings will provide useful knowledge for future research that involves the trapping of feral pigs.

Cyber EcosySTEM: Coding, Trophic Levels, and Landscape Ecology

Kathrin Luce, April A. Torres Conkey, Mary E. Green, and Humberto L. Perotto-Baldivieso

A lesson for 2nd graders was created to teach concepts of trophic levels (food web), landscape interactions, and robot coding/programming. The lesson was tested in 2 school districts near Kingsville, Texas for 5 weeks in February and March 2018. The classes took a field trip to the Tio and Janell Kleberg Wildlife Research Park to learn about “focus” animals (rabbit, lizard, rattlesnake, butterfly, and hawk) in the lesson.

Students learned to code a Bee-bot® robot and practiced programming their robots on a photo mat. The mat was based on drone imagery of the Wildlife Park with a grid and compass overlaid on the photo to assist students in determining the robot steps and locations.

The students wrote scenarios where they described a day in the life of a focus animal (find food, water, shelter, and avoid predators), and concluded with a “challenge activity.” Each team picked a focus animal and received game cards with instructions such as “You are hungry. Find food (but stay away from predators).” They then programmed their robot to go from the start location on the mat to a food source while avoiding hazards (road) and predators.

We found that students improved their knowledge by an average of 10 points (on a 30-point scale), with 25 students (out of 36) earning a perfect score (100%) on the post-test. Student drawings of wildlife scientists included plants, wildlife, scientific equipment, and khaki uniforms, and the sex of the scientist often matched the sex of the student. Additional components of this study have yet to be analyzed; however, we hope this novel teaching approach will improve students’ understanding and retention of ecological and map reading concepts and introduce them to a variety of natural resource-related career options.

Cooperative funding provided by a Texas A&M University-Kingsville Research Award.

Effects of Habitat Restoration on Texas Horned Lizards and Their Prey

Javier O. Huerta, Victoria M. Cavazos, Scott E. Henke, Eric D. Grahmann, Fidel Hernández, Timothy E. Fulbright, Ellart J. Vreugdenhil, Geron G. Gowdy, and Brandon J. Palmer

The Texas horned lizard is a western iconic species. Texas horned lizards were once numerous and widely distributed across the south-central United States. Their numbers have drastically declined, and their distribution has become patchy. This is presumably because of (1) use of pesticides, (2) over-collection for the pet industry and by children and tourists, (3) loss of habitat from suburban sprawl and conversion of land to agricultural crops, and (4) the introduction of the invasive red imported fire ant that out-competes harvester ants (preferred food of Texas horned lizards).

Today, the Texas horned lizard is listed as a threatened species in Texas, a protected species in Oklahoma, Colorado, and Arizona, and is extirpated in Arkansas

and Louisiana. Recent attempts to translocate wild Texas horned lizards to areas of suitable habitat demonstrated that translocation is not a feasible option.

It has been speculated that habitat restoration practices that return non-native grasslands back to native grasslands could help Texas horned lizards. However, to our knowledge, this idea has yet to be tested. On smaller restoration projects conducted on the Hixon Ranch during 2008–2015, both harvester ants and horned lizards recolonized previously uninhabitable areas. Unfortunately, this observation is only anecdotal. Therefore, our objective is to determine the responses of Texas horned lizards and their prey at sites where native grassland is being restored. Knowledge obtained from this project can be used to aid in the management of this threatened species in Texas.

Cooperative funding provided by the Hixon Family.

Influence of Cattle Grazing on Economics, Environment, and Human Dimensions

Gerardo A. Bezanilla-Enriquez, J. Alfonso Ortega-Santos, Benjamin Turner, Carlos Ochoa, Mark Brunson, and David Dubois

Sound management practices to improve environmental health, profitability, and the welfare in rural areas of Mexico are needed. Our objectives will be to (1) identify social factors that influence the decisions of ranchers, (2) measure the response of a planned behavior-influencing strategy (focused on best grazing management practices) on soil features and underground water levels, and (3) estimate profitability changes with the use of best management practices and how such practices affect human behavior.

Data are periodically downloaded from weather stations and saved for analysis. Six 164-foot transects on each of 9 ranches were established and basal cover determined (vegetation, rocks, litter, and bare soil at the ground level). These transects are also being used to collect soil samples to be analyzed for carbon concentration at 2 depths (2.0 and 7.9 inches). In addition, 6 water level loggers have been installed into wells.

We sampled air quality on 2 ranches for 1 week: 1 in Mexico (near the U.S. border in Palomas, Chihuahua) and the other in the United States (near Van Horn, Texas). This will allow us to measure air dust pollution during the same high-wind events and try to relate the amount of dust transported from Chihuahua (Palomas) to Texas (Van Horn).

We have conducted 5 meetings to train ranchers on proper grazing management practices. We will also conduct surveys with landowners of the Chihuahuan Desert in Mexico to identify the main social influences of behavior towards ranching. Profitability of the 9 ranches in the study will also be examined. All variables will be related to the actual grazing activities of each ranch. A dynamic model will be created to integrate all variables and to identify the main leverage variables needed to improve the ranching systems.

Cooperative funding provided by Programa de Formacion de Profesores, Universidad de Chihuahua, and Border Environment Cooperation Commission.

Assessment of Pronghorn Diet Composition Using Metabarcoding Analysis

Gary Mizer, Anthony P. Opatz, Timothy E. Fulbright, Randy W. DeYoung, Humberto L. Perotto-Baldivieso, Warren C. Conway, and Shawn S. Gray

Pronghorns occur in 27 of the 56 counties in the Texas Panhandle Wildlife District. There is little information about how agricultural crops are incorporated into their diet. It is possible that pronghorns may make seasonal trade-offs when selecting between agricultural and rangeland environments. To learn more, we are adding a dietary component to the collaborative research project on pronghorn movements and resource selection using DNA metabarcoding of pronghorn fecal samples.

We have collected 102 fecal samples, 40 from native rangeland, 53 from croplands, 9 samples from



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Rangelands are being converted to irrigated croplands in areas used by pronghorns within the Texas Panhandle.

unknown origin, and at 6 different sampling periods. Fifty samples were from bucks, 37 from does, and 15 were unknown sex. Fresh fecal samples are collected from individuals after observed defecations, along with site characteristics and GPS locations.

Based on 34 samples sent to Northern Arizona University for analysis, 58 plant genera were detected. We will analyze the differences in diet and food habits between males and females to more clearly identify how pronghorns use food resources. These data will be useful to identify plant species or genera that appear most frequently in pronghorn fecal samples, which may help guide natural resource biologists in making regional pronghorn management decisions.

Cooperative funding provided by Texas Parks and Wildlife Department, Dallas Safari Club, and the Rumsey Research and Development Fund at Texas Tech University.

Monitoring Bird-Window Collisions at Texas A&M University-Kingsville

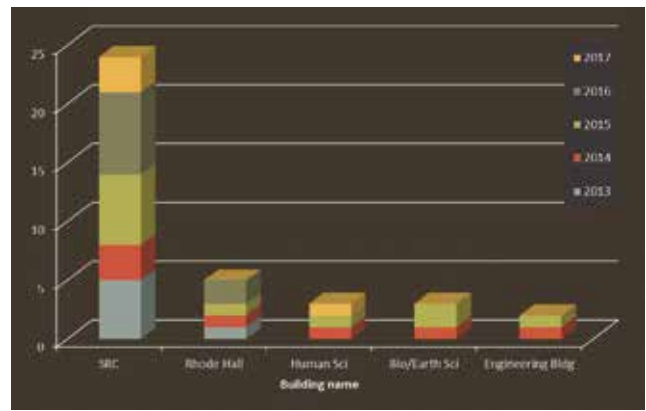
Human-Wildlife Conflict Resolution class students, April A. Torres Conkey, Stephen B. Hager, and Bradley J. Cosentino

On May 4th, 2017, 368 migratory birds (representing 25 species) were killed overnight when they collided with the windows of the 23-story American National Insurance building in Galveston, Texas. Since 2013, the Human-Wildlife Conflict Resolution class students have participated in an annual fall bird-window collision (BWC) survey on the Texas A&M University-Kingsville (TAMUK) campus. The Student Recreation Center (SRC), Rhode Hall, Human



© Matthew Solis and Christina Richey

Yellow-breasted chat carcass found in the courtyard side of the Human Sciences Building, September 26th, 2017.



Bird-window collision mortality counts per building per year at Texas A&M University-Kingsville 2013–2017.

Sciences Building (HSBL), Biology/Earth Science Building, and Engineering Complex have been surveyed each year for a period of 1 month during the fall migration season. The Engineering Complex was not surveyed in 2017 because of window replacement construction; College Hall was surveyed instead.

Four bird-window mortalities were documented during the month of the 2017 survey. A ruby-throated hummingbird, 1 yellow warbler, and 1 Lincoln’s sparrow were killed at the SRC and 1 yellow-breasted chat was killed at the HSBL. Based on the data collected, the SRC averages 5 bird-window kills, Rhode Hall averages 1, and the other buildings have 0 to 1 kill during the month monitored in the study.

While most BWC studies report high numbers of migratory bird deaths, only 42% of mortalities at the TAMUK campus were migratory species. Rather, resident ground-foraging species (such as house sparrows, white-winged doves, and great-tailed grackles) accounted for 58% of bird mortalities at TAMUK. Although the kill numbers appear relatively low on campus, the SRC has multiple building and landscape characteristics that contribute to higher bird mortality at this building.

The Response of Feral Swine to Control Measures in Agricultural Fields

Bethany A. Friesenhahn, Nathan P. Snow, Kurt C. VerCauteren, and Randy W. DeYoung

In the United States, feral swine have dramatically expanded their range because of their adaptability, high reproductive rate, and releases by humans. Coincident with the expansion of feral swine, reports

of human-wildlife conflicts have steadily increased. Damage to agricultural crops is one of the leading conflicts between feral swine and humans. The diet of feral swine can consist of up to 88% agricultural plants in some areas. Feral swine are responsible for more than 1 billion dollars in agricultural damage annually.

Many management options for reducing damage are available. However, the efficacy and cost-to-benefit ratio of the different methods are often unknown. Furthermore, some control efforts may simply cause swine to move to adjacent areas, thereby moving the problem, not reducing it.

The objective of this study is to monitor feral swine intrusion and movements among agricultural fields before and after feral swine control efforts. We will monitor agricultural fields known to experience feral swine damage throughout Texas. We will use a combination of remote camera monitoring, Geographic Information Systems, and GPS radio collars on feral swine to estimate density and determine how feral swine use an agriculturally-based landscape. We will monitor movement responses of feral swine to control efforts and attempt to quantify how control efforts affect the amount of damage in the fields. The results of this study should help determine the effectiveness of feral swine removal in preventing crop damage and provide a foundation for additional research.

Cooperative funding provided by the USDA Animal and Plant Health Inspection Service National Feral Swine Damage Management Program and the USDA Animal and Plant Health Inspection Service National Wildlife Research Center.

Wild Felid Disease Prevalence on the East Foundation's El Sauz Ranch

Jason V. Lombardi, Michael E. Tewes, Clayton D. Hilton, Daniel R. Taylor, John P. Leonard, Justin P. Wied, and Tyler A. Campbell

Port Mansfield, Texas is home to a large feral cat population. In the last 2 years, this population has tested positive for the feline immunodeficiency virus and feline distemper, in addition to other diseases. The East Foundation's El Sauz Ranch, home to one of the largest ocelot subpopulations in the United States, is located adjacent to Port Mansfield. Ocelots occur 7 miles from the city limits. In addition, bobcats may interact with feral cats even closer to town. Consequently, the risk of disease transmission from infected feral cats to bobcats and ocelots and from infected bobcats to ocelots remains a possibility. Any transmission of such diseases would be devastating to small populations of ocelots.

To better understand if feline immunodeficiency and other diseases are present in the ocelot population on private lands, we plan to test serum samples collected from ocelots captured 2011–2017 and from future captures. This research will allow wildlife managers and biologists to gain a better understanding of possible risk factors to ocelot populations in southern Texas and can aid in the planning of management strategies for this endangered species.

Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute, Wild Cat Conservation, Inc., East Foundation, Annova LNG and their parent company Exelon Generation, Brown Foundation, Tim and Karen Hixon Foundation, Travis and Bettina Mathis, and Ben F. Vaughan, III.

Genetic Evaluation of White-tailed Deer Associated with Chronic Wasting Disease

H. Jae Edlin, Masahiro Ohnishi, Damon L. Williford, Randy W. DeYoung, and Mitch A. Lockwood

Chronic Wasting Disease (CWD) is classified as a transmissible spongiform encephalopathy that is found in cervids. It is not caused by bacteria or viruses, but by a malformed version of the prion protein. The misfolded prion converts normal prion proteins into the abnormal form, which is resistant to breakdown in the body and the environment. The abnormal prions then

accumulate in brain and nervous tissue, resulting in death within 1 to 3 years after exposure.

Chronic wasting disease was detected in white-tailed deer in a captive breeding facility in Medina County, Texas in 2015. Since that time, 58 deer from 4 breeding facilities or associated release sites in the county have tested positive. In January 2017, CWD was confirmed in a free-ranging deer in Medina County. The deer's age (1.5 years old) relative to the long incubation time of the disease suggested that the deer must have been exposed shortly after birth. As CWD has not been detected previously in free-ranging deer from Medina County, it is possible that the deer escaped or was released from a captive facility.

We collected samples of hunter-harvested deer from check stations within Medina County and sampled captive herds during CWD monitoring activities. Preliminary analyses indicate that the CWD-positive deer is most genetically similar to captive deer. We were not able to unambiguously assign the CWD-positive to any specific site, but the CWD-positive individual had recent ancestry to captive deer. Our results underscore the importance for testing and monitoring of captive herds and free-ranging deer in the vicinity of facilities containing CWD-positive deer.

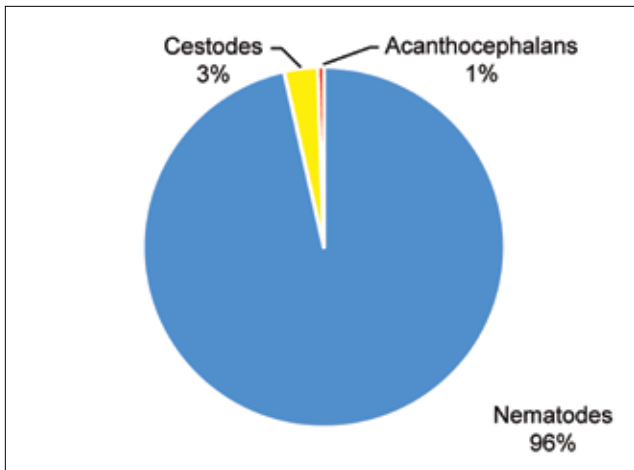
Cooperative funding provided by the Texas Parks and Wildlife Department.

A Multi-Year Study of Northern Bobwhite Parasites within South Texas

Nicole J. Traub and Alan M. Fedynich

Bobwhite populations in Texas exhibit marked variations in abundance among years—a boom-and-bust phenomenon—ultimately attributed to fluctuations in weather conditions. When rainfall is abundant, vegetation is expected to be plentiful, populations of insects are expected to rise, and quail populations boom. How this cycle influences parasite infections in bobwhites is largely unknown.

We are conducting a multi-year (2012–2019) helminth parasite survey of hunter-harvested bobwhites from South Texas in conjunction with a systems-based holistic approach to meet 3 main study objectives: (1) determine if structure and pattern of helminth communities are affected by host and environmental variables, (2) determine which insect species are used as intermediate hosts and the effect



Percentage of parasites by taxonomic group found in 168 northern bobwhites from South Texas that were donated during the 2016–2017 hunting season as part of a long-term study spanning 2012–2019.

intermediate host density has on the parasite community, and (3) create a model to demonstrate the relationships between bobwhite density, insect intermediate host abundance, parasite infections, and precipitation.

Fifteen parasite species have been identified from bobwhites between 2012 and 2017. The cecal worm, *Aulonocephalus pennula*, was the most numerically dominant species with a 5-year mean prevalence of 80%, followed by *Oncicola canis* (7%), *Tetrameres pattersoni* (6%), and *Oxyspirura petrowi* (5%). The remaining 11 parasites rarely occurred.

We have learned from the ongoing long-term study which parasites are infecting bobwhites. We are now taking the next essential step to see which environmental factors are influencing the relationships in the bobwhite-parasite system occurring in South Texas.

Cooperative funding provided by the South Texas Chapter of Quail Coalition.

Diseases in an Urbanized Landscape and its Potential Impact on the Ocelot

Amanda M. Veals, Michael E. Tewes, John H. Young, Jr., Humberto L. Perotto-Baldivieso, and Randy W. DeYoung

The potential for disease outbreaks continues to pose a major threat to the persistence of isolated, endemic wildlife populations. Disease can often spill-over from domestic animals into wildlife, particularly in areas on the fringe of urbanized areas. Habitat loss is increasing worldwide partly because of urban

sprawl and roadways. In the face of urbanization, disease outbreaks are of increasing concern for endangered species.

The ocelot is endangered in the United States with remnant populations of about 80 to 100 individuals in southern Texas. The Lower Rio Grande Valley of southern Texas is one of the fastest growing human population centers in the United States. This has led to a decrease in high-quality habitat for ocelots. In this study, we will examine how roads influence the spatial ecology of ocelots, particularly in regard to the spread of zoonotic diseases such as rabies and mange.

Our goal in this study is to provide management recommendations for preventing or minimizing a disease outbreak that could negatively affect population viability of ocelots in southern Texas. This information can be used to enhance conservation strategies for ocelot conservation.

Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute and Texas Department of Transportation: Environmental Affairs.

Effect of Fire on *Baylisascaris procyonis* Eggs in the Environment

Tiffany L. Pope, Scott E. Henke, Sandra Rideout-Hanzak, and Clayton D. Hilton

The raccoon roundworm, *Baylisascaris procyonis*, is a large nematode found in the small intestine of raccoons. It is nonpathogenic to raccoons, but larvae consumed by other vertebrate species, including humans, can cause blindness, paralysis, and death. Adult



© Tiffany Pope

We are testing to see if raccoon roundworm eggs are killed during prescribed fires in South Texas rangelands.

female worms can shed millions of eggs daily, which are released into the environment when the infected raccoon defecates. A single infected raccoon can contaminate half an acre per year with *B. procyonis* eggs. The eggs in a southern Texas environment can remain viable for at least 2 years. Heat (greater than 155°F) is needed to kill *B. procyonis* eggs. However, soil can act as an insulator from heat, potentially keeping the eggs viable.

We will investigate the potential of using prescribed fire to kill *B. procyonis* eggs occurring within the environment. We will record heat intensity and transfer to soil at various distances and depths. This project, if successful, will offer a management strategy to combat the spread of this zoonotic parasite.

Cooperative funding provided by a Texas A&M University-Kingsville Research Award.

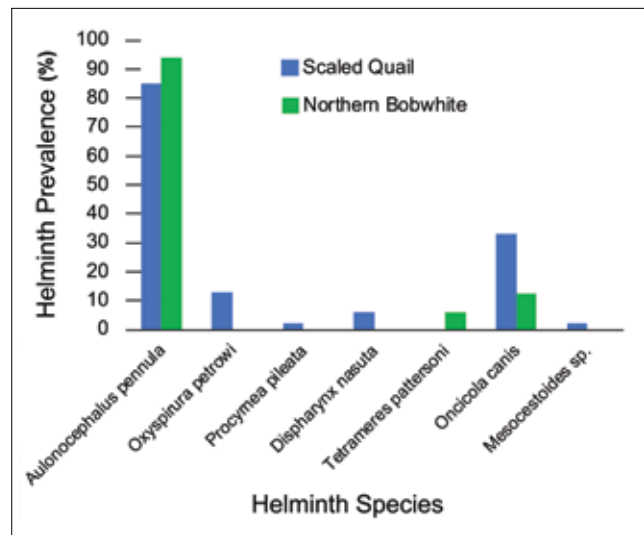
A Comparison of Helminth Communities from Scaled Quail and Bobwhites

Taylor R. Shirley, Nicole J. Traub, and Alan M. Fedynich

Scaled quail and northern bobwhites live sympatrically in certain portions of South Texas. However, little is known regarding the helminth community in scaled quail. We conducted a helminth parasite survey of both quail species to determine if the helminth community in scaled quail resembled the community typically found in northern bobwhites.

Fifty-four scaled quail and 32 northern bobwhites were donated during the 2016–2017 Texas quail hunting season from La Mesa I Ranch in Zapata County, Texas and La Mesa II Ranch in Jim Hogg County, Texas. Each quail was examined for helminth parasites; helminths were identified and counted.

The scaled quail helminth community consisted of 7 species. The cecal nematode, *Aulonocephalus pennula*, had the highest prevalence (83%) and abundance (735 individuals found and averaged 16 per bird examined). The remaining species rarely occurred (each species less than 33% prevalence and less than 125 individuals) and included the eyeworm, *Oxyspirura petrowi*, and a cestode in the genus *Mesocostoides*. The northern bobwhite helminth community consisted of 3 species. The cecal nematode had the highest prevalence (94%) and abundance (1,412 individuals) and averaged 47 worms per bird examined. The other 2 species (*Oncicola canis* and *Tetrameres pattersoni*) rarely occurred (each species less than 12%



Helminth prevalence in scaled quail and northern bobwhites collected during the 2016–2017 hunting season from La Mesa I and La Mesa II ranches in South Texas.

prevalence and less than 23 individuals). Our study presents insight regarding a host-helminth system numerically dominated by a single nematode species occurring in 2 sympatric quail species within South Texas rangelands.

Cooperative funding provided by the South Texas Chapter of Quail Coalition.

Assessing the Potential Transmission of Parasites to Endangered Ocelots

Tiffany L. Pope, Scott E. Henke, Clayton D. Hilton, and Michael E. Tewes

Parasites can reduce survival of individuals and negatively impact populations. Some parasites reduce nutrient absorption or blood cell activity while others may invade the tissues of their host. This study seeks to assess the possibility of transmission of *Baylisascaris procyonis*, *Toxoplasma gondii*, and *Taenia* species to ocelots in southern Texas.

Baylisascaris procyonis is a large nematode normally found in the small intestine of raccoons. Larvae of this parasite are accidentally consumed by other vertebrates, including humans. The larvae migrate throughout body tissues and organs causing significant damage. *Toxoplasma gondii* is a zoonotic protozoan whose life cycle requires a vertebrate intermediate host. This species causes nerve and muscle damage. *Taenia* are tapeworms. They have complex life cycles

with several species being zoonotic, including species previously found in ocelots.

Our objectives are to (1) determine the presence of *B. procyonis* eggs, *Taenia* eggs, and *T. gondii* oocysts in the southern Texas study areas, (2) identify animal species acting as reservoirs for these parasites, and (3) assess the potential for interaction between ocelots and feces containing parasite infective stages. Results from this study can be used to enhance management strategies for the endangered ocelot.

Cooperative funding provided by the East Foundation.

Landscape Genetics to Track Chronic Wasting Disease in Texas Mule Deer

Gael A. Sanchez, Randy W. DeYoung, David G. Hewitt, Timothy E. Fulbright, Humberto L. Perotto-Baldivieso, Louis A. Harveson, and Shawn S. Gray

Chronic Wasting Disease (CWD) affects members of the deer family. This disease is caused by the accumulation of a mis-folded form of the prion protein, which converts normal prion proteins in a type of chain reaction. The abnormal prions are resistant to breakdown and can be transmitted among animals through body fluids or deposited in the environment. The abnormal prions accumulate in the brain, eventually causing death. The disease was detected in free-ranging Trans-Pecos mule deer in 2012 and in Panhandle mule and white-tailed deer in 2015 and 2017, respectively.

Patterns of genetic similarity can reveal how animals use the landscape, and how landscape features



© Timothy Fulbright

Genetics can help us understand how movements of mule deer may lead to the spread of chronic wasting disease.

influence animal movements. Recently, genetic analyses have merged with landscape ecology to form the new field of landscape genetics. We are analyzing genetic data from mule deer harvested throughout their range in Texas to understand how deer movements may lead to future spread of CWD.

Preliminary analyses revealed widespread recent hybridization with white-tailed deer throughout the region. Five percent of mule deer had evidence of hybrid ancestry, but most were back-crosses versus 1st generation crosses. We removed hybrids from the dataset and focused on analyses of mule deer in relation to landscape features. We detected few barriers to mule deer movements in the Trans-Pecos. However, we found evidence of restricted gene flow in the more fragmented Panhandle region, and in a region of unsuitable habitat where the High Plains and Edwards Plateau meet the Trans-Pecos. The results of this study will have important implications for management of CWD in populations of Texas mule deer.

Cooperative funding provided by the Texas Parks and Wildlife Department and the U.S. Fish and Wildlife Service Wildlife Restoration Section 4 Grants Program (TXW-169-R-1).

Disease and Parasite Transmission from Raccoons to Wild Felids

Jason V. Lombardi, Michael E. Tewes, Clayton D. Hilton, Daniel R. Taylor, Daniel Kunz, and Tyler A. Campbell

The ocelot is a small felid whose populations in southern Texas have been reduced to 2 small sub-populations. The cause of this reduction is primarily from habitat loss, collisions with vehicles, and lack of genetic diversity. The raccoon occurs in a wide range of habitat types across its geographic range. Raccoons are known to transmit a variety of disease agents to other carnivore species in areas where they coexist. Willacy and Cameron counties in southern Texas are the last remaining areas where ocelots, bobcats, and raccoons coexist in the United States.

Because of the potential for disease and parasite transmission from raccoons to wild felid populations, we will quantify the abundance of raccoons on the East Foundation's El Sauz Ranch in Willacy County. From 2016–2019, we are capturing and collecting blood and ectoparasites from ocelots, bobcats, and raccoons. In addition, we will be tagging raccoons with identification collars. We will use mark-resight methods using

data from a concurrent trail camera-based survey to estimate raccoon and felid abundance for each year and link it to parasite infections and diseases.

Analysis of the data will provide us with valuable insights on raccoon abundance and implications of potential diseases and parasites. Information from this study has the potential to aid in our understanding of felid presence and ocelot recovery in Texas.

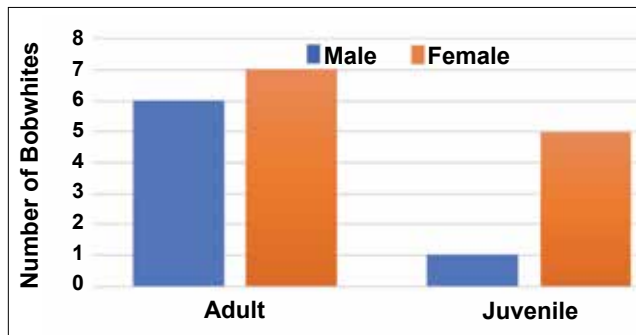
Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute, East Foundation, Wild Cat Conservation, Inc., Annova LNG and their parent company Exelon Generation, Brown Foundation, Tim and Karen Hixon Foundation, Travis and Bettina Mathis, and Ben F. Vaughan, III.

Bobwhite Crop Contents to Determine Intermediate Host(s) for Parasites

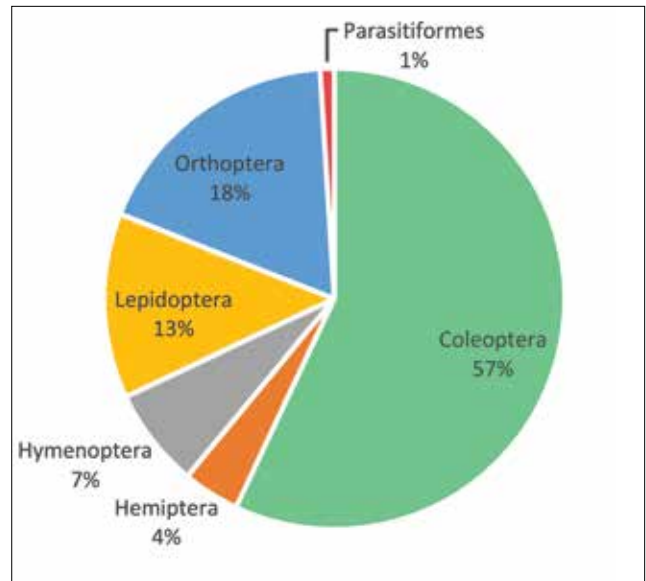
Nicole J. Traub, Tessa M. Green, and Alan M. Fedynich

Although an essential component of the northern bobwhite diet, insects can serve as intermediate hosts for helminth parasites. We are examining bobwhite crops from hunter-donated birds to determine which insects are being used as intermediate hosts for the nematodes *Aulonocephalus pennula* (cecal worm) and *Oxyspirura petrowi* (eye worm).

One hundred and thirty-six bobwhites were examined from the 2016–2017 hunting season, of which 19 had insect species present in the crop at the time of necropsy. Insects of 6 taxonomic orders were present. Order Coleoptera was most abundant followed by Hemiptera, Hymenoptera, Lepidoptera, Orthoptera, and Parasitiformes. The most abundant insect found was a larval Coleoptera species of the Chrysomelidae (leaf beetle) family. In addition, 2 snails and 1 spider were present within the crop contents.



Number of northern bobwhites (n=19) with insects found in their crops separated by age and sex from the 2016–2017 hunting season in South Texas.



Insect orders by their percentage of occurrence that were found in crops of 19 hunter-shot bobwhites donated during the 2016–2017 hunting season in South Texas.

Insects present in bobwhite crops during the hunting season, in addition to those collected during summer months, will be examined for larval parasites to determine which insects may act as intermediate hosts for bobwhite helminth parasites. This information is crucial if we hope to fill in the knowledge gaps regarding bobwhite helminth lifecycles and their effect on bobwhite individuals and populations.

Cooperative funding provided by the South Texas Chapter of Quail Coalition.

Genetics of Partial Resistance to Chronic Wasting Disease in Texas Mule Deer

Gael A. Sanchez, Randy W. DeYoung, David G. Hewitt, Timothy E. Fulbright, Humberto L. Perotto-Baldivieso, Louis A. Harveson, and Shawn S. Gray

Chronic wasting disease (CWD) was discovered in free-ranging North American deer in 1981 and has become a major management concern in recent decades. Chronic wasting disease was detected in Texas mule deer in 2012, and most likely spread to Texas from New Mexico via natural movements of mule deer in the Hueco Mountains. There is no cure for CWD, but mutations in the prion protein gene (PrP) affect susceptibility, incubation time, and the ability to detect the disease.

We amplified and sequenced the PrP gene from tissues of 102 mule deer collected at hunter check stations during 2012–2016. We observed 8 mutations in the PrP gene, including 6 not previously reported in any species of deer. Twenty mule deer had a mutation at codon 96 of the PrP gene, originally identified in white-tailed deer. Seven mule deer had mutations at codon 225, previously associated with partial resistance to CWD in Colorado and Wyoming populations of mule deer. We found a diverse set of PrP alleles in Texas mule deer, partly because of past hybridization and backcrossing with white-tailed deer.

The significance of the new mutations is unclear at this time, but any change in the amino acid sequence of the PrP gene may affect the biological function of the protein. Ongoing work will continue to characterize genetic variation in the PrP gene, with implications for detection of CWD. This information will aid future management decisions throughout the state aimed at controlling the spread of the disease.

Cooperative funding provided by the Texas Parks and Wildlife Department and the U.S. Fish and Wildlife Service Wildlife Restoration Section 4 Grants Program (TXW-169-R-1).

Assessing Social Behavior and Movements of Nilgai for Cattle Fever Tick Control

Lisa D. Zoromski, Randy W. DeYoung, John A. Goolsby, Aaron M. Foley, J. Alfonso Ortega-Santos, David G. Hewitt, and Tyler A. Campbell

The nilgai antelope is an exotic ungulate species that has expanded into much of South Texas since being introduced during the 1920s–1940s. The presence of nilgai in Mexico and South Texas has complicated the eradication of the cattle fever tick (CFT). Cattle fever ticks can transmit bovine babesiosis to cattle, which is a serious economic threat to the U.S. cattle industry. With CFT quarantine areas established in South Texas, ranches with tick-infested cattle are burdened with expensive and time-consuming eradication requirements.

Deer and nilgai are alternative hosts for CFTs. While treated baits are used for control of ticks on deer, nilgai are not attracted to these baits, making control of CFTs challenging. A unique aspect of nilgai behavior is their use of latrines (dung piles). In addition, nilgai use fence crossings, preferring to go under rather than jump over fences to move between ranches. These movements allow nilgai to spread CFTs to new



© Larry Ditto

The nilgai is an exotic species that has adapted well to the South Texas climate and is an important game species.

locations. Both latrines and fence crossings present an opportunity for CFT treatment through the application of acaricides via motion-sensor sprayers. We must understand nilgai latrine and fence-crossing behavior to design efficient strategies for CFT treatment efforts.

We will analyze the density, size, usage, and placement of latrines in rangelands and on ranch roads. We are assessing frequency, time, sex, and age of nilgai that use latrines and fence crossings via camera monitoring. Also, we are using genetic markers to determine how many individual nilgai use latrines. Knowledge on nilgai movement and behavior characteristics will help identify areas to target with remotely activated acaricide sprayers to help with the eradication of CFTs in the United States.

Cooperative funding provided by the Las Huellas Association of South Texas.

The Comanche-Faith Deer Research Project

Charles A. DeYoung, Timothy E. Fulbright, David G. Hewitt, Lindsey M. Phillips, Don A. Draeger, Emily H. Belser, Onalise R. Hill, Ryan M. Rothstein, and Daniel B. Brown

Supplemental feeding of white-tailed deer is a widespread practice in Texas, but the effects of increasing deer densities on deer performance and the vegetation when supplemental feed is available are unclear. In addition, the effects of increasing supplemental feeder density on deer performance and the vegetation are unknown.

The Comanche-Faith Deer Research Project is based in Dimmit County, Texas, and is named after the 2 ranches where the study is replicated. The project's overall objective is to determine the optimal combination of white-tailed deer and supplemental feeder densities for the landscape while maintaining the native habitat.

On each ranch, we are using 6 200-acre high-fenced enclosures, which were constructed in 2003. Phase I of the project began in 2004. Phase II of research began in April 2013 and used the same 6 enclosures on each ranch. Treatments during Phase II for each enclosure on each ranch are outlined in the table below. Numerous projects are being conducted within the overall experimental design. Some projects use all 12 enclosures while others use a subset.

Cooperative funding provided by the Comanche Ranch, T. Dan Friedkin, Faith Ranch, and Stedman West Foundation.

Treatments in enclosures on each of the Comanche and Faith ranches.

	Encl. 1	Encl. 2	Encl. 3	Encl. 4	Encl. 5	Encl. 6
No. of Deer	20	40	60	60	80	0
Actual Acres per Deer	10	5	3.33	3.33	2.5	-
Acres per Deer Adjusted for 33% Count	30	15	10	10	7.5	-
Water and Feeder Sites	1	1	1	3	4	1
Deer per Feeder	20	40	60	20	20	0

Woody Plant Response to White-tailed Deer and Supplemental Feeder Site Densities

Lindsey M. Phillips, Onalise R. Hill, Timothy E. Fulbright, David G. Hewitt, Charles A. DeYoung, and Don A. Draeger

White-tailed deer have the ability to alter the landscape through browsing pressure. This can lead to a change in the canopy cover and density of plant species. Much research on this topic has been conducted in wet, forested areas and these results are not applicable to semiarid regions like South Texas. Our objective was to quantify the impacts of browsing at varying deer and supplemental feeder site densities on the woody plant community.

From June 2012–2017, woody plant canopy cover was estimated by species using the line intercept method on 20, 164-foot transects in each enclosure

on each ranch. The belt transect method was used on each transect to estimate the density of granjeno for 3 height categories.

- Increasing deer density did not affect percent woody plant canopy cover. However, there was an overall shift in the species composition present with honey mesquite becoming more prevalent.
- Density of granjeno did not vary with increasing deer density, but rather appeared to be more impacted by yearly variations, such as rainfall.
- Woody plants in South Texas have evolved under intense browsing, which appears to allow the plants to be able to withstand high levels of browsing by deer. However, land managers should still monitor the woody vegetation for changes due to increased deer density as the woody vegetation can constitute a large portion of deer diets in South Texas.

The Effects of White-tailed Deer Density on Buck Activity During the Breeding Season

Ryan M. Rothstein, Charles A. DeYoung, David G. Hewitt, Timothy E. Fulbright, Lindsey M. Phillips, and Don A. Draeger

Movements of female white-tailed deer have been well-studied. However, much is unknown about buck activities, particularly during the rut. This could have implications for management as the rut is a popular time for hunting, as well as having implications to our understanding of breeding ecology.

Our objective was to determine buck movement patterns during the rut compared to the post-rut across varying deer and feeder site densities. We used data from 33 GPS radio-telemetry collars placed on bucks in a 20 deer per 1 feeder site treatment (low deer density), 60 deer per 1 feeder site treatment (high deer density), and 60 deer per 3 feeder site treatment (high deer density, multiple feeder sources).

- Average distance between telemetry locations taken 30 minutes apart (termed step length) tended to decrease as bucks aged.
- Average step length was 48% greater in the low deer density treatments than in the high deer density treatments.
- Diurnal activity core area size of home ranges doubled during rut compared to the post-rut.
- Deer home ranges were about 60% larger in the low deer density treatments versus high deer density treatments.
- Although bucks increased their movements during rut regardless of deer density, bucks in high deer density treatments moved less, possibly to avoid conflicts because of increased social pressures.
- Bucks in low deer density treatments might have been able to expand their areas of use as they searched for resources such as forage or does due to a lack of other deer infringing on them.

Social Hierarchy of Lactating Does at Pelleted Feed Stations

Austin K. Killam, Ty Elliott, Emily H. Belser, David G. Hewitt, Timothy E. Fulbright, Charles A. DeYoung, David B. Wester, and Don A. Draeger

Pelleted feed stations are a common management tool in South Texas for white-tailed deer to improve nutrition. However, the social hierarchy may influence which deer can access the supplemental feed.

Lactating does need access to feeder sites because lactation is nutritionally demanding. Lactating does would benefit being higher in the social hierarchy because they are able to get a more nutritionally rich diet that they may not be able to get from foraging.

To test our hypothesis, we used the 60 deer and 1 feeder site enclosure on the Comanche Ranch. We analyzed social interactions between marked deer in videos from a 7-day survey during peak lactation in August 2015. Interactions were analyzed to determine each doe's standing in the social hierarchy.

- As a doe's standing in the social hierarchy increased, her probability of lactating also increased.
- This is important because lactating does have a higher nutritional need and being higher in the social hierarchy allows them to access higher quality food and produce more milk for their fawns.

A Test of the Browsing Optimization Hypothesis in South Texas

Lindsey M. Phillips, Onalise R. Hill, Timothy E. Fulbright, David G. Hewitt, Charles A. DeYoung, and Don A. Draeger

Under the browsing optimization hypothesis, plant growth is stimulated with increasing grazing intensity until it reaches a point at which additional grazing causes declines in plant growth. Our objectives were to determine (1) if increasing deer density resulted in increased canopy volume of 3 preferred shrubs and (2) if there was a trade-off where shrubs would allocate resources to leaf and twig growth at the expense of mast (berries and pods) production.



© Randy DeYoung

CKWRI researchers have been studying how plants respond to being grazed by white-tailed deer.

Matching pairs of blackbrush acacia, granjeno, and guayacan were located within each of the enclosures on each ranch in June 2013, and a plant from each pair was caged to protect it from deer browsing. From June 2013 until June 2017, detailed diameter measurements were taken at 9.8-inch increments from the ground to the top of the plant to estimate canopy volume for each plant. Mast production for each plant was also estimated at the same 9.8-inch height increments during April–July 2014–2017.

- Deer and supplemental feeder site density had no effect on canopy volume or mast production for any of the 3 plant species.
- All 3 species appeared to produce new growth to compensate for what was being removed by deer within the densities studied.
- There were no apparent trade-offs between maintaining canopy volume and mast production for the plant species studied.
- Deer diets were greater than 70% supplemental feed in all treatments, which may have reduced browsing impacts.

Effects of White-tailed Deer Density on Antler Growth

Ryan M. Rothstein, Charles A. DeYoung, David G. Hewitt, Timothy E. Fulbright, Lindsey M. Phillips, and Don A. Draeger

Many white-tailed deer managers strive for a herd with a high percentage of mature (greater than 5 years old) bucks in addition to elevated herd densities. However, little is known about whether high-density



© Jessica Glasscock

Ranch managers provide supplemental feed in an attempt to improve antler growth and increase population density.

herds influence antler growth among age classes. Given the large monetary contributions landowners make towards deer management, it is important to know whether deer density impacts antler growth.

Our objective was to determine whether deer density for supplemented populations influenced antler growth among varying age classes of bucks. We used software and trail camera photos to generate gross Boone and Crockett scores for known-age bucks.

- We found gross Boone and Crockett score of yearlings decreased 15.7 inches during 2015 in the 20 deer per 1 feeder site treatment and the 60 deer per 1 feeder site treatment.
- There was no difference in antler scores of these same deer when they were re-scored in 2016 as 2-year-olds.
- Gross Boone and Crockett score of yearlings did not change when deer density increased from 20 to 60 deer, but the deer-to-feeder site ratio was held at 20 deer per 1 feeder site.
- No other age classes exhibited effects of deer or feeder site density on antler growth.
- Young deer were more susceptible to density effects possibly because they had lower social standing and were still growing.
- Multiple food sources spread across a property may reduce social stress in young deer and improve their overall health.

** End of Completed Comanche-Faith Project Abstracts **

Response to Culling for Antler Traits in White-tailed Deer

Masahiro Ohnishi, Randy W. DeYoung, Charles A. DeYoung, Bronson K. Strickland, Don A. Draeger, David G. Hewitt, and Steven Lukefahr

Culling is widely used for improving antler size in populations of white-tailed deer. However, the effectiveness of culling is unclear. We conducted a long-term study of culling on the Comanche Ranch.

The study involved 3 treatments: intensive, where all age classes of bucks were culled; moderate, where bucks 3 or more years old were culled; and a no-cull control. We captured bucks and measured antler traits during 2006–2016; we culled using age-specific culling criteria during 2006–2012. We recorded 5,488 captures of 2,937 bucks and culled 1,333. In addition,

we established strict culling criteria for young bucks in an attempt to produce rapid gains; all 1.5-year-old bucks with less than 6 antler points were removed. We estimated heritability of antler traits and computed the difference between average and selected bucks.

- Culling effectively removed undesirable bucks, and bucks that exceeded the culling criteria sired most offspring. However, the proportion of bucks culled each year remained high and there was no change in Boone and Crockett score or antler points.
- Environmental factors had 2 to 3 times greater influence on antler expression than genetic ancestry.
- The gain of antler points per generation was not enough for the subsequent generations to meet the 6-point minimum, and 94% were culled.
- Response to culling was 50% lower than the potential because selection occurred only on bucks. Does contribute half of the genetic potential, but we cannot select for does without a pedigree.
- Culling is a viable tool for removal of undesirable bucks, but it was not effective for changing the genetic potential for antler traits within South Texas populations.

Cooperative funding provided by the Comanche Ranch and the Texas Parks and Wildlife Department.

Effects of Supplemental Feeding on Tooth-Wear Aging of White-tailed Deer

Oscar Cortez, Aaron M. Foley, David G. Hewitt, Charles A. DeYoung, and Randy W. DeYoung

The tooth replacement and wear (TRW) method is used to age adult deer. Supplemental feed is thought to reduce tooth-wear rates, which may influence estimated ages. Cementum annuli (CA) is an unbiased aging method and the differences between TRW and CA may reveal insights about the role of supplemental nutrition on estimated ages.

We obtained TRW and CA ages from 7,389 bucks harvested on the King Ranch during 2000–2015. In addition to modeling the effect of feeder site density and soil sandiness on estimated ages, we also modeled the effects of visual cues such as antler size, body mass, and harvest date on estimated ages.

- Density of supplemental feed stations had the opposite effect than expected (TRW aged older than CA as feeder density increased).



© Randy DeYoung

Dr. Aaron Foley (right) demonstrating to students how to age white-tailed deer based on tooth replacement and wear.

- Body mass had the largest effect on age differences. The greater the body mass, the higher the TRW age assignment than CA, but the effect was small (0.01 years per 2.2 pounds).
- We did not find evidence that environmental factors explained variability in estimated ages. Most of the variation probably is due to different tooth wear patterns among individual deer.
- TRW and CA were ± 1 year 70% of the time, indicating that TRW has value for deer management.

Recruitment Patterns of White-tailed Deer in South Texas

Michaela F. Rice, Kory R. Gann, Randy W. DeYoung, David G. Hewitt, Michael J. Sheriff, David B. Wester, Aaron M. Foley, J. Alfonso Ortega-Santos, and Tyler A. Campbell

Animals respond to environmental changes through the stress response. Elevated stress hormones help animals cope with short-term changes, but chronic exposure to stressors may lower body condition and reproduction. We investigated how rainfall influenced condition, reproduction, and stress in white-tailed deer in South Texas.

We captured 1,878 does on 4 East Foundation ranches during autumn of 2011–2016 and determined body condition and probability of lactation—an index of fawn production. We also measured stress physiology during 2015–2016.

- Mature does (3 or more years old) had a greater

probability of lactation than juveniles. Spring drought had less of an influence on lactation probability for mature does compared to juveniles.

- Doe body condition varied by age, lactation status, and ranch. Mature does were in better condition than juveniles; doe body condition was greater on ranches with more rainfall and better soils.
- Non-lactating does also were in better condition than lactating does. All lactating females had similar body condition regardless of ranch.
- There was no difference in stress hormone levels in mature does by ranch or lactation status; stress levels were not influenced by March–July rainfall.
- Body condition of does is the integrator of nutritional demands and available nutrition. Our results demonstrate that most fawns are recruited by mature does because they have greater energy reserves than juveniles, who are still growing.
- Mature does are an important demographic in South Texas deer populations by contributing greatly to population maintenance and growth.

Cooperative funding provided by the East Foundation.

Effects of Supplemental Feeding on Fawn Production of White-tailed Deer

Oscar Cortez, Aaron M. Foley, David G. Hewitt, Charles A. DeYoung, and Randy W. DeYoung

Fawn to doe ratios provide insight to future herd size and reproductive success. Helicopter surveys were conducted during September from 2000–2015 on the King Ranch in Texas. We used this dataset to analyze fawn to doe ratios and the ratio's relationship with precipitation, sand composition of soils, and feeder density. Multiple month and month combinations of precipitation were analyzed to determine month(s) that correlated best with fawn to doe ratios.

- We found June precipitation correlated best with fawn to doe ratios.
- For every 3.76 inches of rainfall during June, a 10% increase in fawn to doe ratios occurred.
- For every increase of 1 feeder per 1,000 acres, fawn to doe ratios increased 4%.
- Sand composition of soils had no influence on fawn to doe ratios.
- Feeder densities during 2000–2015 were not high enough to overcome the rainfall effect on fawn to doe ratios.



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Fawn to doe ratios in deer surveys are used to assess the deer population and the effects of management practices.

- Increasing feeder density to levels of influence during drought years may be beneficial.

Temporal Reproductive Success of Male White-tailed Deer

Aaron M. Foley, David G. Hewitt, Matthew J. Schnupp, and Randy W. DeYoung

Mature male white-tailed deer have higher reproductive success because they are more capable of absorbing the high energetic costs. For this reason, young bucks (1.5 and 2.5-year-old bucks) collectively sire about 30% of offspring, whereas males 3.5 years old and older sire about 70% of offspring.

Examining the timing of conceptions can help us better understand reproductive strategies of young males. Because white-tailed deer use the single-female tending system, we hypothesized young males would be more successful during peak rut when the number of estrous females is at an apex. In this study, we estimated conception dates of fetuses collected from harvested females on the King Ranch during 1999–2003 and 2008–2009 and used genetic parentage assignments to identify sires.

- We found 1.5 and 2.5-year-olds were most successful during peak rut compared to early and late rut.
- All litters with 2 or more fetuses conceived by young males had a 2nd sire (i.e., multiple paternity).
- Our results indicate that young bucks are at a disadvantage in a landscape saturated with mature

bucks. However, young males may be presented with breeding opportunities during peak rut when most females enter estrus.

- The high proportion of shared paternity suggests that female access is temporary; young bucks are likely displaced or were breeding surreptitiously.
- These findings aid in our understanding of the white-tailed deer breeding system in South Texas.

Cooperative funding provided by the East Foundation and King Ranch, Inc.

Breeding Values for Antler Traits in White-tailed Deer

Masahiro Ohnishi, Randy W. DeYoung, Charles A. DeYoung, Bronson K. Strickland, Don A. Draeger, David G. Hewitt, and Steven Lukefahr

Culling is a management tool aimed at improving antler traits in populations of white-tailed deer. Culling assumes that antler traits are heritable, and phenotypes are indicative of genetic potential. As part of a long-term study on the Comanche Ranch, we captured bucks and measured antler characteristics during 2006–2016.

We constructed male pedigree records using genetic parentage assignments and used quantitative genetic analyses to predict the average effect of each sire's genes—his breeding value. We recorded 5,488 captures of 2,937 individual bucks and culled 1,333 that did not meet age-specific culling minimums. We assigned sires for 963 male offspring.



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Long-term studies are necessary to answer questions about the impact of culling programs.

- Mature bucks with desirable antler traits sired most offspring. However, the proportion of captured bucks that were culled each year remained constant, and we observed no changes in antler size due to culling.
- Buck breeding values were weakly correlated to antler size, with high variation among bucks with the same antler size. Some large-antlered bucks did not pass on their antler traits to their offspring.
- Some bucks had good potential for antler development but grew small antlers in 1 or more years.
- Many young bucks were not able to express their potential for antler growth until physically mature, probably due to environmental factors.
- Antler size was an inconsistent predictor of genetic quality, but it became more reliable for adult bucks.
- Culling for population management is a viable tool, but culling to improve genetic potential for antler development will be inefficient in most South Texas populations of white-tailed deer.

Cooperative funding provided by the Comanche Ranch and the Texas Parks and Wildlife Department.

Does Movement Explain Loss in Body Mass in Male White-tailed Deer?

Aaron M. Foley, David G. Hewitt, Matthew J. Schnupp, and Randy W. DeYoung

Males may lose about 20% body mass during the reproductive season. However, it is unknown how much loss in body mass is attributed to locomotion (i.e., mate search). We estimated total loss in body mass using data from over 7,500 males, aged 1.5 to over 10.5 years old that were harvested during the rut on the King Ranch during 2000–2015. To estimate loss in body mass attributed to locomotion, we used data from 30 GPS-collared males on the King Ranch during the rut. Our study provides insight about the patterns of investment in reproduction by male white-tailed deer in South Texas.

- Based on harvest records, reproductive effort measured as loss in body mass increased with age until maturity (5.5–6.5 years old, 18% loss in mass), then slightly declined as bucks increased in age.
- Duration of body mass loss overlapped with range of conception dates.
- Yearlings did not exhibit reproductive effort (0% loss in body mass).

- Costs of increased movements during rut would result in only 4 to 5% loss in body mass.
- Because empirical loss of body mass (12 to 18%) exceeded modeled costs of mate-search (4 to 5%), we infer that reduced foraging in males (other than yearlings) is the primary cause in loss of body mass during the reproductive season.
- By relying on fat reserves, males can forego foraging to focus on searching for mates. As males approach maturity, more fat reserves can be accumulated, which should translate into higher reproductive effort.

Cooperative funding provided by the East Foundation and King Ranch, Inc.

Heritability of Antler Traits in White-tailed Deer

Masahiro Ohnishi, Randy W. DeYoung, Charles A. DeYoung, Bronson K. Strickland, Don A. Draeger, David G. Hewitt, and Steven Lukefahr

Managers and hunters have expressed concern that harvest may negatively affect genetic potential for antler size, while others have intentionally practiced culling in an attempt to produce trophy antlers. The genetic contribution to antler traits is unknown in wild populations of deer. We estimated heritability of antler traits, the proportion of variation in antler size among bucks due to inherited genetic factors, during a long-term study of culling at the Comanche Ranch.

We captured bucks each autumn during 2006–2016, estimated age, measured antler size, and



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CKWRI research suggests that environmental conditions play a major role in expression of antler traits.

identified father-son pairs based on genetic markers. We recorded 5,488 captures of 2,937 individual bucks and assigned sires for 963 male offspring.

- Heritability of antler traits was low in young bucks. The heritability of antler points was about 0.25 for bucks less than 3.5 years old versus 0.36 for bucks 3.5–4.5 years old, and heritability of gross Boone and Crockett score was 0.45 for bucks greater than 3.5 years old.
- Environmental conditions during the first year of life had a lasting and detectable permanent effect on antler traits.
- For bucks 3.5 years old and older, 13 to 16% of the variation in antler size was due to the environmental conditions during their first year of life.
- Less than half (25 to 45%) of the variation in antler traits was due to genetic factors. This indicates that the association between antler size and genetic potential may be weaker than previously assumed, especially for young deer.
- Managers may realize greater gains in antler size of wild populations by improvements in habitat and nutrition than are feasible through selection.

Cooperative funding provided by the Comanche Ranch and the Texas Parks and Wildlife Department.

What is a Population? Genetic Structure in White-tailed Deer

Michaela F. Rice, Randy W. DeYoung, David G. Hewitt, Aaron M. Foley, J. Alfonso Ortega-Santos, and Tyler A. Campbell

Wildlife populations are often managed based on human constructs, such as ranch boundaries. However, wildlife may use the landscape at a different scale. The area of a population is defined by movement and dispersal over many generations.

We used genetic markers to describe genetic and spatial structure in 4 unmanaged populations of white-tailed deer on East Foundation ranches in South Texas. We sampled 140 adult (2.5 years old and older) bucks, 209 does, and 74 fawns during 2015–2016.

- Genetic differentiation among ranches was relatively low and correlated with geographic distance between ranches.
- We observed genetic similarity between pairs of does separated by spatial distances up to 2.7 miles.

This corresponds to a spatial area of 3,664 acres, about 4 to 5 times larger than a doe’s home range.

- Bucks displayed no pattern of genetic similarity and spatial distance. However, we observed some pairs of closely related bucks, possibly siblings or parent-offspring pairs, up to 10 miles apart.
- Overall, our results are consistent with deer behavior. Does remain near their birth range, whereas bucks disperse and establish a new range that may be miles away.
- The scale of spatial-genetic relationships for does was 2 to 3 times greater than in high-density deer populations in the eastern United States. This pattern is consistent with the observation that deer in South Texas have larger home ranges compared to deer in habitats with more abundant resources.
- Most properties in Texas are small relative to the scale at which deer use the landscape. Our results help wildlife managers understand the spatial scale at which harvest and management actions affect white-tailed deer populations.

Cooperative funding provided by the East Foundation.

Transition Frequency Analysis of Antler Traits in White-tailed Deer

Masahiro Ohnishi, Randy W. DeYoung, Charles A. DeYoung, Bronson K. Strickland, Don A. Draeger, and David G. Hewitt

Managers often practice culling to improve antler traits in populations of white-tailed deer. Culling implicitly creates 2 categories of bucks: “cull” and “keep.” However, the frequency of transition between categories is unknown.

We estimated the transition frequency for bucks recaptured on the Comanche Ranch during 2006–2016. We established 3 culling treatments: intensive, where all age classes were culled; moderate, where only bucks 3.5 years old and older were culled; and a no-cull control. Bucks were culled if less than 6 antler points at 1.5 years, if less than 8 antler points at 2.5 years, if less than 9 antler points at 3.5–4.5 years, and if less than 145 Boone and Crockett score at 5.5 years old and older.

- We found 30% of bucks may change from keep to cull the next year. The proportion that transitioned from cull to keep was highest in young bucks.
- Managers often establish strict culling minimums for young bucks in an attempt to increase selection

The proportion of bucks that changed from “Keep” to “Cull” and vice versa in subsequent years during a study of culling in white-tailed deer on the Comanche Ranch 2006–2016.

State	Age class	Transition Frequency
Keep to Cull	1.5 to 2.5	34%
	2.5 to 3.5	33%
	3.5 to 4.5	33%
	4.5 to 5.5	32%
	5.5 to 6.5	32%
	6.5 to 7.5	32%
	7.5 to 8.5	31%
	8.5 to 9.5	31%
Cull to Keep	1.5 to 2.5	68%
	2.5 to 3.5	56%
	3.5 to 4.5	44%
	4.5 to 5.5	33%
	5.5 to 6.5	23%
	6.5 to 7.5	16%
	7.5 to 8.5	10%
	8.5 to 9.5	7%

for antler traits. However, young bucks are most likely to change categories among years.

- Managers should carefully consider culling in drought years or for bucks less than 4.5 years old because a high proportion of bucks may change categories under these conditions. Conversely, adult bucks are more likely to transition from keep to cull than cull to keep.
- Our results emphasize the plasticity of antler traits in South Texas.
- Managers should consider age- and environment-specific frequency of transition among categories during the design of culling programs.

Cooperative funding provided by the Comanche Ranch and the Texas Parks and Wildlife Department.

Molecular Ecology of New World Quails: Messages for Managers

Damon L. Williford, Randy W. DeYoung, and Leonard A. Brennan

The New World quails have a broad distribution, extending from the United States to Argentina. Recent genetic studies of New World quails have yielded important, and sometimes, counter-intuitive insights regarding evolutionary relationships, genetic diversity, population structure, and biogeographic history. We undertook this study to examine these relationships in greater detail.

- The New World quails form a distinct family that is most closely related to pheasants, jungle fowl, grouse, and guinea fowl.
- The family originated in Africa and dispersed to North America via the Bering Land Bridge 36–40 million years ago.
- New World quails are composed of 3 lineages: (1) the tawny-faced quail; (2) the wood, singing, and Montezuma quails; and (3) the bobwhites and mountain, tree, crested, and banded quails.
- Genetic studies and ecological niche models have revealed Pleistocene refugia and post-Pleistocene range expansions, contractions, or stasis. Divergence times within and among genera date to climactic or geologic events 1–5 million years ago.
- Genetic studies do not support most subspecies of California, Gambel's, and scaled quails, or northern, crested, and black-throated bobwhites. Ecological regions, rather than subspecies, are probably more appropriate as "management units."
- There is a clear biological basis for conserving large blocks of interconnected habitat to facilitate dispersal and recolonization.

Analysis of Distance Sampling Effort and Density Estimates for Northern Bobwhites

Andrea Bruno, Leonard A. Brennan, Michael L. Morrison, Eric D. Grahmann, and Andrew N. Tri

Distance sampling allows researchers to correct for missed detections due to observer variability, environmental factors, and species characteristics. The use of line-transect distance sampling from a helicopter has proven to be a reliable and efficient method to estimate

northern bobwhite density in Texas. However, the validity of estimates depends on satisfying a number of sample size and model-based assumptions.

We used aerial survey data collected over 4 years. We assessed the following: (1) whether bobwhites flush behind the helicopter; (2) if weather conditions, time of day, and level of observer experience affect detection probability; and (3) if precision changes with survey coverage (transect spacing) and repeated surveys within a short period.

- Review of video footage revealed 1 occasion where bobwhites flushed after the helicopter passed.
- Observers with less than 10 days of experience missed 30% more detections from 0–32 feet than observers with greater than 10 days of experience.
- Observers detected bobwhites at greater distances on clear versus overcast days.
- Precision decreased with increased transect spacing below 50% coverage or greater than 1,312 feet.
- On repeated surveys, density varied less between 2 surveys conducted at 100% coverage 10 days apart compared to 2 surveys conducted at 50% coverage, indicating some degree of uncertainty in the repeatability of estimates below 100%.
- Our results are based on surveys conducted at the juncture of the Coastal Sand Sheet and Tamaulipan Thorn Scrub regions in South Texas and may not be applicable elsewhere.

Cooperative funding provided by the East Foundation, South Texas Chapter of Quail Coalition, and the Richard M. Kleberg, Jr. Center for Quail Research.

Detection and Occupancy of Montezuma Quail in the Edwards Plateau of Texas

Zachary J. Pearson, Eric D. Grahmann, Fidel Hernández, Leonard A. Brennan, Humberto L. Perotto-Baldivieso, and Robert M. Perez

Montezuma quail reside in mountainous oak-juniper savannahs and grasslands in Mexico and the southwestern United States. The relatively scant information on this secretive quail mostly comes from populations found in New Mexico, Arizona, and the Trans-Pecos ecoregion of Texas.

Only 4 studies have focused on the Montezuma quail population inhabiting the Edwards Plateau. Furthermore, information concerning factors that

influence Montezuma quail detection and occupancy is lacking. To mend this lack of information, call-back surveys were conducted at 60 locations on 8 ranches and 1 state park within Edwards County during March–August 2015 and 2016. In addition, weather and vegetation data were collected at each location.

- Montezuma quail were detected during 7% of the surveys and roughly half (46%) of the sites sampled were occupied during the 2 years.
- Temperature was the most important variable influencing detection, while occupancy was best explained by bunchgrass density.
- Probability of detection increased above 70% when temperatures were below 77°F.
- Probability of Montezuma quail occupancy increased above 50% when bunchgrass density was above 229 plants per acre.
- Additional variables undoubtedly have a collective influence on both detection and occupancy of Montezuma quail; however, these could not be teased out with the methodology used in this study.
- Additional research should focus on more fine-scale measurements with the assistance of radio telemetry technologies.

Cooperative funding provided by the Texas Parks and Wildlife Department, 11 ranches and landowner groups within the Southern Edwards Plateau, South Texas Chapter of Quail Coalition, San Antonio Chapter of Quail Coalition, San Antonio Quail Forever, and the Smith Foundation.

Effects of Tanglehead on Habitat Suitability for Bobwhites in South Texas

Jose M. Mata, Humberto L. Perotto-Baldivieso, Fidel Hernández, Eric D. Grahmann, Sandra Rideout-Hanzak, John T. Edwards, Jaclyn D. Robles, Michael T. Page, and Taylor M. Shedd

South Texas quail habitat is considered some of the best in the country. However, increases in tanglehead cover across large areas can negatively impact northern bobwhites by altering habitat structure, thereby limiting the availability, accessibility, and use of important habitat components such as food and cover. Over the past decade, stands of tanglehead have emerged in Jim Hogg and Duval counties.

Our goal was to assess the impact of tanglehead on bobwhite habitat. We used the gradient concept of landscape structure. This is a novel concept that can be useful to build spatially-explicit habitat suitability

models based on landscape variables that describe habitat. We generated a series of habitat suitability models based on landscape variables such as percent woody vegetation cover, mean patch area, edge density, and aggregation index to quantify the distribution of bobwhite habitat and the potential effect of tanglehead in these areas.

- Suitable habitat for bobwhites was composed of tanglehead cover below 39%, which was distributed in small patches across the landscape.
- Validation using covey location data showed that the model predicted areas of high suitability more than 79% of the time.
- The techniques used in this study can be an effective tool for assessing bobwhite habitat suitability and aid in making management decisions.
- Techniques used in our study may also provide applications for habitat assessment of other wildlife species, thereby aiding in restoration and conservation efforts at multiple scales.

Cooperative funding provided by the Rotary Club of Corpus Christi (Harvey Weil Sportsman Conservationist Award).

Vegetation Monitoring and Quail Density in a Grazing Demonstration Area

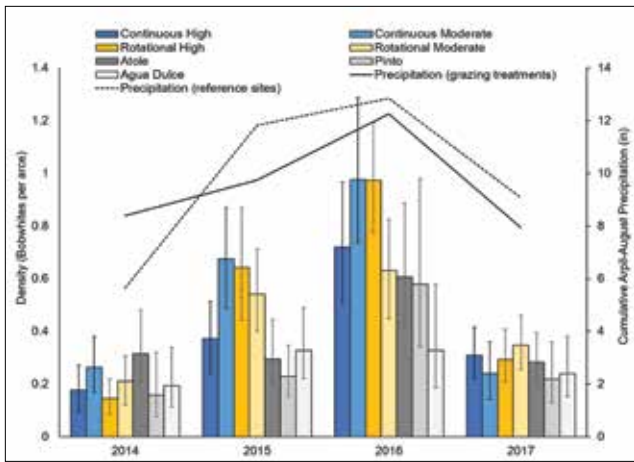
Andrea Bruno, Leonard A. Brennan, Michael L. Morrison, Eric D. Grahmann, and Andrew N. Tri

The northern bobwhite occurs throughout South Texas rangelands where grazing is widespread. To improve public knowledge on grazing and bobwhites,



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In South Texas rangelands, variation in the size of bobwhite populations is dependent upon precipitation.



Northern bobwhite density (bobwhites per acre) estimates on 4 livestock grazing treatment sites (continuous high and moderate; rotational high and moderate) that were deferred during 2014–2015 and 3 reference sites (Atole, Pinto, and Agua Dulce) where grazing was not previously deferred on the San Antonio Viejo Ranch, Jim Hogg County, Texas spanning the period from December 2014–2017. Line shows cumulative precipitation from April–August for each year.

East Foundation personnel implemented a large-scale grazing demonstration with 4 grazing treatments: continuous and rotational grazing systems each at high and moderate stocking rates.

We monitored changes in (1) vegetation (forage standing crop, utilization, structure, and composition) and (2) bobwhite density from before (2014–2015) to after (2016–2017) the grazing implementation. We also monitored 3 pastures, or reference sites, where grazing was not deferred.

- From 2014–2015, bobwhite density increased by 110–340% in the grazing treatments in the absence of grazing and by 0–68% on the reference sites where no deferral occurred.
- From 2016–2017, bobwhite density on the grazing treatments differed between each year coinciding with fluctuations in breeding season (April–August) precipitation, but was similar between grazing systems and stocking rates.
- Bobwhite density was lower on the reference sites compared to the grazing treatments in 2015 and 2016, but similar in 2014 and 2017.
- Forage standing crop and herbaceous cover decreased, and bare ground increased on all grazing treatments and reference sites from 2015–2017.
- Precipitation explained 59% of the variation in annual bobwhite density estimates on all treatments and 36% on reference sites.

- Our results suggest that the type of grazing management in semiarid systems in South Texas is less critical when random and variable precipitation occurs in the short-term.

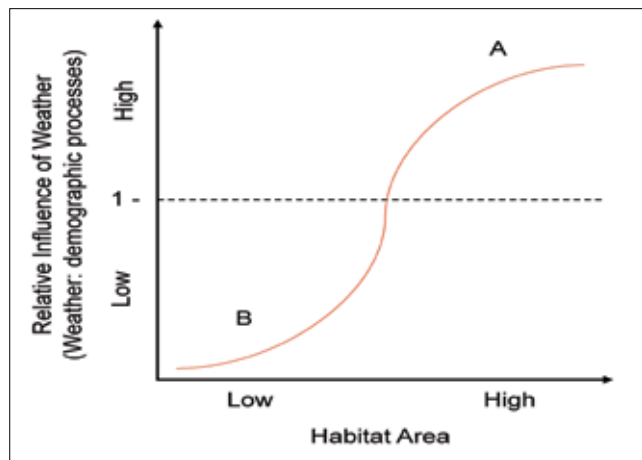
Cooperative funding provided by the East Foundation, South Texas Chapter of Quail Coalition, and the Richard M. Kleberg, Jr. Center for Quail Research.

Influence of Landscape Factors on the Bobwhite and Scaled Quail Declines

John T. Edwards, Fidel Hernández, Leonard A. Brennan, David B. Wester, Chad J. Parent, and Robert M. Perez

Northern bobwhites and scaled quail have experienced range-wide declines over the past century. Habitat loss has been the ultimate factor in the decline of each species. It has been suggested that the relationship between habitat loss and population decline may be non-linear. In addition, factors such as weather and predation may be gaining influence with increasing habitat fragmentation. These factors operate at scales beyond traditional quail studies (local), and their influence must be evaluated at larger scales (landscape).

In this study, we sought to (1) evaluate the linearity of the relationship between quail populations and habitat and (2) determine the relative effects of habitat, weather, and raptors on quail populations across multiple scales. We obtained data from 4 general sources: quail indices (Breeding Bird Survey, Christmas Bird Count, and state-agency counts), habitat composition and configuration (National Land Cover Database),



The relative influence of weather factors relative to habitat area on quail populations. The area labeled A is when weather influence is the greatest under saturated habitat conditions. The area labeled B represents the low influence of weather when there is little habitat available.

raptor population trends (Christmas Bird Count), and weather (PRISM).

- Quail populations were primarily driven by weather (precipitation and temperature) and its interaction with habitat composition.
- Populations showed a relatively linear trend with habitat amount.
- However, we documented a non-linear response to the interaction between habitat and weather. With high amounts of habitat, weather was the key driver of quail populations, but this influence waned as habitat decreased and the amount of habitat becomes the limiting factor.
- The influence of weather was more pronounced for bobwhites than for scaled quail, and there was a stronger influence at larger scales.
- Ultimately, maintaining high amounts of quail habitat should be the top management priority for northern bobwhites and scaled quail.
- Maintaining high quality habitat may help lessen the population-level impacts caused by fluctuating weather patterns.

Cooperative funding provided by the Texas A&M AgriLife Extension Service's Reversing the Decline of Quail Initiative in Texas, Texas Parks and Wildlife Department, South Texas Charity Weekend, Inc., and the Richard M. Kleberg, Jr. Center for Quail Research.

Development of a Predictive Distribution Map for Montezuma Quail

Zachary J. Pearson, Eric D. Grahmann, Fidel Hernández, Humberto L. Perotto-Baldivieso, Leonard A. Brennan, and Robert M. Perez

Montezuma quail were once found in every county in the Edwards Plateau ecoregion in Texas. Habitat loss has occurred over the last 2 centuries in the region, and by 1970 this quail's distribution had become relegated to a handful of ranches in Edwards County, Texas. More recently, Montezuma quail have been found in Edwards, Kinney, Sutton, Real, Uvalde, and Val Verde counties.

Renewed interest in the species could lead to restoration efforts if areas of unoccupied habitat are identified. The objective of this research was to develop a predictive map to identify areas potentially occupied by an expanding Montezuma quail population and identify areas feasible for restoration efforts in the Edwards Plateau.



© Sandy Hurwitz

CKWRI researchers are providing new information that can aid in managing the Montezuma quail in Texas.

- A model was developed using verified Montezuma quail locations (from incidental observations and call-back surveys) and overlaying these locations with elevation, slope, plant communities, and a topographic position index using the computer program MaxEnt.
- Six percent of the Edwards Plateau was classified as having a probability of occupancy over 50% (1,486,657 acres).
- Within Edwards, Val Verde, and Kinney counties (representing the epicenter of Montezuma quail range in the Edwards Plateau), there is 568,342 acres of habitat classified with a probability of occupancy over 50%.
- Occupied patches of habitat ranged in size from 0.2–162 acres with a mean size of 28 acres.
- Outside of the known distribution of Montezuma quail, the model identified Kimble, Sutton, and Mason counties as those that support the greatest amount of habitat. However, all counties in the Edwards Plateau may support suitable habitat patches for Montezuma quail.

Cooperative funding provided by the Texas Parks and Wildlife Department, 11 ranches and landowner groups within the Southern Edwards Plateau, South Texas Chapter of Quail Coalition, San Antonio Chapter of Quail Coalition, San Antonio Quail Forever, and the Smith Foundation.

The Oso Bay Wetlands Preserve Prairie Restoration Project

Keith A. Pawelek, Forrest S. Smith, Anthony D. Falk, and Sara Jose

Restoration plantings following disturbance or construction are often used to help lessen the negative impacts on the ecosystem and prevent soil erosion. In an effort to restore previously disturbed areas of the Oso Bay Wetlands Preserve in Corpus Christi, Texas to native prairie, personnel from *South Texas Natives* and Oso Bay Wetlands Preserve conducted 2 native prairie restoration plantings.

The sites were treated with herbicides prior to planting to help minimize competition from non-native grasses and to reduce future competition from non-native grass seed banks. Each site was planted in late August 2017 to capitalize on fall rains for establishment. These sites will serve as an educational tool to help educate the public about native plants, South Texas ecosystems, and prairie restoration practices.

- The sites have received below average rainfall since planting, but significant establishment was documented on the planting sites.
- Seventeen native plant species were successfully established by 1 year post-seeding.
- Native species density of 0.5 plants per square foot was achieved by 1 year post-seeding.
- Fifty percent basal cover of native plant species was achieved by 1 year post-seeding; non-native grass cover was just 4%.

Cooperative funding provided by the Oso Bay Wetlands Preserve and Citgo.

Release of Permian Germplasm Whiplash Pappusgrass for West Texas

Colin S. Shackelford, Jameson S. Crumpler, Louis A. Harveson, Keith A. Pawelek, Anthony D. Falk, Forrest S. Smith, Brandon Carr, John Reilley, and Shelly D. Maher

Permian Germplasm whiplash pappusgrass is the first of 2 new formal releases of ecotypic plant material developed for West Texas by *Texas Native Seeds*. Development of the germplasm was completed in collaboration with the Borderlands Research Institute at Sul Ross State University and the USDA Natural

Resources Conservation Service's E. "Kika" de la Garza Plant Materials Center and the James E. "Bud" Smith Plant Materials Center.

Whiplash pappusgrass is a warm-season perennial bunchgrass found primarily in fine textured soils. It occurs across a wide variety of ecological sites in West Texas and is tolerant of moderately saline and alkaline soils. Permian Germplasm whiplash pappusgrass is recommended for upland wildlife habitat restoration, highway rights of ways, energy reclamation, and rangeland plantings.

- Permian Germplasm whiplash pappusgrass is comprised of 4 accessions from an evaluation trial of over 20 native collections from West Texas. The selected accessions originate from Hudspeth, Brewster, Martin, and Tom Green counties.
- This release is 1 of 2 releases from *Texas Native Seeds* developed specifically for grassland restoration projects in West Texas.
- Based on collection site attributes and evaluations, Permian Germplasm whiplash pappusgrass will perform well in the Permian Basin, southern Rolling and High Plains, and Trans-Pecos regions of West Texas.
- Licenses for production are being negotiated with multiple growers. Commercial seed for Permian Germplasm whiplash pappusgrass will be available to consumers in 2018.

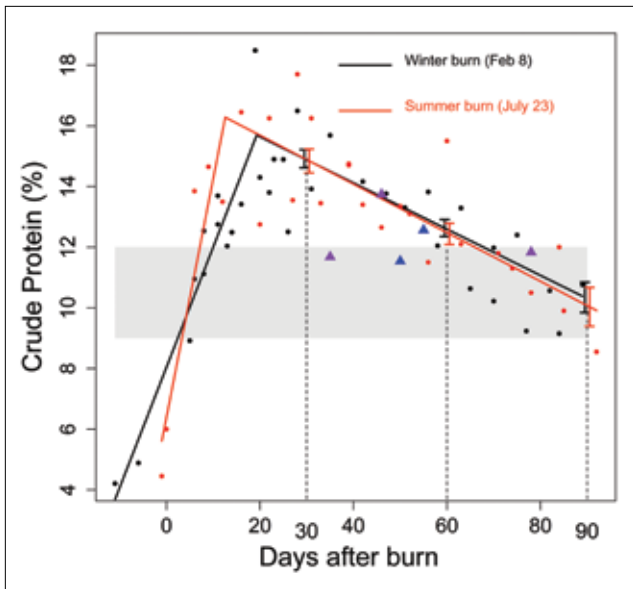
Cooperative funding provided by the Texas Department of Transportation, the USDA Natural Resources Conservation Service, and donors to the Texas Native Seeds Program.

Nutritive Value of Gulf Cordgrass after Burning

Victoria L. Haynes, Jose S. Avila-Sanchez, Sandra Rideout-Hanzak, J. Alfonso Ortega-Santos, David B. Wester, Timothy E. Fulbright, Humberto L. Perotto-Baldivieso, Tyler A. Campbell, and Alfonso Ortega-Sanchez, Jr.

Gulf cordgrass is a perennial bunchgrass common in the Texas Coastal Prairies that provides cover and nesting habitat for wildlife. However, it is poor in nutritive value once it matures. Prescribed fire is an important tool for removing old, coarse growth and encouraging development of new tissue with higher nutritive value through regrowth.

The purpose of our project was to determine whether winter or summer burning improved nutritive



Percent crude protein in gulf cordgrass following winter and summer burning. Predicted values (± 1 standard error) for 30, 60, and 90 days are indicated by dashed vertical lines; blue and magenta triangles represent mean crude protein levels (%) inside grazing exclosures in winter and summer, respectively. Gray area indicates the maintenance levels for lactating cows.

quality. We burned 2 patches (roughly 500 acres each) every winter and summer for 2 years on the East Foundation’s El Sauz property and sampled gulf cordgrass intensively for 90 days following burning.

- There was a faster rise in crude protein following summer burning than following winter burning. Warmer soil surface temperatures along with double the precipitation (4 inches) per month following our summer burns than following our winter burns (2 inches) may be explanations for a faster rise.
- Although the rate of rise differed, similar levels in crude protein between days 19 and 90 suggest there was no meaningful difference in crude protein values of gulf cordgrass regrowth following fire.
- Regardless of season, fiber and lignin levels declined after burning, but progressively rose to return to previous levels within 90 days.
- In conclusion, both seasons of burning improved nutritive value of gulf cordgrass as lower levels of fiber and higher levels of crude protein were achieved for 90 days following burning. Managers could choose to burn at their convenience for the same effect.

Cooperative funding provided by the East Foundation.

Release of Santiago Germplasm Silver Bluestem for West Texas

Colin S. Shackelford, Jameson S. Crumpler, Louis A. Harveson, Keith A. Pawelek, Anthony D. Falk, Forrest S. Smith, Brandon Carr, John Reilley, and Shelly D. Maher

Santiago Germplasm silver bluestem is the second of 2 new formal releases of ecotypic plant material developed for West Texas by *Texas Native Seeds*. It was developed in collaboration with the Borderlands Research Institute at Sul Ross State University and the USDA Natural Resources Conservation Service’s E. “Kika” de la Garza Plant Materials Center and the James E. “Bud” Smith Plant Materials Center.

Silver bluestem is a warm-season perennial bunchgrass found in a wide variety of soil textures and ecological sites. Santiago Germplasm silver bluestem is recommended for upland wildlife plantings, highway rights of ways, energy reclamation, and for inclusion in rangeland seeding mixes. It is a fair to good livestock forage and can compete well with exotic grasses such as Old World bluestems.

- Santiago Germplasm silver bluestem is comprised of 3 accessions from an evaluation trial of over 50 regional collections from West Texas. The selected accessions originate from Kinney, Brewster, and Reeves counties.
- Santiago Germplasm silver bluestem is 1 of 2 new releases from *Texas Native Seeds* developed specifically for grassland restoration projects within West Texas.
- Based on collection site location and evaluation plantings, Santiago Germplasm silver bluestem



© Forrest Smith

***Texas Native Seeds* was involved in the development of Santiago Germplasm silver bluestem for West Texas.**

will perform well in the Permian Basin, southern Rolling and High Plains, western Edwards Plateau, and Trans-Pecos regions of West Texas.

- Licenses for seed production are being negotiated with multiple commercial growers, which will ensure high quality native seeds can be purchased by consumers. Seed from Santiago Germplasm silver bluestem should be commercially available in 2018.

Cooperative funding provided by the Texas Department of Transportation, the USDA Natural Resources Conservation Service, and donors to the Texas Native Seeds Program.

Restoration of Monarch Habitat at the Longoria Wildlife Management Area

Anthony D. Falk, Keith A. Pawelek, Forrest S. Smith, Jimmy Stout, and Anna Strong

Restoration and enhancement of monarch and pollinator habitat have been goals of the Texas Parks and Wildlife Department’s (TPWD) wildlife management areas in recent years. TPWD partnered with *South Texas Natives* to restore retired cropland on the Longoria Wildlife Management Area to diverse native grassland, which also provides habitat to migrating monarchs and other pollinators.

The project began in 2016 with herbicide treatment of non-native grasses and agricultural weeds. After control efforts were made, the site was seeded in the fall of 2017 with a diverse mix of ecotypic native grasses and flowering plant species. This seeding mix helped to create both pollinator habitat as well as



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***South Texas Natives* is helping to restore pollinator habitat in the Lower Rio Grande Valley of Texas.**

acreage that could simultaneously provide habitat to northern bobwhites, doves, and other wildlife.

- We successfully established 26 native species on the site by 6 months post-seeding.
- Monarch butterfly larvae were found on milkweeds within 3 months of planting.
- At 6 months post-planting, 60% of the vegetation cover on the site was made up of seeded native species, with a minimal number of non-native plants.
- The average seeded plant density was 1.2 plants per square foot. This result was twice the threshold desired for successful restoration seedings in grassland habitats.

Cooperative funding provided by the Texas Parks and Wildlife Foundation, National Fish and Wildlife Foundation, and donors to the South Texas Natives Project.

Long-term Responses of Tanglehead to Prescribed Burning and Cattle Grazing

Chase H. Walther, J. Alfonso Ortega-Santos, Humberto L. Perotto-Baldivieso, Sandra Rideout-Hanzak, and David B. Wester

Tanglehead is a grass native to South Texas. It has become increasingly dominant on rangelands and has invasive tendencies. Species that have these tendencies tend to be harmful to many ecosystem components such as wildlife habitat, plant community, and soil characteristics. Our experiment seeks to resolve the trouble with this invasive species by testing a method that will use the expanding forage resource for cattle production as well as reduce its dominance to promote the diversity of native rangeland.

Three 10-acre prescribed burns were conducted in November 2016 on a pasture heavily populated with tanglehead, located south of Hebronville, Texas in Jim Hogg County. Ten cows were outfitted with GPS tracking collars, released prior to burning, and monitored. The cows were allowed to graze continuously for 1.5 years after the burn. The vegetation on the burned patches was sampled to monitor changes in plant community and forage use.

- Cattle used 8 times or more of the available forage in burned areas versus non-burned areas.
- There were twice as many native plant species occurring in the burned plant community than in the unburned plant community.

- Data collected from the GPS collars showed that cattle were 4.5 times more likely to use tanglehead sites after they were burned.
- Cattle productivity was very good with a 90% weaning rate and a 500-pound average weaning weight in the first year of the study.
- Plant species richness and cattle preference for tanglehead may be increased using prescribed burning. Land managers may be able to use this tool to increase grazing use on rangelands that are dominated by tanglehead.

Cooperative funding provided by the Jones Ranch.

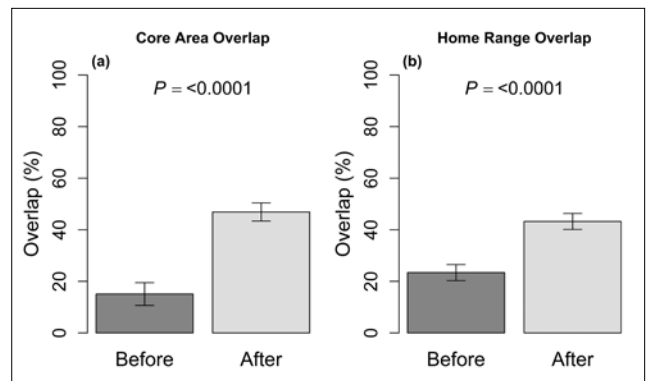
Fire Effects on Cattle Distribution in Gulf Cordgrass

Victoria L. Haynes, Jose S. Avila-Sanchez, Sandra Rideout-Hanzak, J. Alfonso Ortega-Santos, David B. Wester, Timothy E. Fulbright, Humberto L. Perotto-Baldivieso, Tyler A. Campbell, and Alfonso Ortega-Sanchez, Jr.

Cattle often avoid areas of mature gulf cordgrass because it is coarse and low in nutritional value. Fire is an efficient management tool in removing old growth and stimulating higher quality tissues of gulf cordgrass allowing cattle to make better use of it.

We compared prescribed burning in winter and summer to determine the best burning season for optimal livestock use. We burned 2 patches (roughly 500 acres each) on the East Foundation’s El Sauz property each winter and summer for 2 years. To determine use by cattle of gulf cordgrass, we monitored movements of 30 cattle year-round using GPS collars and collected forage for 90 days after burning. The findings below were found regardless of season of burning.

- The proportion of GPS-collared cattle within patches during prime grazing hours (7:00 to 10:30 a.m. and 5:00 to 8:30 p.m.) increased from 17% during the 3 months before burning to 41% during the 5 months following burning.
- Core area and home range size were no different after burning than before burning. However, core area and home range overlap significantly increased (greater than 40%) after burning.
- During the 5 months following prescribed burning, core area was 28 acres, while 95% home range size was 441 acres.
- Forage disappearance in the burned patches was 1,044 pounds per acre during the 90 days post-burn.



Percentage of core area overlap (a) and home range overlap (b) of cattle within burned areas for 5 months following burning during the winter and summer seasons on the East Foundation study sites in South Texas.

- We concluded that 2.5 acres of gulf cordgrass will maintain 1 cow or cow/calf pair for 90 days following either season of burning.

Cooperative funding provided by the East Foundation.

Comparative Microbiota of the GI Tract of Southern Texas Rodents

Molly McClurg, Sarah D. Garza, Scott E. Henke, and Richard C. Laughlin

Despite the co-occurrence of various rodent species within the same ecosystem, many differences exist within the digestive systems of rodents. Rodents eat a variety of foods. Some are predominately carnivorous or herbivorous, and some are omnivorous. Central to this diversity is the unique microbial community found within the intestinal tract of each animal. These microbes are critical for digestion, nutrient production, and protection from pathogens.

We chose cotton rats, hispid pocket mice, grasshopper mice, and deer mice to study, which occur in the same ecosystem. Each species has distinctive digestive predilections, and we were interested in how this distinction affects the microbiota within their caecum.

To better understand the bacteria in these animals, samples were collected from the caecum of each animal, enriched, and cultured for *Salmonella*, *Escherichia*, and *Enterococcus* species, as well as cellulose-degrading bacteria. Selective tests were cultured using Tetrathionate broth and 4 different agars.

- Cultures were successfully grown from cotton rats and hispid cotton mice.
- *Enterococcus* species and *Escherichia* species were found in both rodent species.
- No *Salmonella* species were found in any sample.

Cooperative funding provided by a Texas A&M University-Kingsville Research Award.

Assessing Habitat Associations of Birds During Migration

Samantha J. Wolfe, Arlene J. Arnold, Bart M. Ballard, Matthew J. Schnupp, and John T. Edwards

It is estimated that about 80% of North American avian migrants travel through the southern coast of Texas. Quality of stopover habitat for terrestrial birds is of concern in South Texas because of increasing development and agriculture.

In this study, we investigated habitat associations of migratory birds to identify important factors driving density along the southern Texas coast. We used data

from bird surveys, which took place during spring and autumn migration from 1991–1993 and 2006–2008 within 6 common habitats in South Texas (grassland, shrub-grassland, brushland, parkland, woodland, and oak motte) where 125 species were detected.

- Species richness was highest in the oak motte habitat and lowest in the grassland habitat. Generally, habitats with more cover of woody vegetation tended to support more species.
- Species diversity was highest in habitats with more woody cover during migration periods and was more than 29% higher than in habitats with minimal to no woody vegetation.
- The oak motte habitat had the highest bird density for all bird groups, except the grain eating birds (during spring and autumn) and the flying insect eating birds (during autumn only).
- We calculated feeding guild diversity and found that only brushland, oak motte, and woodland had representatives of all 10 guilds during both spring and autumn migration.
- Although the grassland habitat ranked lowest in other measurements of bird habitat use, it ranked highest for birds listed as species of concern.
- Our findings indicated that oak mottes had a greater abundance of migratory birds and was more diverse in number of species than the other habitats. Minimizing human-related disturbances to oak mottes and managing the native grasslands that surround them are ways to preserve these important habitats for migratory birds.

Noninvasive Genetics: Scat Sampling for Bobcats and Ocelots in Texas

Daniel R. Taylor, Randy W. DeYoung, Michael E. Tewes, Terry L. Blankenship, and Tyler A. Campbell

Genetic methods have become highly useful for tracking genetic diversity and migration in wildlife populations. Non-invasive sources of DNA are especially useful for monitoring carnivores, which tend to be wary and difficult to trap. Scat is a noninvasive source of DNA that can provide more efficient sampling over large areas compared to trapping. We evaluated noninvasive scat sampling as an additional monitoring tool for bobcats and ocelots by establishing transects on 20 miles of ranch roads on the East Foundation's El Sauz Ranch in Willacy County, Texas.

- We found bobcat scats, but no ocelot scats. Six photos of ocelots were taken at our camera monitoring stations during the scat sampling period, confirming that ocelots occupied the study area during our scat collections.
- We identified 20 individual bobcats (12 females and 8 males) based on microsatellite DNA genotypes from 39 bobcat scats obtained during 10 days of sampling in winter 2017.
- The 20 miles of road transect surveys yielded an average of 3.5 bobcat scats per day, which was double the number of bobcat photos per day with 27 camera stations.
- Road-based scat sampling was an efficient way to obtain DNA for bobcats, but our lack of ocelot detections suggests that ocelots do not use ranch roads for scat marking as bobcats and coyotes do.
- Future ocelot research into fine-scale habitat use and scent-marking behavior could reveal a better method of collecting DNA from ocelots. Doing so may be possible with the aid of trained dogs.

Cooperative funding provided by the Rob and Bessie Welder Wildlife Foundation, Brown Foundation, James R. Dougherty Foundation, Travis and Bettina Mathis, Rachael and Ben Vaughan Foundation, and the East Foundation.

Raccoon Roundworm as an Occupational Hazard to Wildlife Caregivers

Austin A. Killam, Tiffany L. Pope, Scott E. Henke, Humberto L. Perotto-Baldivieso, and Clayton D. Hilton

Baylisascaris procyonis is a large nematode found in the small intestine of raccoons. Adults are not harmful to raccoons. However, larvae in intermediate hosts can cause blindness, paralysis, and death. Infected raccoons expose intermediate hosts through their feces, which can contain millions of eggs.

Recently, we demonstrated a single *B. procyonis*-infected raccoon could contaminate half an acre per year with *B. procyonis* eggs. This is a conservative estimate because this calculation assumes every square inch of ground would become contaminated.

Baylisascaris procyonis represents a risk to wildlife caregivers and wildlife rehabilitation personnel. Therefore, our objectives were to (1) determine the prevalence of *B. procyonis*-positive scats within the Tio and Janell Kleberg Wildlife Research Park, (2) determine the potential exposure to captive wildlife and human caregivers, and (3) determine the most

effective methods to minimize or prevent transmission to humans and captive animals.

- Twenty-eight fecal samples from raccoons were collected and analyzed using the centrifugal flotation method for parasite eggs. Of these, 5 specimens (18%) were positive for *B. procyonis* eggs.
- Two locations were contaminated with *B. procyonis* eggs within the captive deer pasture, 1 location within the hay storage facility, and 1 location within the aviary.
- Raccoon trapping, coupled with burning contaminated soil, has been the only successful method to reduce *B. procyonis* eggs.
- Personnel in *B. procyonis* egg-contaminated areas should always wear gloves and thoroughly wash their hands upon leaving the area to reduce their risk to this zoonotic parasite.

Cooperative funding provided by a Texas A&M University-Kingsville Research Award.

Training K-12 Educators on the Wild Bird Conservation Curriculum

Janel L. Ortiz, April A. Torres Conkey, Leonard A. Brennan, La Vonne Fedynich, and Mary E. Green

The Wild Bird Conservation Curriculum Program held educator training workshops where 5 lesson plans were covered: bird identification, mist-netting, citizen science, quail internal parasites, and habitat fragmentation mapping. These free lesson plans, aligned with state of Texas standards, provided local educators with



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During the training workshop, participants conducted a bird survey as part of the lesson “Basics of Birding.”

tools to incorporate wildlife and introduce students to a STEM (Science, Technology, Engineering, and Mathematics) career.

Forty-nine participating educators were evaluated by pre- and post-workshop surveys on their affinity, perceptions, and attitudes towards wildlife and birds. Four 2-day training workshops took place during summer 2015, summer and winter 2016, and summer 2017 with participants coming from private and public schools, colleges, and various environmental, state, or non-profit agencies or organizations such as Kingsville ISD, Texas A&M University-Kingsville, Oso Bay Wetlands Preserve, and Texas Parks and Wildlife.

- Educators came into the workshop with positive perceptions and attitudes towards wildlife.
- Workshops were minimally effective in improving educators' perceived bird knowledge.
- Educators emphasized the importance of outdoor lessons and the potential for integrating citizen science in the classroom.
- Feedback on the workshop was positive, with educators most interested in the topics of mist-netting and banding and bird identification.
- Educators considered the workshop well organized, meeting their expectations, and would recommend this workshop to their colleagues in the future.
- Creating connections between educators and workshop instructors helped to encourage a positive relationship with the surrounding community, assisted the Caesar Kleberg Wildlife Research Institute in promoting wildlife conservation, and helped others learn about the importance of wildlife.

Cooperative funding provided by the Elizabeth Huth Coates Charitable Foundation of 1992, Coastal Bend Audubon Society, Rachael and Ben Vaughan Foundation, and Leatrice Koch.

Estimation of Rangeland Biomass Using Unmanned Aerial Systems

Karelys N. Labrador-Rodriguez, Humberto L. Perotto-Baldivieso, J. Alfonso Ortega-Santos, Chase H. Walther, Jinha Jung, Anjin Chang, and Junho Yeom

Unmanned Aerial Systems (UAS) can be used in the management and monitoring of rangelands. They can be useful in the estimation of forage standing biomass. The low altitude platforms, reduction in the size of sensors, development of high spatial resolution imagery, and flexibility to fly UAS in remote



© Timothy Fulbright

The use of unmanned aerial systems can be a cost-effective approach for vegetation surveys and habitat monitoring.

environments can help increase the areas sampled for biomass estimation. The use of UAS can also help us quantify areas that are invaded by monocultures such as tanglehead. Tanglehead is a native perennial grass found on rangelands in Texas and its growing abundance is a concern for many landowners in the South Texas region.

The goal of this study was to test the feasibility of a UAS-based approach to estimate aboveground vegetation biomass. Imagery at 0.78 inches (2 cm) resolution was acquired by flying Phantom IV UAS over an area invaded with tanglehead in Jim Hogg County, Texas in October 2016. We created an image and a digital surface model to identify and quantify tanglehead biomass.

- We were able to estimate total standing tanglehead biomass with a 66% accuracy.
- Our results showed that we can identify tanglehead and assess tanglehead biomass using imagery obtained from UAS.
- The methodology we used for assessing tanglehead can be used for estimating forage in more heterogeneous pastures.
- Our findings provide landowners with a new and useful way to monitor forage biomass, which can aid in improving the estimation of livestock stocking rates.

Cooperative funding provided by USDA National Institute of Food and Agriculture Hispanic Serving Institutions Award No. 2016-38422-25543, Jones Ranch, and Rotary Club of Corpus Christi (Harvey Weil Sportsman Conservationist Award).

The Effectiveness of Using Paint Pens to Mark Turtles for Population Assessment

Kelley A. Wood, Tristan Summy, and April A. Torres Conkey

Turtles can be used as an indicator species to evaluate pond or lake health. Their populations can be monitored and estimated using mark-recapture methods.

Typically, marking is accomplished using a file to make a series of notches unique to that individual along the edge of its shell. This is a time-consuming and difficult method for students to perform and cannot be used on softshell turtles. In this study, we tested the effectiveness of using paint pens to mark turtles and to estimate the size of a turtle population.

We used hoop nets baited with sardines to capture turtles in a pond for 5 days between September 28th through October 5th, 2017 at the Dick Kleberg Park in Kingsville, Texas. Each individual turtle was given a unique mark with a paint pen on the underside of its shell. Turtles were measured and released back into the pond.

- We caught 64 turtles; all were red-eared sliders (39% juveniles, 25% subadults, and 36% adults).
- We found 31% of the adults were female, 55% were male, and 14% were too young to sex.
- The population size within the pond was estimated to be 250 individuals.
- No softshell turtles were captured.
- Painted marks showed some wear on recaptured individuals. The marking location under the shell may have caused some paint to come off due to contact with the bottom substrate of the pond.



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Undergraduate students learned how to identify, measure, and mark turtles for a population survey.

- We concluded that paint pens can be used as a non-invasive marking technique for hard-shelled turtles during a short-term study.

Winter Habitat Selection by Sandhill Cranes Along the Texas Coast

Emily D. Wells, Bart M. Ballard, Shaun L. Oldenburger, Daniel P. Collins, David A. Brandt, Aaron T. Pearse, Humberto L. Perotto-Baldivieso, and David W. Wolfson

The Gulf Coast subpopulation of sandhill cranes winters along the Texas coast and relies on specific habitats to meet seasonal and daily needs. Over the last few decades, the Texas coast has experienced significant land changes, including expanding development, changes in agricultural practices, and wetland loss—all having unknown impacts on sandhill cranes. To better understand the impacts of these land changes, we attached tracking devices to 40 adult sandhill cranes wintering along the Texas coast and collected location data from 2015–2018.

- We found that during the day, sandhill cranes selected grasslands (includes pastures and fallow fields), freshwater emergent wetlands, and agricultural grain fields to feed.
- At night, cranes roosted predominately in inland freshwater wetlands and flooded grasslands, as well as shallow, open water bays in coastal areas.
- Use of roost sites was positively related to the amount of grassland and grain crops within a morning's foraging commute (about 4 miles), and negatively related to the amount of human development and coastal estuaries.
- Sandhill cranes within the Gulf Coast subpopulation appear to be more mobile than other sandhill crane populations as their home ranges were considerably larger than found in other populations. Also, they exhibited low levels of fidelity to wintering sites among years.
- Our results emphasize the importance of maintaining landscapes with adequate roosting habitat located within a matrix of grasslands, crop fields, freshwater wetlands, and a limited amount of human development.

Cooperative funding provided by the Texas Parks and Wildlife Department, U.S. Fish and Wildlife Service, and U.S. Geological Survey.

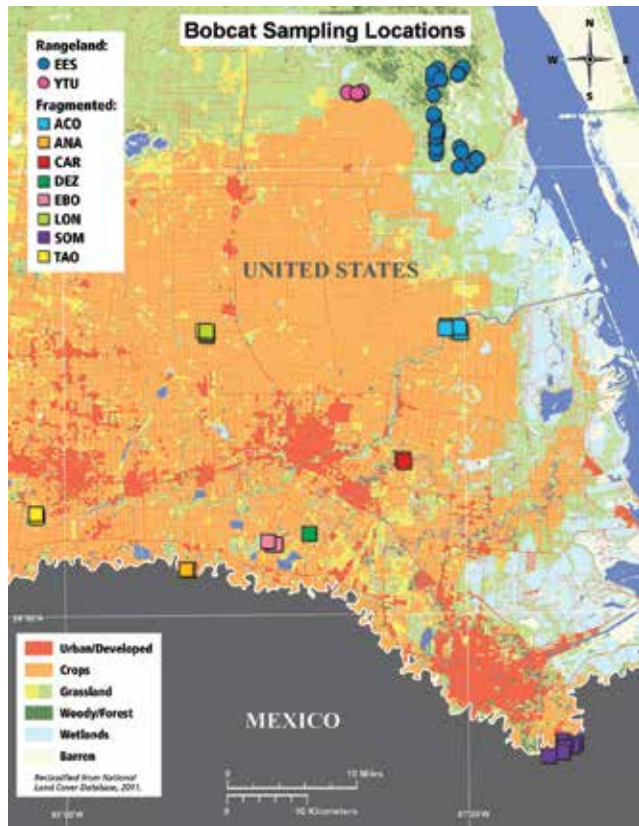
Genetic Analysis of Bobcats Occurring in a Fragmented Landscape

Daniel R. Taylor, Randy W. DeYoung, Michael E. Tewes, Terry L. Blankenship, and Tyler A. Campbell

Some of the highest rates of human population growth and land-use changes in the United States are taking place in the Lower Rio Grande Valley of South Texas. Bobcats can live in small habitat patches within urban landscapes. Their movements through the fragmented areas can be indicative of the effects of fragmentation on other species.

In this study, we compared genetic differentiation and diversity of bobcats in the Lower Rio Grande Valley of South Texas that occurred in fragmented areas to bobcats that occurred in rangeland habitats using DNA extracted from scat. We detected 68 individuals within our sampling sites.

- Genetic data analysis revealed evidence for restricted movement and dispersal of bobcats in fragmented habitat patches.
- In fragmented areas, bobcats sampled within 9 miles of each other were genetically similar, whereas bobcats sampled in rangelands showed no



Individual bobcats sampled within the heavily altered landscape of the Lower Rio Grande Valley of South Texas.

The proportion of individual bobcats per generation that migrated from or stayed within their respective rangeland or urban populations, estimated from genetic data collected in South Texas during 2016–2017.

Bobcat Population Dispersal		
	FROM Rangeland	FROM Urban
TO Rangeland	71.4%	28.6%
TO Urban	3.3%	96.7%

relationship between genetic similarity and geographic distance.

- Estimates of migration rates and direction indicated that bobcats within the fragmented areas are likely to remain or disperse to rangeland, but dispersal rarely occurred into fragmented areas from rangeland habitats.
- Directional migration raises concerns that the feline leukemia virus and the feline immunodeficiency virus could spread to rangeland bobcat populations from urban bobcats exposed to infected feral cats.
- Bobcats should continue to be used as an indicator species for the effects of fragmentation on wildlife populations because of their wide range, mobility, and adaptable generalist diet.
- Habitat fragmentation that affects bobcats in South Texas will likely affect other species that are less adaptable to landscape changes, such as the endangered ocelot.

Cooperative funding provided by the Rob and Bessie Welder Wildlife Foundation and the East Foundation.

Evaluating Ground Juniper and Mesquite in Goat Feedlot Diets

Jessica L. Glasscock, Travis R. Whitney, David G. Hewitt, Fred C. Bryant, and Susan M. Cooper

Woody plant encroachment can limit rangeland production for livestock and wildlife. To improve production, thinning of invasive species in high density areas can be beneficial. Such projects would be more economically feasible if the cleared brush could be marketed.

For this research project, 4 species of juniper (which are invasive woody trees or shrubs found on rangelands throughout North America) and 1 species of mesquite (honey mesquite) were harvested and

ground for use in goat total mixed rations. Our goal was to assess the effectiveness of ground juniper and mesquite as the roughage ingredient in Spanish x Boar kid goat feedlot diets.

Growth performance, including body weight, average daily gain, weight gain to the amount of feed consumed, and blood serum chemistry, was evaluated for 48 kid goats during 2 feeding trial periods. The percentage of ground woody roughage was 30% during period 1 (growing period) and 14% during period 2 (finishing period).

- Results suggested that ground redberry, blueberry, and one-seed juniper can effectively be used to completely replace cottonseed hulls—a traditional roughage ingredient used by the livestock industry in goat feedlot diets.
- During the growing period, feeding goats a diet with 30% eastern red cedar or honey mesquite may not be justifiable, based on growth performance. However, their use during the finishing period at 14% is warranted.
- Blood serum chemistry indicated no negative impacts to animal health.
- Results from this research can help to reduce the cost of livestock production, especially when the costs for traditional feed ingredients increase because of drought or other environmental or economic factors.

Cooperative funding provided by Texas A&M AgriLife Research and Extension Service and the Rob and Bessie Welder Wildlife Foundation.

Neoplasia in a Texas Tortoise from Willacy County, Texas

Javier O. Huerta, Cord B. Eversole, and Scott E. Henke

The Texas tortoise is the smallest and most sexually dimorphic of the 4 tortoise species within its genera. It is considered threatened in Texas and is typically found in the southwestern portion of the state. Little is known about the ecology of the Texas tortoise and even less is known about their diseases and parasites.

On March 22nd, 2018, we observed a female Texas tortoise alongside a private ranch road in Willacy County, Texas. The individual exhibited an abnormal growth on the lower right side of the mandible.

We hypothesized that the growth was a tumor (neoplasm). Because of extensive fire damage to the



© Javier Huerta

Neoplastic formation on the lower right-side mandible of a wild Texas tortoise sighted in Willacy County, Texas.

carapace, which is common in land tortoises, age of the tortoise could not be determined using the growth ring count method; however, the individual appeared quite old.

- Mobility, health, and normal function were seemingly unaffected by the deformity. For example, there were no signs of weight loss, which would be evident if it had difficulty eating.
- The only noticeable impairment of function caused by the tumor was the individual's inability to fully retract its head into its shell. This is an important finding because the tumor could potentially increase this individual's vulnerability to predation or another fire event.
- To our knowledge, no previous reports of neoplasia have been documented in Texas tortoises.
- Because of the threatened status of Texas tortoises, future research on health problems is important in the overall conservation of this species.

Bringing Back the Dead: Genetic Data from Avian Carcasses

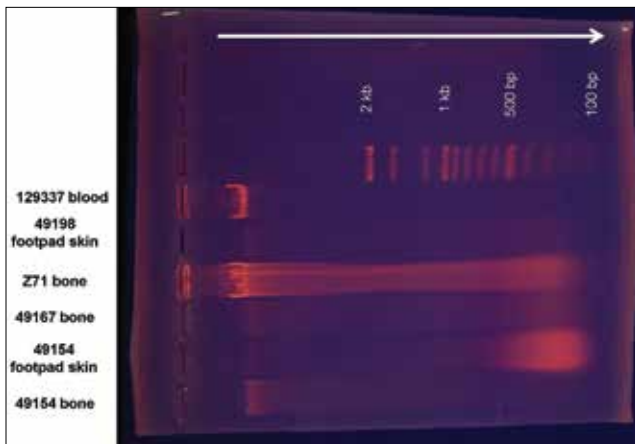
Lianne M. Koczur, Damon L. Williford, Randy W. DeYoung, and Bart M. Ballard

Advances in molecular biology and DNA sequencing technology now enable scientists to conduct genetic analysis of museum specimens, fossils, and carcasses. Genetic material obtained from avian carcasses may be a valuable tool for conservation of birds, especially

waterbirds. However, aquatic birds typically live in warm, humid climates—conditions that are not conducive to the preservation of DNA.

We conducted this study to determine if DNA can be obtained from avian carcasses associated with a marine environment. Seven marked reddish egrets were recovered from the Laguna Madre of South Texas during 2010–2014 that had been dead from 2 weeks to 3 months. We obtained samples from toepad, bone, and feather material.

- We determined the sex of the 7 reddish egrets (6 males and 1 female). Replication of the molecular sexing indicated that the skewed sex ratio may be due to timing or methods of capture or sex-bias in survival rather than allelic dropout or postmortem DNA degradation.
- We obtained mitochondrial DNA sequences from 6 of the carcasses, but some of the mitochondrial DNA sequences showed signs of DNA degradation.
- Mitochondrial DNA sequences from the reddish egret carcasses were identical or closely related to those obtained from fresh tissues and previously published haplotypes.
- The ability to extract usable DNA from avian carcasses salvaged in a marine environment has implications for ecology and management of waterbirds, many of which are rare, sexually monomorphic, and poorly understood.
- The ability to amplify genetic markers from carcasses provides valuable sex-specific information on longevity and mortality, migratory strategies, habitat use, site fidelity, and dispersal.



Electrophoresis gel showing DNA extracted from reddish egret carcasses using bone and skin samples compared to DNA extracted from blood. The streaks produced indicates low quality DNA due to degradation. Despite lower quality samples from carcasses compared to blood, we were able to extract DNA from all samples and determine the sex of all individuals.

- Genetic studies that use DNA sequences from carcasses should estimate the extent of postmortem molecular damage and consider how it may impact estimates of genetic relatedness and diversity.

The Effectiveness of Mint as a Repellent to Rodents

Scott E. Henke and David B. Wester

Rodents can be considered a major pestilence world-wide because of health hazards and damage to households and agricultural crops. Numerous rodenticides have been developed to control rodents. However, most rodenticides are poisonous.

Plant secondary metabolites (PSMs) are used by plants to deter their predators. Natural extracts of PSMs have been considered as an alternative method to poisons. Learned avoidance can be accomplished with aromatic PSMs by ingestion followed by digestive distress. Thereafter, animals will avoid places with the same smell. Mint has been hypothesized to have such effects on rodents.

Our objectives were to determine if mint leaves produce digestive distress, and if so, determine whether a learned avoidance to mint developed. We provided wild rodents with free-choice feeders containing fresh vegetation and mint leaves and determined their daily consumption to each and whether rodents avoided mint thereafter and for what period of time.

- Mint did not cause intestinal distress or sickness; therefore, a learned avoidance was not established.
- The smell or taste of mint did not repel rodents.
- Sex differences in mint consumption did not occur. However, we found males consumed more food than females.
- Products that use mint to deter rodents do not appear to be effective.

Change in Woody Cover Affects Ocelot Recovery in the Rio Grande Delta

Jason V. Lombardi, Michael E. Tewes, and Humberto L. Perotto-Baldivieso

The Rio Grande Delta is perhaps one of the most rapidly developing areas in the United States. Over the last 30 years, agricultural and rangeland conversion

has led to degradation of woody cover types in South Texas. Over the same period, ocelots have experienced severe population declines from loss of preferred thornshrub cover, collisions with vehicles, and loss of genetic diversity.

We classified LANDSAT imagery from 1987–2016 to determine the change in land cover and the rate of habitat fragmentation. Using the U.S. Environmental Protection Agency’s housing density projections, we quantified the effect of urban development on changes in woody cover, changes in agriculture and rangelands, and changes in habitat fragmentation.

- Since 1987, woody cover increased from 12% to 16%, while Euclidean distance to nearest neighboring habitat patch, patch density, and mean patch size decreased.
- As time progressed from 1987 to 2016, small habitat patches (less than 50 acres) increased from 8,000 to 30,000 and the number of large patches (greater than 12,350 acres) decreased.
- Within the next 32 years, rapid urbanization along the U.S.-Mexico border will lead to significant losses in agriculture, woody cover, and rangelands in the Rio Grande Delta and form an impenetrable wall for fragmentation-sensitive species such as the endangered ocelot.
- The key to ocelot survival remains in the northern private lands, which hold the largest patches of woody cover in the region and will see no effects of the rapid urbanization near the international border.

Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute, Wild Cat Conservation, Inc., Annova LNG and their parent company Exelon Generation, Brown Foundation, Tim and Karen Hixon Foundation, Travis and Bettina Mathis, and Ben F. Vaughan, III.

Landscape Characteristics that Drive Migratory Bird Density in South Texas

Samantha J. Wolfe, Arlene J. Arnold, Bart M. Ballard, Matthew J. Schnupp, Humberto L. Perotto-Baldivieso, Sandra Rideout-Hanzak, and David B. Wester

South Texas provides stopover sites for millions of migratory birds seeking resources prior to and after long flights across the Gulf of Mexico. Habitat selection at spring stopover sites plays a crucial role in the success of terrestrial birds arriving at their breeding grounds in optimal body condition. In particular, the

Number of observations (n) made in each bird group during spring and autumn migration in South Texas from 2006–2008.

Bird Group	Spring (n)	Autumn (n)
Flycatchers	898	743
Warblers	230	204
Grassland-Specific Birds	1,636	570

spatial arrangement and amount of vegetation influence the movement of birds. Thus, we investigated habitat associations of birds during migration along the lower Texas coast to identify important factors driving bird density.

We conducted line transect surveys for flycatchers, warblers, and grassland-specific birds during spring and autumn migration from 2006–2008. Using distance sampling, we calculated transect-specific bird densities during spring and autumn. We extracted landscape features that provide information on spatial structure of land cover types at each transect, and then ran statistical tests to determine which ones were influencing bird densities.

- Density of warblers during migration was negatively influenced by herbaceous ground cover and positively influenced by woody cover.
- In addition to an obvious affinity for a herbaceous component, grassland-specific birds also showed a positive relationship with woody vegetation during the migratory period.
- Although our findings contradict what is considered typical grassland bird habitat during the breeding season, they supported findings from previous studies that were conducted in South Texas during the non-breeding season.
- Density of flycatchers was positively related to several herbaceous and woody landscape features suggesting that a mixed landscape is preferred.
- Our findings support the idea that natural resource managers in South Texas should aim to preserve a mosaic of diverse habitats that are in various successional stages.

ABSTRACT EXTERNAL AUTHORS AND CO-AUTHORS

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- Mr. Tristan Summy

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PARTING SHOTS



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Graduate students working for the Caesar Kleberg Wildlife Research Institute spend a lot of time outdoors. They see amazing sights and capture some of these through the lens of a camera. Because of the importance of captivating images to wildlife conservation, we share some of our students' photographs here. Enjoy these parting shots.

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