

CAESAR KLEBERG  
**WILDLIFE**  
RESEARCH INSTITUTE  

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TEXAS A&M UNIVERSITY-KINGSVILLE



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Current Research 2020–2021

*Editor* Sandra Rideout-Hanzak, Ph.D.

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December 2021

# **Report of *Current Research***

**September 1, 2020 to August 31, 2021**

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## Foreword

Dear Friends of the CKWRI,

The scientists and students at the Caesar Kleberg Wildlife Research Institute are world-class. That is a bold statement, and I can back it up.

There are many ways to gauge the strength of a science program. Two of the primary measures of productivity are grant dollars and publications. Grant dollars are important because studying wildlife and its habitat requires sophisticated techniques, advanced equipment, travel, and sometimes a small army of people. All of this is expensive, making external grants essential to conducting research. And just like any free-market, grant dollars flow to successful scientists and to successful programs. Thus, the \$5 million in external funds acquired by CKWRI scientists last year is evidence of an outstanding research program.

Publications are another measure of success and the publications that matter most in science are those that have been reviewed by other scientists. These peer-reviewed publications are important because they are only published if they pass muster. Last year CKWRI scientists and graduate students published 60 articles. This is a large number of peer-reviewed publications from a single program and many of the publications were in top journals for applied wildlife and range research. Publishing our science is important because it provides assurances to our supporters that our science is top-notch.

The downside to peer-reviewed publications is that these papers are in scientific journals, are not widely available, and are written in scientific prose. Clearly, scientific articles are not useful to most wildlife managers and land stewards. For this reason, CWKRI students and scientists do something that is almost unheard of in other wildlife scientists. Our people not only publish scientific articles, they invest a great deal of effort sharing their results in publications that target land stewards. CKWRI publishes *Caesar Kleberg Tracks* and *South Texas Wildlife Newsletter*. We write articles for Texas Wildlife Association's (TWA) *Texas Wildlife* magazine and some of our articles appear in *Texas Farm & Ranch*. We produce



a podcast, *A Talk on the Wild Side*, which often showcases our own scientists, and our work has been featured on the outdoor program *West of Texas*. We will soon be featured on *Somewhere West of Wall Street*. Our scientists and students present at workshops and seminars throughout the state, some of which are hosted by TWA, Texas Parks and Wildlife, and by The Institute itself. Our scientists enjoy nothing

more than visiting a ranch and discussing wildlife management with the owners and others involved in ranch operations. We work hard to share our findings with land stewards because they are the people who can apply our research in the service of wildlife and habitat conservation.

A final mark of a successful research institute is that people from outside the organization want to work with you. The project abstracts in this year's Current Research report have 120 co-authors not affiliated with CWKRI. Last year there were 132 external co-authors. We not only have many external research partners but we attract students from all over the country. This year our graduate students came from 16 states and 2 foreign countries. Since the Institute's inception, we have had students from 44 states.

CKWRI scientists write the books, lead the professional societies, serve on the advisory committees, and teach the classes that ensure the wildlife profession remains vibrant and relevant. After reviewing this edition of Current Research, I am sure you will agree our scientists and students are top-notch. I hope you will also realize the reason they are able to shine is because of your support of, and interest in, what they do. Thank you!

A handwritten signature in black ink that reads "David Hewitt".

David Hewitt  
*Leroy G. Denman, Jr. Endowed  
Director of Wildlife Research*

# Scholarships and Fellowships

## Student Scholarships

*René Barrientos Fund for Graduate Student Tuition*  
Every graduate student in our program financially benefits from this fund.

*Houston Safari Club Dan L Duncan  
Scholarship Program*

Dustin A. Golembiewski, Megan M. Granger, Ashley G. Hodge, Zachary J. Pearson

*Quail Coalition Scholarship in Wildlife Management  
Graduate Scholarships, South Texas Chapter*

Matti R. Bradshaw, Rider C. Combs, Jacob L. Dykes, Georgina R. Eccles, Jesse Exum, Bethany A. Friesenhahn, Dustin A. Golembiewski, Megan M. Granger, Mikayla M. House, B. Kye Johnston, Austin K. Killam, Jason P. Loghry, Michael T. Page, Maksim Sergejev, Kathryn M. Sliwa, Brianna M. Slothower, Kristyn G. Stewart, Nicole J. Traub, Amanda M. Veals, Rebecca R. Zerlin

*Quail Coalition Scholarship in Wildlife Management  
Undergraduate Scholarships, South Texas Chapter*

Alejandro Bazaldua, Juan C. Elissetche, John E. Herschberger, Lori D. Massey, Eve Schrader, Taylor Trafford, Joshua Vasquez

*Amanda Whitaker Memorial Graduate Student Scholarship  
in Wildlife Management, South Texas Chapter of Quail  
Coalition*

Donal A. Woodard

*San Antonio Livestock Exposition Scholarship*

Matti R. Bradshaw, B. Kye Johnston

*Houston Livestock Show and Rodeo Graduate Scholarship*  
Alexandria M. DiMaggio, Austin K. Killam

*Houston Livestock Show and Rodeo Graduate Fellows in  
Wildlife Research*

Katie Pennartz, Bryan Spencer

*Lon and Leigh Cartwright Graduate Scholarship  
in Grass Management*

Dustin A. Golembiewski, Michael T. Page, Brianna M. Slothower

## Endowed Student Scholarships

*Robert and Rebecca Palmer Scholarship Fund  
Graduate Students*

Maksim Sergejev, Nicole J. Traub, Amanda M. Veals, Donal A. Woodard

*Robert and Rebecca Palmer Scholarship Fund  
Undergraduate Students*

John E. Herschberger, Lori D. Massey, Eve Schrader, Joshua Vasquez

*A. E. Leonard Undergraduate Student Scholarship in  
Wildlife Conservation*

Alejandro Bazaldua, Juan C. Elissetche, Taylor Trafford

*Phillip M. Plant Endowment for Graduate Scholarships in  
Wildlife*

Megan M. Granger, Jesse Exum, Mikayla M. House, Kathryn M. Sliwa, Kristyn G. Stewart, Rebecca R. Zerlin

## Endowed Student Fellowships

*Sam Walton Fellowship in Quail Research*  
Search in progress

*Alice Gertrudis King Kleberg Reynolds Endowed  
Fellowship in Quail Research*  
Zachary J. Pearson

*Elliot B. and Adelle Bottom Fellowship in  
Quail Research*

John E. Herschberger, Kristyn G. Stewart

*Walter Fondren, III Fellowship in Shorebird and Wading  
Bird Research*

Jason P. Loghry

*Betty and George Coates Fellowship in Habitat  
Enhancement Research*

Aidan B. Branney

*Jess Y. Womack, II Fellowship in Wetlands and Wetland  
Bird Research*

Search in progress

*Boone and Crockett Club Fellowship in Ungulate Research*  
Calvin C. Ellis, Levi J. Heffelfinger

*Hixon Fellowship in Deer*  
Levi J. Heffelfinger

*Hixon Fellowship in Quail*  
Lindsey K. Howard

*Hixon Fellowship in Range Restoration*  
Katherine A. Travis

*Kenneth E. Leonard Fellowship for Livestock-Wildlife  
Research*

Rider C. Combs

*Stuart W. Stedman-Faith Ranch Fellowships in Deer  
Research*

Jesse Exum, Breanna R. Green

*Mike and Mary Terry Family Endowed Fellowship for  
Habitat Research*

Dustin A. Golembiewski

*Frances and Peter Swenson Fellowship in Rangeland  
Restoration Research*

(Swenson Fellowship matched by the Estate of  
Nadine Arrington)

Brianna M. Slothower

**We acknowledge the donors of these student scholarships and fellowships with gratitude.**



# In Memory and Honor & Endowment Updates

## In Memory and Honor...

Many people choose to send unsolicited gifts in honor of cherished friends or family. In FY2021, we have received memorials and gifts to honor...

*Leon Bauerle*  
*James “Jimmy” Dale Evans*  
*Hugh Fitzsimons*  
*John Harris*  
*Harold Hees*

*\*Charlie M. Herrington*  
*\*Radcliff Killam*  
*\*Tio and Janell Kleberg*  
*\*Meredith Long*  
*Ed Randall*

*Patrick “Pat” Rutherford*  
*\*Alec D. Ritzell*  
*\*David Villanueva*  
*Kathryn and Mickey H. West Jr.*  
*\*Anse Windham*

\* Also honored in previous years

## New Endowments

*The Morton Cohn Family Endowment  
 for Quail Research*

*The Kate Fisher Foundation Endowed Fund  
 for Habitat Restoration in Central Texas*

*David G. Hewitt Endowment for Deer Research*

*Laurie & Duane Leach Avian Research Endowment*

*Meredith Long Wildlife Internship Program*

*James R. and Alinda H. Wikert Endowment  
 for Quail Research*

*Isabel B. and Wallace S. Wilson Endowment  
 for Quail Research*

## Elevated Endowments

The following endowments were already established, however, the donors have graciously elevated the endowment level as reflected in the title (Chair and Fellowship)

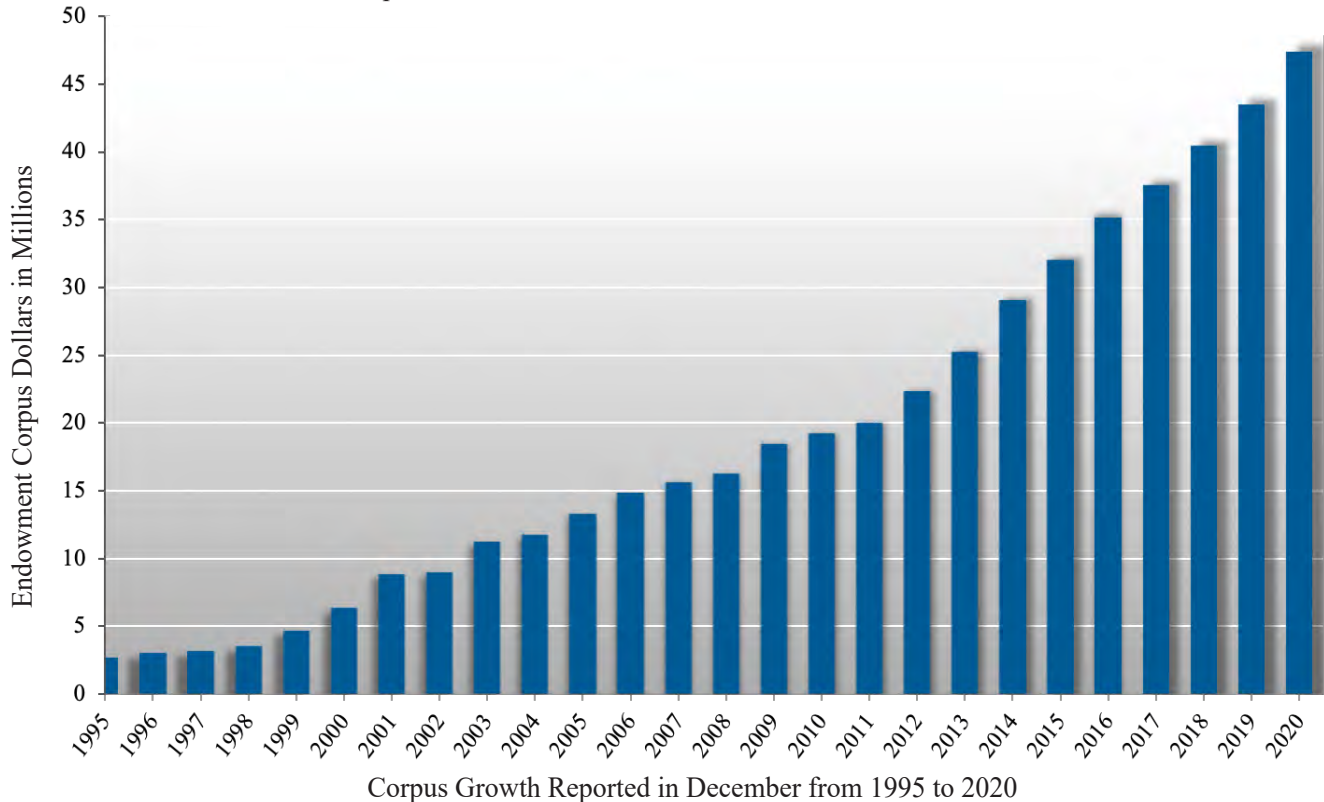
*Alfred C. Glassell, Jr. Endowed Chair  
 for Quail Research*

*Frances and Peter Swenson Endowed Chair  
 in Rangeland and Restoration Research*

*The F. Peter Zoch, III Fellowship  
 for Research in Habitat Enhancement*

## Endowment Financials

The Caesar Kleberg Wildlife Research Institute Endowments ended the year on December 31, 2020, with a corpus value of \$47.4 million and a market value of \$62.5 million.



# Our Students

The world-class program at the CKWRI attracts some of the brightest minds from all over the United States and beyond. Our program is unique in that we offer students the opportunity to conduct research on private lands. Because of this, our students leave with a greater appreciation for private landowners and their stewardship values.

*We had over 55 graduate students  
in our program during the  
2020-2021 academic year.*



## Where They Go

Once they graduate, our students are some of the most sought after in the field of wildlife biology and habitat management. CKWRI graduates are working for:

American Bird Conservancy  
The Center for Environmental  
Management of Military Lands  
CrossTimbers Consulting, Inc.  
Deseret Cattle & Timber  
Ducks Unlimited  
Florida Fish and Wildlife Conservation  
Georgia Department of Natural  
Resources  
Idaho Fish and Game  
Kansas Wildlife Service  
King Ranch, Inc.  
Michigan Department of Natural  
Resources  
Michigan State University

Mississippi Department of Wildlife,  
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Montana Fish, Wildlife, and Parks  
The Nature Conservancy  
Pheasants Forever  
Private Ranches  
Quail Forever in Arkansas  
Rocky Mountain Bird Observatory  
Stephen F. Austin State University  
in Forest Wildlife Management  
Texas A&M International  
Texas A&M University-College Station  
Texas A&M University-Kingsville  
Texas Parks and Wildlife Department  
Texas Tech University

USDA - NRCS  
U.S. Fish and Wildlife Service  
U.S. Forest Service  
U.S. Geological Survey, Patuxent  
Wildlife Research Center  
U.S. Geological Survey, National  
Wildlife Health Center  
University of Idaho  
University of San Diego  
Department of Biology  
Washington Department of  
Fisheries & Wildlife  
Welder Wildlife Foundation  
Wisconsin Department of  
Natural Resources

# Our Students

## 2020-2021 M.S. & PH.D. GRADUATES

*Jose Cortez, M.S.*

Thesis: Accelerating Maturation of Thornscrub Habitat for Ocelots

*Alexandria Dimaggio, M.S.*

Thesis: Prescribed Burning and Cattle Grazing of Tanglehead

*Javier Huerta, M.S.*

Thesis: Effects of Habitat Restoration on Texas Horned Lizards and their Prey

*Jessica Glasscock, Ph.D.*

Dissertation: Evaluating a Forage Based Supplemental Feed for White-Tailed Deer

*Michael Page, M.S.*

Thesis: Developing Unmanned Aerial Vehicle Approaches for Range and Wildlife Habitat Studies

*Seth Rankins, M.S.*

Thesis: Micro-Habitat Influences the Phenotypic Quality of White-Tailed Deer in South Texas

*Kathryn Sliwa, M.S.*

Thesis: Evaluation of Methods for Eradication of Cattle Fever Ticks on Nilgai and White-Tailed Deer



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# Our Science Team

## Science Team: By The Numbers

PERSONNEL

18

FACULTY



28

RESEARCH  
STAFF

5

ASST. PROFESSORS  
OF RESEARCH



PEER  
REVIEWED  
PUBLICATIONS

60

104

PROFESSIONAL  
PRESENTATIONS



RESEARCH  
GRANTS &  
CONTRACTS

\$5.12

Million

## Science Team: Awards & Achievements

The **Professor Emeritus** designation was given to Dr. Alan Fedynich by the TAMU Board of Regents.

The **2021 Senior Teaching Award** was presented to Dr. Bart Ballard by the College of Agriculture & Natural Resources at TAMUK.

The **2021 Senior Research Award** was given to Dr. Humberto Perotto-Baldivieso by the College of Agriculture & Natural Resources at TAMUK.

The **Outstanding Science Article Award** was given to Dr. Charles A. DeYoung, Dr. Tim Fulbright, Dr. David Hewitt, and Dr. David Wester for Linking White-Tailed Deer Density, Nutrition, and Vegetation in a Stochastic Environment, from the Texas Chapter of The Wildlife Society.

**First place** in the **Popular Publication Category** went to Keith Pawelek for Land Disturbance: Problem or Opportunity? from the Texas Section of the Society for Range Management.

**First place** in the **Technical Publication Category** was awarded to Drs. Timothy Fulbright, Fidel Hernández, Leonard Brennan, and David Wester, former CKWRI graduate student, Holley Kline, Dr. Eric Grahmann (El Coyote Ranch), and Michael Hehman (Hixon Ranch) for Non-native Grasses Reduce Scaled Quail Habitat from the Texas Section of the Society for Range Management.

**Second place** in the **Technical Publication Category** went to former CKWRI graduate student, Justin Wied, and coauthors Drs. Humberto Perotto-Baldivieso, April Conkey, Leonard Brennan, and former CKWRI graduate student, José Mata for Invasive Grasses in South Texas Rangelands: Historical Perspectives and Future Directions from the Texas Section of the Society for Range Management.

**TIM FULBRIGHT**  
**HONORARY**  
**LIFE MEMBER**  
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THE WILDLIFE SOCIETY

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**TIM FULBRIGHT**  
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**LEONARD BRENNAN**  
**OUTSTANDING BOOK**  
**QUANTITATIVE ANALYSIS**  
**IN WILDLIFE SCIENCES**  
TEXAS CHAPTER OF  
THE WILDLIFE SOCIETY

# Caesar's Circle Donor Wall

In honor of the Caesar Kleberg Wildlife Research Institute's 40th Anniversary, we created the Caesar's Circle donor wall as a way to commemorate all donors who have given \$1 million or more to support The Institute.

The Caesar's Circle donor wall is located at the Caesar Kleberg Wildlife Center within the Tio & Janell Kleberg Wildlife Research Park in Kingsville, Texas.  
A tremendous thank you to our Caesar's Circle donors!

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in honor of Bruce F. Harrison and Dan J. Harrison III

Ellen and Edward Randall, III

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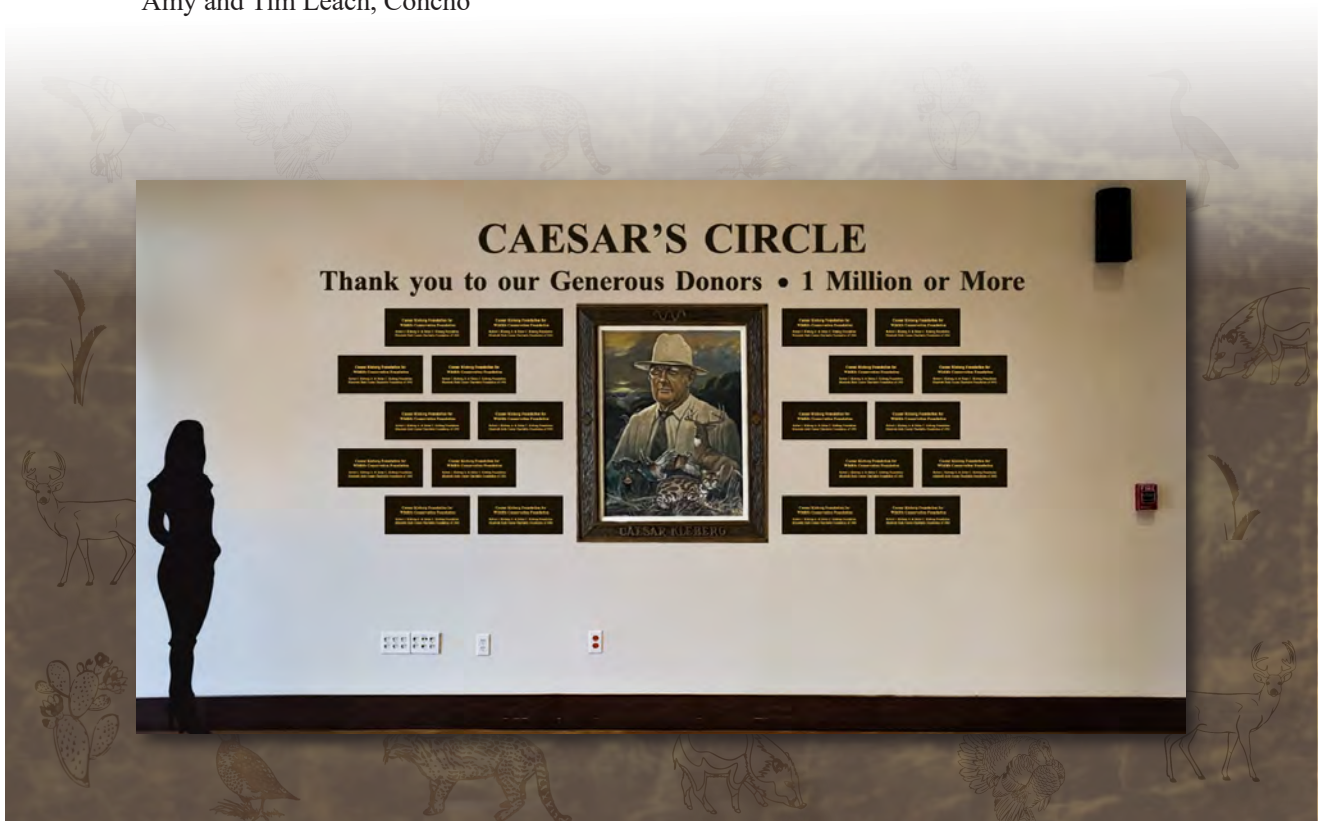
South Texas Chapter of Quail Coalition, Inc.

Stuart W. Stedman

Dr. Peter and Frances Swenson

Ellen and Buddy Temple, East Texas Natives

Ed Whitacre



# CKWRI Personnel

## Scientists and Staff

Dr. Heather N. Abernathy, Research Specialist I  
Dr. C. Jane Anderson, Research Assistant Professor  
Dr. Bart M. Ballard, Professor  
Mrs. Yolanda Ballard, Assistant Director, CKWRI Administration  
Mrs. Sara K. Barrera, Facilities Specialist III  
Dr. Jeremy A. Baumgardt, Research Assistant Professor  
Ms. Amelia J. Berle, Research Associate  
Mr. John R. Bow, Assistant Director, Texas Native Seeds–Central Texas  
Mr. Joshua D. Breeden, Research Technician I  
Dr. Leonard A. Brennan, Professor  
Dr. Fred C. Bryant, Director, CKWRI Development  
Mrs. Gina M. Cavazos, Administrative Coordinator I  
Mrs. Cecilia A. Chapa, Purchasing Specialist  
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Dr. Michael J. Cherry, Assistant Professor  
Mr. Marcus Collado, Research Technician I  
Mr. Seth M. Cook, Research Specialist I  
Dr. Charles A. DeYoung, Research Scientist  
Dr. Randy W. DeYoung, Professor  
Mr. Tim Drake, Research Technician I  
Mr. Anthony D. Falk, Research Scientist, Texas Native Seeds  
Dr. Alan M. Fedynich, Professor  
Mrs. Sandra L. Fischer, Business Coordinator II  
Dr. Aaron M. Foley, Research Assistant Professor  
Ms. Carly Folsom, Research Associate  
Mr. Colton A. Fowler, Research Technician I  
Ms. Bethany A. Friesenhahn, Research Specialist I  
Dr. Timothy E. Fulbright, Research Scientist  
Mr. Delmiro L. Garcia, Facilities Specialist II  
Mr. Gustavo A. Garcia-Ortega, Research Associate  
Dr. Lon I. Grassman, Jr., Research Scientist  
Mr. Christian A. Guajardo, Research Technician I – Internship  
Mr. Levi J. Heffelfinger, Senior Research Instructor  
Dr. Scott E. Henke, Professor  
Dr. Fidel Hernández, Professor  
Dr. David G. Hewitt, Executive Director  
Mrs. Liisa L. Hewitt, Research Specialist I  
Dr. Clayton D. Hilton, Professor  
Ms. Miranda L. Hopper, Research Technician I  
Mr. Aaron M. James, Research Associate  
Mrs. Nancy T. Jennings, Business Coordinator III  
Mr. Connor Jetton, Research Technician I  
Mr. Douglas L. Jobes, Assistant Director, Texas Native Seeds–Coastal Prairies Texas  
Ms. Nina Kappel, Research Technician I  
Ms. Julieanna M. Keclik, Research Associate  
Mrs. Edna G. Kirkpatrick, Travel Specialist I  
Dr. William P. Kuvlesky, Jr., Professor  
Mr. Brian Loflin, Instructor  
Dr. Jason V. Lombardi, Research Assistant Professor  
Mr. Samuel R. Lufy, Assistant Director, Texas Native Seeds–Permian Basin  
Ms. Lindsay Martinez, Research Technician I  
Mrs. Caroline McAllister, Director of Donor Relations  
Mr. Hagen D. Meyer, Research Technician I  
Mr. David Navarro, Research Associate  
Mr. Robert Obregon, Research Associate  
Dr. Masahiro Ohnishi, Laboratory Manager  
Dr. J. Alfonso Ortega-Santos, Professor  
Mr. Keith A. Pawelek, Interim Program Director, South Texas Natives and Texas Native Seeds  
Dr. Humberto L. Perotto-Baldivieso, Associate Professor

Mrs. Shyla E. Rabe, Administrative Coordinator I, Texas Natives Seeds  
Mr. Matthew F. Rector, Research Associate  
Mr. Ernesto J. Reyes, Research Technician II  
Dr. Sandra Rideout-Hanzak, Professor  
Mr. Marcus A. Rodriguez, Research Technician II  
Mrs. Selinda A. Rojas, Administrative Associate V  
Mr. Thomas F. Rose, Purchasing Specialist  
Dr. Daniel G. Scognamillo, Research Associate Professor  
Ms. Kimberly Shoback, Research Technician II  
Mr. Colin S. Shackelford, Assistant Director, Texas Native Seeds–West Texas  
Ms. Kathryn M. Sliwa, Research Associate  
Mr. Forrest S. Smith, Program Director, South Texas Natives and Texas Native Seeds  
Mrs. Susan C. Smith, Administrative Coordinator  
Mr. Jacob L. Sparger, Research Technician I  
Ms. Amaris Shammas, Research Technician I  
Dr. Vijayan Sundararaj, Research Assistant Professor  
Dr. Evan P. Tanner, Assistant Professor  
Dr. Michael E. Tewes, Professor  
Mrs. Rebecca S. Trant, Director, CKWRI Administration  
Dr. Ashley Unger Tanner, Research Assistant Professor  
Ms. Elizabeth L. Walker, Business Coordinator II  
Mr. Zachary M. Wardle, Research Associate  
Mr. Tyler C. Wayland, Assistant Director, Texas Native Seeds–East Texas  
Dr. David B. Wester, Professor

## Graduate Students

Mr. Cole C. Anderson  
Mr. Jose S. Avila-Sanchez  
Ms. Chloe Bates  
Ms. Emily R. Bishop  
Ms. Matti R. Bradshaw  
Mr. Aidan B. Branney  
Ms. Annalysa Camacho  
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Mr. Joseph A. Hediger  
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 National Christian Foundation  
 National Fish and Wildlife Foundation  
 National Science Foundation  
 The Nature Conservancy-Texas City Prairie Preserve  
 Neotropical Migratory Bird Conservation Act  
 New Mexico Department of Game and Fish  
 Noble Foundation  
 Noble Research Institute  
 North Texas Municipal Water District  
 Occidental Petroleum Company  
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 Cory Overton, U.S. Geological Survey, Dixon, California  
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 Zachry Foundation  
 Zarsky Lumber Company,  
     Kingsville

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## Analyses of Deer Populations during Florida Panther Recovery

*Heather N. Abernathy, Randy W. DeYoung, and Michael J. Cherry*

In South Florida, white-tailed deer are a popular game species and the primary prey of the endangered Florida panther. However, monitoring data suggests white-tailed deer populations have declined in some areas within the Big Cypress National Preserve (BCNP) since 2000. These declines have occurred with changes in hydrology, habitat conditions, hunting regulations, and the predator community. The predator community has experienced considerable rearrangement during the recent decades. Florida panther populations have increased following genetic rescue efforts, with recent estimates exceeding 200 individuals. In addition, Florida black bear populations have increased, and coyotes and Burmese pythons have colonized South Florida. However, the relative effects of hydrology, hunting, and predators on deer populations remains unknown.

We are conducting an analysis of long-term aerial survey data to identify the drivers of deer population declines over the past 20 years. We are exploring changes in deer abundance and herd dynamics across BCNP and how populations trends are related to changes in hydrology, habitat conditions, hunter harvest, and panther recovery. Understanding the drivers of past declines may provide the foundation of management recommendations aimed at maintaining sustainable deer populations in South Florida.

*Cooperative funding provided by the National Park Service.*

## Behavioral Thermoregulation of White-Tailed Deer in South Texas

*Breanna R. Green, Michael J. Cherry, Evan P. Tanner, Randy W. DeYoung, Jacob L. Dykes, and Bryan D. Spencer*

Determining what attributes of rangelands support wildlife during times of high heat stress is important



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**Heat stress is common in South Texas. Shade provided by brush increases the amount of usable space for deer.**

towards understanding how management influences behavior during hot periods. Additionally, landscape features that may only be needed rarely (such as birth site selection) may be critical toward maintaining healthy wildlife populations. In South Texas, heat stress can be common, and the amount of space usable for deer may be limited during extremely hot periods. Understanding how deer mitigate heat stress through behavioral changes may highlight key attributes of the landscape that facilitate these behavioral responses. This may give landowners the opportunity to focus management that supports areas of thermal refuge. With a captive white-tailed deer herd at the Alkek Ungulate Research Facility, we will measure forage consumption during periods of high heat under various shade levels (0%, 30%, 90%). We seek to determine if thresholds exist where temperature is too high, and shade quality is too low to facilitate feeding activities. In addition, we will be collecting temperature data from birth sites of white-tailed deer at the San Antonio Viejo Ranch, in partnership with the East Foundation. The purpose will be to determine if white-tailed deer select birth sites with specific thermal characteristics. This is because fawns are incapable of regulating their temperature as well as adults. Data collection will take place from 2021-2022. Results of this research will provide new insight into white-tailed deer behavior and adaptability to extreme temperatures in South Texas.

*Cooperative funding and support provided by the Albert and Margaret Alkek Foundation and the East Foundation.*

**Effects of DMP Pens on Average White-Tailed Deer Antler Size**

*Stuart W. Stedman, Matthew T. Moore, Charles A. DeYoung, Randy DeYoung and Michael Cherry*

Texas Parks and Wildlife Department issues Deer Management Permits (DMPs) for the purpose of confining and breeding a large-antlered buck with up to 20 does. The goal of this permit is to upgrade the overall antler size on the permitted property as all deer and fawn offspring are released onto the ranch.

This 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 (West Yana) prior to data collection and it has been restocked with DMP-sired offspring. The control

pasture (East Yana) has resident deer that were present when the high-fence was constructed. DMP pens are stocked with native bucks and does from 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 is compared within age classes across each pasture.

After 12 years of research, the Boone and Crockett scores for 4.5 year old bucks were 9 inches larger in the West Yana pasture with DMP deer than the East Yana control pasture.

*Cooperative funding by Faith Ranch.*

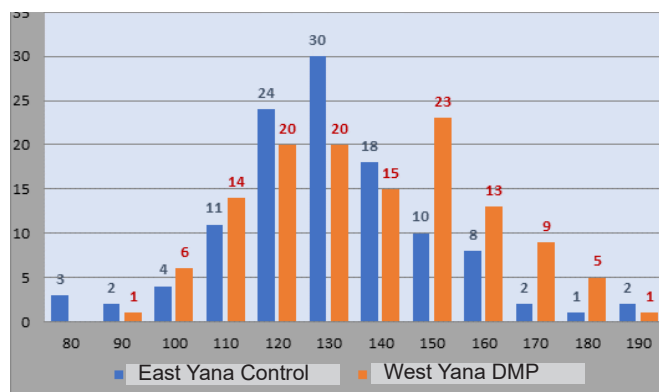
**Prescribed Fire and White-Tailed Deer Maternal Behavior**

*Daniel A. Crawford, L. Mike Conner, and Michael J. Cherry*

Predators kill prey but also affect prey behavior. These effects depend on the regularity of predator-prey interactions and their outcomes. Attributes of prey, such as age and sex, as well as the environment where predators and prey interact can affect vulnerability to predators. Habitat management often alters the location and quality of resources, which can affect prey vulnerability to predators. Thus, prey must make decisions that maximize food intake while minimizing exposure to risk from predators.

This study focuses on how prescribed fire affects behavior of female white-tailed deer and how those behaviors influence fawn survival. We are working at the Jones Center at Ichauway, the approximately 30,000-

**Boone and Crockett scores for 4.5-year-old deer in the East Yana (Control) and West Yana (DMP) pastures of the Faith Ranch.**



acre quail plantation in southwestern Georgia, owned by the Woodrow Foundation. Using camera trap data and GPS-telemetry data, we will explore how prescribed fire and predation risk influence female movements, space use, and fawn recruitment. We are using four approximately 100-acre predator exclusion plots and four unfenced control plots to better understand the effects of predation risk on behavior of fawning does, and how prescribed fire influences this process.

Our research presents a valuable opportunity to experimentally evaluate how prescribed fire and predation risk influence adult female deer behavior, fawn survival, and recruitment of young. With this research, we aim to improve our understanding of the role parental decisions play in offspring survival while providing practical knowledge on how fire, as a management tool, affects fawn survival.

*Cooperative funding provided by the Jones Center at Ichauway.*

**Nutritional Benefits of Cropland for Mule Deer**

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

Crop production is an extensive land-use in the Southern Great Plains. Crops may be a high-quality food source for mule deer but fields are fallow in some seasons. Therefore, cropland may be detrimental overall. Our objective was to assess the net effect of agriculture on mule deer in the Texas Panhandle. We captured, measured, and fitted 146 adult male and female mule deer with GPS collars across several sites and years. We analyzed deer habitat use and capture records to test how the use of cropland by mule deer affects body fat, lactation rates, and survival.

Preliminary analyses indicate that both young (1–2 years old) and mature ( $\geq 3$  years old) males that used cropland during winter and summer had more rump fat in October than males that did not use cropland. Furthermore, of males that used cropland, rump fat increased with increasing proportion of locations in cropland. There was no such relationship in female mule deer. However, female deer that used cropland had a greater probability of raising fawns, as indicated by lactation rates in October. Annual survival of adult mule deer was high (about 90%) and not influenced by percent time spent in cropland for either males or females. Our results indicate that mule deer nutritional

status and reproduction benefit from up to 40% of their home range being cropland. Understanding these effects is important given agriculture’s uncertain trajectory in the Panhandle from depletion of the Ogallala Aquifer and a warming climate.

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

**Population Dynamics of Deer in the Appalachian Mountains**

*Garrett B. Clevinger, Marcella J. Kelly, W. Mark Ford, and Michael J. Cherry*

Restoration of historical disturbance regimes in the Central Appalachian Mountains is being achieved by timber harvest and the reintroduction of prescribed fire. However, few studies have evaluated the results of these management actions on wildlife resources. We are studying white-tailed deer population dynamics in the Appalachian Mountains where fire restoration efforts have occurred. Monitoring population dynamics is important to managing deer in dynamic landscapes, such as the Appalachian Mountains, where variable acorn production creates unpredictable boom and bust cycles.

From 2018-2020, we captured 85 adult deer on public lands in Bath County, Virginia, including 38 does which were equipped with GPS tracking collars and vaginal implant transmitters (VITs) used to aid in fawn capture. We captured and monitored 53 fawns, using expandable very high frequency (VHF) tracking collars. We are monitoring 138 trail cameras deployed across the site from May-September to identify individual fawns based on their unique spot patterns.

In 2019, we estimated 12-week survival of fawns to be 29.4%, with the majority of mortalities occurring in the first 20 days of life. We have cataloged over 2,750 images of fawns, identifying individuals and creating records of when and where the fawn was detected. This project will provide wildlife managers with a basis for implementing a field-tested, non-invasive method to monitor and investigate deer populations at scales relevant to white-tailed deer management.

*Cooperative funding provided by the Virginia Department of Game and Inland Fisheries - Federal Aid and Restoration Project (WE99R).*



## Comparing Body Fat Indices in White-Tailed Deer

*Ashley G. Hodge, Seth T. Rankins, Jacob L. Dykes, Kathryn M. Sliwa, Bethany A. Friesenhahn, Jeremy A. Baumgardt, Aaron M. Foley, Randy W. DeYoung, Michael J. Cherry, David G. Hewitt, J. Alfonso Ortega-Santos, Eric P. Garza, and John A. Goolsby*

Body fat represents stored energy that can be used for growth, reproduction, or to survive drought conditions. Thus, animal body condition indices are useful for evaluation of range quality, animal health, and the effects of management. Condition indices should enable quick assessment with minimal processing. Three methods meet these criteria: (1) body condition scoring based on fat around the ribs, hips, and spine, (2) thickness of fat under the skin on the rump, and (3) the ratio of kidney fat to kidney weight.

Body condition scoring is simple and can be done on live animals. Unfortunately, it is harder to assess small differences and requires consistency among observers. Rump fat thickness is used on live or dead animals, but loses accuracy below 8% total body fat. Measuring rump fat on live animals requires expensive ultrasound machines and trained personnel. Kidney fat is simple, but plateaus when an animal



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**Antler traits are primarily genetic, but what other factors also contribute to antler development?**

is in good condition and can only be performed on dead animals. We collected body condition from 298 female white-tailed deer harvested near Zapata, Texas, during March 2020. We are comparing body condition indices with the goal of finding a reliable combination that can be used on live and harvested deer.

Our preliminary results indicated large variation in kidney fat index for deer with little to no rump fat, which was unexpected. Body condition scores followed trends in rump and kidney fat, but were less sensitive. The results of this study will clarify the relationships between condition indices and fat stores in South Texas populations of white-tailed deer.

*Cooperative funding provided by the USDA Agricultural Research Service.*

## Environmental and Genetic Influences on Antlers in White-Tailed Deer

*Randy W. DeYoung, Michael J. Cherry, Matthew T. Moore, David G. Hewitt, Charles A. DeYoung, and Stuart W. Stedman*

Antler traits are genetically controlled. However, antler growth is greatly influenced by the animal's age and the environment. Therefore, management actions that target age, nutrition, and genetics all have the potential to affect antler size in managed populations. Managers restrict harvest to control age, and address nutrition via vegetation management and supplemental feed. It is more difficult to affect genetic traits in wild deer because managers lack control of breeding. The Texas Parks and Wildlife Department has a Deer Management Permit (DMP) program that allows managers of game-fenced properties to confine wild white-tailed deer temporarily to allow natural breeding. Typically, managers place a large-antlered buck in an enclosure with up to 20 does, allow them to breed, and then release the adults and fawns back onto the ranch. The DMP program is popular among landowners, but there are many unknowns in how best to apply the technique or its effectiveness. For instance, what are the best strategies to select parents or evaluate the performance of offspring? We are analyzing the factors that contribute to antler development as part of a long-term study of the DMP approach on the Faith Ranch. We will estimate relationships among individuals based on parentage and genetic similarity. We will then combine the relationship information with antler records to understand how antler traits are inherited and to calculate breeding values for individual males. The results of this study

will improve our understanding of how genetic and environmental factors affect antler size in managed populations and the cost-benefit ratio of management actions.

*Cooperative funding provided by the Stedman West Foundation and Faith Ranch*

### Influence of Cropland on Mule Deer Movements

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

Cropland is widespread and increasing in the Texas Panhandle. Understanding how cropland influences mule deer movement and the threshold of cropland that deer can tolerate will help managers integrate mule deer needs into land-use decisions.

We established 3 study areas in the Panhandle that varied in the proportion of cropland. We captured male and female mule deer, fitted each with a GPS collar, and used location data to evaluate mule deer space use relative to cropland. Preliminary results indicate males in the Southwest Panhandle had larger home ranges (15.0 – 17.7 mi<sup>2</sup>) than males at the other 2 sites (12.0 – 12.9 mi<sup>2</sup>). Overall, males had larger home ranges (12.0 – 17.7 mi<sup>2</sup>) than females (2.9 – 5.5 mi<sup>2</sup>). The proportion of deer that used cropland depended on proximity of cropland. Where female deer had wheat within 2 miles of the center of their home range, 88–100% used wheat fields, whereas in areas deer had to travel further than 2 miles, <5% of females used wheat fields. Mule deer spent 3–5% of their time in crop fields during summer (April – September) and 11–14% of their time during winter (October – March). Use of crops by mule deer declined relative to availability once an area exceeded 20% cover of cropland.

Home range sizes of male mule deer are large compared to the size of many properties and therefore landowners are managing deer with their neighbors. Mule deer do not appear to make large movements to use crops which simplifies population monitoring and harvest management.

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



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**Timing of breeding and fawn births help explain habitat use, energetics, and reproductive strategies.**

### Movements of Mule Deer during Reproduction

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

Reproduction is critical for maintenance of wildlife populations. The timing of breeding and births and the extent of movements during reproduction are important to understand habitat use, energetics, and reproductive strategies of a species. Our objective was to determine peak births, rut timing, and rut movements of mule deer in the Texas Panhandle.

We captured and fitted 69 male and 77 female mule deer with GPS collars across 3 study sites. We used female movement rates during summer to determine when they gave birth then determined breeding by backdating using a gestation period of 205 days.

Fawns were born an average of 3–4 weeks earlier in the Canadian River Breaks (CRB; June 25) than the Southwest Panhandle (SWP; July 13) and Western Rolling Plains (WRP; July 22). These birth dates corresponded to peak rut of December 3 in CRB, December 21 in SWP, and December 30 in WRP. Average movement rates of bucks increased 64 – 224%, depending on study site, from pre rut to peak rut. The greatest daily movement during peak rut was an average of 5.1 miles for bucks in the SWP. The only deer we documented shifting their home range (3–18 miles) to crop fields were bucks, primarily during the rut, suggesting that bucks may visit agricultural fields to find does for breeding.

Our findings will be valuable in future studies assessing habitat use during fawning and breeding strategies



of male and female mule deer. Increased movements of male deer during rut might increase their susceptibility to mortality from harvest and vehicle collisions.

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

### Linking Long-Term Capture Data to Cattle Stocking Records

*Bryan D. Spencer, Randy W. DeYoung, J. Alfonso Ortega-Santos, Landon R. Schofield, Tyler A. Campbell, and Michael J. Cherry*

Livestock can have a significant competitive influence on wildlife, affecting an animal's reproductive success, morphology, and habitat use. In North America, cattle influence on deer is of significant interest due to the economic opportunities possible from managing both. Understanding how deer respond to this competition with cattle will help inform managers when integrating grazing and wildlife management strategies.

We examined the competitive relationship between white-tailed deer and cattle on the South Texas Ranches of the East Foundation. We captured white-tailed deer across four properties owned by the East Foundation

annually since 2011. During the captures, we collected data on whether does were lactating, an index of reproductive activity, as well as other morphological measurements and body condition scores. The East Foundation has also maintained cattle stocking, inventory, and movement records for all of its properties since 2016. We will analyze how white-tailed deer lactation rates and morphology vary with precipitation, stocking rates, and time since and length of the last deferment.

Our research provides a unique opportunity to link a long-term capture study to the land and management practice implemented by the East Foundation. It will allow us to evaluate how cattle grazing strategies can influence fawn recruitment and the health and condition of adult white-tailed deer. With this research, we aim to improve the understanding of how grazing management decisions can have population-level effects on white-tailed deer.

*Cooperative funding provided by the East Foundation.*

### Brush Management Influences Landscape Use by Male Deer

*Jacob L. Dykes, Levi J. Heffelfinger, Randy W. DeYoung, Timothy E. Fulbright, J. Alfonso Ortega-S., and Dean W. Wiemers*

Brush encroachment is an ongoing problem on southwestern rangelands. Mechanical brush management is a common practice. If done properly, mechanical treatments can benefit both livestock and wildlife. Managers often clear brush in alternating strips to facilitate follow-up treatments and promote habitat diversity. One variation to this treatment plan is to leave brush mottes in the cleared strips under the rationale that the brush mottes are beneficial to wildlife. However, there is little information on how wildlife use the brush strips and mottes.

We are studying how white-tailed deer respond to mechanical brush management in South Texas. In summer 2008, root-plowing was implemented in a strip-motte pattern within a 1,065-acre block of dense regrowth mesquite, leaving brush outside of the root-plowed strips undisturbed. Once brush clearing was completed, the study site consisted of 39% brush strips, 46% root-plowed strips, 3% brush mottes, and 10% oil development sites. We captured and fitted 10 male deer with GPS radio-collars and monitored their use of the landscape from October 2008 to August 2009.

Preliminary analyses suggested male deer avoided the open root-plowed strips and preferred mottes over



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**Deer require both brushy areas and more open areas in their habitat. Researchers are studying the optimal arrangement for land managers in South Texas.**

brush strips during most of the year. Forty percent of GPS locations were in brush strips, 36% in root-plowed strips, and 8% in mottes. The creation of mottes while strip-disking increases time and makes follow-up treatments difficult and more expensive. However, the mottes appear to benefit deer and possibly other wildlife. Understanding deer behavior and landscape use after brush management is important when designing brush management plans and may assist land managers when considering the broader context of management actions.

*Cooperative funding provided by the USDA Natural Resources Conservation Service, the Jack R. and Loris J. Welhausen Experimental Station, and the ExxonMobil Corporation.*

### Genetic Structure of Mule Deer in the Texas Panhandle

*Lindsey K. Howard, Levi J. Heffelfinger, Randy W. DeYoung, David G. Hewitt, Shawn S. Gray, Warren C. Conway, Timothy E. Fulbright, and Louis A. Harveson*

The Southern Great Plains is the eastern boundary of the mule deer distribution, and includes the Texas Panhandle. The region is comprised of rangelands but has become increasingly fragmented by croplands. Mule deer population trends indicate stable to slightly increasing populations, but little is known about the influence of agriculture on space use of mule deer. We used genetic analyses to study fine-scale spatial response of mule deer in fragmented landscapes in the Texas Panhandle. As part of a study of mule deer movements and home range, we collected tissue samples from 314 individuals across 3 study sites with varying degrees of habitat fragmentation. By combining home range and



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**Bloodwork is a vital part of genetic and disease analyses.**

genetic information, we can determine if fragmentation affects movement and relatedness of individuals.

We extracted DNA and used a panel of genetic markers to quantify how genetic similarity between pairs of individuals changed in relation to spatial distance. Preliminary results revealed no difference among sites in fine-scale genetic similarity of females or males. Pairs of females were more related than pairs of males, which may reflect differences in social groups and dispersal between the sexes. Male deer within 66 miles and female deer within 36 miles were more genetically similar than average. Based on these results, mule deer populations span 2,369,718 acres and 746,029 acres for males and females, respectively. Our results suggest that agricultural fragmentation in our study sites had only minor effects on mule deer populations. The results of this study will help land managers understand how home range and movements affect the scale of management for mule deer.

*Cooperative funding provided by the Texas Parks and Wildlife Department*

### Habitat Use of White-Tailed Deer in Relation to Cattle Fever Tick Management

*Ashley G. Hodge, Jeremy A. Baumgardt, Randy W. DeYoung, Michael J. Cherry, David G. Hewitt, John A. Goolsby, Kimberly H. Lohmeyer, and Adalberto A. Pérez de León*

Cattle fever ticks can carry a parasite that causes babesiosis in livestock, a disease with serious implications for the cattle industry. Cattle fever ticks were eradicated from the U.S. during the 1940's, but remain endemic in Mexico. The U.S. maintains a permanent quarantine zone along the Texas-Mexico border to prevent re-invasion of ticks. Recent increases of wildlife in the quarantine zone have complicated tick management efforts. White-tailed deer can act as alternative hosts for the tick but are not limited by borders or fences. Deer with ticks can thus move across the border or outside of the quarantine zone, resulting in new outbreaks. At the local scale, ticks survive best in sites where they are likely to find new hosts and avoid desiccation. Therefore, vegetation or landscape characteristics may be an important factor in recurring outbreaks of ticks in the quarantine zone.

We are analyzing the relationship between deer habitat use and tick abundance on the International Boundary Waters Commission lands surrounding Falcon Lake, Texas. We captured 100 white-tailed deer in February 2020, assessed tick loads, and fitted them



with GPS radio-collars. We will use satellite imagery to delineate vegetation types used by deer and compute distance from deer locations to landscape metrics, such as distance to the lake shore or feeders, ruggedness of the landscape, and relative deer abundance. Understanding the relationship between deer space use and tick abundance will allow managers to target treatment efforts and predict future outbreaks.

*Cooperative funding provided by the USDA Agricultural Research Service.*

### Shade Influences Space Use and Feeding in Captive Deer

*Jacob L. Dykes, Austin K. Killam, Randy W. DeYoung, Evan P. Tanner, Michael J. Cherry, and Clayton D. Hilton*

South Texas summers can be extremely hot, forcing animals to change their behavior to avoid heat stress. Animals often reduce activity and seek shade during the hottest part of the day. Vegetation provides most shade resources in the South Texas environment due to the lack of rugged terrain. Therefore, shade in different types, heights, and combinations of vegetation influences the amount of sunlight that reaches ground level. The greater the intensity, or consistency, of shade, the cooler the temperature. The extent to which animals discriminate between shade of differing intensities is not well understood. We are studying the preference of white-tailed deer for differing combinations of shade



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**By providing varying combinations of shade and sunlight in captivity and observing deer behavior, researchers can better understand how summer temperatures impact deer behavior and physiology.**

and how shade intensity influences deer food and water consumption using an experimental approach at the Albert and Margaret Alkek Ungulate Research Facility. In a captive setting, we can control access to shade and shade intensity. We will place captive deer in an open-air pen and manipulate shade intensity using commercial shade cloth. Deer will be able to choose locations where there is no shade as well as that produced by shade cloth that blocks 30%, 60%, or 90% of sunlight. We will monitor deer choice of shade intensity throughout the day compared to the temperature recorded inside a black copper sphere, an indicator of both air temperature and potential heat absorption. We will also record how shade and temperature influence food and water consumption. The results of our study will improve our understanding of how summer temperatures influence deer behavior and physiology.

*Cooperative funding provided by the Zachry Foundation and the Albert and Margaret Alkek Foundation.*

### Social Structure in White-Tailed Deer: Implications for Managing Cattle Fever Tick

*Ashley G. Hodge, Jeremy A. Baumgardt, Masahiro Ohnishi, Randy W. DeYoung, Michael J. Cherry, David G. Hewitt, John A. Goolsby, Kimberly H. Lohmeyer, and Adalberto A. Pérez de León*

Female white-tailed deer form small family groups composed mainly of close relatives, which can contain several generations of offspring. Yearling males disperse from their birth areas and form new home ranges, a behavior that avoids inbreeding. Outside of the rut, males form loose social groups, termed “bachelor groups” thought to be composed of unrelated individuals. These social structures and dispersal events are influenced by population density and sex and age structure. The spatial scale of animal home ranges, social groups, and dispersal movements can inform management for issues such as wildlife disease.

We are studying fine-scale population structure of a high-density population of white-tailed deer near Falcon Lake Reservoir, in South Texas, using genetic markers. The site is located in the permanent quarantine zone for cattle fever ticks, a 1-host tick which can transmit bovine babesiosis to cattle. The disease is economically important for the livestock industry; white-tailed deer are alternative hosts for the ticks, which complicates tick eradication efforts. We collected tissue samples from 400 deer, 100 of which were fitted with GPS radio-collars, and extracted DNA. We

will use a panel of genetic markers and GPS locations of captured and collared deer to estimate how genetic similarity changes with geographic distance. We will also compute home range overlap for males and females in relation to genetic similarity and tick loads. The resulting information will inform our understanding on how population density and landscape features influence male and female social structures, with implications for host-population dynamics in this area.

*Cooperative funding provided by the USDA Agricultural Research Service.*

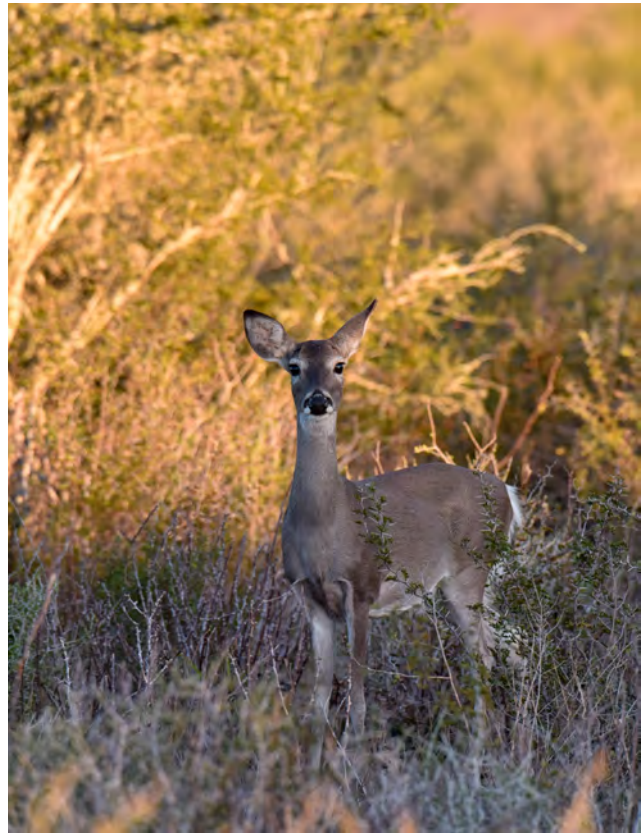
### White-Tailed Deer Acceptance of Motion-Activated Sprayers at Feed Sites

*Jeremy A. Baumgardt, Ashley G. Hodge, Randy W. DeYoung, Aaron M. Foley, David G. Hewitt, John A. Goolsby, and Adalberto A. Pérez de León*

Cattle fever ticks (CFT) can transmit bovine babesiosis, also termed cattle fever. CFT were eradicated from the U.S. in the 1940s, but remain common in Mexico and along the Rio Grande. White-tailed deer can carry CFT and are likely responsible for recent outbreaks of the tick in South Texas. To reduce CFT populations, the USDA Cattle Fever Tick Eradication Program maintains hundreds of corn feeders in a quarantine zone along the Mexico border using corn treated with Ivermectin. However, the feeder strategy is only viable during February–July due to a 60-day withdrawal period before the hunting season to allow safe consumption of harvested deer.

The purpose of this study was to determine if motion-activated sprayers attached to feeders could be used during the withdrawal period and hunting season to continue treatment with a non-toxic solution. We set up active sprayers at 25 feeders and inactive sprayers at 16 feeders. We mounted a motion sensor to the base of each feeder, which activated a battery-powered sprayer pump. The pump then sprayed a stream of water aimed where a feeding deer would likely be standing. We maintained each sprayer and filled feeders with untreated corn and monitored feeder sites from November through January 2020 with trail cameras. Active sprayers had no detectable effect on use of corn feeders by white-tailed deer. These results suggest that motion-activated sprayers at feeders may be an effective method for delivering a topical treatment to white-tailed deer.

*Cooperative funding provided by the USDA Agricultural Research Service*



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**Understanding deer use of shaded areas and open areas will help managers make sound management decisions.**

### Thermal Ecology of White-Tailed Deer in South Texas

*Jacob L. Dykes, Randy W. DeYoung, Timothy E. Fulbright, David G. Hewitt, Charles A. DeYoung, J. Alfonso Ortega Santos, Aaron M. Foley, Landon R. Schofield, and Tyler A. Campbell*

Summer temperatures in South Texas cause animals to change their behavior or physiology to avoid heat stress. Adaptive behaviors, such as seeking shade or wind, or becoming less active, require less energy than panting or increased heart rate. However, behavioral changes may lead to competition with other species, such as livestock. The interactions between wildlife and cattle during summer heat are an important but little understood component of range management.

We deployed 40 GPS radio-collars (30 deer, 10 cattle) on the East Foundation's El Sauz Ranch in South Texas during spring 2019. Collars recorded GPS locations at 30-minute intervals throughout the summer. We used remotely sensed data to delineate open grassland



and woody cover, and deployed 100 thermometers at representative sites across the area to record temperature at 30-minute intervals. We used this information to develop a temperature map of the area and determine how temperature affected deer preference for woody cover. Finally, we calculated how GPS locations of deer and cattle overlapped during the day.

Preliminary results indicate that woody cover contained the coolest sites within the study area during daylight hours. Deer actively sought out woody cover and their preference for woody cover increased as the temperature increased. Deer and cattle sometimes used the same patches of woody cover, but never within the same hour. Knowledge of how landscape characteristics influence deer and cattle during summer heat will assist in making sound management decisions. Management implications include improvements in habitat management strategies, and a better understanding of deer-livestock relationships.

*Cooperative funding provided by the Zachry Foundation and the East Foundation.*

### Impact of Winter Storm Uri on Nilgai in South Texas

*Aaron M. Foley, Randy W. DeYoung, and David G. Hewitt*

Nilgai antelope are a large exotic animal that have become well-established in South Texas and northern Mexico. Nilgai are adapted to warm environments and do not put on much body fat as a strategy to reduce overheating. This strategy works well in the summer but makes nilgai vulnerable during prolonged cold periods. For instance, in the early 1970's, a severe winter in South Texas caused ~1,400 nilgai to perish.

Winter Storm Uri arrived on 14–17 February 2021, which provided us an opportunity to better understand the impact of prolonged cold weather on nilgai. We conducted helicopter surveys several days after the storm in 2 pastures on King Ranch with contrasting nilgai densities. We counted the number of fresh carcasses and compared that number to the estimated size of the total population. We found 22% of the estimated population died due to cold weather in the high-density pasture, versus 3% in the low-density pasture. Most deaths were adult bulls.

The results indicate that nilgai in the high-density pasture were likely limited by food, and thus were unable to survive with their relatively limited body fat reserves. Further, bulls were sensitive to cold because



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**Nilgai antelope observed on the move during aerial surveys by CKWRI researchers.**

they had likely depleted their fat reserves from rutting activities that peaked several weeks prior to the winter storm. Overall, our findings indicate that brief food limitations can cause issues for species that do not develop significant body fat reserves. Further, deaths may increase if timing of extreme weather coincides with energetically demanding activities.

*Cooperative funding provided by King Ranch, Inc.*

### White-Tailed Deer Spatial Response to a Stocking Event

*Bryan D. Spencer, Randy W. DeYoung, J. Alfonso Ortega-Santos, Landon R. Schofield, Tyler A. Campbell, and Michael J. Cherry*

Cattle production and white-tailed deer management are two of the largest land uses in South Texas. However, these objectives can have conflicting management strategies and landscape requirements. This can result from competition for resources between cattle and deer, affecting white-tailed deer's habitat use, distribution, and resource availability. Understanding how deer respond to this competitive influence at varying stocking intensities has been a subject of interest for both managers and researchers.

To evaluate the response of white-tailed deer to the stocking of cattle, we captured and deployed GPS collars on 20 does on the East Foundation's San Antonio Viejo Ranch in spring 2020. That fall, the East Foundation stocked cattle in the pastures where the does were captured as part of a concurrent low-intensity grazing study. We recaptured the does in spring 2021, to retrieve

the GPS data from the collars. We will compare how the does' home ranges varied with time depending on cattle stocking rates and habitat availability.

Our research will allow managers to make informed decisions when developing grazing strategies and the potential influences they may have on the movement and distribution of white-tailed deer. It may also illuminate how habitat use of white-tailed deer may buffer the competitive influence of cattle.

*Cooperative funding provided by the East Foundation.*

### White-Tailed Deer Movements along the U.S.-Mexico Border

*Ashley G. Hodge, Jeremy A. Baumgardt, Randy W. DeYoung, Michael J. Cherry, David G. Hewitt, John A. Goolsby, Kimberly H. Lohmeyer, and Adalberto A. Pérez de León*

Cattle fever ticks can carry a parasite that causes babesiosis in cattle, a disease with a fatality rate of up to 90%. The ticks were eradicated from the U.S. in the 1940's, and a permanent quarantine zone was established along the Texas-Mexico border to prevent re-invasion. In Mexico, the ticks and parasite are common, creating concern in areas where livestock and wildlife can cross the border freely. White-tailed deer can act as alternative hosts for the tick, and can also move outside of the quarantine zone and seed new outbreaks. There are few treatment options available for wildlife. We are evaluating how reduction of deer numbers affects tick prevalence in a high-density population of white-tailed deer near Falcon Reservoir, Texas. The site is within the permanent quarantine zone and experienced persistent outbreaks of cattle fever ticks.

We captured 100 deer and fitted them with GPS collars during February 2020. We removed 298 female deer from the area during March 2020, and monitored how the removal affected home range and movements of the collared deer. Home ranges were relatively small; females averaged 156 acres and males averaged 195 acres. Collared deer crossed the border 93 times, with the highest number of crossings during February–April 2020. We will compare deer movements and home range pre- and post-removal and analyze long-distance movements and dispersal events. The results of this study will help identify sources of tick outbreaks in the region and determine the best management tools for wildlife.

*Cooperative funding provided by the USDA Agricultural Research Service.*



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**Matrice 210 drone flying an Altum Micasense multispectral camera.**

### Estimating White-Tailed Deer Population Sizes via Drones

*Jesse Exum, Aaron M. Foley, Randy W. DeYoung, David G. Hewitt, Jeremy A. Baumgardt, and Mickey W. Hellickson*

Drones are a rapidly developing technology with important implications for wildlife management. They are ideally suited to estimate the size and trends of wildlife populations. Prior to wider use of drones for population surveys, we must understand how drone-based population estimates compare with estimates from traditional survey methods.

We conducted daytime drone surveys on 3 South Texas study sites during spring 2020. The drone was equipped with both thermal and standard video cameras. Thermal cameras are efficient for detecting animals, but standard video is needed to identify age and sex.



Surveys were repeated at least 2 times at each study site. We used distance sampling to generate drone-based population estimates, and compared them to estimates derived from helicopter and spotlight surveys.

Five repeated thermal surveys at site A generated estimates of 0.11 deer/acre, which was identical to the corrected helicopter survey estimate. However, estimates based on video footage alone were 44% lower. Eleven thermal surveys at site B produced estimates of 0.31 deer/acre, which is comparable to 0.33 deer/acre from spotlight survey estimates; video estimates were 28% lower. We were unable to apply distance sampling at Site C, which was primarily grassland and bare ground, due to excessive brightness in the thermal footage caused by the reflection of sunlight from the ground.

Overall, we found that drone-based distance sampling with thermal sensors can be used to generate population estimates for deer but application may be limited to certain habitat types. Because video population size estimates were lower than estimates from thermal imaging, it appears that many deer were unavailable to be detected with standard video alone.

*Cooperative funding provided by the Arroyo, Dolores-Needmore, and Zacatosa Ranches, and the Dallas Safari Club Foundation.*

### Precision of White-Tailed Deer Ratio Data from Helicopter Surveys

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

In South Texas, helicopters are commonly used to survey white-tailed deer during autumn prior to hunting season. Fawn:doe and buck:doe ratios are frequently calculated; however, there is no literature indicating the minimum number of detections needed to generate precise ratio data.

We analyzed data collected by King Ranch during their annual September pre-season helicopter surveys during 2011–2015 to calculate precision of fawn:doe and buck:doe ratios. We used the Czaplewski et al. (1983) method to generate 90% confidence interval of both ratios. We considered a ratio to be precise when the 90% confidence interval was  $\leq 10$ . For instance, if a fawn:doe ratio was 30:100 with a confidence interval of 5, we are 90% confident that the fawn:doe ratio is between 25:100 and 35:100.

Of the 166 surveys conducted, 74 (44.6%) fawn:doe and 41 (24.7%) buck:doe ratios were precise. Precise ratios were typically achieved when ~450 deer were observed during a survey which translates into a minimum



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**Graduate student, Lori Massey, landing a Matrice 210 drone.**

of 27,000 acres flown at 100% coverage given a density of 30 acres/deer. However, both ratios became, on average, stable by the 30th doe observed during a survey.

Our results indicate that large tracts (>27,000 acres) are needed to generate precise ratios in South Texas likely because helicopter surveys only detect ~50% of the deer available to be seen in conjunction with relatively low deer densities associated with semi-arid environments. However, smaller ranches (<27,000 acres) can use trend-based analyses to determine changes in ratios over time.

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



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**CKWRI researchers conducting white-tailed deer surveys via helicopter.**



# Quail and Other Upland Gamebirds

## Landscape Appearance Effects on Quail Reproduction

*Lindsey K. Howard, Fidel Hernández, and Clayton D. Hilton*

Quail in semiarid environments experience drastic population fluctuations. These fluctuations are strongly influenced by rainfall, but the exact cause of such booms-and-busts is unknown. Bird reproduction is controlled by both long-term predictive information (daylength) that forecasts favorable breeding conditions, as well as supplemental information (e.g., food supply) that fine-tunes breeding to local conditions. Because vegetation color changes dramatically from crisp brown to lush green following rainfall, it may be possible that quail use landscape appearance to fine tune their breeding. Our objective is to investigate whether landscape appearance serves as a breeding stimulus for northern bobwhites inhabiting semiarid rangelands.

We will trap 16 wild bobwhite hens during late winter in southern Texas. We will individually house them in cages in an outdoor aviary during March–August 2022. Cages will be lined with either dead, crisp vegetation (brown treatment) or lush green vegetation (green treatment). During the mid-point of the experiment, we will replace the dead vegetation in some of the cages to lush green vegetation to simulate what occurs following rainfall. We will obtain blood every two weeks from each hen throughout the experiment. We also will document egg production of each hen. We will use these data to determine if reproductive hormones



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**Does lush green vegetation vs. brown dead vegetation affect bobwhite hen egg-laying rate?**

increase following the change in vegetation color, as well as compare egg-laying rate among treatments.

Our results will shed light into the possible mechanisms driving the quail “boom and bust” phenomenon. Our study also will provide insight on how the predicted changes in rainfall resulting from climate change may affect bobwhites in semiarid environments.

*Funding for this project is provided by the South Texas Chapter of Quail Coalition, the South Texas Charity Weekend, Inc., and the Richard M. Kleberg Jr. Center for Quail Research*

## Quantifying Habitat for Scaled Quail in South Texas

*Dakota R. Moberg, Humberto L. Perotto-Baldivieso, Leonard A. Brennan, Evan P. Tanner, and Jesús Franco*

The scaled quail is an upland game bird that has seen declines in abundance across its geographic range. However these declines in the South Texas Plains were not as strong as in other areas until the 2000s. South Texas has seen a significant increase in human population in the last 20 years. Significant changes have occurred in land cover spatial structure and the forecast models show there will be increased fragmentation in woody vegetation in the next 30 years. Therefore, there is a need to quantify scaled quail population trends in South Texas and evaluate the factors affecting these changes in population.

Our goal is to start developing a framework to identify the restoration and management priorities in the South Texas Plains for scaled quail habitat. Our first step is to identify and quantify spatial trends in scaled quail abundance in the region. Once these trends are identified and quantified, we will be able to integrate finer scale analyses to understand the potential drivers behind changes in population abundance. We will use Christmas Bird Counts (CBC) and Breeding Bird Survey (BBS) data to examine spatial and temporal trends in scaled quail counts in South Texas with an emphasis in the Tamaulipan Brushland conservation region. We will use the Texas Ecological Mapping Systems with an emphasis on Starr, Zapata, Webb and Jim Hogg Counties to assess the amount and spatial distribution of vegetation communities. These analyses will give us insight into the spatio-temporal dynamics of quail abundance across South Texas.

*Cooperative Funding provided by the American Bird Conservancy and by Mr. Rob T. Stacy.*



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**Bobwhite quail management decisions are often driven by results of winter population surveys. CKWRI researchers are studying both drone and helicopter survey methods.**

### Using Drones to Conduct Winter Quail Surveys

*Zachary J. Pearson, Leonard A. Brennan, Humberto Perotto-Baldivieso, Fidel Hernández, David DeLaney, and Andrea Montalvo*

Resource management is guided by the precise estimation of populations. Recent technological advances have changed the way we approach modern wildlife research and management. Drones are one source of technology which has become a popular interest in wildlife research. However, for over a decade helicopters have played a key role in conducting bobwhite quail surveys on Texas rangelands. Although reliable, helicopter surveys can become costly and dangerous, and flights must usually be scheduled weeks or months in advance.

Drones equipped with high-resolution thermal cameras are showing potential to be an effective tool to sample wildlife populations. To assess the feasibility of using drone-mounted thermal cameras to detect

bobwhite quail we will conduct a controlled experiment to determine if quail are detectable during roosting periods.

Drone flights will be conducted at various elevations and during a range of thermal conditions using pen-reared quail in a controlled environment. Following the successful detection of quail with drone-mounted thermal cameras we will be able to evaluate this platform as a potential for estimating quail populations.

*Cooperative support was provided by the Alice Gertrudis King Kleberg Reynolds Endowed Fellowship in Quail Research, King Ranch Inc., South Texas Quail Coalition, and the Hill Country Quail Coalition*

### Winter Aerial Distance Sampling Surveys for Bobwhite Quail

*Zachary J. Pearson, Leonard A. Brennan, Humberto Perotto-Baldivieso, Fidel Hernández, David DeLaney, and Andrea Montalvo*

Effective management of natural resources is driven by the collection of precise survey data and accurate estimation of populations. In Texas, countless acres of rangeland are managed with the goal of producing abundant populations of northern bobwhite quail for harvest. For more than a decade helicopter-based surveys have been used as an effective tool to conduct quail surveys over large expanses of rangeland. Beginning in 2008 King Ranch began using helicopter-based distance sampling surveys to estimate winter quail abundance with the goal of creating spatially explicit harvest quotas on portions of the Norias and Santa Gertrudis divisions. These surveys have been conducted annually during December following the same transects using an R-44 helicopter. The objective of this study is to assess the performance of surveys to refine sampling and analysis techniques.

During surveys conducted during 2010–2020, 7,092 coveys were detected with an average covey size of  $8.6 \pm 0.04$ . Coveys were detected at an average perpendicular distance from the flight path of  $75.8 \pm 0.72$  feet. These flight paths, on average, deviated from the designated transect by  $45.6 \pm 8.1$  feet. By understanding the performance of surveys we can refine the sampling and analysis to ensure precise estimation of populations from helicopter-based distance sampling surveys.

*Cooperative support was provided by the Alice Gertrudis King Kleberg Reynolds Endowed Fellowship in Quail Research, King Ranch Inc., South Texas Quail Coalition, and the Hill Country Quail Coalition*



### Habitat Assessment for California, Gambel's, and Mountain Quail in California

*Sarah K. Jacobson, Leonard A. Brennan, Humberto L. Perotto-Baldivieso, Evan P. Tanner, and Katherine S. Miller*

California is a nature-rich state that supports habitat for California quail, Gambel's quail, and mountain quail. The state has seen extensive land use changes over the past 50 years, leading to potential habitat loss due to impacts of urban development, large-scale agriculture, and changes in forest and rangeland management. As such, there is a need to investigate responses of California's quail populations to landscape changes at multiple spatial scales. This project has three objectives. First, we will measure how changing land uses have impacted statewide and local population changes in the three species of quail. Second, we will compile a list of areas that have the potential to sustain quail populations. Third, we will develop models to identify how projected increases in human development are likely to impact quail populations in California over the next 50 years.

To meet these objectives, we are determining population trends for each species for 1968-2019 using Breeding Bird Survey data. We will also use 1960-2019 data from the Christmas Bird Count. At the state scale, we will compare population trends with road density, human population, and land use. At the county and home-range scale, we will compare landscape

metrics between counties with stable and declining quail numbers. Finally, we will use projections from the Environmental Protection Agency (EPA) to determine potential losses of habitat for these species. This research will provide a numerical basis for wildlife biologists and stakeholders to prioritize areas for quail population and habitat conservation in California.

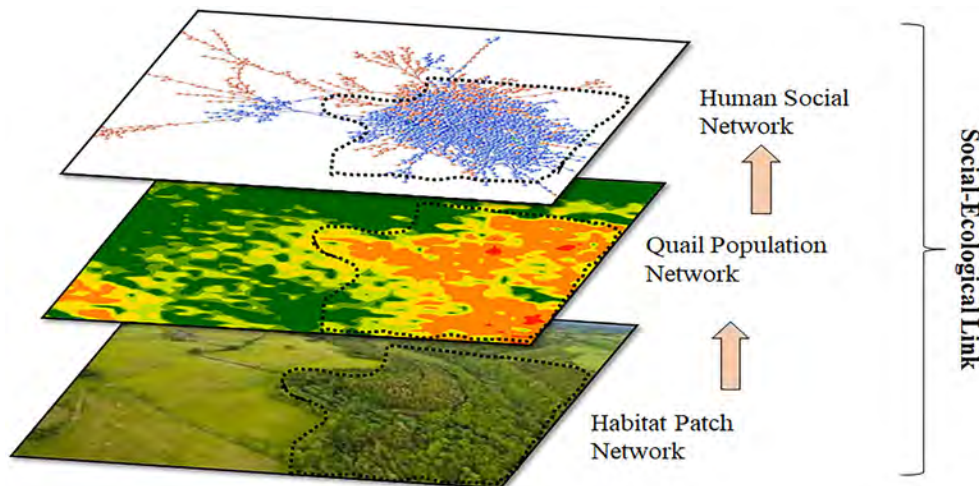
*Cooperative funding provided by Tall Timbers Foundation and California Department of Fish and Wildlife.*

### A Network Perspective on the Northern Bobwhite Decline

*Kristyn G. Stewart, Fidel Hernández, Alejandra Olivera-Méndez, Sabrina H. Szeto, Jon S. Horne, Angela M. Guerrero, David B. Wester, David. G. Hewitt, and John W. McLaughlin*

Networks are found lurking behind many day-to-day activities such as social-media posts, banking transactions, and cellphone calls. Networks are structures comprised of 2 components: nodes and links. Nodes represent objects, and links represent the relationship between objects. Networks are so ubiquitous in society that network theory has been applied in many disciplines including economics, engineering, and sociology. In ecology, networks are gaining popularity and are being used to model systems such as food webs. We propose to use network theory to better understand

**Network theory can help explain relationships between landscapes, people, and wildlife, and can help researchers understand the flow of information among the various components.**



the northern bobwhite decline in Texas. Systems in natural resources consist of at least 3 networks: the landscape (habitat), wildlife (bobwhite), and people (stakeholders). Relationships exist, and information flows, not only within networks but also among networks. Understanding social-ecological systems therefore involves an integrated approach called meta-network analysis.

We will use northern bobwhites as a case study to conduct a meta-network analysis of the social-ecological system comprising the bobwhite decline in Texas. Specifically, our objectives are to use network theory to (1) quantify bobwhite habitat connectivity in southern and northern Texas, (2) delineate population clusters

within these regions based on population growth, (3) quantify stakeholder perceptions, attitudes, and beliefs of the bobwhite decline by region, and (4) quantify spatial relationships and information flows within and among these networks (i.e., habitat, quail, people). Our study will help provide a more unified framework of bobwhite conservation and assist institutions in making more informed decisions and implement more effective outreach to address the bobwhite decline in Texas.

*Cooperative support was provided by the Texas Parks and Wildlife Department, the South Texas Chapter of Quail Coalition, and the Richard M. Kleberg Jr. Center for Quail Research.*



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**A bobwhite quail forages in the short grass. Researchers at the CKWRI are using network theory to help determine the connections between quail, their habitat, and people.**



## Monitoring U.S. 77 for Ocelot Habitat Permeability

*Daniel G. Scognamillo, Zachary M. Wardle, Thomas J. Yamashita, Michael E. Tewes, John H. Young Jr., and Jason V. Lombardi*

U.S. Highway 77 (US 77) in South Texas is a major transportation corridor between the Rio Grande Valley and eastern Texas. As traffic volume increases, US 77 will be expanded and improved as it transitions into Interstate Highway 69 (IH-69). This corridor passes through important habitat for ocelots, so, as part of this upgrade, the Texas Department of Transportation will be installing wildlife crossings to allow for the safe passage under the road for ocelots, bobcats, and other mammals.

We will be monitoring wildlife crossing sites and wildlife road mortalities along future IH-69 in Willacy and Kenedy counties. One structure has already been completed. We have been monitoring it using camera traps since October 2020. We have detected bobcats, coyotes, deer, and raccoons using the crossing to safely pass under the road. We also have been monitoring wildlife road mortalities along the highway corridor. Most mortalities have been deer, coyote, raccoon, and bobcat.

This research will help guide placement of wildlife crossings for ocelots and other mammals along the IH-69 corridor. Long-term monitoring of road mortalities and use of wildlife crossing locations will also aid in assessing the effectiveness of wildlife crossings at reducing ocelot road mortalities and allowing connectivity between patches of available ocelot habitat.

*Cooperative funding provided by the Texas Department of Transportation-Environmental Affairs Division.*

## Bobcat Use of Cleared Brush Strips for Game Enhancement

*Aidan Branney, Zachary M. Wardle, Michael Cherry, Humberto Perotto-Baldivieso, and Michael E. Tewes*

Ranch landscapes are managed for a variety of natural resources and for the harvest of game. This requires constant and diverse management of woody and herbaceous plant communities. To cultivate grasslands and restore rangeland ecosystems that historically occurred in South Texas, managers regularly clear and burn woody plant communities. Bobcats are



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**A bobcat is seen using an established livestock trail on a South Texas ranch.**

an apex predator in these ecosystems, and it is poorly understood how habitat management strategies and restoration practices impact their spatial ecology.

In 2021, we GPS-collared 10 bobcats on the Hixon Ranch in La Salle County, Texas that will be monitored for an entire year. From the data we will assess habitat selection and determine how bobcats establish home ranges within managed areas of the ranch, and how these ranges may shift in time. Remote sensing techniques such as Light Detection and Ranging (LiDAR) also will allow us to assess how bobcats select vegetation height within their home ranges.

More robust conclusions will be developed as data are collected throughout the year. These data should inform managers on how landscape level habitat management strategies effect bobcats. It will also provide insights into how strip clearing may help prey communities, which in turn may benefit ocelot use of managed rangelands.

*Cooperative funding provided by the Tim and Karen Hixon Foundation and Wild Cat Conservation, Inc.*

## HotSpotter: A Machine Learning Approach to Identify Ocelots and Bobcats

*Zachary M. Wardle, Michael E. Tewes, Landon R. Schofield, and Jason V. Lombardi*

Machine learning methods are increasingly being used in wildlife research to better manage time-consuming and complex tasks. Biologists commonly use

remote cameras to study mammal populations and assess abundance, density, and distribution. HotSpotter software uses machine learning to identify individual animals in camera-trap photos based on their unique coat patterns.

We conducted a study using a subsample of ocelot and bobcat photos from a remote camera dataset obtained on the East Foundation's El Sauz Ranch in Wilacy and Kenedy Counties, January 2011 to December 2019. Results to date have shown that 40 individual ocelots and 100 bobcats were identified in the subset of photos. Overall, HotSpotter was more reliable in identifying ocelots than bobcats. To increase precision for bobcats, more photos were needed compared to ocelots.

This method shows promise for improving the identification of spotted felids, which is important for ocelot recovery and bobcat management. This advance will allow researchers to gain a better understanding of the population ecology of these and other species of spotted felids across large areas.

*Cooperative funding provided by the East Foundation, Wild Cat Conservation, Inc., and the Feline Research Program of the Caesar Kleberg Wildlife Research Institute.*

### Landscape Structure of Woody Habitat for Ocelots in South Texas

*Jason V. Lombardi, Humberto L. Perotto-Baldivieso, Maksim Sergeyev, Amanda M. Veals, Landon Schofield, John H. Young Jr., and Michael E. Tewes*

Few ecological studies have explored landscape suitability using the gradient concept of landscape structure for wildlife species. Advancements in remote sensing and landscape ecology now allow the examination of the full range of conditions that may be encountered by a species. Identification of conditions influencing the landscape ecology and population dynamics of threatened and endangered species allows for the development of more robust recovery strategies. Our goals were to (1) identify the range of cover metrics associated with woody vegetation used by ocelots, and (2) quantify the potential distribution of suitable woody cover patches for ocelots across South Texas.

We used the gradient concept of landscape structure and the theory of slack combined with GPS telemetry data from 10 adult ocelots to identify the range of the landscape structure of woody cover. We estimated the amount of suitable woody cover types across South

Texas and determined the transferability of this approach across years. High suitability landscape-level patch structure for ocelots occurs in 28.1% of woody cover present. Spatial distribution of highly suitable woody cover is made up of large woody patches, with low patch and edge densities. Large patches of suitable woody cover exist in the western and northeastern counties in South Texas.

Our study shows a novel approach for measuring vegetation cover suitability for ocelot populations in South Texas. The range of landscape variables identified suggest that there are more woody cover patches with the spatial structure used by ocelots than previously suspected.

*Cooperative funding provided by Texas Department of Transportation-Environmental Affairs Division, the Tim and Karen Hixon Foundation, and the East Foundation.*

### Interactions among Four Wild Cats and other Carnivores in Northeastern Mexico

*Jason V. Lombardi, Aidan B. Branney, Arturo Caso, Sasha Carvajal-Villareal, W. Chad Stasey, and Michael E. Tewes*

Northeastern Mexico is one of the last areas of North America that contains areas with an intact historical carnivore community. In south-central Tamaulipas, the Sierra of Tamaulipas is ecologically rich and contains a diverse carnivore community. However, species interactions within this area are not well known.

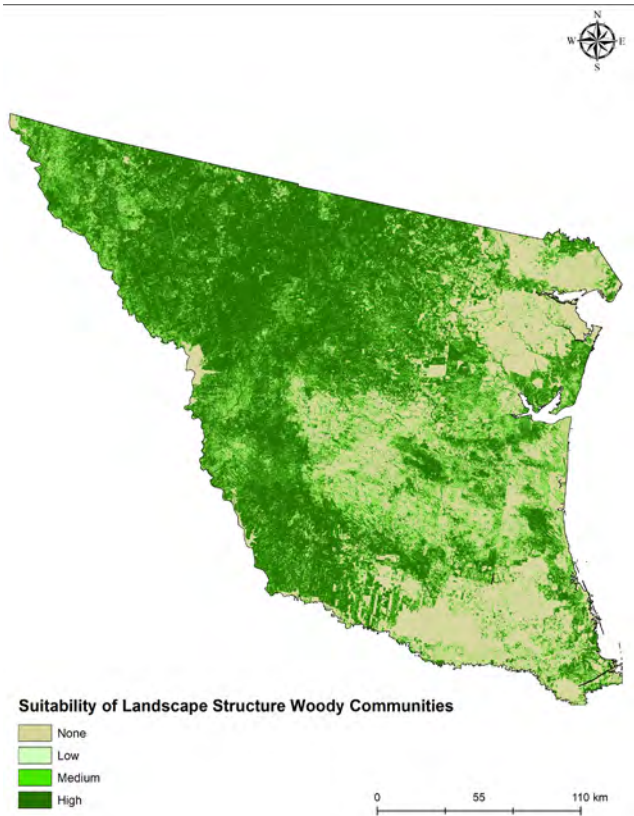
From February 2009 to April 2010, we conducted surveys using camera traps to determine the activity patterns of jaguar, mountain lion, ocelot, jaguarundi, coyote, gray fox, white-nosed coatimundi, and northern raccoon. We will be examining the activity and ranges among these carnivores, and if their ranges overlap.

This study will provide a good opportunity to explore an intact historic carnivore community in an undisturbed area. These results will provide a better understanding of the ecological patterns and processes that affect wild cats within a large carnivore community.

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



**Landscape structure suitability of woody cover for ocelots across an 18-county region in Southern Texas.**



**Impacts of Genetic Erosion on Wild Felid Reproductive and Immune Fitness**

*Ashley M. Reeves Wilmoth, Debra L. Miller, William F. Swanson, Clayton D. Hilton, Tyler A. Campbell, Jason V. Lombardi, and Michael E. Tewes*

Threatened ocelots are found in two small groups in South Texas where they have become inbred over time. As this occurs, their ability to fight infections and produce healthy kittens in the future could be at risk. This allows for an increase in infections, that in a healthy cat would not cause sickness, and a decrease in kitten and ocelot numbers in the wild. Our study goals are to determine the health and reproductive success of ocelot and bobcat groups in South Texas by evaluating blood tests for infections, conducting exams for parasites, and assessing ability to produce kittens to investigate the possible concern of close relations of these cats.

Texas ocelots and bobcats are being tested for bacteria, viruses, and parasites that can infect cats. Sperm qualities such as sperm shape, sperm activity, fertilization success, and sperm numbers are being measured

on sperm collected from ocelots and bobcats to study their ability to produce kittens. Increases in close group relations and decreases in the ability to fight infections may worsen disease risks and decrease the production of kittens over time as compared to less related groups.

This study will provide a report of ocelot and bobcat reproductive qualities, overall health, and infection presence to determine the possible consequences of their close relationships. Results from this study will be helpful in developing reproductive skills and forming conservation plans to improve kitten and ocelot numbers in this fragile group.

*Cooperative funding provided by the Feline Research Program of the Tim and Karen Hixon Foundation, Caesar Kleberg Wildlife Research Institute, East Foundation, Cincinnati Zoo, and the University of Tennessee at Knoxville.*

**Drivers of Bobcat Home Range and Core Area Size in Northern Washington**

*Zachary M. Wardle, Rebecca M. Windell, and Laura R. Prugh*

Bobcats are the most abundant wild felid in the United States and have an extensive North American distribution that encompasses a large variety of ecosystems. Since they are an adaptable habitat generalist, bobcat spatial ecology varies greatly across their range, with high variation in patterns of space use.

To understand the home range and core area characteristics of a bobcat population in a northern latitude, we captured and fitted 37 bobcats with GPS collars in northeastern and north-central Washington from 2018 to 2020. We will determine the location and extent of each animal’s home range and core area of use. We will assess the effects of biological, environmental, and anthropogenic factors on home range and core area size and compare findings between the two study sites.

Preliminary results from northeastern Washington show that average bobcat home range size was 20.8 mi<sup>2</sup> and mean core area size was 5.2 mi<sup>2</sup>. Male home ranges were 1.6 times larger than those of females, and male core areas were 1.8 times larger. Results suggest that terrain slope was an important predictor of home range and core area size.

Understanding the space use patterns of bobcats in northern Washington, where they are a lucrative fur-bearing species, will help inform management of this species. This information is important since the region

is experiencing the recolonization of gray wolves, seasonal wildfires, timber harvest, and increased human development.

*This project is led by collaborators at the University of Washington and is sponsored by funding external to the Caesar Kleberg Wildlife Research Institute.*

**Ocelot Density and Habitat Use in Northeastern Mexico**

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

Northeastern Mexico is one of the most diverse regions in the country. This region also sits on the northern periphery of the geographic distribution of ocelots, which are listed as endangered in Mexico. Ocelot ecology is poorly known in these diverse temperate mountains, a perceived stronghold for ocelots. These populations are genetically similar to isolated populations in Texas and may serve as a source population for future ocelot reintroduction efforts. From May to December 2009, we conducted two camera-trap surveys on Rancho Caracol and Rancho Catamol in the Sierra Tamaulipas to assess population density and habitat use patterns of ocelots. During the study, ocelots were less likely to use areas with more edge and were more likely to be detected in greater densities of tropical deciduous forest. Ocelot densities varied by sex, with greater densities of females (20.4 ocelots / 100 mi<sup>2</sup>) than males (9.87 ocelots / 100 mi<sup>2</sup>).



© Jason Lombardi

**An ocelot mother and kitten detected on the East Foundation’s El Sauz Ranch in March 2020. Data from individuals will help estimate ocelot population size and density in South Texas.**

This study reports the first sex-specific density of ocelots in Mexico, which are among the highest reported. The high ecological integrity of the Sierra Tamaulipas and recent protection as a Biosphere Reserve suggests long-term security of the ocelot population in this region. Therefore, this area may represent a potential source population to improve the genetics of ocelots in the United States.

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

**Bobcat Interactions with a Diverse Carnivore Community in Managed Ranches**

*Aidan Branney, Michael Cherry, Evan Tanner, Humberto Perotto-Baldivieso, and Michael E. Tewes*

Species often compete for resources, especially when those resources are scarce on the landscape. Competition is an important factor for species distributions and can shape the ecological community of an area. Further, fragmented habitat landscapes can influence the distribution and abundance of key resources. South Texas is home to a diverse array of carnivore species, which often compete for these key resources. Intensive brush management in South Texas can dramatically change the availability of key resources, such as shade, cover for prey, and water.

The Hixon Ranch in La Salle County, Texas supports a rich community of carnivores including bobcat, coyote, raccoon, grey fox, badger, ringtail, and an occasional mountain lion. Using trail cameras, we aim to understand where carnivores are present on the landscape and assess the habitat features that drive their occurrence and influence bobcat use. We aim to understand fine scale habitat and temperature conditions that influence this carnivore community. We will analyze the data and investigate potential positive and negative interspecific interactions among bobcats and this diverse carnivore community. This study has the potential to inform how dynamic resources and habitat structure may influence bobcats in South Texas and their interactions with a diverse carnivore community.

*Cooperative funding provided by the Tim and Karen Hixon Foundation, Wild Cat Conservation, Inc., and the Feline Research Program of the Caesar Kleberg Wildlife Research Institute.*



**Monitoring Ocelot Habitat in South Texas from 1982-2017**

*Amanda M. Veals, Joseph D. Holbrook, Michael E. Tewes, AnnMarie Blackburn, C. Jane Anderson, Randy W. DeYoung, Tyler A. Campbell, and John H. Young, Jr.*

Human-mediated encroachment and fragmentation of habitat is the largest threat to biodiversity worldwide. Understanding the dynamic between habitat change and animal behavior is critical for conservation, yet long-term studies of habitat selection and monitoring are rare.

We used a 35-year dataset (1982–2017) to assess resource selection by the endangered ocelot in South Texas. We used a timeseries of satellite imagery to map change in availability of woody cover, which is critical to ocelots but has decreased in availability due to human development. Ocelots were grouped based on gender and time frame of data collection. We used resource selection models to estimate habitat selection for 78 ocelots across all groups at the landscape scale. We used group-level estimates to map the probability of an ocelot using certain areas within our study area.

Average availability of woody cover has decreased since the 1980s and ocelots used areas with a higher proportion of woody cover farther from high-traffic roads. Both sexes were predicted to consistently use

areas with high proportions of woody cover. Further, areas closer to high-traffic roads were consistently predicted as non-habitat. The extent of predicted habitat never exceeded 47% of the study area, reflecting the confined nature of ocelot habitat within the United States. Private lands consistently contained  $\geq 79\%$  of the predicted high-quality habitat over time.

The future of ocelots in the U.S. relies on private land stewardship. Therefore, this study should inform managers pursuing landowner incentive programs and conservation agreements to ensure the long-term preservation of quality habitat.

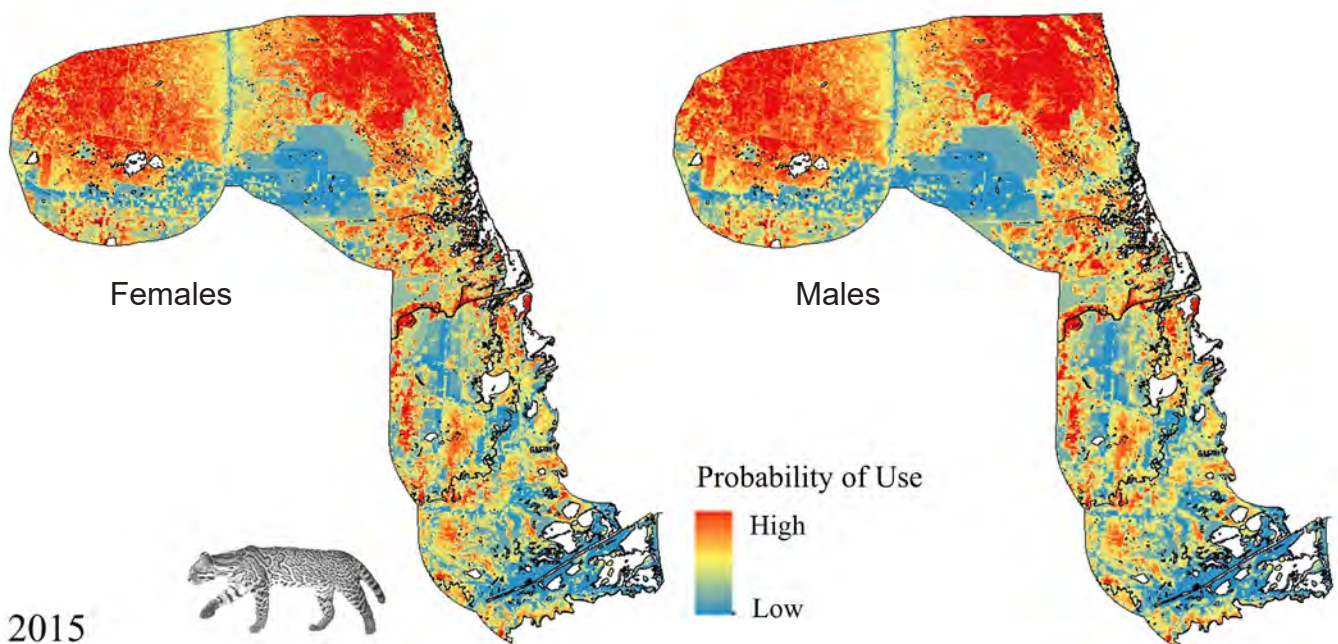
*Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute and the Texas Department of Transportation-Environmental Affairs Division.*

**Optimal Time Intervals from GPS Data for Ocelot Ecological Niche Models**

*Jason V. Lombardi, Humberto Perotto-Baldivieso, Michael E. Tewes, Daniel G. Scognamillo, David G. Hewitt, and Tyler A. Campbell*

Ecological niche models use presence-only data, which is often affected by lack of true absences, leading to sampling bias. Occurrence data from GPS

Researchers at the CKWRI predicted areas on the South Texas landscape that female and male ocelots were more likely to use. Ocelots were more likely to occur in areas with warmer colors (reds and oranges); cooler colors represent areas ocelots avoided.



telemetry data have been used in ecological niche models using geographic filters and subsampling techniques. Yet no study has used a method to identify the optimal time interval to use when integrating GPS telemetry data into ecological niche models.

We used radio telemetry data from ocelots to assess the optimal time interval for species-specific ecological niche models. The performance of shorter, 2-hour time intervals was comparable to 12-hour intervals. Shorter intervals under/overestimated the least amount of data compared to 12 hours. This study illustrates that by conducting rigorous spatial analyses the optimal time intervals for ocelots can be identified for use in ecological niche models.

Our study identified the correct subsampling interval to estimate ocelot ecological niche models using high-frequency data at different spatial scales. This same method may be used for other terrestrial species as well.

*Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute, Wild Cat Conservation, Inc., East Foundation, The Brown Foundation, the Tim and Karen Hixon Foundation, Travis and Bettina Mathis, and Ben F. Vaughan, III.*

**Characterizing Habitat Selection of Ocelots Using LiDAR**

*Maksim Sergeev, Michael E. Tewes, Jason V. Lombardi, and Tyler A. Campbell*

Many species depend on specific features within the landscape for survival. Characterizing available vegetation can be essential for managing these specialist species. One such habitat specialist is the ocelot, a medium-sized wild felid adapted to dense thornshrub vegetation. Availability of this habitat in South Texas has decreased due to agriculture and urbanization, leading to population declines for this federally endangered species. Consequently, quantifying the characteristics of vegetation most suitable for ocelots is an essential aspect to conservation of the species.

Light Detection and Ranging (LiDAR) imagery differs from other remote sensing techniques in its ability to penetrate through the canopy and describe the inner structure of the vegetation. Using LiDAR, we quantified overall canopy height and percentage cover at 3-foot increments.

We captured 8 ocelots on the East Foundation’s El Sauz Ranch in South Texas and fitted individuals with GPS collars that recorded locations every 30 minutes. We used a step selection function to determine selec-

tion of canopy height and cover. We compared selection across 4 spatial scales to examine if habitat use changed during increasing broader views of the landscape. Ocelots selected for greater canopy cover at lower heights (0-3 ft above ground). Selection for low cover increased with increasing spatial scale.

By combining accurate, fine-scale measurements derived from LiDAR data with high-frequency GPS locations, a more detailed understanding of ocelot habitat selection can be gathered. This can be used to inform conservation strategies by preserving existing habitat patches and reforesting habitat.

*Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute, Tommy and Sue Arnim, the Arnim Family Foundation, Travis and Bettina Mathis, The Brown Foundation, and the East Foundation.*



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**Dr. Jason Lombardi programs a Reconyx camera trap to record the presence of ocelots and bobcats.**

**Bobcat Habitat Selection in Brush Managed Landscapes**

*Aidan Branney, Amanda M. Veals, Jennifer Korn, Michael Cherry, Humberto Perotto-Baldivieso, and Michael E. Tewes*

The majority of rangeland ecosystems in South Texas occur on private lands. These landscapes are managed heavily for white-tailed deer and northern bobwhite, which represent significant financial revenue to landowners. These game species benefit from early successional stages achieved by regular clearing and maintenance of woody plants. Brush clearing alternated with brush strips provide supplemental browsing areas and escape patches for these game spe-





© Maksim Sergeev

**Blood is collected from bobcats when they are captured and fitted with GPS collars to assess movement patterns.**

cies. This in turn creates a structurally diverse landscape for other species that may occupy these areas. Bobcats are an ambush predator and require cover to effectively hunt prey. There has been no assessment of how brush management efforts benefit bobcat habitat selection and spatial ecology.

From 2011-2012, we placed eight GPS collars on bobcats on the Santa Gertrudis Division of the King Ranch and tracked their movements. From these data, we modeled the elements bobcats were selecting within their home range. We found that bobcats strongly selected locations closer to herbaceous cover and water bodies, indicating that brush strips may not negatively impact bobcats. It follows that bobcats likely hunt in these areas, as well.

This research will provide an understanding of the effects of brush management on bobcat spatial ecology. Information from this study should provide guidelines for ranch managers to plan brush clearing for the benefit of bobcats and other wildlife.

*Cooperative funding provided by the Tim and Karen Hixon Foundation, King Ranch, and the Feline Research Program of the Caesar Kleberg Wildlife Research Institute.*

### Fine-Scale Space Use and Activity Patterns of Ocelots in Restored Thornshrub Habitats

*Jason V. Lombardi, Sarah Lehnen, Michael E. Tewes, and Grant Harris*

Understanding movement patterns at different life history stages of wildlife species is essential to making informed conservation and land management decisions. Over the last century, large patches of Tamaulipan thornshrub have declined on private rangelands in coastal southern Texas, which has contributed to the decline of ocelots in the region. Restoration efforts have been underway to help increase connectivity of habitat patches in areas close to existing ocelot populations. Information on ocelot space use and activity patterns is unknown in these areas, and this information is critical to understanding ocelot thornshrub characteristics.

We will attach GPS collars with activity sensors on captured ocelots on the Yturria San Francisco Ranch. Data from this study will be used to determine activity patterns and space use in restored habitats. We will also assess the fine-scale structure of the restored areas to examine the quality and quantity of cover that is needed to support ocelots. This study will provide a better understanding of the role of thornshrub restoration on ocelot activity and space use. This information will be critical for ocelot recovery in South Texas.

*Cooperative funding provided by U.S. Fish and Wildlife Service, Feline Research Program of the Caesar Kleberg Wildlife Research Institute, Travis and Bettina Mathis, and The Brown Foundation.*

### Wildlife Crossing Effectiveness for Wild Cats

*Thomas J. Yamashita, Daniel G. Scognamillo, Humberto L. Perotto-Baldivieso, John H. Young Jr., Jason V. Lombardi, Zachary M. Wardle, and Michael E. Tewes*

Roads can have major impacts on wildlife, causing habitat fragmentation and direct mortality from wildlife-vehicle collisions. Wildlife crossings often are built to help reduce these impacts on mammals. To assess the effectiveness of wildlife crossings, it is important to monitor use of the site and wildlife road mortalities before and after construction of the crossings. It is also important to determine how surrounding landscape characteristics contribute to use.

We are assessing the use of crossing sites by wild cats and other mammals before and after construction of new crossings on Farm-to-Market (FM) 1847

in Cameron County. We are monitoring camera traps and conducting wildlife road mortality surveys before, during, and after construction of wildlife crossings. We also will use Light Detection and Ranging (LiDAR) imagery to map the internal structure of woody vegetation around crossings. We will compare the landscape and internal vegetation structure around crossings to random locations away from major roads and determine the threshold for bobcat use.

Before construction began, we documented mammal species at crossing sites including bobcats, coyotes, deer, opossums, and raccoons. To date, most road mortalities have been opossums and cottontail rabbits, with one bobcat and no ocelot mortalities.

This research will aid landscape conservation efforts for wild felids in South Texas. It also will provide biologists and Texas Department of Transportation personnel a better understanding of landscape characteristics and internal structure around wildlife crossings used by different mammal species.

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

### Identifying Behavior of Ocelots with Hidden-Markov Models

*Maksim Sergeyev, Michael E. Tewes, and Tyler A. Campbell*

Describing behavior of wildlife is essential to understanding the ecology of a species. However, it often is difficult to obtain accurate data on behavior in the field. Advances in monitoring technology have provided the ability to obtain reliable GPS data on captured wildlife. From these data, behavioral states can be identified by analyzing differences in animal turning angle and step lengths between locations.

From 2017 - 2020, we captured 8 ocelots on the East Foundation's El Sauz Ranch. Each individual was fitted with a GPS collar that collected locations every 30 minutes. We used a statistical model, the Hidden-Markov, to distinguish between 3 different behavioral states. We considered low turning angles and longer step lengths to be associated with patrolling territory. Larger turning angles with lesser distances between successive points represented hunting behavior, and low angles and minimal movement to be indicative of periods of rest. We predicted that ocelots exhibit 3 behavioral states: resting, hunting and territory patrolling. Our results show that ocelots moved further for

patrolling their territory in open areas. Resting and hunting behavior occurred in greater vegetative cover.

By identifying distinct behavioral states, we can gain insight into the movement patterns and energy use of ocelots. Further, understanding the factors that influence the movement states of ocelots can improve our understanding of the ecology of the species and improve conservation efforts.

*Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute, Travis and Bettina Mathis, The Brown Foundation, and the East Foundation.*

### Temporal and Spatial Partitioning by Ocelots, Bobcats, and Coyotes

*Maksim Sergeyev, Michael E. Tewes, Joseph D. Holbrook, Jason V. Lombardi, and Tyler A. Campbell*

Interactions between competing species can play an important role in the ecology of a species. Competition can influence activity patterns, survival rates, and habitat use. As such, understanding the effect of a competitor species on a rare species is essential for management and conservation. Ocelots in South Texas share their range with bobcats and coyotes, which are two similar-sized predators with comparable ecological niches. Understanding how these species partition the landscape by space and time can provide vital insights into the dynamics between these species and improve efforts to conserve ocelots.

Our objective is to use GPS data obtained from collared ocelots, bobcats, and coyotes on the East Foundation's El Sauz Ranch to better understand the mechanisms driving coexistence. We will examine differences in habitat selection and timing of activities to shed light on the mechanisms that allow these species to occupy the same area, despite their similarities.

By determining the ecological differences between these species, we will have a better understanding of their ecological interactions. Additionally, this research will help to inform management of ocelots to ensure that the ecological needs of this species are prioritized and preserved.

*Cooperative funding provided by the Tim and Karen Hixon Foundation, Feline Research Program of the Caesar Kleberg Wildlife Research Institute, the Las Huellas Association, Tommy and Sue Arnim, the Arnim Family Foundation, and the East Foundation.*



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**Black globe thermal devices were positioned across varying microclimates on El Sauz Ranch. The effect of thermal fluctuations on habitat selection of ocelots during extreme temperatures will be assessed using thermal data in combination with high-frequency GPS data from ocelots.**

### Population Size and Density of Ocelots on the El Sauz Ranch in Texas

*Jason V. Lombardi, Zachary M. Wardle, Thomas Yamashita, Maksim Sergeev, Landon Schofield, and Michael E. Tewes*

Understanding the population structure and ecological patterns that influence wildlife species is fundamental in wildlife ecology. For endangered species, knowledge of population sizes and densities is important to making sound conservation and land management decisions. Since 1982, ocelots have been classified as endangered, but precise estimates of populations are unknown. Current population estimates of about 80-100 ocelots have been proposed over the past three decades.

We conducted camera trap surveys on the East Foundation's El Sauz Ranch (28,000 acres) in north-eastern Willacy and southeastern Kenedy Counties. Surveys were conducted across 42 camera trap stations in live oak forests, thornshrub, and woody wetlands from Fall 2020 to Spring 2021. This study will use capture-recapture analyses to estimate a current population size and density of ocelots on private ranchland in South Texas.

These population estimates will provide critical information for ocelot populations on working rangelands, and how densities vary in different habitats. Subsequently, this information can be incorporated into future recovery and road planning efforts.

*Cooperative funding provided by the Texas Department of Transportation-Environmental Affairs Division, Tommy and Sue Arnim, the Arnim Family Foundation, and the East Foundation.*

### Influence of Extreme Temperature on Ocelot Habitat Use

*Maksim Sergeev, Michael E. Tewes, Evan P. Tanner, Joseph D. Holbrook, and Tyler A. Campbell*

Temperatures are often an important driver in influencing where species occur on the landscape. Species' geographic ranges are often strongly tied to temperatures. Furthermore, the exchange of energy is a central component to a wide range of ecological concepts including predator-prey interactions, habitat selection, community composition, movement patterns, diet, and behavior. As such, the influence of thermal variation on a species can be significant. The ocelot is a Neotropical felid adapted to the warmer temperatures of Central and South America, with its northern-most breeding range extending into South Texas. Though adapted for hotter climates, ocelots are nocturnal and often seek thermal refuge in vegetative cover.

Our objective is to examine the role of extreme temperature during summer and winter in influencing habitat use and activity of ocelots in South Texas. We will use data from 130 black globe thermal stations positioned around the East Foundation's El Sauz Ranch, and GPS data acquired from ocelots on the ranch to assess selection of vegetation as thermal cover. Furthermore, we will examine if areas of thermal refuge function similarly in summer and winter.

Understanding ocelot habitat selection during periods of extreme heat and cold should aid managers in protecting important habitat micro-sites. Ensuring sufficient cover for thermal escape will be an important strategy for future ocelot conservation in South Texas.

*Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute, Tommy and Sue Arnim, the Arnim Family Foundation, Travis and Bettina Mathis, The Brown Foundation, Las Huellas Association, and the East Foundation.*

### Estimating Bobcat Density on Rangelands in South Texas

*Zachary M. Wardle, Jason V. Lombardi, and Michael E. Tewes*

Population density is an important aspect of wildlife management but can be hard to assess for solitary, elusive species such as the bobcat. Bobcats are widespread across North America and are found in varying



numbers based on regional and local conditions. Little is known about bobcat population density in Texas, particularly in the Rio Grande Valley and surrounding rangelands of South Texas.

Camera trapping is a non-invasive technique for studying wildlife across large areas at a relatively low cost. We will use camera traps on private rangelands in South Texas to estimate bobcat density. Paired camera stations will be set to photograph both sides of bobcats, and individuals will be identified based on their unique coat patterns. We will then produce density estimates and examine how environmental and human-related factors are associated with changes in bobcat density across the study area.

This research will provide baseline information for bobcat density in the region and allow for comparisons with bobcat densities in other areas. The results will improve our understanding of the effects of ecological and human-related variables on bobcats in Texas. Use of this method will enable future research on bobcat density in South Texas to directly evaluate changes over time.

*Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute.*

### Road Crossing Patterns of Ocelots in Urbanized and Ranch Lands of South Texas

*Jason V. Lombardi, C. Jane Anderson, David B. Wester, Shelby B. Carter, AnnMarie Blackburn, Amanda M. Veals, Tyler A. Campbell, Humberto Perotto-Baldivieso, Michael E. Tewes, and John H. Young, Jr.*

Identifying how different road surfaces impact wildlife species has increasingly become a topic of conservation concern. These road impacts also may be influenced by additional factors including presence of suitable habitat patches, traffic volume and flow, and road density within home ranges. In South Texas, the ocelot is an endangered felid that is threatened by road mortality. Understanding the differences between different road surfaces and their impact on road crossing patterns is key to understanding how ocelots may perceive the landscape.

In this study we used a historic and contemporary telemetry dataset of 69 ocelots (36 males, 33 females) monitored in Cameron County from 1982 to 2001, and Kenedy and Willacy Counties from 2011 to 2020 to examine ocelot ecology in relation to roads. We evaluated how road density varied by road type within



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Morphological measurements being taken on a collared ocelot.

ocelot home ranges, as well as biological and study design factors. We further explained how these factors influenced road crossing rates within and across populations. Preliminary data from the more highly urbanized Cameron County indicate ocelots had higher within-home range paved road densities than areas without ocelots. Further, males in these areas crossed paved roads more often than females.

The results of this study will allow for a greater understanding of how ocelot movements and home ranges are affected by road types in different landscapes. Further, it will aid in developing road mitigation measures to prevent ocelot road mortality and increase ocelot use of mitigation measures.

*Cooperative funding provided by Texas Department of Transportation-Environmental Affairs Division, the East Foundation, and the Feline Research Program of the Caesar Kleberg Wildlife Research Institute.*

### **Circuit Theory Estimation of Road Crossings for Ocelots**

*Amanda M. Veals, Joseph D. Holbrook, Michael E. Tewes, Michael J. Cherry, Randy W. DeYoung, Tyler A. Campbell, and John H. Young, Jr.*

Landscapes must allow movement of individuals to support wildlife populations. Roads are increasing in natural areas and limit animal movements. Understanding how roads limit animal movements is important to conserve threatened populations.

This study focused on the ocelot which is threatened by vehicle collisions. Ocelots in the U.S. occur in a highly fragmented landscape due to extensive urban and agricultural development. This study will determine the probability of ocelot habitat use across South Texas and identify potential movement pathways between habitat patches. Additionally, we will assess which model of resistance best represents the landscape.

We modeled probability of habitat use with resource selection using a 35-year telemetry dataset (1982-2017). We developed resistance scenarios for differences in landscape connectivity and difficulty of movement. We then used circuit theory to identify potential movement pathways and assess resistance scenarios. Circuit theory is a tool to test for landscape connectivity, including how landscape features impact animal movement.

Identifying movement paths across the fragmented landscape can help reduce mortality for ocelots. The

use of crossing structures in transportation projects may help restore connectivity. Transportation planners can use this information to plan for the placement of ocelot road crossing structures.

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

# Habitat Restoration and Enhancement

## Native Species Richness and Pipeline Restoration

*Brianna M. Slothower, Anthony D. Falk, Terry Blankenship, Sandra Rideout-Hanzak, and David B. Wester*

It is widely accepted that seed mixes used for restoration of disturbed landscapes should include locally-adapted species. But how many different kinds of native grasses should be used? And what about their role in the changes that follow plant establishment? These considerations are not well understood in South Texas.

We designed a study to assess effects of native grass species richness on plant establishment. We are using both native grasses and exotic grasses common in South Texas landscapes. We have established study plots along a natural gas pipeline in San Patricio County that vary in the number of different kinds of native grasses. Some plots were seeded with three different kinds of grasses. Other plots received either 5 or 11 kinds of native grasses. Grasses that we used differ in their seed coats. Some grasses have hard seed coats; others have fluffy seeds. Some species are more weedy than others.

Initial results for summer-seeded plots suggest that native grass richness does not affect either native grass or exotic grass density. Weedy species are more abundant. We also found that fluffy-seeded species had higher plant density than hard-seeded species. It is important to note that slender grama, one of most successful plants, is an early-successional species that has fluffy seeds. Future plant dynamics will be monitored to better understand the factors that affect plant establishment in disturbed areas in South Texas.

*Cooperative funding provided by the Swenson Fellowship and L.H and P. M. Stumberg.*

## Restoring Pollinator Habitat at Goldsmith Solar Farm

*Samuel R. Lutfy, Veronica G. Rapp, Rhett K. Kerby, and Forrest S. Smith*

In the Permian Basin and Panhandle regions of Texas, rapid development of large-scale solar energy facilities is underway. In 2019, Texas Native Seeds was consulted on a recently developed 200-acre solar farm in Goldsmith, TX. The goals of the project included reducing soil erosion and creation of pollinator and wildlife habitat.



© David B. Wester

**Disturbance on the landscape, such as the installation of a natural gas pipeline, can create opportunity for invasive plants to establish on the soil surface.**

In fall 2019 site preparation included caliche removal and disking. This was followed by drill seeding a cover crop of winter wheat. Erosion-prone areas were then hydroseeded with a cotton byproduct and a nutrient amendment to reduce erosion, retain moisture and encourage plant establishment. In spring 2020, a mix of native grasses and forbs was no-till drilled into the growth of wheat and native wildflowers; however, due to summer drought conditions germination of the drilled mix was poor. In 2021 seeding was repeated, and good spring rainfall should help ensure establishment.

It is our hope that this project will serve as an example of the possible benefits of restoration projects in the region alongside solar energy development. Results will be monitored in the coming years and will also be included in a broader understanding of solar site restoration across Texas, as our other regional projects are engaged in similar studies.

*Cooperative funding provided by Occidental Petroleum Company, KerTech, LLC, and donors to the Permian Basin-Panhandle Native Seed Project.*

## Seeding Rates, Plant Establishment, and Effects on Guineagrass

*Anthony D. Falk, Keith A. Pawelek, Joshua D. Breeden, Bart Dupont, Jimmy Rutledge, Eric D. Grahmann, and Forrest S. Smith*

The standard seeding rate for range seeding is 20 pure live seeds per ft<sup>2</sup> according to the USDA



Natural Resources Conservation Service. This rate provides enough seed to establish a successful stand without creating unnecessary competition and costs. Additionally, some native species have demonstrated the ability to be highly competitive against non-native species.

In summer 2020, La Paloma ranch completed a brush control project and expected an increase in non-native Guineagrass afterward. To combat the Guineagrass, STN is testing standard seeding rates of Dilley Germplasm slender grama, Maverick Germplasm pink pappusgrass, Hidalgo Germplasm multi-flowered false Rhodesgrass, and Mariah Germplasm hooded windmill grass plus a standard mix resulting in a final seeding rate that is twice the standard rate. An additional treatment includes seeding each of the species listed above at the standard rate. This equals a rate 4 times the recommended amount of just 4 species. The last treatment is seeding a diverse seed mix at the standard rate.

South Texas Natives staff will collect data on this project every spring and fall for the next 2 years. This project will help determine the effects of seed density on establishment of native species and suppression of non-native species.

*Cooperative funding provided by The Lee and Ramona Bass Foundation.*

### Restoration of Horned Lizard Habitat at Toyota Motor Manufacturing

*Anthony D. Falk, Keith A. Pawelek, and Jo Ann Ortiz*

South Texas Natives (STN) and Toyota Motor Manufacturing began a collaborative effort to convert 20 acres of Bermudagrass to native grassland with the hopes of re-introducing Texas horned lizards to the area. Texas horned lizards are a state threatened species that require open native grassland with intermixed brush for over-head cover. This collaborative effort is taking place on the Toyota Motor Manufacturing facility in San Antonio, Texas.

To complete the conversion STN staff began an aggressive herbicide regime in the spring of 2020 to control the non-native Bermudagrass that was on site. This consisted of 4 applications of Roundup Powermax® applied monthly from June through September. Following the herbicide applications, a seed mix, which consisted of 15 native grass species and 12 native forb species was seeded in late September. In the spring of 2021, staff from Toyota

Motor Manufacturing transplanted a number of brush species into the restoration area to complete the restoration efforts of the area.

South Texas Natives staff plans to collect data on the establishment and coverage of the seeded species, along with the survival of brush species transplanted every spring and fall for the next 3 years. Data from this project will help other landowners interested in re-establishing native rangeland and Texas horned lizard habitat in the area. In addition, this restoration project will refine areas of adaptation for STN released species.

*Cooperative funding provided by Toyota Motor Manufacturing.*

### Soil Seed Banks in Northeast Texas Tallgrass Prairies

*Emily R. Bishop, Tyler C. Wayland, Keith A. Pawelek, Sandra Rideout-Hanzak, and David B. Wester*

Plants are prolific seed producers. Many of these seeds become buried in the soil where they form what is called a soil seed bank. Soil seed banks represent both current and historical plant communities and can be an important resource for future plant dynamics.

Most ecological restoration efforts involve seeding locally-adapted species during the first year of the restoration process with the hope that plants will successfully establish themselves. Subsequent plant dynamics and ultimate vegetation composition depend on seeds



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**Regrowth at the restoration site on Riverby Ranch in Northeast Texas.**

produced by first-year plants as well as plants that emerge from the soil seed bank. In fact, seed banks can have higher diversity than associated aboveground vegetation. It is also true, however, that the similarity between soil seed bank composition and aboveground plant community composition is low. Additionally, soil seed bank persistence can be low for grasslands.

As part of our work to develop restoration practices in tallgrass prairies in Northeast Texas, we are studying soil seed bank characteristics. In particular, we are studying the soil seed bank that lies below the plow layer that has formed after many years of farming—because this is the layer that may still harbor seeds of the historic plant community. Our goals are to determine if this seed bank still exists after many years of farming, and if we can recover seeds, we will assess their viability. Additionally, we will characterize the soil seed bank in undisturbed native prairies so that we can assess effects of farming on soil seed bank persistence. Our results will be used to inform future restoration practices for tallgrass prairies in Northeast Texas.

*Cooperative funding provided by RES Texas Mitigation, LLC and North Texas Municipal Water District.*

**Use of Cover Crops and Native Seed to Compete with Guineagrass**

*Anthony D. Falk, Keith A. Pawelek, Joshua D. Breeden, Jimmy Rutledge, Bart DuPont, Eric D. Grahmann and Forrest S. Smith*

Guineagrass is a highly competitive non-native species capable of forming dense stands in the South Texas Sand Sheet. Cover crops are relatively cheap short-lived species that can be planted at times when seeding permanent vegetation is not recommended. South Texas Natives (STN) is collaborating with the La Paloma Ranch to evaluate the ability of 2 different cover crops, coupled with native seeding, to compete with Guineagrass following brush removal.

In the summer of 2020, La Paloma Ranch completed an extensive brush removal project and expected an increase in Guineagrass across the pasture. In an effort to compete with the Guineagrass, STN staff established research plots of two commonly used summer cover crops; browntop millet and hay grazer. These cover crops were seeded in individual stands and in separate plots combined native seed mixes. Additional treatments included half rates of the cover crops with the native seed mixes. In the spring of 2021, the same

native seed mix was planted into the plots that were previously planted to just the cover crops.

South Texas Natives staff plans to collect data on these plots every spring and fall for the next 2 years. Results from this project will help STN staff provide recommendations to landowners on the effects of cover crops in native plant establishment. Additionally, information will be gathered on the competitive advantage of these summer cover crops on Guineagrass.

*Cooperative funding provided by The Lee and Ramona Bass Foundation.*



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**South Texas Natives is evaluating the use of cover crops to compete with Guineagrass at La Paloma Ranch.**

**Developing Spectral Signatures for South Texas Grasses Using Multispectral Sensors**

*Annalyssa M. Camacho, Walter E. Gless, Michael T. Page, Melaine A. Ramirez, Humberto L. Perotto-Baldivieso, J. Alfonso Ortega-S., Evan P. Tanner, Forrest S. Smith, Anthony D. Falk, Dwain Daniels, Tony Kimmet, and Shad D. Nelson*

Multispectral sensors are becoming part of the drone toolbox for vegetation monitoring in rangelands. Multispectral sensors can capture spectral bands in the visible and non-visible regions of the light spectrum which can be analyzed to identify plant species. Using drone mounted multispectral sensors allows for high spatial resolution (less than 1-inch pixels) data acquisition, increased spectral resolution and on-demand data collection. This could potentially help the assessment of grass cover composition over larger areas in rangelands. Our goal is to develop methods to create

spectral signatures for native grasses in South Texas. Our objectives are to 1) create a digital library of spectral signatures for important native grasses in South Texas and 2) identify gulf cordgrass at the landscape level using spectral signatures, drones, and satellite imagery. To achieve these objectives, we are currently acquiring data from monoculture plots at the USDA NRCS E. “Kika” de la Garza Plant Materials Center and the South Texas Natives Project Farm in Kingsville, Texas. We are building digital libraries of spectral signatures using MicaSense Red Edge MX multispectral sensor mounted on a drone. We are conducting monthly flights throughout the year, to assess both spatial and phenological variability. We are using these images to create a digital library containing the different signatures for each species at different growth stages throughout the year. The results of this study will provide a tool to identify, monitor, and quantify the presence of native grass species in the South Texas landscape.

*Cooperative Funding provided by Natural Resources Conservation Service, National Science Foundation, and The Rotary Club of Corpus Christi Harvey Weil Sportsman Conservationist Award.*

### What Happens to Buried Seeds?

*Brianna M. Slothower, Anthony D. Falk, Terry Blankenship, Sandra Rideout-Hanzak, and David B. Wester*

Texas uses rangelands for many purposes including energy extraction and transportation. Restoring disturbed rangelands with native grasses presents many challenges. Native grass emergence can be delayed, or grasses can fail to establish because of competition with invasive plants or low quality of seed. Other limiting factors include unfavorable environmental conditions. Our goal is to monitor native grass seed germination and viability throughout the year.

We are assessing changes in viability and germination of native grasses that have been seeded along a pipeline in San Patricio County, Texas. We buried seeds in pouches along our pipeline in late summer and also in early winter. We are extracting pouches 1, 2, 6, 9 and 12 months following burial. We are counting the number of remaining seeds in each pouch, and testing their ability to sprout. Initial results following 9 months of burial show an increase of seed germination of slender grama and Hall’s panicum, and switchgrass up to 6 months of burial. With longer burial times, germination decreases. Shortspike windmill grass and

Rhodesgrass had low germination (< 10%) and white tridens had higher germination (24%). Germination of these three species was not affected by duration of burial. Our results will inform recommendations about the need for re-seeding if conditions following seeding are not favorable for emergence and establishment success.

*Cooperative funding provided by the Swenson Fellowship and L.H and P. M. Stumberg.*



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**Researchers at the CKWRI are studying methods for restoring native plants at multiple sites across the state.**

### Native Grassland Restoration in the Edwards Plateau Region of Texas

*Molly E. O’Brien, Evan P. Tanner, David B. Wester, Anthony D. Falk, Sandra Rideout-Hanzak, John R. Bow, and Forrest S. Smith*

Diverse native rangelands are important for wildlife conservation. Past land use and common disturbances can reduce native plant cover and degrade the potential of rangelands. The development of



commercially-available, locally-sourced native seed sources has been an important approach to successful native rangeland restoration in the past. However, current mixes are lacking within areas of the Edwards Plateau. Restoration methods can often be site-specific. Thus, locally-developed techniques may enhance restoration success.

At sites in Menard County, Texas, plots have been established in agricultural fields to test seed mixes. Additionally, we will be testing site preparation methodologies and herbicide application on restoration success. Plant density and diversity data will be recorded three times a year for two years (2021-2022) to assess plant responses to our experimental restoration treatments. This research will provide new local seed sources for this important area of Texas. It will also provide critical information necessary for landowners in Central Texas who wish to restore degraded rangelands and agricultural fields.

*Cooperative funding and support provided by AEG Dos Ranches LLC and facilitated through Texas Ecological Laboratory (EcoLab), and the Texas Native Seeds Program (TNS).*

**Native Seed Development for East Texas Understory**

*Tyler C. Wayland, Jacob L. Sparger, Keith P. Pawelek, Thomas C. Philipps, Forrest S. Smith, and Robert A. Shadow*

The National Forests and Grasslands of Texas make up about 675,000 acres that are managed by the U.S. Forest Service (USFS) in East Texas. Land disturbance that follows construction, oil and gas activity, or



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**A diverse mix of species emerges in a restoration planting.**

extreme weather events on these lands are great opportunities to restore native habitat on the landscape. However, one of the largest challenges facing native plant restoration in the region is the lack of reliable native seed sources available for use. We are partnering with the USFS and the NRCS East Texas Plant Materials Center to increase the quality and quantity of native seeds available to meet demand in the region.

The commercial production of native seed is critical in providing the amount of seed needed to meet regional demand. In order to increase the production and success of native plant materials, we are utilizing a scientific approach to seed source development. We are working to collect, evaluate, and select the best performing populations of native understory plant species for large scale commercial production. The end goal is a strong and reliable supply of certified native seed sources available for all land managers in the region to use. Adapted seed sources from this partnership will help to increase restoration success of the understory species within the iconic open pine systems of East Texas.

*Cooperative Funding Provided by the United States Forest Service, the United States Department of Agriculture Natural Resource and Conservation Service, and the numerous private donors of the East Texas Natives Project.*

**Ecology and Management of Whitebrush in Texas**

*Katie J. Pennartz, Evan P. Tanner, Megan C. Clayton, Anthony D. Falk, Humberto L. Perotto-Baldivieso*

Whitebrush is a common shrub species found throughout Central, West, and South Texas rangelands. It is often the target of mechanical and chemical treatments to reduce coverage and promote growth of plant species desirable for wildlife populations. Dense shrub stands reduce the presence of grasses and wildflowers that serve as important wildlife food resources. Traditional treatments used in shrub management, such as roller chopping and recommended herbicides, have been ineffective. New herbicides have been developed to control this species, though research in field settings is needed to better understand what promotes application success. Furthermore, there is limited knowledge on the basics of whitebrush ecology such as seed production and growth habit. A better ecological understanding would provide researchers and managers with information necessary to address management concerns related to this species.

To gain this information we will collect seeds from whitebrush shrubs at sites in Frio, Kleberg, and Webb Counties, Texas, and establish a greenhouse study to quantify elements of the basic reproductive ecology of whitebrush. In addition, root systems will be collected from the field sites to observe growth habits. We will also establish research plots at these sites in which whitebrush stands will be treated with the newly-developed herbicides at varying application rates during both dormant and growing seasons.

These approaches will help to determine the most effective treatments to control dense stands of whitebrush across Texas rangelands. Site treatments will begin in fall 2020 and will continue through fall 2021. Greenhouse trials will begin in spring 2022. Results from this research will allow rangeland managers and scientists to establish informed management options related to the control of this native, yet locally invasive, shrub species.

*Cooperative funding and support provided by the Houston Livestock Show and Rodeo, Bayer, Corteva Agriscience, the Texas Native Seeds (TNS) Program, and Texas AgriLife.*

over time. We will continue to measure plant density and diversity to better understand changes on disturbed areas. With these long-term data, we can provide better information for management recommendations for restoring rangelands following energy development.

*Cooperative funding provided by Alston and Holly Beinhorn.*



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**Vegetation Dynamics on a Restored Frac Pond in the Western Rio Grande Plains**

*Dustin A. Golembiewski, Sandra Rideout-Hanzak, and David B. Wester*

Plant communities are dynamic, both in space and time. Plant density and species composition vary because of fluctuating environmental conditions and interactions among plants. These processes are especially important to understand in restoration ecology.

We have been monitoring native grasses on a restored frac pond in Dimmit County, Texas, since 2017. In our approach, we spread out top, middle and bottom layers of a stock-piled soil over the surface of the frac pond. Then we seeded with native grasses or a native grass plus an annual grass cover. Controls included seeded and non-seeded plots that were not topsoil. After seeding, and with every sampling period since, the control surface has higher native grass density and higher species richness. However, differences between the control surface and surfaces restored with stock-piled topsoil have lessened over time.

The unexpected “head start” that we measured on the control surface is becoming less apparent over time. Also, plots that were seeded with native grasses changed more than plots that were not seeded. This trend is expected to continue as seeded plants expand

**Diverse native seed grass mixes can be strong competitors with invasive, non-native grasses in restoration efforts.**

**Developing a Seed Mix for Harris County Flood Control District**

*Douglas L. Jobs, Keith A. Pawelek, Tyler C. Wayland, Forrest S. Smith, and Jeff Jowell*

The flood control infrastructure of Harris County consists of different types of waterways that include drainages, ponds, and water channels that total nearly 2,500 miles. Plans to promote the management of these systems in an ecologically beneficial manner while maintaining their function is a priority for Harris County Flood Control District (HCFCD). Reseeding and vegetation establishment after construction and maintenance are typical demands. However, the use of native seed sources is limited due to the lack of availability and limited testing.

We are implementing an adaptability study using native species at 2 locations in Harris County. The plots are located in soil types typical of the adjacent drainages and basins. Maintenance and monitoring will occur throughout the 2022 growing season. Plots at each location are 100 ft<sup>2</sup> and include several species that are commercially available. Also included in

the plots are 6 upcoming germplasm releases including herbaceous mimosa, swamp sunflower, ashy sunflower, eastern gamagrass, little barley, and knotroot bristleglass. Collections are also underway to increase evaluations of other candidate species.

Results from this study will play an important role in providing reliable seed sources for use within the drainages and waterways of HCFCO. This will also help encourage the use of native seeds for restoration and reclamation by other groups, agencies, and landowners of the region.

*Cooperative funding provided by the Harris County Flood Control District.*

**Cover Crop Considerations for Native Grass Establishment along Pipelines**

*Brianna M. Slothower, Anthony D. Falk, Terry Blankenship, Sandra Rideout-Hanzak, and David B. Wester*

It is common for rangelands to experience disturbance. After a disturbance event, soil is vulnerable to erosion and susceptible to invasive grasses. To mitigate these effects, managers may choose to restore disturbed areas with native grasses. In a recent study, it was recommended to seed an annual cover crop with a native seed mix. Our goal in this study is to monitor plant interactions between cover crops, native grasses, and exotic grasses to determine (1) when to seed a cover crop and a native grass mix, and (2) whether establishment dynamics are different between summer and winter seeding. Our experiment is located on a natural



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**Utility-scale solar facilities create huge disturbances. South Texas Natives is evaluating seed varieties for optimal establishment and erosion control properties.**

gas pipeline in San Patricio County, Texas. It includes a summer and winter seeding. In each season some plots are seeded with native grasses and cover crops (legume or annual grass) simultaneously, other plots are seeded with cover crops one month prior to native grass seeding. We are monitoring plant establishment dynamics and changes in species composition.

We found higher native grass densities three months after the summer planting when grasses and cover crops were seeded at the same time; native grass density was lower, however, when seeded into an established cover crop. Additionally, native grass density was similar when grasses were seeded alone or with a legume cover crop. The legume cover crop, however, enhanced grass density compared to a grass cover crop. We will continue to monitor these interactions because they are expected to change as the plant community establishes.

*Cooperative funding provided by the Swenson Fellowship and L.H and P. M. Stumberg.*

**Restoration at a Utility-Scale Solar Facility**

*Anthony D. Falk, David B. Wester, and Matthew McGruder*

Texas has recently seen an increase in the construction of solar production facilities. These facilities range in size from a couple of acres to several thousand acres. When creating such large disturbances on the land, many solar producers would like to minimize their impact as much as possible.

To minimize their impact, energy company Orsted has partnered with South Texas Natives (STN) to fund research evaluating the ability of several native seed varieties to meet the needs of the solar industry. Particular interests to the solar industry include vegetation coverage to prevent erosion, and stand height to allow for the most efficient energy production. Additionally, STN staff is going to evaluate the effects of drill seeding and hydroseeding on plant establishment and erosion control. Finally, staff are going to evaluate stand establishment based on planting date within the sequence of the solar field construction process. The first round of seeding took place in summer 2021 with the second phase scheduled for winter 2021. Following seeding, data will be collected in spring and fall 2022, 2023, and 2024. Results from this project will be used to guide future solar farm developments in establishing native vegetation.

*Cooperative funding provided by Orsted OnShore North America.*





© Emily Bishop

Overlooking the fall planting in October 2019.

### National Fish and Wildlife Foundation Research

*Colin S. Shackelford, Samuel R. Lutfy, Louis A. Harveson, and Keith A. Pawelek*

The West Texas Native Seed Project and the Permian Basin-Panhandle Native Seed Project are in the second year of a project funded by the National Fish and Wildlife Foundation (NFWF). The ongoing project is part of NFWF’s Pecos Watershed Conservation Initiative. The Initiative is a partnership between NFWF, 11 major oil and gas producers operating in West Texas, and the USDA Natural Resources Conservation Service.

Funding from NFWF will continue to support existing efforts of the West Texas Native Seed Project. These efforts include development of new seed sources for habitat restoration across West Texas, and help with farm operations for seed production of new plant releases. New seed source research made possible by the project include hairy grama, Arizona cottontop, and Canada wildrye grasses. NFWF funding is providing partial support for two assistant director positions and a full-time technician position employed through project partner Sul Ross State University in Alpine, Texas. Funding from the Pecos Watershed Conservation Initiative will also help in the development of best practices guidelines for restoration in West Texas. Fifteen acres of new restoration research plantings have been completed in the region through the project with an additional 10 acres planned for this year. This exciting new partnership with the NFWF is a big step forward in making successful grassland habitat restoration a reality in West Texas.

*Cooperative funding provided by the National Fish and Wildlife Foundation, Concho Resources, Inc., Caesar Kleberg Foundation for Wildlife Conservation, CF Properties and the Sierra la Rana Development, Stan Smith, and the Railway Ranch.*

### Tallgrass Prairie Restoration in Northeast Texas

*Emily R. Bishop, Tyler C. Wayland, Keith A. Pawelek, Sandra Rideout-Hanzak, and David B. Wester*

Tallgrass prairies are found throughout the Great Plains. Many of the dominant grasses—plants like little bluestem and big bluestem—can be found from South Dakota to southern Texas. Although these grasses are widely distributed, they are also adapted to their local environmental conditions. One of the most important considerations in restoration is fine-tuning seed sources to specific growing conditions. This information is lacking in Northeast Texas. We are developing restoration strategies for 3,000 acres of former farmland on the Riverby Ranch. Our project is associated with the development of the Bois d’Arc Reservoir.

In fall 2019, we seeded 30 varieties of native grasses, as well as mixtures of native grasses and forbs, in 315 research plots in Fannin County, Texas. Another 315 plots were seeded in spring 2020. Plant density is being monitored in nearly 2,000 locations to determine which seed varieties are best adapted to this region. Six of the 13 grasses had more than one variety planted. These included grammas, eastern gamagrass, Indiangrass, switchgrass and both little and big bluestems. First year establishment results from the autumn seeding suggest that Coastal Plains little bluestem and Earl big bluestem are the most successful varieties. There were no differences among varieties of the other 4 groups of plants. Further monitoring is needed to document establishment dynamics and evaluate future restoration success.

*Cooperative funding provided by RES Texas Mitigation, LLC and North Texas Municipal Water District.*

# Shorebirds and Waterfowl

## Identifying Key Stopovers for Migratory Shorebirds

*Jason P. Loghry, Bart M. Ballard, Sarah Clements, Mitch D. Weegman, and David J. Newstead.*

During migration, birds manage their time and energy for a timely arrival on breeding areas in optimal body condition. Many of these birds spend most of their time at stopover sites where they rest and refuel to enable them to make the next leg of their journey. Therefore, distribution and quality of stopover sites are crucial for successful migration.

A clear understanding of how human-induced changes to stopover sites impact migratory birds is difficult to measure. This is because of the complexity of migration and the difficulty in relating changes to stopover sites to survival and reproductive success on breeding areas long distances away. To help understand this connectivity, we attached automated tracking devices to three species of shorebirds prior to their departure on spring migration. From the location data, we have been able to determine migratory tracks, stopover site locations, and breeding site locations for each species.

We will now investigate how variation in migration metrics is linked to each bird's estimated reproductive success and assess patterns of habitat use and selection for each species at stopover areas. This information will help us identify important stopover areas, and will be useful to regional management planners in helping to reverse the declines observed in many species of shorebirds in North America.

*Cooperative funding provided by the Robert J. and Helen C. Kleberg Foundation and the University of Missouri.*



© David Newstead

**Researchers at the CKWRI are investigating key stopovers to aid with regional management planners to help reverse declines in many species of shorebirds.**

## Factors Affecting Settling Patterns of Breeding Northern Pintails

*Matti R. Bradshaw, Bart M. Ballard, Kevin J. Kraai, Daniel P. Collins, J. Dale James, James H. Devries, and Jay A. VonBank*

Nesting studies of breeding waterfowl are traditionally based on where biologists predict individuals will likely select a nest site. However, this could bias our assessment of breeding ecology as our predictions may be different from what actually occurs. The northern pintail is a species of concern to managers, since their population has not recovered to historic numbers after several decades of decline. Females nest in cropland more often than any other species of duck, which is believed to be a primary driver of their population decline. Unbiased assessment of habitat selection by northern pintails on breeding areas is imperative to enable biologists to effectively manage this species.

The objectives of this project are to (1) investigate settling patterns of northern pintails on breeding areas relative to landscape and environmental conditions, and (2) estimate breeding effort (nest initiation date, number of nesting attempts, etc.) and nest success as functions of small-scale habitat features. To date, we have deployed 326 tracking devices on female pintails across their winter range in North America during January and February 2020 and 2021 to allow an unbiased account of settling on breeding areas. We plan to deploy more tracking devices on female pintails in 2022. Results from this project will allow us to test current conservation planning tools used by resource managers to allocate resources to waterfowl breeding habitat in the Prairie Pothole Region of Canada and the U.S.

*Cooperative funding provided by Texas Parks and Wildlife Department, U.S. Fish and Wildlife Service, Ducks Unlimited, Inc., New Mexico Department of Game and Fish, U.S. Geological Survey, and Canadian Wildlife Service.*

## Nonbreeding Ecology of Northern Pintails in North America

*Georgina R. Eccles, Bart M. Ballard, Kevin J. Kraai, Daniel P. Collins, J. Dale James, Mitch D. Weegman, and Clayton D. Hilton*

Habitat improvements to waterfowl breeding areas have resulted in population increases for many species. However, northern pintail populations remain

below management goals. Conditions on nonbreeding areas may play a role in pintail population declines as pintails spend large portions of their annual cycle in nonbreeding areas. Pintails wintering in different regions are subject to varying stressors, survive winter at different rates, and migrate through very different landscapes during spring migration. Thus, investigations into pintail nonbreeding habitats could aid in understanding their effects on pintail population declines. The aim of this research is to investigate the winter ecology of pintails wintering in different regions across North America. We will also compare spring migration strategies from different wintering regions. Last, we plan to investigate the links between migration strategies and nesting success, as well as identify important stopover areas for pintails migrating from different wintering regions.

To date we have attached 326 tracking devices on female pintails, with more devices being deployed in late winter 2022. The areas we have captured females include the Louisiana Coast, Texas Coast, Texas Panhandle, Central New Mexico, Southwestern Arizona, and the Central Valley of California. In total, we have obtained nearly 700,000 GPS locations and over 4 million accelerometer fixes from all birds that are currently alive. Our results will assist resource managers in answering important management questions.

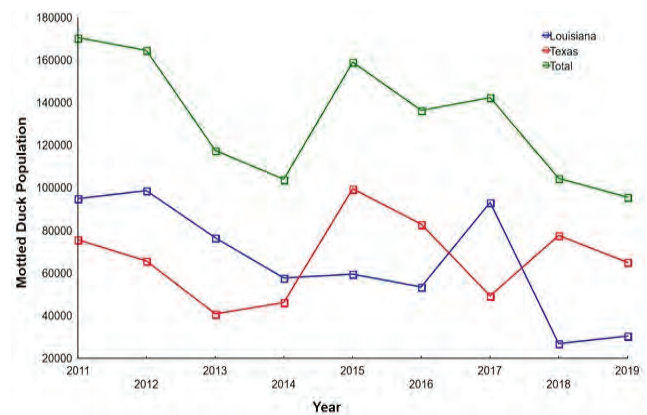
*Cooperative funding provided by Texas Parks and Wildlife Department, U.S. Fish and Wildlife Service, Ducks Unlimited, Inc., New Mexico Department of Game and Fish, U.S. Geological Survey, and Canadian Wildlife Service.*

### Assessment of the Breeding Mottled Duck Survey along the Western Gulf Coast

*Vijayan Sundararaj, Bart M. Ballard, Daniel P. Collins, Kathy K. Fleming, and Kevin J. Kraai*

A dedicated breeding population survey began in 2008 for estimating the mottled duck population along the Western Gulf Coast of Texas and Louisiana. The survey is conducted along transects via airplane. A helicopter is also used on a subset of transects to provide a visibility correction factor within different habitat types. The visibility correction factor is then used to determine a final population estimate. We investigated the effect of vegetation cover and the amount of wetland area on the number of ducks counted. We also tested whether there was variation among observers conducting the aerial survey and if that varied across

### Population trends of mottled ducks in the Western Gulf Coast over the last decade show a general decline.



different habitat types. In both Texas and Louisiana, vegetation cover influenced the number of ducks counted with numbers increasing with the amount of vegetation cover. Survey observers varied in their ability to detect ducks across different habitat types suggesting ground conditions affect duck detection. In certain regions of the survey, frequent changes in aerial survey observers across years contributed largely to variation in population estimates. Our findings reveal the importance of habitat structure as well as observer bias in animal detections during aerial surveys.

*Cooperative funding provided by U.S. Fish and Wildlife Service.*

### Community Dynamics of Migratory Shorebirds in the Laguna Madre

*Jason P. Loghry and Bart M. Ballard*

The Laguna Madre is a diverse hypersaline lagoon that supports large numbers of shorebirds during migration. As a result of much of the lagoon's inaccessible nature, the migratory shorebird community has yet to be thoroughly quantified or characterized. Therefore, we initiated a study to better understand the importance of the Laguna Madre as a stopover area for shorebirds during spring migration.

We conducted biweekly surveys from late February through May in 2020 and 2021 to determine abundance and species composition of migrating shorebirds. Using an airboat, each survey covered about 165 miles of tidal flat habitat. For each flock encountered, we recorded overall number of shorebirds, species composition, and location. Shorebird abundance



was determined through a combination of direct counts and visual estimation of large flock sizes. Species composition was determined by direct identification during counts of smaller flocks and video recordings of larger flocks. Peak abundance occurred in early April each year with over 300,000 shorebirds tallied in 2020 and about 150,000 in 2021. Although 29 species of shorebirds were recorded, dunlin, sanderling, and western sandpipers were the most numerous. An understanding of abundance, timing of migration, and areas of use for migrating shorebirds in the Laguna Madre will provide crucial information to resource managers to limit the impacts of increased development on shorebirds.

*Cooperative funding provided by the Robert J. and Helen C. Kleberg Foundation.*

Texas private landowners, agencies, and conservation non-profits towards the conservation of buff-breasted sandpipers and other grassland shorebirds.

*Cooperative funding provided by the Knobloch Family Foundation, U.S. Fish and Wildlife Service, Neotropical Migratory Bird Conservation Act, National Fish and Wildlife Foundation, Asociación Calidris, and Polar Knowledge Canada.*

### **Buff-Breasted Sandpiper Stopover Selection in the Texas Gulf Coastal Plain**

*Tara L. Rodkey, Bart M. Ballard, and Richard Lanctot*

Agricultural intensification has been identified as one of the largest drivers of habitat loss and global bird declines. The central North American grasslands are particularly threatened. Over 80% of these grasslands have been converted to agriculture and other land uses. As a result, grassland-associated birds have experienced large declines in the past half-century. The buff-breasted sandpiper is an obligate grassland shorebird and a long-distance migrant. It travels from the high Arctic to South America each year, and is a species of global conservation concern due to the array of current threats to habitat along its migratory pathway.

The Texas Gulf Coastal Plain is a critical stopover during migration for the buff-breasted sandpiper, as these birds rest and replenish their fat stores in this region during both their southbound and northbound migrations. Habitat conservation efforts for this species are expected to benefit a suite of other grassland bird species. Understanding how they use habitat in this important migratory area is vital for creating and implementing effective conservation measures in the region. To evaluate habitat use of buff-breasted sandpipers while they travel through the Gulf Coastal Plain in Texas, we will capture and fit birds with GPS transmitters. Transmitters will allow us to discover what types of habitat they use during migration. From these location data, we will build models to identify and predict high-use areas. These models will then be used by

## Downtown Midland Demonstration Native Plant Garden

*Samuel R. Lutfy, Jesse Wood, Colin S. Shackelford, and Forrest S. Smith*

Concho Resources, Inc. has partnered with the Permian Basin-Panhandle Native Seed Project to establish and maintain a native plant and restoration demonstration garden, in downtown Midland, Texas, to showcase current and future commercially available species for restoration projects in the region. This garden was established in spring 2018, and it contains 6 native wildflowers and 21 native grass species that are available or in development. Two species of native wildflowers were added to the garden in spring 2020, and a mixture of grasses was planted in the adjacent lot. Each species is displayed in 10-foot square areas with five-foot walking rows in between. This garden gives people an idea of the plants' growth habits and the aesthetic benefits of restoration.

Signs were posted in summer 2019 that explain the benefits of habitat restoration, names of each species, and information about the Texas Native Seeds Program. In addition, we have met with industry professionals and public organizations and received positive feedback about the educational benefits this demonstration garden has provided. The garden will continue to be expanded as the program develops new plant materials for the region.

*Cooperative funding provided by Concho Resources, Inc.*

## Prescribed Fire and Butterflies in Coastal South Texas

*Rebecca R. Zerlin, Juan C. Elissetche, David B. Wester, Richard Patrock, Tyler A. Campbell, Dennis M. Berry, Gertrudis Ruiz-Balli, D. Blake Jordan, and Sandra Rideout-Hanzak*

Insects outnumber humans 200 million to one, and they provide many important services, such as acting as food for other species, decomposing, and pollinating. Approximately sixty-seven percent of flowering plants worldwide rely on insects for pollination, including 3/4ths of the major agricultural crops, making insect pollinators, such as butterflies and bees, vital in any ecosystem. With major declines in insect populations in the past three decades, pollinator conservation is becoming increasingly important

Knowing this, land managers should strive to improve pollinator habitat in their management areas. Prescribed burning is one method for improving rangelands. Fire can reduce dead plant matter, recycle nutrients, and promote new plant growth.

The purpose of this study is to determine effects of prescribed fire on butterfly populations. Our field site is located on a private ranch in South Texas. Sixteen plots ranging from 500 to 1,200 acres are burned in different seasons (winter and summer) and time intervals (long-term, short-term, and no-burn). Monthly walking butterfly and plant surveys are completed to examine how butterflies respond to the varying burning regimes. Our results will aid in determining the optimal burning regimes for conservation of various butterfly species in the South Texas Coastal Plains.

*Cooperative funding provided by the East Foundation.*

## Bobwhite Response to Cattle Grazing in South Texas

*Bradley K. Johnston, J. Alfonso Ortega-S., Leonard A. Brennan, Humberto L. Perotto-Baldivieso, and Fidel Hernandez*

Range management practices used to improve habitat for wildlife by reducing brush and increasing herbaceous plants, coupled with reduced stocking rates can lead to thick stands of dominant grasses, such as



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**Prescribed fire removes old vegetation and allows growth of nutritious new plants for butterflies and caterpillars.**

four-flower trichloris. These monocultures of four-flower trichloris create dense areas unsuitable for bobwhite quail while also reducing plant species richness.

The objectives of this study are to evaluate use of a proper cattle grazing regime to maintain or improve bobwhite habitat, as well as to develop a management guide that documents how to use cattle in such a way. The study area is two pastures, totaling 6,000 acres, in Duval County, Texas. One pasture serves as the control (no cattle grazing) while the other is grazed to maintain a stubble height of 12-16 inches (ideal for bobwhite quail habitat), as needed. There are 10 grazing exclosures and 82-foot transects within each pasture. Double sampling and forage utilization surveys are completed monthly while cattle are present in the pasture, and percent cover is also recorded along each transect. Forage standing crop, plant species richness, total plant cover, and forage utilization are then calculated. Helicopter surveys will be conducted during December each year to assess quail populations.

Additionally, ~75 bobwhite quail are fitted with radio transmitters each year to track their movement and determine nest site selection, breeding season survival, and nesting success. Results from the first year of the study revealed that there were 60% more bobwhite per acre in the grazed pasture, and it was also noted that losses to forage standing crop significantly exceeded the amount traditionally allocated.

*Cooperative funding provided by the Sweden Ranch.*

### Use of Environmental DNA to Detect Spot-Tailed Earless Lizards

*Allison Harris, Christin Moeller, Luke Willard, E. Drake Rangel, Scott E. Henke, Cord B. Eversole, Ruby Ayala, Chelsea Jones, and Humberto L. Perotto-Baldivieso*

Spot-tailed earless lizards are considered a rare species whose historical distribution within the U.S. ranged from South Texas, north to Austin, and extended westward to Midland, Texas. The once single species of spot-tailed earless lizards has been divided into two distinct species, the plateau and Tamaulipan spot-tailed earless lizards. Recently, the plateau earless lizard was petitioned for federal protection and the United States Fish and Wildlife Service found that a ‘threatened’ listing may be warranted.

Much emphasis for potential federal protection was placed on the distributional overlap between spot-tailed earless lizards and red-imported fire ants. Critics of the threatened status argue that virtually too



© J. Alfonso Ortega-S.

**Cattle grazing can be used to manipulate thick stands of grass to favor bobwhites.**

little is known about the species to know if the species are vulnerable to various direct and indirect external factors. Hence it is unknown if the species are declining or just rare.

Environmental DNA (eDNA) is a fairly new technique by which laboratory techniques can detect trace amounts of chemicals specific to a species that were left by a specimen that came into contact with a surface, such as soil. Therefore, our goal is to identify chemicals specific to spot-tailed earless lizards that can be used for eDNA detection. Then we propose to place lizards on soil for 0.1, 1, 6, 12, 24, and 48 hours to determine the quantity of contact time needed to detect lizards. Once the minimum time for detection is established, we will expose lizard-subjected soil to the environment for 1, 7, 30, 90, and 180 days to determine the longevity of detection. This research, if successful, will provide a new means to determine the presence of spot-tailed earless lizards within an area.

*Funding Provided by the Texas Comptroller of Public Accounts.*

### Using Drones to Quantify Wild Pig Damage to Crops

*Bethany A. Friesenhahn, Lori D. Massey, Michael T. Page, Humberto L. Perotto-Baldivieso, Justin W. Fischer, Randy W. DeYoung, Michael J. Bodenchuk, Bruce R. Leland, Nathan P. Snow, and Kurt C. VerCauteren*

Presently, there are an estimated 6.9 million wild pigs in the U.S., which cause about \$1.5 billion in



damage to agriculture and the environment annually. Wild pigs are unlikely to be eradicated, thus management of damage is an ongoing exercise. There is a clear need to quantify the impacts of wild pigs to better understand how to allocate resources for control and management efforts. Our goal was to use remote sensing approaches to detect and quantify pig damage in corn fields.

We used drones to monitor corn fields in an agricultural matrix in Delta County, Texas. We flew drone missions during growing seasons in 2019 and 2020 in 5 separate corn fields ranging from 75 acres to 295 acres using a Phantom 4 Pro v.2 RTK. We flew at 300 feet altitude with an 80% overlap of transects during 5 different growth stages of corn. We merged the digital imagery to generate a composite image, a Digital Terrain Model, and a Digital Surface Model for each field and growth stage. We are in the process of classifying the imagery and comparing it to damage detected during ground surveys. Preliminary results show that drones are an efficient and practical method to detect pig damage at the field scale. The use of drone monitoring will allow producers to assess crop damage and estimate yield loss due to pigs. The resulting information will help determine the cost-benefit ratio of management actions.

*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.*

**Management of Invasive Rose-Ringed Parakeets on Kauai**

*C. Jane Anderson, Leonard A. Brennan, Clayton D. Hilton, Page E. Klug, William P. Bukoski, Shane R. Siers, Bryan M. Kluever, Aaron B. Shiels, and Steven C. Hess*

The rose-ringed parakeet is among the most invasive bird species worldwide. Rose-ringed parakeets were introduced to Kauai, Hawaii, in the 1960s. The population initially remained relatively small but began growing in the early 2000s. It had rapidly increased to an estimated 6,800 individuals in 2018. This population is causing extensive agricultural damage by foraging on fruit and grain crops. The parakeets also congregate nightly in large roosts in urban areas. This causes disturbance through loud vocalizations and by threatening human property and health through excessive droppings. To address this problem, we are

estimating current rose-ringed parakeet abundance in Kauai to evaluate the annual population growth rate. Monitoring a roost culling effort from March 2020 – March 2021, we are evaluating the number of birds culled per unit of effort. We are also investigating age and sex ratio of birds removed, average morphometric measurements, and whether roost culling instigates roost abandonment.

We estimated the 2020 population to include >10,500 parakeets, despite the removal of >7,000 individuals over the preceding 15 years. Preliminary results indicate ~45 animals can be removed per shooter per hour of effort. Early results also indicate likelihood of roost abandonment depends on initial roost size as well as previous exposure of animals to roost culling. Our results will be used in an integrated pest management plan to reduce the invasive rose-ringed parakeet population and related impacts on Kauai.

*Cooperative funding provided by the Hawaii Department of Land and Natural Resources via the USDA APHIS Wildlife Services National Wildlife Research Center and the C. C. (Charlie) Winn Endowed Chair for Quail Research.*

**East Texas Natives: Collections and Evaluations**

*Tyler C. Wayland, Jacob L. Sparger, Keith A. Pawelek, and Forrest S. Smith*

The demand for native seeds and information on completing native plant restoration is far greater than the current supply in East Texas. The East Texas Natives Project (ETN) is working to develop adapted native seed sources needed to support large-scale native plant restoration across the East Texas region.

The Texas Native Seeds Program (TNS) expanded into East Texas in early 2018. East Texas Natives is working to have similar regional impacts as seen in other areas where TNS operates. We are collecting and evaluating populations of common native plant species with the goal of selecting top performers for release to commercial seed producers.

East Texas Natives is now entering into the project's 4th year of operation in the region. To date, we have made over 630 native seed collections from 59 counties in the region. The project oversees 4 different native plant evaluation sites. These sites included the major regions of East Texas. Species currently being evaluated include Indiangrass, purpletop tridens, rattlesnake master, and spotted beebalm. In addition to

evaluations, selections for seed increase of silver blue-stem are being made for the project's first native plant release. The ETN collection and evaluation process will help to increase the quality and quantity of available native seed sources on the commercial market needed to support restoration efforts across the region.

*Cooperative funding provided by Ellen Temple, Mr. and Mrs. Rufus Duncan, Amanda Haralson and Thomas Livesay, Jim Brown, Susan Temple, the Winston 8 Ranch, the Mitchell Foundation, the Pineywoods Foundation, the East Texas Community Foundation, the Texas Department of Transportation, United States Department of Agriculture Natural Resources Conservation Service, and the U.S. Forest Service.*

### Spatial Models for Estimating Wintering Rio Grande Wild Turkey Density

*Chloe E. Bates, Humberto L. Perotto-Baldivieso, William P. Kuvlesky, Jr., Alfonso Ortega-Santos, Leonard A. Brennan, Jason V. Lombardi, Thomas J. Yamashita, Michael T. Page, and Nicholas R. Kolbe*

Population density is a valuable estimate for wildlife managers. Spatially explicit capture-recapture methods can be used to estimate population density and population size. To our knowledge there are no studies that have used spatially explicit capture-recapture methods for estimating Rio Grande wild turkey density. Our objective is to use spatially explicit capture-recapture methods to estimate the densities of Rio Grande wild turkey on the Camp Swift Training Center in Bastrop, Texas, and the Camp Bowie Training Center in Brownwood, Texas.

Camera-traps will be placed at each site with four camera stations per average wild turkey home range (2,965 ac.). Trapping will occur on each site, and each turkey captured will be marked with unique identity tags. To estimate wild turkey abundance with data collected from camera-traps we will use a recently developed extension of spatial capture-recapture models, spatial mark-resight. The spatial mark resight model uses data of marked/recognizable individuals and unmarked/unidentifiable individuals; this allows the model to be more flexible in terms of usable data. We will use two models to analyze our data. The first model will use data for all identifiable and unidentifiable individuals. The second model will use the data for identifiable individuals and divide the data into two periods, sighting and resighting.

This research will aid wildlife managers in conserving and managing Rio Grande wild turkey.



© Humberto Perotto-Baldivieso

**Rio Grande wild turkey captured on a trail cam in March 2021.**

Specifically, this research will help wildlife managers determine the density and population size of Rio Grande wild turkey on their property.

*Cooperative Funding provided by Texas Military Department, Mr. Homero Vera of the Kennedy Ranch, Mr. Bart DuPont of the Bass Ranches, the Las Huellas Association, the Henry Hamman Foundation, and the Rachel and Ben Vaughan Foundation.*

### Movements and Crop Selection of Wild Pigs in an Agricultural Landscape

*Bethany A. Friesenhahn, Benton K. Kennamer, Kyle S. Patterson, Bruce R. Leland, Michael J. Bodenchuk, Michael J. Cherry, Randy W. DeYoung, Humberto L. Perotto-Baldivieso, Nathan P. Snow, and Kurt C. VerCauteren*

Understanding how and when animals use different parts of the landscape can enable more efficient and effective management actions. Wild pigs have expanded into many agricultural landscapes and cause extensive damage to crops and pasture. Pigs are highly adaptable, thrive in many different ecosystems and have rapid reproductive rates. Furthermore, wild pigs adjust quickly to trapping and shooting, and move mostly at night. These traits make it difficult to control populations or wild pigs or prevent damage to agricultural resources.

Our objective was to quantify movements, space use, and crop selection of wild pigs in an agricultural landscape in relation to growth stages of corn. We monitored hourly movements of 68 adult wild pigs using GPS locations taken during the growing season in Delta County, Texas during 2019–2020. We

conducted separate analyses during the pre-planting, establishment, vegetative, blister/milk, and dent/mature growth stages of corn.

Preliminary results indicate that both male and female home ranges overlapped with corn fields more during the mature growth stage vs. the earlier stages. Wild pigs selected woody cover during all growth stages and selected corn only during the mature growth stage, the time when the plant provides both nutritional value and shelter. Because pigs changed space use during the growing season to move closer to corn as it matured, management efforts timed before the milk stage would be best to protect agricultural resources. Our study provides a better understanding of wild pig landscape use and can inform management strategies aimed at the alleviation of crop damage.

*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.*

### Analysis of Survey Methods for Wintering Rio Grande Wild Turkeys

*Chloe E. Bates, Humberto L. Perotto-Baldivieso, William P. Kuvlesky, Jr., Alfonso Ortega-Santos, Leonard A. Brennan, Michael T. Page, Joshua P. Vasquez, Daniel J. Ramirez, and Nicholas R. Kolbe*

Many researchers have developed methods of surveying for wild turkey abundance; however, Texas wildlife biologists still do not have a consistent and precise method to survey wild turkey populations in the southern range of the Post Oak Savannah and Cross Timbers ecoregions of Texas. Therefore, the aim of this study is to determine the most consistent and precise method to estimate Rio Grande wild turkey abundance on our study sites.

Our study sites are the Camp Swift Training Center in Bastrop and the Camp Bowie Training Center in Brownwood. Road, roost, and camera surveys will take place January-March of 2021 and 2022. Routes will be selected randomly and will be proportional to each habitat type on each site. Road and roost surveys will be similar, and will follow protocols for the northern range of the Post Oak Savannah and Cross Timbers ecoregions of Texas. Camera-traps will be placed at each site with four camera stations per average Rio Grande wild turkey home range (2,965 ac.). Trapping will occur on each site in December 2021, each turkey captured will be marked with unique identity tags.

We hypothesize that road-based surveys and camera-traps will provide significant information to estimate wild turkey density across the landscape. This research will aid wildlife managers and biologists in conserving and managing Rio Grande wild turkey. Specifically, this research will help wildlife managers determine the density and locations of Rio Grande wild turkey on their property to better manage their land and wildlife.

*Cooperative funding provided by Texas Military Department, Mr. Homero Vera of the Kennedy Ranch, Mr. Bart DuPont of the Bass Ranches, the Las Huellas Association, the Henry Hamman Foundation, and the Rachel and Ben Vaughan Foundation.*

### Diet Selection of Plateau and Tamaulipan Spot-Tailed Earless Lizards

*Allison Harris, Christin Moeller, Luke Willard, E. Drake Rangel, Scott E. Henke, Cord B. Eversole, Ruby Ayala, Chelsea Jones, and Humberto L. Perotto-Baldivieso*

Spot-tailed earless lizard species are seldom-studied species whose populations have declined substantially in distribution and abundance. Because of their sharp decline, both plateau and Tamaulipan spot-tailed earless lizards are being considered by the United States Fish and Wildlife Service as candidates for ‘threatened’ status. However, little is known about the species, including their diet. A close relative to spot-tailed earless lizards is the Texas horned lizard, which is known to be a dietary specialist preferring harvester ants. However, anecdotal information suggests that



© Christin Moeller

**Researchers are studying the Plateau and Tamaulipan spot-tailed earless lizard species to determine diets.**



spot-tailed earless lizards may be a dietary generalist throughout their lives. Our objective is to capture wild spot-tailed earless lizards and maintain them in captivity until they defecate. We then will dissect their feces and identify prey items to determine if they are dietary specialists or generalists. This will be useful to understand the species' ecology, which is needed for determination of conservation status.

*Funding Provided by the Texas Comptroller of Public Accounts.*

### Commercial Production of Texas Native Seeds Releases

*Keith A. Pawelek, Anthony D. Falk, Forrest S. Smith, Dean N. Williams, Nick Bamert, Darcy Turner, and Tracy Tally*

Texas Native Seeds (TNS) and Commercial Native Seed Producers have been working hard to increase ecotypic seed availability for use across Texas. In 2020, commercial seed producers were able to bring 10 new germplasm releases to the commercial market. New spring plantings for 2021 focused on increasing the production of species that are currently seeing an increase in demand but have limited availability.

In total, over 77,000 lbs. of seed from releases developed by TNS were produced during the 2020 growing season. Commercial seed production grew rapidly in spite of the challenges of 2020. While this was great improvement, many species still have limited supply due to production issues. Thus far, weather in 2021 has been such that current reports are favoring another year of good seed production.

Seed demand in 2020 was noted as high, and by fall several releases were out of stock. With the added



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**Nilgai were sprayed with a biocontrol agent for ticks. Researchers tracked their movements and tick loads while studying cattle fever tick control.**

seed production in 2021, some supply issues should be resolved. However, since demand for many of these species is still outweighing supply, it is highly recommended that landowners consider preordering any seed needed for upcoming projects to ensure availability.

*Cooperative Funding Provided by the numerous donors to the Texas Native Seeds Program.*

### Control of Cattle Fever Ticks on Nilgai Using Remote Sprayers

*Jeremy A. Baumgardt, Kathryn M. Sliwa, Randy W. DeYoung, J. Alfonso Ortega-Santos, David G. Hewitt, John A. Goolsby, and Adalberto A. Pérez de León*

The southern cattle fever tick spreads bovine babesiosis, also known as cattle fever. The disease was common throughout the southern U.S. in the 1800s and early 1900s. The ticks were eliminated from most of the U.S. in the mid-1940s through intensive management that involved regularly treating cattle with pesticides. The disease and ticks remain common in Mexico, and the U.S. government maintains a permanent quarantine zone along the border to prevent re-infestation. Recent tick outbreaks outside of the quarantine zone probably involve wildlife, especially nilgai antelope. Nilgai are native to India and were introduced to South Texas in the early 1900s. Nilgai are free-ranging in South Texas, where current populations range between 30,000 and 70,000 individuals.

We evaluated the use of motion-activated sprayers to treat ticks on free-ranging nilgai. The sprayers were located at wildlife fence-crossings and emitted a non-toxic, biocontrol-based solution of water containing nematodes when activated. We deployed over 100 sprayers on private ranches in Cameron County, Texas during 2019–2020. We tracked nilgai using 30 GPS radio-collars and monitored trail cameras at sprayer sites. We captured nilgai before and after a 3-month treatment period each year to collect and count ticks.

Preliminary results suggest that collared nilgai avoided using fence crossings where sprayers were located. We were not able to determine if treatment by sprayers reduced individual tick loads, but we are analyzing our data to determine if the sprayers affected overall tick populations. Our work has important implications for the management of cattle fever ticks on wildlife.

*Cooperative funding provided by the USDA Agricultural Research Service.*

## The Permian Basin-Panhandle Native Seed Project

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

The Permian Basin-Panhandle Native Seed Project (PBPNSP) was started in fall 2017. The mission of the project is to develop commercially available native seed sources for the Permian Basin and Panhandle regions. The project also focuses on working with the energy industry and landowners, encouraging them to use native plant seed for restoration and reclamation projects. Currently, 419 grass and wildflower seed collections have been made from private and public lands in the region. Collections are stored at the USDA Natural Resources Conservation Service (NRCS) James E. “Bud” Smith Plant Materials Center. Evaluations and selections are conducted at the Railway Ranch near Odessa, USDA NRCS Knox City Plant Materials Center, and Texas Tech University’s Quaker Avenue Research Farm in Lubbock.

Other goals of the project include developing partnerships with the energy industry and landowners in the Permian Basin. Concho Resources, Inc. has partnered with PBPNSP in research plantings, developing



© Randy DeYoung

**Dead limbs are important habitat features for golden-fronted woodpeckers.**

a demonstration plot in Midland, as well as restoration study trials at their ranches. The Railway Ranch is another important partner whose owner and staff have worked with us to install two series of 5-acre restoration plantings, the first in fall 2018 and the second in spring 2019. We have also had the opportunity to provide native plant seed mix specifications to various oil and gas, renewable energy, and pipeline companies which has impacted thousands of acres in the region.

*Cooperative funding provided by Concho Resources, Inc., Fish and Wildlife Foundation, and USDA Natural Resources Conservation Service.*

## Assessing Bird Populations on East Foundation Ranches

*Delanie E. Slifka, Leonard A. Brennan, April A.T. Conkey, Humberto L. Perotto-Baldivieso, Tyler A. Campbell, Javier O. Huerta, Tenley N. Housler, Nathan Young, and Jason P. Loghry*

Bird surveys have been conducted on East Foundation properties in South Texas annually since 2010 to document species occurrence, richness, and abundance. Both breeding and non-breeding bird surveys have been conducted on San Antonio Viejo, El Sauz, and Santa Rosa properties. Non-breeding surveys were conducted from August–April through the use of transect surveys. During May and June, breeding bird point count surveys were conducted.

The East Foundation properties have a unique mix of avian species and vast diversity of landscape types due to their varying locations. Large ranches in South Texas, such as the ranches owned by the East Foundation, help preserve large continuous tracts of land that are critical to the survival of birds during migration. Many private landowners understand the value of documenting trends and managing for non-game birds on their property; however, few long-term bird studies exist from South Texas ranchlands. Data sets of ten years are rare, yet they can provide unique insights into population dynamics and processes.

Over 200 bird species have been documented on the East Foundation ranches throughout the study period, 53 of these species were seen frequently enough to establish trends. Approximately 90% of these species remained stable throughout the study period and had no significant relationship with year-to-year rainfall.

*Cooperative funding provided by the East Foundation and The C. C. “Charlie” Winn Endowed Chair for Quail Research.*

## How Does Season of Burning Change the Neighborhood of Plant Species?

*J. Silverio Avila-S., Juan C. Elissetche, Dennis M. Berry, D. Blake Jordan, Gertrudis Ruiz-Balli, Tyler A. Campbell, Landon Schofield, David B. Wester, and Sandra Rideout-Hanzak*

Fire has the potential to change plant communities in grasslands. Seasonal timing and return interval, as well as rainfall before and after burning, all affect the ecological outcome of a prescribed burn. While plant species may seem to be randomly scattered on the landscape, they do appear in clumps with other associated species. This implies that species have associations in which some species may be attracted to or repelled by other species. These plant associations can be studied through nearest-neighbor relationships.

The purpose of this study is to determine changes in nearest-neighbor plant relationships as a result of varied season and interval of burning. We have 16 plots that are a minimum of 500 acres each on East Foundation's El Sauz ranch. Plots receive one of the following burning treatments: summer short interval, summer long interval, winter short interval, winter long interval or control (no burn). Our results will help land managers determine which burning season and return interval are most effective for meeting various vegetation objectives in South Texas.

*Cooperative funding provided by the East Foundation.*

## Update on the South Texas Natives Project

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

Despite the numerous challenges during the past year, South Texas Natives (STN) has continued to develop new seed releases, meet commercial seed dealer demand, and initiate new research projects. While Covid19 presented a new set of challenges, STN was able to continue to meet project goals because of dedicated employees and a tradition of strong program supporters.

During the last year STN staff completed a new release, Menard Germplasm purple threeawn, and they are nearing completion of two additional releases, Loma Germplasm purple threeawn, and Cibolo germplasm little barley. Along with completing new releases, we have distributed seeds of 12 previous seed releases to commercial seed growers. Staff have also worked to ramp up production, as a few of our current commercial licenses will be renewed next year, requiring additional



© J. Silverio Avila-S.

**A prescribed burn will improve the vegetation quality and change the plant composition.**

seed to be distributed to commercial growers. Besides seed production and releases, STN has started or been a pivotal contributor to 5 new research projects started this year. These research projects are focused on the effects of cover crops, seeding rates, area of adaptation, and restoration of solar farms. Finally, STN staff have assisted other project regions with cleaning, storing, and cataloging harvested seed.

*Funding provided by the many generous donors to South Texas Natives.*

## Clutch Success of Spot-Tailed Earless Lizards

*E. Drake Rangel, Allison Harris, Christin Moeller, Luke Willard, Scott E. Henke, Cord B. Eversole, Ruby Ayala, Chelsea Jones, and Humberto L. Perotto-Baldivieso*

The spot-tailed earless lizard species are rare. Recently the two subspecies were determined to be two distinct species, the plateau and Tamaulipan species. Populations of both the plateau and Tamaulipan spot-tailed earless lizards have experienced sharp declines in their abundance and distribution. Hypotheses for the decline of both species include pesticides, invasive fauna such as the red-imported fire ant, invasion of exotic grasses, agricultural practices, and urbanization. Few studies have been conducted on spot-tailed earless lizards; thus, little information is known about the species' natural history and ecology. Our objectives are to capture spot-tailed earless lizards from the wild, breed



them in captivity, and determine typical clutch size, egg viability, hatching success, sex ratios at hatching, and growth rates during their first year. Such information is critical to build population models that can predict population viability.

*Funding Provided by the Texas Comptroller of Public Accounts.*

### Disease Ecology of Vultures in South Texas

*Michael A. Kalisek, Ashley M. Tanner, Evan P. Tanner, Clayton D. Hilton, Bart M. Ballard, Christine Hoskinson, Michael J. Bodenchuk, Ken A. Wells, and Sarah J. Corbett*

Turkey and black vultures are important native species in South Texas that provide valuable ecosystem services by consuming carrion. However, when found in large urban roosts, they can create conflict between humans in many different forms. For instance, large urban vulture roosts present a human health concern, in which diseases may become a concern for humans directly in contact with pellets or fecal matter associated with this roosting activity.

To better understand what potential diseases humans may be exposed to when working on urban roosts, we

are conducting a disease ecology study on a large (>450 individual vultures) urban roost located in Kingsville, Texas. We are capturing vultures using baited walk-in traps and using cloacal samples to determine the presence of many species of bacteria and fungi. In addition, we are testing for antibiotic-resistant strains of *Salmonella*, which may be indicative of increased antibiotic resistance within the local wildlife community.

As of June 2021, one capture event has occurred in which 27 black vultures were captured. We tested 20 individuals for various bacterial and fungi presence. The most common bacteria found were *E. coli* and intestinal bacteria, which were present in 100% of the samples and are commonly found in wildlife. Moreover, a high level of antibiotic resistance was found in *Salmonella* samples taken from the captured vultures. Additional captures will allow us to further determine the bacterial and fungal communities associated with vultures at urban roosts.

*Cooperative funding by the U.S. Customs and Border Protection and U.S. Department of Agriculture - Wildlife Services in Texas.*

### 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 (TNS) collects and evaluates native plant material for releasing seed sources of native plants that are adapted to certain parts of Texas. Plant differences are clear during the evaluation portion of our field research, but the impact of seed origin in relation to these differences is poorly understood. The objective was to compare native plant populations of little bluestem, silver bluestem, and blue grama to plants already available by looking at differences in genetic sequences.

We have conducted genetic sequencing on different plant populations consisting of 53 little bluestem, 12 silver bluestem, and 6 blue grama plants. The project produced 508 million sequences for an average of 5.6 million sequences per plant. Sequence analysis is currently being conducted at Texas A&M University, and it is probable that we will begin a separate analysis in Stephenville also. We will use the data to identify plant population structures that will guide geographic decisions for future plant releases.

Once the genomic data have been analyzed, we will also conduct a microbiome-genome-wide association



© Ashley Tanner

Researchers taking samples from a captured black vulture.

study to determine if there are genetic determinants of plant microbial communities. The same plants used for the genome sequencing have been sequenced from a common garden study in Stephenville that contains two replications of every genotype used in the little bluestem partial genome sequencing study.

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

### Movements of Wild Pigs in Response to Aerial Shooting

*Bethany A. Friesenhahn, Michael J. Bodenчук, Bruce R. Leland, Benton K. Kennamer, Kyle S. Patterson, Randy W. DeYoung, Michael J. Cherry, Humberto L. Perotto-Baldivieso, Nathan P. Snow, and Kurt C. VerCauteren*

Wild pigs are considered a destructive and invasive species in much of the world. The U.S. government spends over \$30 million annually to control wild pig populations and on research and management actions to protect crops and resources from damage. Aerial shooting from a helicopter is an efficient method for removal of pigs and damage control. However, aerial shooting can be expensive and success is influenced by time of year and land cover types. Furthermore, pigs may either evade the helicopter or immigrate into the control area from adjacent populations.

The goal of this study is to determine how pigs respond to aerial shooting and the cost-benefit of aerial shooting in terms of damage reduction. We trapped 30 adult pigs in Delta County, Texas, an agricultural landscape composed of pasture, cropland, and riparian forest. We fitted each pig with a GPS radio collar that recorded a location every hour. Texas Wildlife Services conducted aerial shooting operations throughout our study area during February and March 2020.

We will analyze hourly GPS locations by determining home range sizes, distance moved, and differences in movement rates pre-, during, and post-helicopter events. This will allow us to understand the short-term effects aerial shooting has on pigs that were not eradicated. We will also estimate abundance and population growth rate between the events based on remote camera surveys and number of pigs removed to determine the proportion of the population removed. Our results will inform decisions on control efforts of farmers, ranchers, and managers.

*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.*



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**A rapid assessment of crude protein on rangelands would facilitate decisions about supplementation needs.**

### Estimating Crude Protein in Tanglehead Using Drones

*Rider C. Combs, J. Alfonso Ortega-S., Humberto L. Perotto-Baldivieso, Sandra Rideout-Hanzak, David B. Wester, Douglas R. Tolleson, Michael T. Page, and Annalysa M. Camacho*

Over the past 20 years, tanglehead grass has been forming large stands on South Texas ranches. As tanglehead matures the percent crude protein often decreases to less than 7%. This can be problematic for cattle to meet their nutritional requirements. The goal of this study is to determine whether high-resolution drone imagery can be used to estimate percent crude protein in tanglehead.

On a private ranch in Jim Hogg County, Texas, in a 10-acre area, 10 different circular patches of tanglehead were mowed. After 35 days, this provided a sufficient variation in percent crude protein for five growth stages to be sampled. Two overlapping drone flights were conducted at an altitude of 150 feet above ground level. Prior to the flights, ten plants of five different growth stages were selected and marked with spray-painted 2.7 ft<sup>2</sup> frames. Once the flights were completed, all plants were clipped, bagged and mailed to a forage laboratory to determine the percent crude protein.

Pixel values obtained from multispectral drone maps will be used to calculate four different vegetation indi-



ces. We will develop mathematical equations to allow us to estimate percent crude protein in tanglehead using drone maps.

*Cooperative funding provided by the Jones Ranch and the Ken Leonard Fund for Livestock Interactions Research.*

### Central Texas Native Seed Project Update

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

The Central Texas Native Seed Project’s (CTNSP) goal is to develop native local seed sources to restore plant communities throughout Central Texas. The CTNSP collects native seed in 67 counties for evaluating, selecting, and releasing native seed to the commercial market. Evaluations are planted at the Texas A&M AgriLife Research Center in Stephenville, the USDA NRCS James E. “Bud” Smith Plant Materials Center in Knox City, and the Sandbrock Ranch in Aubrey.

A new evaluation of Canada wildrye consisting of 52 native plant populations was established from greenhouse transplants at all 3 sites in 2020. Data collection included growth measurements, plant characteristic rankings, and seed quality. An existing state-wide evaluation of Indiangrass will continue to include data collected from each location. New wild seed collections in 2020 were focused on pollinator plants with a goal of starting new evaluations in 2021.



© Christin Moeller

**Spot-tailed earless lizards are exceedingly difficult to find in the wild as they blend well into their surroundings.**

Past plant population selections of hairy grama, tall grama, sideoats grama, and seep muhly are being grown for seed increase in isolated field plots at Stephenville. Bulk seed harvested will then be available for a release of the selected native germplasm. These new plant populations, along with several other future releases (little bluestem, meadow dropseed, and silver bluestem), will result in commercially available seed sources for reclamation and restoration use in Central Texas.

*Cooperative funding provided by Texas Department of Transportation.*

### Detectability of Plateau and Tamaulipan Spot-Tailed Earless Lizards

*Allison Harris, Christin Moeller, Luke Willard, E. Drake Rangel, Scott E. Henke, Cord B. Eversole, Ruby Ayala, Chelsea Jones, and Humberto L. Perotto-Baldivieso*

The spot-tailed earless lizard was historically separated into two subspecies, the plateau subspecies found in central Texas and the Tamaulipan subspecies found in southern Texas. However, recently, genetic evidence indicates these two groups are two distinct species. Both species have experienced sharp declines in abundance and distribution. So drastic was the decline that the plateau spot-tailed earless lizard was petitioned by WildEarth Guardians for federal protection. Preliminary reports by the U.S. Fish and Wildlife Service (USFWS) suggest that listing the lizard species as threatened may be warranted.

Critics of the USFWS finding argue that the spot-tailed earless lizard is an elusive lizard that can be present but difficult to locate. Therefore, our goal is to determine the detectability of plateau and Tamaulipan spot-tailed earless lizards by various survey techniques within a 2.5-acre enclosed area. Survey techniques will include pitfall traps, funnel traps, rock mounds, cover boards, remote camera surveys, detector dog surveys, systematic visual surveys, and road cruising. Five, 10, 20, and 40 lizards will be placed within the enclosure and each survey technique will be evaluated at each lizard density to determine if a threshold abundance of lizards is needed before detectability is noted. Our research will provide insight as to whether these lizards are potentially declining or just difficult to detect.

*Funding Provided by the Texas Comptroller of Public Accounts.*



## Habitat Characteristics of Plateau and Tamaulipan Spot-Tailed Earless Lizards

Allison Harris, Christin Moeller, Luke Willard, E. Drake Rangel, Scott E. Henke, Cord B. Eversole, Ruby Ayala, Chelsea Jones, and Humberto L. Perotto-Baldivieso

Spot-tailed earless lizards are an elusive and potentially rare species found in scattered pockets of central and southern Texas. Recently the species was separated into two distinct species; the plateau and Tamaulipan species located in central and southern Texas, respectively, with the two species separated by the Balcones Escarpment fault. Both species appear to use open areas of low grasslands and croplands with intermittent shrubs.

Spot-tailed earless lizards are thought to be similar to the Texas horned lizard in respect to habitat preference, preferring sandy soil that provides easy burrowing, and which is free of much ground litter thus providing unobscured travel lanes. However, this is speculative and data to support this hypothesis are lacking.

Therefore, our objective is to locate specimens of plateau and Tamaulipan spot-tailed earless lizards, and measure habitat characteristics associated with these species. Habitat characteristics will include soil texture, soil associations, vegetation communities, and thermal properties. This research will increase general knowledge about the ecology of two little-known species.

*Funding Provided by the Texas Comptroller of Public Accounts.*

## A Talk on the Wild Side Podcast

Andrew C. Lowery, Rebecca R. Zerlin, Paul C. (Tre') Kendall, Gabriella D. Olivas, Brianna M. Slothower, and Sandra Rideout-Hanzak

In 2021 CKWRI entered the podcasting world! With generous funding from the Harvey Weil Sportsman Conservationist Award, we have launched A Talk on the Wild Side: Your Bi-Weekly Tour of All Things Wild in Texas. Each episode features an interview with a subject matter expert on a specific topic of conservation interest in Texas.

Our first episode aired in June 2021, and in our first few months we have covered such topics as bobwhite quail and environmental reproductive cues, white-tailed deer buck breeding strategies, dolphin reproductive morphology, managing introduced bluestems, restoring oyster beds, CWD, Texas horned lizards, nurdles, and



© Gabriella Olivas

**A Talk on the Wild Side podcast is your bi-weekly tour of all things wild in Texas.**

other interesting topics. You can find us on any podcast app you use—Apple Podcasts, Spotify, Castbox, etc., or you can listen on your computer at Spotify Webplayer. Be sure to subscribe on your favorite podcast app so you don't miss anything.

*Cooperative funding by the Harvey Weil Sportsman Conservationist Award of the Corpus Christi Rotary Club.*

## Using Drones to Assess Thermal Landscapes

Jacob L. Dykes, Humberto L. Perotto-Baldivieso, Evan P. Tanner, Randy W. DeYoung, Timothy E. Fulbright, J. Alfonso Ortega-Santos, David G. Hewitt, Aaron M. Foley, and Tyler A. Campbell

Summer heat in South Texas forces animals to seek shade or wind to cool themselves. Although heat is an expected and prolonged part of the South Texas climate, there has been little study or consideration of the effects of heat on wildlife. For example, most assessments of habitat focus on food, water, and hiding cover, and not thermal cover. Overall, our understanding of thermal cover for wildlife, or how best to measure it, is lacking. Recent technological advances have the potential to change the way we survey landscapes. Drones equipped with thermal cameras have the ability to map the thermal landscape for wildlife. Because of the manner in which heat diffuses through vegetation, temperature at ground level can be assayed from above with the use of drones.

We will fly drones equipped with thermal cameras over an array of black-globe thermometers in South Texas rangeland. The black-globe thermometers measure the operative temperature, or the combination of

air temperature, wind, and heat from the sun. Using operative temperature instead of air temperature alone will provide a more accurate representation of potential heat loads to which wildlife are exposed. We will fly drone missions at 2-hour intervals at an altitude of 300 feet and will collect over 100 thermal images per flight.

We will compare the thermal images to the temperatures recorded by the black-globe thermometers to validate the relationship between ground temperature and thermal imagery. The results of this study may provide a cost-effective strategy to identify, rank, and monitor thermal cover in rangelands.

*Cooperative funding provided by the Zachry Foundation.*

### Developing Native Seed Supplies for the Coastal Prairies Region

*Douglas L. Jobes, Keith A. Pawelek, Forrest S. Smith, Aaron D. Tjelmeland, Garry S. Stephens, Jim Willis, and Sonia Najera*

A major threat to wildlife in the Coastal Prairies and Marshes ecoregion of Texas comes from urban sprawl and rural land development. Very few coastal prairies remain, and as more land is converted the wildlife and native plants that live here become less common. As the growth of the area continues it will become more important to offset habitat loss. This includes the development of native seed sources for restoration and reclamation. Currently there is a lack of native seed sources, and Texas Native Seeds and the Coastal Prairies Native Seed Project (CPNSP) are working to



© Randy DeYoung

**Researchers are studying the prevalence of various diseases in Texas tortoises in the Rio Grande Valley and Coastal Bend.**

develop adapted native seed that will allow large-scale use in the region.

We are collecting seed within an 18-county area, and collections are stored in the USDA Natural Resources Conservation Service E. “Kika” de la Garza Plant Materials Center in Kingsville, Texas. Seed from these collections are used to evaluate native plant populations from the coastal prairies for seed source development. Field evaluations are underway at two sites that represent the region’s main soil types. Plants being evaluated include little bluestem, Indiangrass, silver bluestem, purple top tridens, rattlesnake master, and spotted beebalm. The top performing populations of knotroot bristlegrass have been identified for commercial seed production, and will be produced and released to the market. In addition, silver bluestem has been evaluated and is currently being prepared for seed increase in the region.

Developing quality seed plays an important role in wildlife habitat conservation and restoration. In addition to native plant seed source development, personnel from the CPNSP are also working to provide guidance to landowners and managers across the region, and to educate the public on the importance of native plants.

*Cooperative funding provided by the Texas Department of Transportation, USDA Natural Resources Conservation Service, Henderson-Wessendorf Foundation, Chiltepin Charitable Fund, Trull Foundation, and the Willard and Ruth Johnson Charitable Foundation.*

### Prevalence of Selected Diseases in Texas Tortoises

*Christin Moeller, Allison Harris, Luke Willard, E. Drake Rangel, Scott E. Henke, Cord B. Eversole, Sandra Rideout-Hanzak, Tony Henehan, Terry E. Hanzak, and Paul Crump*

The Texas tortoise is a threatened species in Texas. Two diseases of concern have been noted in Texas tortoises, necrotizing scute disease and upper respiratory tract disease. Necrotizing scute disease is caused by a fungus, which manifests as white, discolored patches on the carapace of the tortoise. Tortoises in the Lower Rio Grande Valley have a much higher prevalence than tortoises from more northern populations.

Upper respiratory tract disease (URTD) is caused by bacterial species of the genus *Mycoplasma*. The disease causes a range of symptoms including nasal discharge, swollen eyelids, lethargy, and a general failure to thrive. Recent research suggests that these bacteria have a commensal relationship with their tortoise hosts and

that stressors alter their immune system and can lead to infection.

Our objective is to collect serum samples from Texas tortoises located in the Rio Grande Valley and in coastal Texas to determine the prevalence of these diseases. It is important to determine disease prevalence prior to translocation efforts of a companion study because it is undesirable to introduce a disease to a novel area.

*Funding provided by Welder Wildlife Foundation and Next-Decade.*

### Seed Increase and Demonstration Area for the CPNSP

*Douglas L. Jobes, Keith A. Pawelek, Forrest S. Smith, and Patrick Brzozowski*

The Coastal Prairies Native Seed Project (CPNSP) and Lavaca Navidad River Authority have signed an agreement to aid development of native seed sources for the Coastal Prairies and Marshes region. The seed increase stage is an important part of the seed development process that occurs after evaluations are completed. The top performing populations are grown in a larger setting to increase the amount of seed available to be released for commercial production. Currently, the seed increase for CPNSP occurs at the South Texas Natives farm in Kingsville, Texas, but a region-specific location will best serve and benefit the local project.

In April 2021, a 10-year agreement was signed to begin the development of a 40-acre seed development facility in Jackson County, Texas. The area will serve as a base of operations, and as a seed increase site for the regional project. An irrigation system capable of providing suitable water for the fields will be installed along with an 8-foot game-proof perimeter fence to decrease wildlife damage.

In addition, a covered area will be constructed to serve as a storage and work zone, as well as a small parking area for visitors and staff. Additional uses of the facility will include field days and tours. These outreach and demonstration efforts will promote the research and application-based approach of Texas Native Seeds and CPNSP

*Cooperative funding provided by the Lavaca Navidad River Authority, Texas Department of Transportation, USDA Natural Resources Conservation Service, Henderson-Wessendorf Foundation, Chiltepin Charitable Fund, Trull Foundation, and the Willard and Ruth Johnson Charitable Foundation.*



© Douglas J. Goodwin

**Understanding the relationships among soil health metrics across soil types and land use gradient can provide actionable information for management decisions.**

### Soil Health Gradients and Relationships in Semi-Arid Grazinglands

*Douglas J. Goodwin, Stephen L. Webb, Kundan Dhakal, J. Alfonso Ortega-S., Humberto L. Perotto-Baldivieso, Doug Tolleson, and William E. Fox*

Soil health is the continued capacity of soil to function as a living ecosystem. The soil's ability to function is dependent on its physical, chemical and biological constituents. These constituents facilitate the soil's ability to support functioning ecological processes.

To understand the relationships among soil health metrics across ecological landscapes more aptly, 19 properties in Oklahoma and Texas were sampled in 2019. In ranches selected, 110 variables (both soil and non-soil) were measured on 519 sites. Of the soil variables, 32 metrics are being considered for analysis. The objectives of this research are to (1) investigate the relationships among soil health metrics across soil types and land use gradients and (2) investigate the relationships among soil health metrics and commonly-used monitoring variables.

Preliminary results suggest that there are identifiable gradients within soil health metrics, and positive relationships exist with commonly measured monitoring variables. Understanding the relationships among soil health metrics will aid researchers, consultants and land managers to customize monitoring strategies that provide actionable information for management



decision making. Further investigation regarding relationships among soil health gradients is ongoing.

*Cooperative funding provided by the Noble Research Institute, LLC.*

**Expansion of Tanglehead after Prescribed Burning and Cattle Grazing**

*Rider C. Combs, J. Alfonso Ortega-S., Humberto L. Perotto-Baldivieso, Sandra Rideout-Hanzak, and David B. Wester*

Tanglehead is a native invasive grass that is quickly expanding across the South Texas Sand Sheet ecoregion. The earliest report of expansion occurred from a rancher in the late 1990’s in Jim Hogg County, Texas. Prescribed fire is a common management practice used to improve wildlife habitat and increase the forage quality of large mature stands of tanglehead.

The goal of this study is to determine the rate of expansion of tanglehead under four different combinations of cattle grazing and prescribed fire. On a 236-acre pasture in Jim Hogg County, Texas three 10-acre prescribed patch burns were implemented in February

2019. Over the course of two years, cattle have been stocked at a rate of 0.04 cows/ac/year. Every 30-40 days following the prescribed fire, changes in thirty plants inside permanent grazing exclosures and thirty plants paired outside of the exclosures were documented. The treatment effects on tanglehead circumference, seed head counts, seedling establishment, foliar cover, ground cover, and other plant species foliar cover inside a 2.7 ft<sup>2</sup> frame surrounding each plant were recorded. The treatment effects recorded can provide information on management strategies to improve ground nesting bird habitat in tanglehead-dominated pastures.

*Cooperative funding provided by the Jones Ranch, Ken Leonard Fund for Livestock Interactions Research.*

**A Plant Photo Guide for the Coastal Prairie**

*Douglas L. Jobs, Forrest S. Smith, Eliot P. Tucker, Dexter Peacock*

One of the most important aspects of land management is understanding the influential roles plants have within the landscape and on wildlife. Identifying plants



© Rider Combs

**Determining how fast a few spots of tanglehead can evolve to become a tanglehead-dominated pasture is vital to understanding how to stop its spread.**

can be a difficult task, and most books are viewed as impractical by many. The use of technical and botanical terminology is often misunderstood or simply viewed as unhelpful.

In the Coastal Prairies Region of Texas, an easy to use and detailed photographic guidebook for identification purposes is needed. Photographs and easy-to-read descriptions will be a particularly useful tool for those who are interested, but not especially familiar with the field of botany. Plant species descriptions are currently being completed for 155 common plants of the region. Photographs of grasses, forbs, shrubs, and trees are also being processed and compiled. Plants in the guide will be categorized by their physical appearance, and each plant entry will include photographs at various stages of its life cycle. Collaboration will continue to occur within the region, and landowner participation is an important role in the development of this guide. Support is growing and many landowners have expressed interest in the guide through positive feedback and requests for updates.

Whether it is for enjoyment or for better understanding, the guide will provide an important tool that can encourage and assist landowners of the region. By identifying native plants, those interested can begin to understand the importance of protecting and promoting this landscape. This work will continue to aid Texas Native Seeds and the Coastal Prairies Native Seed Project by fostering new relationships and expanding our outreach opportunity.

*Cooperative funding provided by the Wildlife Habitat Federation and donors to the Coastal Prairie Native Seed Project.*



© Samuel Lutfy

**A planting takes place in a highway median as part of the collaborative work between TxDOT and the Texas Native Seed program.**

### Assessment of South Texas Loma Habitat for Texas Tortoise

*Juan C. Elissetche, Jr, Jason R. Singhurst, Scott E. Henke, Evan Tanner, Humberto L. Perotto-Baldivieso, I-Kuai Hung, David B. Wester, Terry E. Hanzak, Sandra Rideout-Hanzak*

Clay lomas can be found along the Gulf Coast in northern Mexico and southern Texas most commonly near the mouth of the Rio Grande. In South Texas they only occur in Cameron, Willacy, Kenedy, and Kleberg Counties. They were formed during the dry seasons when windblown sediments were caught on vegetation and accumulated over time. They are typically round or elliptical, and they host diverse woody plant communities that range from 6 to 13 feet in height. Current threats to lomas include debris rain from the SpaceX site near Boca Chica State Park and the Rio Grande Valley National Wildlife Refuge, urbanization, wind erosion, oil and gas development, agriculture, rising water levels, and storm surges.

The goal of this project is to assess the vegetation on the lomas and their value as habitat for Texas tortoises. This will be done by rating each loma’s habitat condition using landscape, vegetation and soil information as well as Texas tortoise density. Our results will help Texas Parks and Wildlife Department understand the value of lomas for Texas tortoise habitat and how to conserve the unique loma vegetation.

*Cooperative funding provided by Texas Parks and Wildlife Department.*

### TxDOT and Texas Native Seeds Program Collaboration

*Keith A. Pawelek, Shyla E. Rabe, Anthony D. Falk, Colin S. Shackelford, Samuel R. Lutfy, John R. Bow, Doug Jobs, Tyler C. Wayland, Forrest S. Smith, and Travis Jez*

This past year, 2021, marked the 20th year Texas Native Seeds (TNS) and the Texas Department of Transportation (TxDOT) have worked together on research and development of native seeds for use on Texas highways. A major accomplishment of this partnership has been the changes TXDOT has made to their rural revegetation specifications. Thanks to this partnership, TxDOT is now using only native plant species for over two thirds of the state.

This year, TNS focused on developing seed supplies of pollinator plants, commercializing an annual cool-season native cover crop, and on testing new seed



mixes across the state for use by TxDOT in the revision of their seeding specifications. This spring we began evaluation studies on 2 new pollinator species and a cool season grass for potential use by TxDOT.

This collaboration resulted in over 24,000 lbs. of the newly released Cibolo Germplasm little barley being available for purchase and use by TxDOT, private landowners, and restoration practitioners in fall 2020. This enables TxDOT to use a native cool-season annual in place of introduced wheat and oats for use as a temporary cool season cover crop on construction projects. Specification of native plants for use on Texas roadsides helps provide habitat for wildlife, helps minimize the use of exotic grasses, and positively influences native seed markets in Texas. We look forward to continuing to work with TxDOT to enable the use of native plants in highway rights of way revegetation.

*Cooperative funding provided by the Texas Department of Transportation.*

### Daytime Behavior of Plateau Spot-Tailed Earless Lizards

*Luke Willard, Allison Harris, Christin Moeller, E. Drake Rangel, Scott E. Henke, Cord B. Eversole, Ruby Ayala, Chelsea Jones, and Humberto L. Perotto-Baldivieso*

Plateau spot-tailed earless lizards are being considered for federal ‘threatened’ status. Little information is available concerning the species. Spot-tailed earless lizards spend much of their time buried just under the soil surface. They bury themselves during the hottest times of day and also in the evening for resting, and they spend winters hibernating. It is unknown if they are declining in number or just undetectable.



© Colin Shackelford

**Hooded windmill grass seed development is one of the successes of the West Texas Native Seed project.**

Our objectives are to capture and place individual spot-tailed earless lizards in 50 ft<sup>2</sup> pens equipped with video cameras, soil and air temperature monitors, and light meters. Video will be reviewed and lizard behaviors will be quantified for time spent at each activity, and those activities will be correlated to time and temperatures. Our goal is to establish behavior patterns of spot-tailed earless lizards that will provide researchers with parameters for ideal times to search for lizards.

*Funding Provided by the Texas Comptroller of Public Accounts.*

### Update on the West Texas Native Seed Project

*Colin S. Shackelford, Samuel R. Lutfy, Louis A. Harveson, and Keith A. Pawelek*

Significant progress was made in the development of locally-adapted native seed supplies for West Texas in 2020 and 2021. Sixty-two collections of Canada wildrye, 44 collections of Arizona cottontop, and 10 collections of hairy grama were planted for evaluation. These evaluations were planted at the Sierra la Rana Plant Evaluation and Research Facility in Alpine and the Railway Ranch Plant Evaluation and Research Facility near Odessa. Data will be collected on these plantings through 2022. To date, 25 native plant species have been or are currently undergoing evaluation for West Texas.

Thirteen plant species are currently undergoing seed increase to provide seed for commercial release. These include black grama, blue grama, Hall’s panicum, hooded windmill grass, sand dropseed, sideoats grama, silver bluestem, tobosa grass, and whiplash pappusgrass. Additionally, 4 forb or shrub species, cowpen daisy, Gregg’s mistflower, skeletonleaf goldeneye, and Tahoka daisy are undergoing seed increase.

Three seed releases have been completed and are in commercial production: Brewster Germplasm sideoats grama, Permian Germplasm whiplash pappusgrass, and Santiago Germplasm silver bluestem. We have plans for the additional releases of sand dropseed and cowpen daisy. Seed collections are continuing to support future selections for West Texas. Presently, over 1,400 native seed collections have been made for the region.

*Cooperative funding provided by the Texas Department of Transportation, the USDA Natural Resources Conservation Service, Caesar Kleberg Foundation for Wildlife Conservation, Concho Resources, Inc., National Fish and Wildlife Foundation, A. S. Gage Foundation, Faye L. and William A. Cowden Foundation, CF Properties and the Sierra la Rana Development, Stan Smith, and the Railway Ranch.*



## Nutrition and Body Size of White-Tailed Deer in the Coastal Sand Plain

*Seth T. Rankins, Randy W. DeYoung, Aaron M. Foley, J. Alfonso Ortega-S., Timothy E. Fulbright, David G. Hewitt, Landon R. Schofield, and Tyler A. Campbell*

There is increasing evidence that regional differences in animal body size are nutritionally, rather than genetically, driven. For instance, trends in body size often follow ecoregion and soil boundaries. However, it is not clear if the regional differences in animal body size is caused by differences in the amount or the quality of food. We captured white-tailed deer and measured body weight and antler size at 4 sites in South Texas during 2011–2019. The sites span a range of soil and vegetation communities, including Coastal Prairie, Coastal Sand Plain, and Tamaulipan Thornscrub. We sampled forage quantity, quality, and diversity and correlated them to body and antler size.

- Antler size and body weight of male deer averaged 8% smaller and 20% lower, respectively, on the eastern edge of the Coastal Sand Plain ecoregion compared to the Tamaulipan Thornscrub. Female body weights were 9% lower between the same regions.
- Digestible energy in browse and mast (fruits, beans, and pods) species was about 132 kcal per pound lower at sites with smaller-bodied deer. Plant diversity also was lower at sites with smaller-bodied deer, with lower forb diversity at 1 site and lower browse diversity at another site. There was



© Randy DeYoung

**A doe nibbles on some browse on a South Texas ranch.**

no difference in crude protein content of forage species among sites.

- Our research suggests that differences in the nutritional quality of forage drives regional size differences in body and antler size of white-tailed deer.
- We suggest managers focus their efforts on increasing the quality, rather than the quantity, of nutrition available to deer in South Texas. Plant diversity is important because diverse forb and browse communities help ensure that high-quality forage is available to deer throughout the year.

*Cooperative funding provided by the East Foundation.*

## Regional Copper and Mineral Abnormalities in White-Tailed Deer

*Seth T. Rankins, Randy W. DeYoung, Aaron M. Foley, J. Alfonso Ortega-S., Timothy E. Fulbright, David G. Hewitt, Landon R. Schofield, and Tyler A. Campbell*

Regional variation in soil type and forage quality may cause mineral imbalances, which may, in turn, affect animal growth and body size. We investigated if mineral imbalances could explain regional differences in body and antler size of white-tailed deer. We collected serum samples and age-specific antler and body measurements from free-ranging white-tailed deer captured during 2011–2019 from coastal and inland rangeland sites in South Texas. We measured 9 mineral concentrations in serum from captured deer, and compared them to concentrations in soils and deer forage plants at each location.

- Body weights of male and female deer were 20 and 9% lower, respectively, for deer at the coastal site compared to the inland site. Antler size was 8% smaller.
- Sampled deer at both sites had an average of 6.3 out of 9 serum mineral concentrations that deviated from published norms. All deer at the coastal site had deficient levels of serum copper, vs. 21% of deer at the inland site. Soil copper concentrations were twice as high at the coastal compared to the inland site; there was no difference in forage copper concentrations.
- Differences in copper concentrations between soil and forage may be due to soil texture and composition. Soil calcium concentrations were 2.6 times greater at the coastal site as opposed to the inland site; calcium can inhibit copper uptake in plants.

- Our results suggest regional mineral deficiencies in deer might limit antler and body development in parts of South Texas. Our study also highlights the lack of knowledge of normal serum mineral ranges and mineral nutrition of white-tailed deer and other wildlife.

*Cooperative funding provided by the East Foundation.*

### Post-Capture Movements of White-Tailed Deer

*Seth T. Rankins, Jacob L. Dykes, Randy W. DeYoung, Aaron M. Foley, Timothy E. Fulbright, J. Alfonso Ortega-S., David G. Hewitt, Landon R. Schofield, and Tyler A. Campbell*

The helicopter net-gun technique is a safe and efficient method for capturing large animals. Post-capture behavior is rarely evaluated, but has important implications for studies of animal movements as well as animal welfare. For instance, it is unclear if capture locations fall within the individual's home range, or if animals flee their normal range in an attempt to evade capture. Furthermore, captured animals are often

transported to a central processing site that may be outside of their normal range. The time for animals to return to their home range and resume normal movement behavior is not known. During 2019–2020, we captured 54 white-tailed deer on South Texas rangelands and transported them to a central processing site, where each was fitted with a GPS collar. We compared deer movements within and outside of their home range for 2 weeks post-capture.

- Deer returned to their home range within an average of 26 hours (range: 0.5–140 hrs) after being transported an average of 1.5 miles (range: 0.5–3 miles) from the capture site.
- We found that 52% of capture locations fell within the individual's home range.
- Our results indicate the helicopter net-gun capture method did not cause deer to flee the immediate vicinity of their home ranges.
- Deer maintained high site fidelity after being transported several miles, and all deer returned within 6 days post-capture.

*Cooperative funding provided by the Zachry Foundation and the East Foundation.*



© Randy DeYoung

Researchers studied the time required for deer to return to their capture location and resume normal movements after release.



# Quail and Other Upland Gamebirds

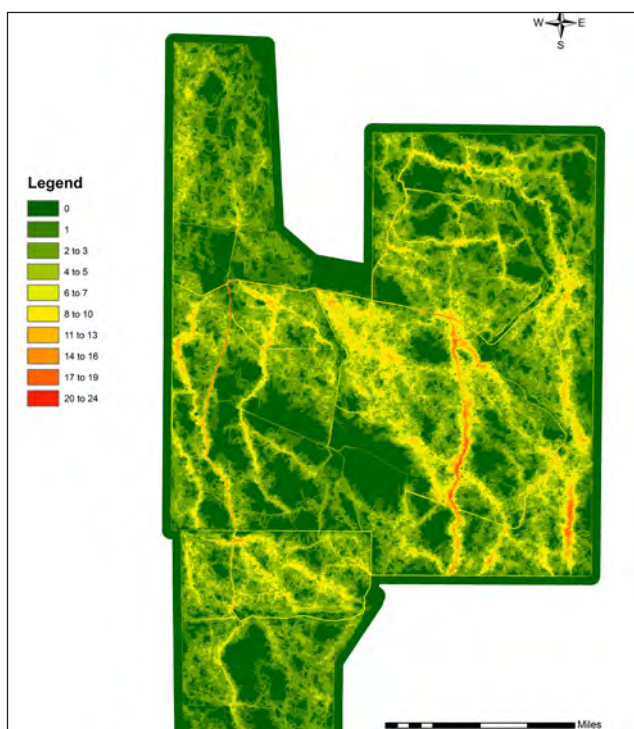
## Analyses of Quail Hunting Variables in South Texas

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

A variety of factors influence the harvest of northern bobwhites. Many of these factors can be quantified and used to make predictions (e.g., hunter-covey interface). Managers can also manipulate various factors, such as area hunted, to distribute harvest pressure according to desired spring densities.

The goal of this study was to analyze the quail hunting variables in South Texas. The project took place on 15,030 acres of East Foundation property in Jim Hogg County. Hunting cooperators were prescribed annual harvest quotas from November survey estimates, with hunts ongoing until quotas were reached. We collected spatial hunting distributions using GPS units on trucks and hunting dogs during each hunt, along with detailed hunting logs during the statewide quail hunting seasons in 2018–2019, 2019–2020, and 2020–2021.

**Total hunting pressure distribution for 211 quail hunts beginning November 2018, ending February 2021 on Buena Vista Ranch, Jim Hogg County, Texas.**



- Hunting cooperators conducted 211 hunts during the three hunting seasons: 59 hunts (163 hours) in 2018–2019, 74 hunts (254 hours) in 2019–2020, and 78 hunts (251 hours) in 2020–2021.
- Hunting activity occurred on 76% of the total available hunting area, with areas hunted on multiple occasions within and between years. Hunting parties effectively covered 60 acres per hour, ranging from 31 to 87 by hunt.
- On average, hunters encountered nearly 3 coveys per hour in 2018 through 2021.
- Harvest efficiency varied only slightly per season. The number of bobwhites harvested per covey ranged from slightly less than 1 in 2018–2019 to just over 1 in the 2020–2021 season. Hunters retrieved a bobwhite for roughly every 5 each year.
- The rate of crippled bobwhites that were detected during hunts to bobwhites retrieved was 25% in 2018–2019, 29% in 2019–2020, and 35% in 2020–2021. These findings do not include crippled bobwhites that remain unnoticed by hunters and researchers.
- The findings from this research will assist managers to strategically plan hunts spatially and temporally across properties and hunting seasons.

*Cooperative funding provided by the East Foundation, The Richard M. Kleberg, Jr. Center for Quail Research, South Texas Chapter of Quail Coalition, and the C.C. Winn Endowed Chair for Research.*

## Plant Diversity and Eyeworm Prevalence in Northern Bobwhite

*John E. Herschberger, Shaelyn T. Rainey, Fidel Hernández, Kristyn G. Stewart, Andrea Montalvo, and Lindsey Howard*

Eyeworms are a potential factor influencing northern bobwhite populations in Texas. Eyeworm prevalence appears to be greater in the Rolling Plains ( $\approx 60\%$ ) than the Rio Grande Plains ( $\approx 9\%$ ), a pattern generally attributed to possible differences in the occurrence of insects (i.e., intermediate hosts). We explored an alternative hypothesis based on plant diversity.

Many plants possess phytochemicals with anthelmintic properties. Because wildlife suffering from parasitic infestations are capable of self-medicating via diet selection, animals foraging in diverse plant communities should possess lower parasitic levels. We predicted that plant diversity would be greater and bobwhite diet more diverse in the Rio Grande Plains



than the Rolling Plains, and we reviewed the literature to explore this hypothesis. We conducted three separate literature reviews for: (1) plants potentially possessing anthelmintic properties, (2) bobwhite diet in Texas, and (3) cecal and eyeworm prevalence in bobwhites.

- Our results indicated that the number of plants with potential anthelmintic properties was greater and the bobwhite diet more diverse in the Rio Grande Plains compared to the Rolling Plains.
- We found no relationship between cecal-worm prevalence and latitude. We did document a positive relationship, however, between eyeworm prevalence and latitude, with eyeworm prevalence increasing 3% for each 1° increase in latitude.
- Our study only provides circumstantial evidence for the plant-diversity hypothesis and warrants experimental testing.

*Cooperative support was provided by the South Texas Chapter of Quail Coalition and the Richard M. Kleberg Jr. Center for Quail Research.*

### Evaluating Dog-Based Estimates of Northern Bobwhite Density

*D. Abraham Woodard, Leonard A. Brennan, Fidel Hernández, Humberto L. Perotto-Baldivieso, Neal Wilkins, and Andrea Montalvo*

The “dog-based” method of estimating northern bobwhite density was designed as an inexpensive alternative to other methods, such as line-transect distance sampling. This technique uses GPS tracking systems, distance sampling theory, and pointing dogs. Our objective was to compare bobwhite density estimates from the dog-based method to those obtained from line-transect distance sampling from a helicopter.

The study took place on East Foundation’s Buena Vista Ranch (15,030 acres) in Jim Hogg County, Texas. We completed line-transect distance sampling surveys from a helicopter during the 2018–2019, 2019–2020, and 2020–2021 quail hunting seasons. Hunters conducted bobwhite hunts using pointing dogs, with all dog paths recorded via Garmin GPS tracking systems. The area covered by dogs was estimated using their effective search width (43.3 feet) with redundancy removed (i.e., repeated coverage).

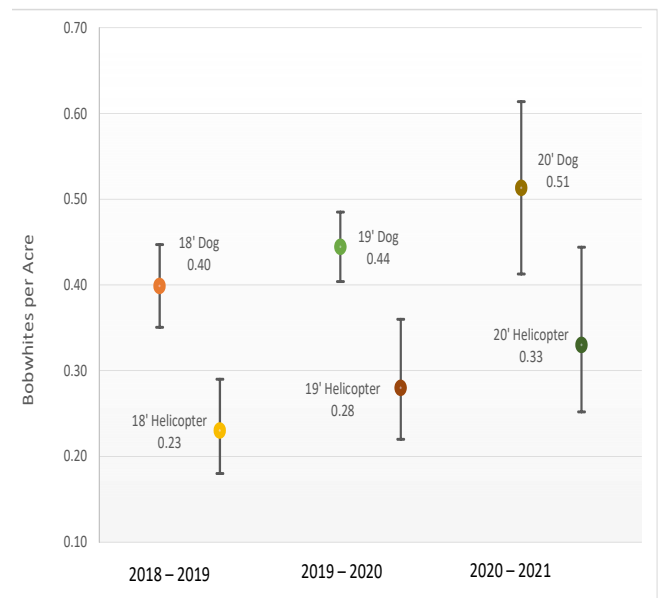
- Over three hunting seasons, we recorded 211 bobwhite hunts. These hunts were segmented based

on hunting activities, resulting in 922 hunting segments with one or more dogs actively hunting.

- We analyzed the redundancy of the area covered by individual dogs and braces (e.g., two or more dogs) per hunting segment and between segments per hunt. Overall, the redundancy of individual dogs per hunting segment was 32.6%, and the redundancy between dogs (e.g., brace) per segment was 39.4%. The redundancy between segments per hunt was 3%.
- Our results suggest that dog-based density estimates are consistently larger than helicopter-based estimates despite statistical similarities. Annual density estimates between the two methods were highly correlated over three years—but require larger sample sizes to make reliable bobwhite density predictions.
- In conclusion, we recommend using line-transect distance sampling from a helicopter when feasible and interpreting dog-based density estimates with caution in South Texas rangelands.

*Cooperative funding provided by the East Foundation, The Richard M. Kleberg, Jr. Center for Quail Research, South Texas Chapter of Quail Coalition, and the C.C. Winn Endowed Chair for Research.*

**Annual bobwhite density estimates with confidence intervals obtained from dog-based method and line-transect sampling from a helicopter during the 2018-2019, 2019-2020, and 2020-2021 quail hunting seasons on Buena Vista Ranch in Jim Hogg County, Texas.**



## Road Effects on Ocelot Survival

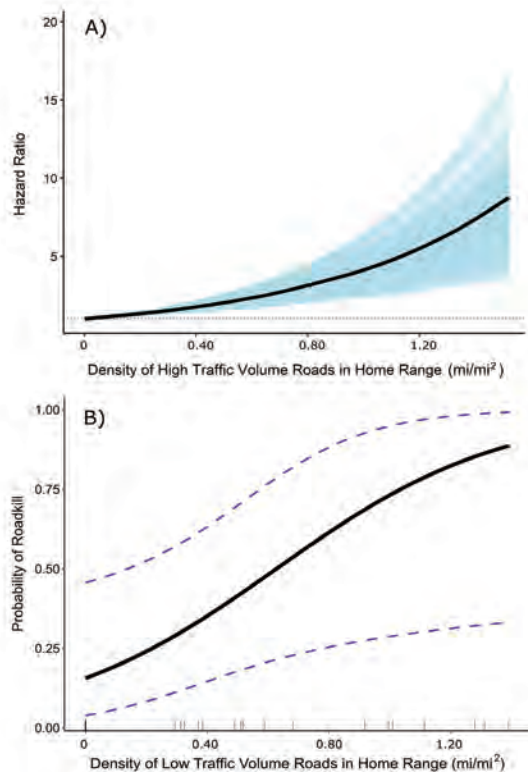
*AnnMarie Blackburn, Levi J. Heffelfinger, Amanda M. Veals, Michael E. Tewes, and John H. Young, Jr.*

Expanding urban development is a leading cause of habitat loss. Roadways can influence the behavior and survival of mammalian carnivores, which threatens long-term survival and conservation of sensitive populations. Ocelot breeding populations are restricted to the Lower Rio Grande Valley of South Texas, which is an area of extensive human development.

We evaluated the influence of road networks on ocelot survival using a long-term telemetry dataset (1982–2001) compared with historical ocelot-vehicle collisions in the same area and time frame (1982–2020). We then evaluated biological and road-related factors that may influence ocelot survival.

- Vehicle collisions accounted for 40% of radio-collared ocelot fatalities. Annual survival rates were 90% for resident ocelots and 66% for transient ocelots.

**The effect of increasing density of roads in the home range of ocelots on A) risk of mortality on high-traffic roads, and B) probability of roadkill from low-volume roads based on 59 ocelots monitored in South Texas from 1982 to 2001.**



- Within the historical dataset of ocelot-vehicle collisions, 46% occurred on low-volume roads while 39% occurred on high-volume roads.
- Mortality risk increased 16% with every increase of 75 yards of high traffic roads per 250 acres. Additionally, probability of mortality from vehicle collision increased with greater density of low-volume roads within ocelot home ranges.
- Our results highlight the necessity for mitigation strategies on low-volume roads which cause the most ocelot-vehicle collisions. In addition, continued attention to high-volume roads is necessary for ocelot conservation.

*Cooperative funding provided by the Feline Research Program of the CKWRI and the Texas Department of Transportation-Environmental Affairs Division.*

## Frequency of Use of Irrigation Canal Bridges by Ocelots, Bobcats, and Coyotes

*Eve Schrader, Zachary M. Wardle, Landon Schofield, Michael E. Tewes, and Jason V. Lombardi*

Bridges across irrigation canals and other water bodies have historically been constructed on public and private rangelands for cattle movements, ranch and range management, and to facilitate human convenience, among other activities. These structures also are believed to aid wildlife movement across the landscape, acting as conduits across difficult terrain or water bodies. In coastal areas of South Texas there are large rangelands with diverse carnivore guilds consisting of bobcats, coyotes, and ocelots. Many of these areas consist of private lands with a variety of bridge crossings. From June to September 2020, we conducted camera surveys at two irrigation canal bridges on the East Foundation's El Sauz Ranch in Willacy County to determine the frequency of use by coyotes, ocelots, and bobcats. We set four cameras on each side of the bridge to allow for individual identification of felids and to capture behaviors on all angles of each bridge.

- We recorded 189 distinct crossing events (bobcat: 44%, coyote: 34%; ocelot: 21%).
- Bobcats used the bridges as latrine sites, and ocelots showing interest in bobcat latrines, but were not recorded using bridges as latrine sites.
- Canal bridges serve dual purposes as movement corridors and olfactory communication sites.

- Our results help biologists and ranch managers further understand the importance and value of existing bridge structures for carnivores, in addition to livestock.

*Cooperative finding provided by Tommy and Sue Armin, the Arnim Family Foundation, and the East Foundation.*

### Landscape Patterns of Ocelot-Vehicle Collision Sites

*AnnMarie Blackburn, Amanda M. Veals, Michael E. Tewes, David B. Wester, John H. Young Jr., Randy W. DeYoung, C. Jane Anderson, and Humberto L. Perotto-Baldivieso*

Road networks can negatively impact wildlife populations through habitat fragmentation, decreased landscape connectivity, and wildlife-vehicle collisions, thereby influencing the spatial ecology and population dynamics of imperiled species. The ocelot is endangered in South Texas, with a high mortality rate linked to vehicle collisions.

We quantified and examined landscape structure at ocelot roadkill locations, and between roadkill locations of male and female ocelots. We quantified the spatial distribution of land cover types at 26 ocelot-

vehicle collision sites in South Texas that occurred from 1984–2017. We compared landscape metrics of woody, herbaceous, and bare ground cover types across multiple spatial scales at roadkill locations to those from random road locations, and between male and female ocelots.

- Roadkill sites consisted of 13–20% more woody cover than random locations. Woody patches at roadkill sites were 7.1–11% larger closer to roads and spaced closer together farther away from roads compared to random locations.
- Percent woody cover was the best indicator of ocelot-vehicle collision sites; there were no differences in woody cover between male and female road mortality locations.
- These findings suggest that ocelots are likely struck by vehicles while crossing between habitat patches. Roads that bisect areas of woody cover have negative impacts on ocelots by increasing habitat fragmentation and vulnerability to vehicle collisions. Therefore, crossing structures should be placed in areas with  $\geq 30\%$  woody cover.

*Cooperative funding provided by the Feline Research Program of the CKWRI and the Texas Department of Transportation-Environmental Affairs Division.*



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**Ph.D. candidate, Maksim Sergeyev, and veterinarians, Dr. Clay Hilton and Dr. Ashley Reeves-Wilmoth, perform health and condition assessments on a captured ocelot.**



# Habitat Conservation and Management

## Long-Term Response of Tanglehead to Prescribed Fire and Cattle Grazing

*Alexandria M. DiMaggio, J. Alfonso Ortega-S., Humberto L. Perotto-Baldivieso, Chase H. Walther, Sandra Rideout-Hanzak, and David B. Wester*

Large monocultures of an invasive grass, tanglehead, are taking over parts of south Texas. Tanglehead is challenging other native species, homogenizing the plant community, and negatively impacting wildlife habitat and livestock production. Patch-burn grazing is a method used to promote heterogeneity on the landscape by burning these large stands to increase forage quality and promote higher grazing density to combat tanglehead.

We monitored the effects of prescribed fire and cattle grazing on (1) the composition of a plant community dominated by tanglehead; and (2) cattle and wildlife use of tanglehead-invaded areas treated with prescribed fire. A tanglehead-dominated pasture in south Jim Hogg County, Texas was used for this study. Prescribed fire was applied to plots in Fall 2016 and Winter 2018. Cattle were allowed to roam freely throughout the pasture at a stocking rate of 23 ac/AU/yr. Plant species richness, percent bare ground, tanglehead cover, litter cover, grazing utilization, and forage standing crop were monitored monthly.



© J. Alfonso Ortega-S.

**Prescribed fire on tanglehead produces regrowth of high nutritive value and palatability for cattle.**

- Plant species richness increased in both burn treatments for the length of the study compared to the control.
- Percent bare ground increased for at least one year after each burn.
- Grazing utilization was higher in the burned plots compared to the controls for the length (21 months) of the study.
- The two treatments (Fall 2016 and Winter 2018 burn) may have increased usable space for bobwhite quail.
- Fall and winter prescribed burns in combination with cattle grazing can be used to reduce tanglehead dominance, and to increase plant species richness and tanglehead utilization by cattle with acceptable levels of cattle productivity.

*Cooperative funding provided by the Jones Ranch and the Houston Livestock Show and Rodeo.*

## Valley Crossing Pipeline Creates Pollinator Corridor

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

The installation of a new pipeline allows landowners and pipeline companies the ability to work together to attempt to create native grassland habitat. These types of activities help reduce the impact new pipelines have on the land and species that utilize it.

This was the goal of Valley Crossing pipeline that crossed Kenedy County, Texas. The landowners worked together with South Texas Natives and Embridge, to develop a native seed mix of 19 species focused on creating pollinator habitat along the new 200-foot wide by 56-mile long corridor.

- Plant density and basal coverage were the same on both the pipeline and in undisturbed areas adjacent to the pipeline two years after seeding.
- Continuous moderate to heavy grazing by cattle had no effect on the establishment or persistence of vegetation on the right-of-way.
- All areas of saline clay soils that were impacted by the new pipeline were converted from saltgrass flats to non-native Bermudagrass.
- On the pipeline, right-of-way plant density of seeded species ranged from 0 to 0.5 plants per square foot. These numbers just meet or are below

the standard measure of success, which is 0.5 plants per square foot.

- While not seeded, many species that provide nectar to pollinator species were present on the right-of-way, but not in adjacent undisturbed areas, indicating the disturbance created by the installation of a new pipeline increased pollinator habitat.

*Funding provided by Embridge.*

### Accelerating Restoration of Ocelot Habitat

*Jose G. Cortez Jr., Jonah Evans, Michael E. Tewes, Weimin Xi, David B. Wester and Sandra Rideout-Hanzak*

The purpose of this project was to test different treatments to thornshrub plants that could potentially speed up their growth to develop dense, multi-stemmed habitat that is preferred by ocelots. Naturally established plants and newly planted saplings were both tested to help determine when treatments would be most effective.

Treatments included physical alterations to the plants which consisted of shredding, mulching, and a combination shred plus mulch treatment. A passive treatment of browsing exclosures was also used to protect the plants from being browsed by wildlife.

- Protection from browsing had the strongest impact on plant growth. When browsers, such as white-tailed deer and exotic ungulates, are densely populated within an area, population control may be required for successful plant establishment and growth.
- All plants grew over time, but shredded plants showed a different plant structure after a short period of 2 years. Shredded plants remained shorter, but had larger canopy areas and more stems.
- Survival of the planted saplings was low. This was caused partly by excessive browsing from ungulates. Also, they may not have adapted well to environmental conditions after transplanting.
- Mulching treatments were not very effective and did not improve plant growth.
- Two years may have been insufficient to determine full treatment effects on plant growth. Future projects should study treatment effects for a longer period of time.

*Cooperative funding provided by the Texas Parks and Wildlife Department.*



© Samuel Lutfy

**Texas Native Seeds researchers are studying planting methodologies and the use of nurse crops for stand establishment in the Permian Basin.**

### Restoration Research in the Permian Basin

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

Energy infrastructure development in the Permian Basin and Panhandle regions of Texas presents an opportunity for thousands of acres of degraded rangeland to potentially become available for habitat restoration projects. While new Texas Native Seeds seed releases are in development, there is a need for the study and promotion of successful planting methodologies with the currently available seed sources for the region.

We installed 2 research projects of this kind on the Railway Ranch, located south of Odessa, Texas. Plantings on these plots were completed in fall 2018 and spring 2019. Each planting consists of three replicates totaling 5 acres, seeded with a native plant seed mix of 20 species.

- Comparisons between sites with and without exclosures suggest that rabbit herbivory negatively affected the success of the seeding establishment.
- Plots seeded with a Truax no-till native seed drill resulted in greater plant establishment than those seeded with a Trillion broadcaster.
- Future research will investigate using nurse crops and additional ways to reduce rabbit herbivory to benefit native plant establishment and restoration.

*Cooperative funding provided by Stan Smith and the Railway Ranch.*

## Sandbrock Ranch Restoration and Demonstration Project

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

In its third year of a restoration project with the Sandbrock Ranch in Denton County, the Central Texas Native Seed Project (CTNSP) has seeded over 300 acres in the Blackland Prairie of North Central Texas back into native grassland. The objectives of the restoration project also included the establishment of demonstration plots of native plants used in the restoration. CTNSP provided seed mixture recommendations, collected data on plants, and monitored the growth and establishment of native grassland seed mixes. This new location in the Blackland Prairie also served as a new native seed source evaluation site for sideoats grama, seep muhly, Indiangrass, and Canada wildrye.

- Results will be used to make new seed mix recommendations for the North Central Texas region.
- Native plant demonstration plots will be used for educational efforts to create greater awareness of the importance of native grasslands in the area.
- New plant populations of sideoats grama and seep muhly were selected for seed increase and will be released for commercial seed production for use in restoration efforts where appropriate.

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

## Quail Ranch Grassland Restoration Research Plantings

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

As the Texas Native Seeds Program continues to release new native plant seed releases into the commercial market, there is an opportunity for research on planting techniques and the viability of existing seed releases in the region. Results of this research will help inform landowners, land managers, and public and private business operators on best practices for habitat restoration projects.

The Permian Basin-Panhandle Native Seed Project (PBPNSP) has partnered with Concho Resources, Inc. to install 20 acres of plantings on the Quail Ranch, located in Upton County. The plantings include 2



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**The Permian Basin-Panhandle Native Seed Project studied plantings at the Quail Ranch in Upton County, TX. Their results indicate that rabbit herbivory can have important impacts on restoration projects.**

separate 10-acre sites. Each site was no-till drilled with native plant seed mixtures containing 15 species. Each site also included 5 acres enclosed with rabbit-proof fencing to study the impacts of herbivory on restoration seeding.

- Results from these initial experiments showed that in areas where rabbit herbivory was excluded, successful restoration was achieved. All species seeded were present 3 years after planting.
- In seeded areas where herbivory was allowed, the invasive species, Lehmann lovegrass, dominated the vegetation, and the seeded species were negatively impacted or eliminated entirely by rabbit grazing.
- In the future, larger scale plantings, or those that include nurse-crops may be necessary to achieve successful stand establishment of native plants during times of high rabbit density in the Permian Basin.

*Cooperative funding provided by Concho Resources, Inc.*

## Restoration of Native Grassland on the South Texas Sandsheet

*Anthony D. Falk, Keith A. Pawelek, Bart Dupont, Jimmy Rutledge, Eric D. Grahmann, and Forrest S. Smith*

Restoring native grasslands in the South Texas Sandsheet ecoregion has historically been difficult. Restoration in the region is difficult because of the



soils, climate, and non-native grasses. Additionally, competition from persistent annual forb species such as sunflower and croton, add to the problem. In an effort to find a more reliable method for restoring native grasslands in this region, South Texas Natives staff implemented 2 separate research projects. The first to evaluate several newly available commercial seed sources and the second is testing two common seeding techniques.

- Several seed sources have been identified as being highly effective for restoration within the region. These sources include Kenedy Germplasm big bluestem, Wilson Germplasm yellow Indiangrass, Carrizo blend little bluestem, Duval germplasm red lovegrass, and Mariah Germplasm hooded windmillgrass.
- There were no differences in overall establishment and coverage between drill seeding with a Flex II native seed drill and a Trillion drop seeder.
- Both seeding methods achieved the industry standard of success of 0.5 plants per ft<sup>2</sup>.
- In both experiments, continuous moderate grazing appeared to limit the ability of Guineagrass and buffelgrass in the area from forming dense single species stands.

*Funding provided the Lee and Ramona Bass Foundation and the many generous donors to South Texas Natives.*

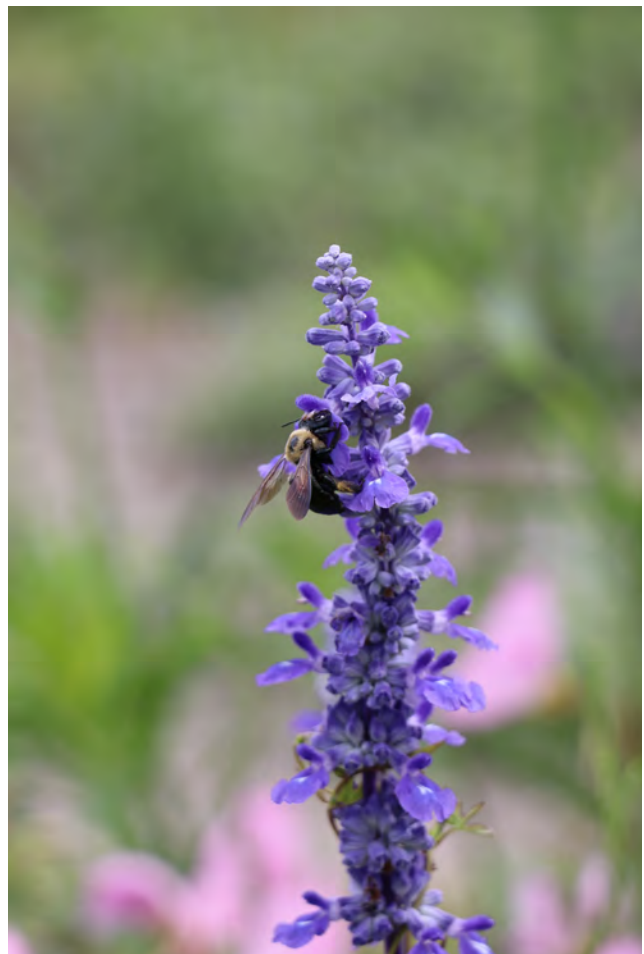
### Restoration of Pollinator Habitat on the Martindale Army Airfield

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

South Texas Natives (STN) collaborated with the Texas Military Department to restore pollinator habitat on land surrounding the Martindale Army Airfield in San Antonio. The first phase of the project involved herbicide treatments of the weeds that remained from prior agricultural use. This was completed between spring 2017 and spring 2018. STN seeded the site during fall 2018 with a commercially produced, locally-adapted seed mix comprised of 37 grasses and forbs.

- Quality native pollinator habitat, including 2 different species of milkweed that are vital for monarch butterfly larvae, was created through seeding native species in lands adjacent to the active Army Airfield.

- Nectar producing plants accounted for 30% of the total cover on the site, and were available year-round for multiple pollinator species.
- Seeded native species accounted for 0.7 plants per ft<sup>2</sup>, and 27% of the ground cover on the site. All 37 native species within the seed mix were recorded on the site.
- Establishment across the 100-acre site was highly variable with the percent cover of seeded native species ranging from a low of 8% to a high of 74%.
- Native grassland restoration with a focus on pollinator species can be successfully achieved in the southern Blackland Prairie Ecoregion.



© Anthony Falk

**Mealy blue sage is a pollinator plant species of interest.**

## Reproductive Capabilities of Nilgai in South Texas

Megan M. Granger, Clayton D. Hilton, Scott E. Henke, Humberto L. Perotto-Baldivieso, and Landon R. Schofield

Nilgai antelope are bovids native to India and portions of Pakistan and Nepal. They were introduced into South Texas in the 1920's and now have a free-roaming population of approximately 33,000 individuals. Current understanding from both native and introduced ranges indicate that nilgai have high reproductive rates, commonly have twins, and reach sexual maturity at approximately 2-3 years of age. However, these studies do not provide reliable quantitative data to prove these claims. Commercial nilgai harvests were conducted during the summers of 2018-2020 on three ranches in southern Texas resulting in 571 harvested nilgai. Pregnancies and fetal sex and crown-rump lengths were recorded.

- Of 412 adult cows harvested, 320 (78%) individuals were pregnant, and of those cows, 200 (63%) produced twins.
- Unborn calves occurred in an even sex ratio (291 males:295 females).
- The fetus crown-rump lengths varied by month, indicating that nilgai are capable of breeding year-round. However, the average fetal lengths increased with each successive month (April-September), except during August where the average fetal size was smaller than the previous month.
- Multiple large fetal lengths ( $\geq 73$ -cm) were recorded in mid-September and the positive lactation status



© Aaron Foley

**Nilgai antelope, capable of traversing long distances, have high reproductive rates in Texas and no natural predators.**

of those individuals indicates that nilgai have a peak calving season beginning mid-September through October. With a ~245-day gestation period, this would put the peak breeding season beginning in mid-January through February.

- Our results confirm previous assumptions of nilgai having high reproductive rates in southern Texas. Considering their reproductive rate and that natural predators to nilgai appear lacking in Texas, nilgai populations have the potential to drastically increase.

*Funding provided by the East Foundation.*

## Changes in Agricultural Land Cover in the Texas Panhandle: 2004–2019

Shae N. Diehl, Justin P. Wied, Humberto L. Perotto-Baldivieso, Timothy E. Fulbright, Randy W. DeYoung, Warren C. Conway, David G. Hewitt, and Shawn S. Gray

The Texas Panhandle is known for large portions of irrigated agricultural land focused on cotton, sorghum, and wheat. The area used to grow these crops was historically uncultivated rangelands. However, there is little information on how changes in the amount and spatial distribution of these cropland areas affect rangeland connectivity or the impact on wildlife. Our objective was to quantify the spatial distribution of crop fields and the changes that have occurred in the past 15 years in the Texas Panhandle. We used aerial photography from the National Agriculture Imagery Program provided by Texas Natural Resources Information Systems for the years 2004, 2006, 2010, 2012, and 2016, and Sentinel-2 satellite imagery for 2019 spanning 24 counties within the Texas Panhandle.

- In 2019, there were 17,805 cultivated fields with an average size of 175 acres and a total cultivated area of 3,108,517 acres.
- Between 2004 and 2012, the number of cultivated fields decreased by 33% and the total area decreased by 23%; however, the average field size increased by 15%.
- Between 2012 and 2019, the number of cultivated fields increased by 5%; the total cultivated area increased by 4% and the average field size remained constant at 175 acres.
- While the total amount of cultivated land has decreased in the last 15 years, the increased average size of fields from 146 acres in 2006 to 175

acres in 2019 may create larger connectivity gaps for rangelands with impacts for wildlife.

*Cooperative funding provided by the Texas Parks and Wildlife Department.*

### Evaluation of Indiangrass Genetic Lineage in Texas

*Samuel R. Lutfy, Thomas E. Juenger, Joseph D. Napier, John R. Bow, Tyler C. Wayland, and Forrest S. Smith*

Collections made by Texas Native Seeds Program (TNS) may serve as an excellent resource for the genetic study of Texas' native plant species. Genetic studies can help further our understanding of variation across the state. In 2019, TNS began a statewide evaluation of Indiangrass, containing 55 collections from across Texas. It also included 16 previously released varieties of the species. Texas Natives Seeds collaborated with researchers at The University of Texas to complete genetic evaluations on this species.

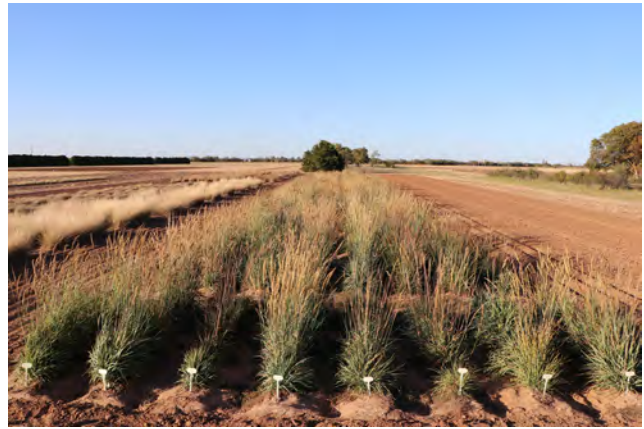
- In 2019, TNS collected leaf tissue from 80 accessions for processing. After analyses, samples were organized into matriarchal lineage “trees” where significant divergences in their genetic codes were observed.
- Results of this study showed a significant difference in the lineage of two accessions made near Galveston, Texas, compared to all other accessions.

*Cooperative funding provided by donors to the Texas Native Seeds Program and the Juenger Lab at The University of Texas at Austin.*

### Nilgai Movements and Implications for Cattle Fever Ticks

*Kathryn M. Sliwa, Jeremy A. Baumgardt, Randy W. DeYoung, J. Alfonso Ortega-Santos, David G. Hewitt, John A. Goolsby, and Kimberly H. Lohmeyer*

The southern cattle fever tick (CFT) can transmit the *Babesia* parasite to cattle, a serious threat to the U.S. livestock industry. The ticks prefer cattle, but will infest nilgai antelope, an exotic free-ranging species in South Texas. Tick eradication efforts are complicated if nilgai carry CFT outside the designated quarantine zones. Research on nilgai is limited, but previous studies report nilgai have large home ranges



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### An Indiangrass evaluation at the Texas Native Seed Program site at Knox City.

and make long-distance movements. We attached satellite GPS collars to 30 nilgai in Cameron County, Texas, during 2019–2020 to estimate home range size, quantify long-distance movements, and determine habitat selection.

- Nilgai had large and variable home ranges: annual median home range estimate for females was 1,465 acres (range = 259–3,818) and for males 2,315 acres (range = 546–3,959).
- Two young females made separate, long-distance movements resembling dispersal behavior; each traveled about 25 miles from their initial capture location.
- Nilgai home range sizes and long-distance movements have the potential to overlap multiple ranches, as the typical ranch size in South Texas ranges from 618–14,826 acres. Therefore, CFT eradication efforts need to be broad-scale and consistent across ranches.
- Eradication efforts use treated cattle to remove ticks from the landscape. Nilgai select for areas with greater brush cover, which is also suitable tick habitat. However, these areas are not frequented by cattle and can act as a source of re-infestation.
- Understanding how host species use and move throughout the landscape can aid in the creation of a better cattle fever tick eradication plan for South Texas.

*Cooperative funding provided by the USDA Agricultural Research Service.*



## Estimating Soil Organic Carbon with Spectroscopy and Remote Sensing

*Douglas J. Goodwin, Dan Kane, Kundan Dhakal, J. Alfonso Ortega-S., Humberto L. Perotto-Baldivieso, Doug Tolleson, William Fox*

Soil organic carbon (SOC) influences several landscape ecological processes and is a primary driver of biologically active soil systems. Soils' ability to sequester carbon is becoming recognized as a mechanism to mitigate the negative impacts of climate change. There is a need for defining methods and technologies that can address the soil's spatial variability and the time and cost of sampling soil organic carbon. Visible and near-infrared spectroscopy has been suggested as a potential tool to aid sampling strategies. In order to evaluate this relationship, 19 ranches across Oklahoma and Texas were selected and SOC was measured at different depths at 519 sampling locations in 2019. Our data suggest that the MultispeQ Beta reflectometer can estimate soil organic carbon within a reasonable degree of accuracy ( $\pm 0.3\%$  SOC) on its own.

- The MultispeQ Beta reflectometer, although consistently accurate at lower soil carbon concentrations, was less accurate than a model built using just remote sensing and digital soil map data as predictors.
- Combining the two data sources was the most accurate method, and explained 73% of the variability in SOC.

*Cooperative funding provided by the Noble Research Institute.*

## Forage Mass Estimation Using Drones in South Texas Rangelands

*Michael T. Page, Rider C. Combs, Bradley K. Johnston, Annalysa M. Camacho, Alexandria M. DiMaggio, Melaine Ramirez, Humberto L. Perotto-Baldivieso, J. Alfonso Ortega-S., Jay P. Angerer, Evan P. Tanner, Dwain Daniels, and Tony Kimmet.*

The use of drones has exponentially increased in recent years for monitoring and management of rangelands. High-resolution cameras and improved sensors provide new opportunities to collect data. Our goal was to develop a pasture-scale sampling methodology to estimate forage mass in rangelands using 3D

models derived from drones. Our specific objectives were (1) to compare double sampling and vegetation clipping methods with drone-based forage estimation methods, (2) to compare forage mass estimation between methods using different numbers of drone derived samples, and (3) to estimate time efficiency of each one of these methods. To accomplish these objectives we flew a drone at two altitudes, 150 feet and 300 feet above ground level (AGL), and captured data for seven 67-acre sites in a 2,618 acre pasture. We compared six forage mass sampling approaches: double sampling, vegetation clipping, drone-double sampling at both heights AGL, and drone-vegetation clipping at both heights AGL.

- The double sampling estimations were similar between the ground- and drone-based methods with values ranging between 6688 – 7134 lb/ac.
- We produced 22 samples/hour with the double sampling method and up to 52 samples/hour with the drone-double sampling method.
- Our results show that we can use data derived from drone imagery to estimate forage mass on rangelands at a large pasture scale, and field time and effort may be reduced.

*Cooperative funding provided by the USDA Natural Resources Conservation Services, the Rotary Club of Corpus Christi Harvey Weil Sportsman Conservationist Award, and the Sweden Ranch.*



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**Researchers use telemetry to track collared nilgai and other large animals.**

## Genetic Variation in the Immune System of Nilgai Antelope

*Kathryn M. Sliwa, David Navarro, Randy W. DeYoung, Jeremy A. Baumgardt, J. Alfonso Ortega-Santos, David G. Hewitt, John A. Goolsby, and Kimberly H. Lohmeyer*

The nilgai antelope, native to India, has flourished in South Texas since their introduction in the 1930s. Nilgai are a valued resource, but are implicated in recent outbreaks of cattle fever ticks. The ticks can transmit a parasite that causes bovine babesiosis, or cattle fever. The disease is a serious concern for the cattle industry and may cause death in up to 90% of naïve cattle. Genetic diversity can determine how well a population responds to parasites and disease. The major histocompatibility complex (MHC) is part of the immune system that recognizes self from non-self, one of the body's first immune defenses. Genetic variation at the MHC could enable individuals to have a greater resistance to parasites. Nilgai populations were founded by a small number of individuals, and thus may have low genetic diversity. We captured nilgai in Cameron County, Texas, during 2019–2020, collected ticks, and compared tick loads to genetic diversity at the MHC.

- We discovered 7 alleles, or genetic variants, in the MHC of South Texas nilgai and 62% of nilgai were



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**The Texas Native Seeds Program has improved the process of creating and commercializing seed releases all over Texas.**

heterozygous. Nilgai have low MHC diversity compared to other species in the Bovid family.

- Individual tick loads collected from nilgai captured 2 or more times varied over time regardless of their MHC alleles.
- The rarer alleles found in our population of nilgai paired together at a higher frequency than expected. However, more information is needed to determine if these alleles are related to parasite burdens.
- Understanding how immune diversity can influence susceptibility to tick infestation is important for disease management within this introduced population.

*Cooperative funding provided by the USDA Agricultural Research Service.*

## Licensing Production of Native Seed Releases

*Keith A. Pawelek and Janie Hurley*

The Texas Natives Seeds Program began working to improve the process of commercializing its releases in 2017. The strategy to bid out production and licensing of a new release was piloted in 2018 and has since become the go-to method. Seed licenses have become an integral tool in achieving the program's mission, and the ultimate goals of enabling the successful and economically feasible restoration of Texas' native plant communities to benefit wildlife in Texas.

- The process allows commercial seed producers a fair chance to produce a germplasm released by our program.
- The process allows our program to maximize commercial production of the releases being licensed, decrease the amount of seed needed, and set production and quality thresholds.
- The process resulted in 10 new seed releases that were licensed in 2018 and available for purchase in 2020.
- The process has cut an average of 2 years off the commercialization timeline.

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



## Nilgai Response to Treatment by Remote Sprayers

*Kathryn M. Sliwa, Jeremy A. Baumgardt, Randy W. DeYoung, J. Alfonso Ortega-Santos, David G. Hewitt, John A. Goolsby, and Kimberly H. Lohmeyer*

Nilgai antelope are an exotic species implicated in recent outbreaks of cattle fever ticks (CFT) in South Texas. The ticks carry a parasite that causes bovine babesiosis in cattle, a serious threat to the cattle industry. Nilgai can make long-distance movements, and will readily cross under livestock fences to neighboring properties. The USDA Agricultural Research Service developed a motion-activated sprayer system to target nilgai with CFT treatment. Nilgai do not respond to bait, so we deployed sprayers at fence-crossing sites, the only places we expected nilgai to re-visit. We monitored nilgai movements across livestock fences using re-sightings of 41 tagged and 30 GPS-collared animals during 2019–2020 in Cameron County, Texas, as part of a field test of the sprayer technique.

- Individual collared nilgai crossed a boundary fence from 3 to 504 times during the year based on GPS locations. Seventeen of the 30 collared nilgai crossed a fence >1 time per month, 9 of the 30 nilgai had  $\geq 1$  month with 0 fence crossings, and 4 of the 30 nilgai left the study area.
- Only 17 of 30 collared nilgai were photographed crossing a fence at a recognized crossing site by remote cameras; the animals crossed 63 times.
- The lack of crossing events at camera-monitored sites indicated nilgai had alternative places to cross fences. Therefore, the sprayer technique may be inefficient unless fences are well-maintained.
- The limited amount of knowledge on the behavior and movement of nilgai in South Texas limits CFT eradication efforts in South Texas. The results of this study will help refine treatment strategies for targeted nilgai-CFT treatment programs.

*Cooperative funding provided by the USDA Agricultural Research Service.*



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**A nilgai antelope runs off after being tagged for a study of remote sprayers for cattle fever ticks.**



## Using a Drone to Estimate Forage Mass in a Semi-Arid Rangeland

*Alexandria M. DiMaggio, Humberto L. Perotto-Baldivieso, J. Alfonso Ortega-S., Karelys N. Labrador-Rodriguez, Michael T. Page, Jose de la Luz Martinez, Sandra Rideout-Hanzak, Brent C. Hedquist, and David B. Wester*

The application of drones in the monitoring and management of rangelands has increased in recent years due to the sensors becoming smaller, the ability to capture imagery with high spatial resolution, lower altitude platforms, and the ease of flying drones in remote environments. The aim of this research was to develop a method to estimate forage mass in rangelands. The specific objectives of this research were to (1) evaluate the feasibility of estimating forage mass in semi-arid rangelands using a double sampling technique with high-resolution imagery, and (2) to compare the effect of altitude on forage mass estimation. The study site was in Duval County, Texas. Forage was clipped in the field to estimate forage mass, and imagery was acquired by the drone at different altitudes (98, 131, and 164 ft) to produce values of forage volume. Forage mass estimations for the clippings and volumes obtained from imagery collected with the drone were used to develop a prediction equation.

- Forage volumes and forage mass had a positive relationship; this justifies the models we produced from the imagery.
- The highest altitude flight produced similar results to lower altitude flights while increasing the efficiency of the data sampling and processing.
- Drones may improve capabilities of field data collection and allow for efficient large-scale forage mass estimations that are useful to landowners, ranchers, and rangeland managers to make management decisions.

*Cooperative funding provided by the Houston Livestock Show and Rodeo.*

## Evaluating Mesquite Canopy Height Using Drones

*Michael T. Page, Victoria M. Cavazos, Hunter Carroll, Kiri Baca, Rider C. Combs, Melaine Ramirez, Humberto L. Perotto-Baldivieso, J. Alfonso Ortega-Santos, Jay P. Angerer, Evan P. Tanner, Dwain Daniels, and Tony Kimmert*

Drones have opened new opportunities to better identify and quantify features within the landscape.

Encroachment of invasive plant species on rangelands is of critical concern, and honey mesquite is one of the most invasive native species in Texas and in the southwest United States.

The aim of this project was to test the feasibility of using drones to estimate structure and distribution of mesquite on the landscape. The specific objectives were to (1) evaluate the accuracy of drones to estimate honey mesquite height, (2) classify honey mesquite using a combination of digital surface models and spectral information, and (3) compare drone and satellite imagery mesquite classification methods.

We used two study sites in the South Texas Plains region and one site in the western Cross Timbers region. We located mesquite trees and recorded field measurements of tree canopy heights. Once field measurements were completed, we flew the drone at two altitudes, 150 feet and 300 feet, above ground level (AGL). We obtained very high-resolution imagery that we analyzed and merged with Sentinel-2 imagery.

- Our analysis showed that 150 feet AGL mesquite height estimates from drones explained 95% of the variability.
- Using drone imagery data to predict the extent of honey mesquite cover with Sentinel-2 imagery yielded overall accuracy of over 80% for all sites, user accuracies up to 86%, and producer accuracies up to 92%.
- We can use drone imagery as training data for Sentinel-2 satellite imagery to assess the extent of honey mesquite cover on Texas rangelands.

*Cooperative funding provided by the USDA Natural Resources Conservation Service and the Rotary Club of Corpus Christi Harvey Weil Sportsman Conservationist Award.*

## Assessing Pronghorn Movements in Agricultural Landscapes

*Victoria M. Cavazos, Dakota R. Moberg, Anthony P. Opatz, Timothy E. Fulbright, Randy W. DeYoung, David G. Hewitt, Warren C. Conway, Humberto L. Perotto-Baldivieso, and Shawn S. Gray.*

Pronghorns are found in 27 counties across the Texas Panhandle. Their behavior and movements are influenced by the distribution and quality of forage as well as landscape features and human activity. However, there is very limited information on the ecology and movement behavior of pronghorns in this area. We selected two study areas within the

Texas Panhandle near Pampa and Dalhart. Our objectives were to determine pronghorn spatial and temporal movements and their distribution in relation to the landscape features. For this study, satellite GPS collars were used to track pronghorn movements by recording data every two hours. We analyzed GPS locations to quantify the number of locations, distance traveled, and distance in natural and agricultural landscapes. We have partitioned the data by months, and are examining the spatial and temporal variability by sex and study area.

- The largest average distance travelled by pronghorns in the panhandle was 118 miles during March 2017.
- The shortest average distance travelled by pronghorns in the panhandle was 70 miles during October 2017.
- Given these travelled distances, pronghorns may require large amounts of connected land to maintain their population.
- Barriers to movements by pronghorns may cause loss of connectivity and have potential negative effects on population abundance.

*Cooperative funding provided by the Texas Parks and Wildlife Department.*

We selected pronghorns because their behavior is influenced by forage availability and landscape disturbance. We created space-time cubes for each individual collared pronghorn using a monthly step time. We classified patterns as hot or cold spots or no pattern areas, then quantified them based on the amount of cropland around each area.

- Our analyses showed that cropland areas were used by females 1-4% of the time and by males just over 1% of the time in the Dalhart and Pampa areas.
- Cold spots were in rangelands and hotspots were located in croplands.
- The location of cold and hot spots suggest that these patterns depend on forage availability.
- The spatial distribution of space-time cubes suggest that roadways may act as barriers.

*Cooperative funding provided by the Texas Parks and Wildlife Department.*

### Distribution of Pronghorns over Space and Time

*Dakota R. Moberg, Victoria M. Cavazos, Shae N. Diehl, Anthony P. Opatz, Timothy E. Fulbright, Randy W. DeYoung, David G. Hewitt, Warren C. Conway, Humberto L. Perotto-Baldivieso, and Shawn S. Gray*

Space-time cubes are models that can help us understand patterns on the landscape across space and time. The cube can provide information as to whether wildlife movements have distinctive patterns across the landscape through time. These patterns are classified as emerging hot spots, emerging cold spots, or no patterns areas. Hot spots are defined as trends in the clustering of location densities of an individual. This information combined with land cover data can provide new insights into how a particular species uses the landscape throughout the year.

We used GPS data collected from 64 pronghorns (32 males and 32 females) evenly distributed across two contrasting landscapes in the Texas Panhandle: Dalhart, which represents an agriculture-dominated landscape and Pampa, which represents a rangeland.

## Abstract External Authors & Co-Authors

- Dr. Jay P. Angerer, USDA Agricultural Research Service
- Ms. Ruby Ayala, Texas A&M University-International
- Ms. Kiri Baca, New Mexico State University
- Mr. Nick Bamert, Bamert Seed Company
- Dr. Natasha L. Bell, Texas A&M University-Kingsville
- Dr. Terry Blankenship, Welder Wildlife Refuge
- Mr. Michael J. Bodenchuk, Texas Wildlife Services
- Dr. Jeff A. Brady, Texas A&M AgriLife Research and Extension Center
- Mr. Patrick Brzozowski, Lavaca Navidad River Authority
- Mr. William P. Bukoski, USDA APHIS Wildlife Services
- Dr. Tyler A. Campbell, East Foundation
- Dr. Sasha Carvajal-Villareal, PredCons
- Mr. Brandon Carr, USDA NRCS James E. "Bud" Smith Plant Materials Center
- Dr. Arturo Caso, SEMARNAT-Secretaria de Medio Ambient Y Recursos Naturels
- Dr. Ambika Chandra, Texas A&M AgriLife Research and Extension Service, Dallas
- Dr. Megan K. Clayton, Texas A&M AgriLife
- Dr. Daniel P. Collins, U.S. Fish and Wildlife Service
- Ms. Sarah J. Corbett, U.S. Customs and Border Protection
- Ms. Sarah Clements, University of Missouri
- Mr. Garrett Clevinger, Virginia Tech University
- Dr. Daniel P. Collins, U.S. Fish and Wildlife Service
- Dr. April A. T. Conkey, Graduate Faculty, Texas A&M University-Kingsville
- Dr. L. Mike Conner, Jones Center at Ichauway
- Dr. Warren C. Conway, Texas Tech University
- Dr. Susan M. Cooper (retired)
- Dr. Paul Crump, Texas Parks and Wildlife Department
- Mr. Jameson S. Crumpler-Borderlands Research Institute, Sul Ross State University
- Ms. Stephanie A. Cunningham, University of Missouri
- Mr. Dwain Daniels, USDA Natural Resources Conservation Services
- Mr. David DeLaney, King Ranch, Inc.
- Dr. James H. Devries, Ducks Unlimited, Canada
- Mr. Don A. Draeger, Comanche Ranch
- Dr. Kundan Dhakal, Noble Research Institute
- Mr. Bart Dupont, El Coyote Ranch
- Mr. Jonah Evans, Texas Parks & Wildlife Department
- Dr. Cord B. Eversole, Texas A&M University-International
- Mr. Justin W. Fischer, USDA APHIS Wildlife Services National Wildlife Research Center
- Dr. Kathy K. Fleming, U.S. Fish & Wildlife Service
- Dr. W. Mark Ford, U.S. Geological Survey, Virginia Cooperative Fish and Wildlife Research Unit
- Dr. William E. Fox, Texas A&M AgriLife Research and Extension Service
- Mr. Jesus Franco, American Bird Conservancy, Rio Grande Joint Venture
- Dr. Douglas J. Goodwin, The Noble Foundation
- Dr. John A. Goolsby, USDA APHIS ARS
- Dr. Eric D. Grahmann, El Coyote Ranch
- Mr. Shawn S. Gray, Texas Parks and Wildlife Department
- Dr. Angela M. Guerrero, Stockholm Resilience Centre, Sweden
- Mr. Terry Hanzak, Always Faithful Dog Training of the Coastal Bend
- Dr. Louis A. Harveson, Borderlands Research Institute, Sul Ross State University
- Dr. Mickey W. Hellickson, Orion Wildlife Management
- Mr. Tony Henehan, Texas Parks and Wildlife Department
- Dr. Steven C. Hess, USDA APHIS Wildlife Services National Wildlife Research Center
- Dr. Joseph D. Holbrook, University of Wyoming
- Dr. Jon S. Horne, Idaho Department of Fish and Game
- Mr. Devin Hotzel, Enbridge, Inc.
- Ms. Janie Hurley-Texas AgriLife Research
- Dr. J. Dale James, Ducks Unlimited, Inc.
- Mr. Travis Jez, Texas Department of Transportation
- Ms. Chelsea Jones, Texas Comptroller Public Account Office
- Mr. Jeff Jowell, Harris County Flood Control District
- Dr. Thomas E. Juenger-The University of Texas at Austin
- Mr. Daniel Kane, Yale University
- Dr. Marcella J. Kelly, Virginia Tech University
- Mr. Benton K. Kennemer, Texas Wildlife Services
- Mr. Rhett K. Kerby, KerTech, LLC.
- Mr. Tony Kimmet, USDA Natural Resources Conservation Services
- Dr. Bryan M. Kluever, USDA APHIS Wildlife Services National Wildlife Research Center
- Dr. Page E. Klug, USDA APHIS Wildlife Services National Wildlife Research Center
- Mr. Nicholas R. Kolbe, Texas Military Department
- Mr. Kevin J. Kraai, Texas Parks and Wildlife Department
- Dr. Richard Lanctot, U.S. Fish and Wildlife Service
- Mr. Bruce R. Leland, Texas Wildlife Services
- Dr. Kimberly H. Lohmeyer, USDA APHIS ARS
- Mrs. Shelly D. Maher, USDA NRCS E. "Kika" de la Garza Plant Materials Center
- Mr. Matthew McGruder, Orsted Onshore North America
- Mr. John W. McLaughlin, Texas Parks and Wildlife Department
- Dr. Debra Miller, University of Tennessee
- Dr. Andrea Montalvo, East Foundation
- Mr. Matthew T. Moore, Faith Ranch
- Dr. James P. Muir, Texas A&M AgriLife Research and Extension Center at Stephenville
- Mr. Chase A. Murphy, Texas A&M AgriLife Research and Extension Center at Stephenville
- Mrs. Sonia Najera-The Nature Conservancy
- Dr. Joseph D. Napier-The University of Texas at Austin
- Dr. Alejandra Olivera-Méndez, Colegio de Posgraduados, México



Ms. Jo Ann Ortiz, Toyota Manufacturing  
 Mr. Kyle S. Patterson, Texas Wildlife Services  
 Mr. Dexter Peacock, Las Cuatas Ranch  
 Dr. Adalberto A. Perez de Leon, USDA APHIS ARS  
 Mr. Thomas C. Phillips, U.S. Forest Service  
 Mrs. Veronica G. Rapp, Occidental Petroleum Company  
 Dr. Ashley M. Reeves Wilmoth, University of Tennessee  
 Mr. John Reilley, USDA NRCS E. "Kika" de la Garza Plant Materials Center  
 Mr. Jimmy Rutledge, El Coyote Ranch  
 Mr. Landon R. Schofield, East Foundation  
 Dr. Chrissie A. Segars, Texas A&M AgriLife Research and Extension Service, Dallas  
 Dr. Robert A. Shadow, USDA NRCS East Texas Plant Materials Center  
 Dr. Aaron B. Shiels, USDA APHIS Wildlife Services National Wildlife Research Center  
 Dr. Shane R. Siers, USDA APHIS Wildlife Services National Wildlife Research Center  
 Dr. Nathan P. Snow, USDA APHIS Wildlife Services National Wildlife Research Center  
 Dr. W. Chad Stasey, U.S. Forest Service  
 Mr. Stuart W. Stedman, Faith Ranch  
 Mr. Garry S. Stephens, Wildlife Habitat Federation  
 Dr. William Swanson, Linder Center for Conservation and Research of Endangered Wildlife, Cincinnati Zoo and Botanical Garden  
 Ms. Sabrina H. Szeto, Szeto Geospatial Consulting, Germany  
 Mr. Tracy Tally-Justin Seed Company  
 Mr. Aaron D. Tjelmeland, The Nature Conservancy, Texas City Prairie Preserve  
 Dr. Douglas R. Tolleson, Texas A&M University-College Station  
 Mr. Elliot P. Tucker-Wildlife Habitat Federation  
 Mr. Darcy Turner-Turner Seed Company  
 Dr. Kurt C. VerCauteren, USDA APHIS Wildlife Services National Wildlife Research Center  
 Dr. Jay A. VonBank, U.S. Geological Survey  
 Dr. Stephen L. Webb, Noble Foundation  
 Dr. Mitch D. Weegman, University of Missouri  
 Mr. Ken A. Wells, U.S. Customs and Border Protection  
 Dr. Ben Wherley, Texas A&M AgriLife Research and Extension Service  
 Dr. Dean W. Wiemers, Southwest Texas Junior College  
 Dr. R. Neal Wilkins, East Foundation  
 Mr. Dean N. Williams, Douglass W. King Seed Company  
 Mr. Him Willis, Wildlife Habitat Federation  
 Mr. Jesse Wood, Concho Resources Inc./Conoco-Phillips  
 Dr. Weimin Xi, TAMUK Dept. of Biological Sciences  
 Dr. John H. Young, Jr., Texas Department of Transportation  
 Mr. Robert Ziehr, USDA Natural Resources Conservation Service

### **TAMUK Undergraduate Students**

Ms. Meghan Anderson  
 Mr. Aidan B. Brannen  
 Mr. Dennis M. Berry, III  
 Ms. Victoria M. Cavazos  
 Ms. Hunter Carroll  
 Ms. Shae Diehl  
 Mr. Walter Gless  
 Ms. Lindsey K. Howard  
 Mr. D. Blake Jordan  
 Mr. Paul Kendall, III  
 Mr. Michael A. Kalisek  
 Mr. Andrew Lowery  
 Ms. Lori Massey (now a graduate student)  
 Ms. Dakota R. Moberg  
 Ms. Gabriela Olivas  
 Mr. Daniel P. Ramirez  
 Ms. Melaine Ramirez  
 Mr. Evan D. Rangel  
 Ms. Gertrudis Ruiz-Balli (Agriculture graduate student)  
 Ms. Eve M. Schrader  
 Mr. Joshua P. Vasquez  
 Mr. Luke Willard

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# Parting Shots



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The CKWRI faculty often capture wildlife with a camera lens merely for sport, and some of them are quite good at it. This year's CRR features many photos taken by Dr. Randy DeYoung, including these of pollinators doing what they do best. We hope you enjoy these parting shots.



Caesar Kleberg Wildlife Research Institute  
Texas A&M University-Kingsville  
700 University Boulevard, MSC 218  
Kingsville, Texas 78363-8202

(361) 593-3922

<http://www.ckwri.tamuk.edu>



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