CAESAR KLEBERG

WILDLIFE

RESEARCH INSTITUTE

TEXAS A&M UNIVERSITY-KINGSVILLE

© Jose S. Avila-Sanchez

Current Research 2019–2020

This year's cover features a photograph of gulf cordgrass being treated with prescribed fire. When mature, gulf cordgrass is considered poor forage for livestock and fair for wildlife. Prescribed burning improves the nutritional quality of gulf cordgrass and allows room for other grasses and forbs to grow.

Editors Alan M. Fedynich, Ph.D. and Sandra Rideout-Hanzak, Ph.D.

December 2020

Report of *Current Research*

September 1, 2019 to August 31, 2020

Caesar Kleberg Wildlife Research Institute

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Kingsville, Texas

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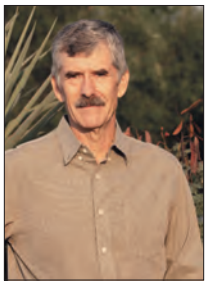
FOREWORD



Dear Friends of the CKWRI,

CKWRI scientists and students have dream jobs. We get to spend time outside, and we get to study the wildlife and habitat that have enthralled us all our lives. We immerse ourselves in learning all we can about a wildlife species, the ecology of a region, and the challenges of managing wildlife and its habitat. We are able to pose questions and then do the research to answer those questions. We know countless people, including those of you reading our Current Research report, appreciate our work.

However, there is an aspect of the research process that many of us at the CKWRI are rarely able enjoy. We are rarely on the landowner side of a research project. That changed for me this summer when Matti Bradshaw, one of Dr. Ballard's graduate students studying black-bellied whistling ducks, chose a nesting box in my yard to include in her research. Ever since being granted access to private properties in western Virginia 30 years ago to study ruffed grouse, I have been amazed (and thankful!) that landowners would open their gates for students and scientists to conduct research. It is akin to letting someone into your living room. Opening the gate is a personal, trusting, and gracious act.

Now that I have been on the landowner side of the research process, I understand why so many landowners are supportive of wildlife research. First, I enjoyed knowing I was supporting a project on a species of wildlife I see regularly in my yard. The nesting box on my property often had 20 or more eggs in it, and I had seen up to six whistling ducks at a time vying to get into the box. Clearly, something interesting was happening but without the research expertise and ecological knowledge of Dr. Ballard and his students, I could only guess at what was happening.

Second, I was excited to be supporting a graduate student and knowing that this student would soon be working on behalf of wildlife conservation. Third, I was rewarded with the opportunity to spend time with Matti and her fellow students while they captured, marked, and measured the pair of whistling ducks incubating the nest. Finally, I now have a whole new way to enjoy the time I spend outside in my yard, knowing what the ducks are up to and being able to watch for the marked birds.

Graduate student Matti Bradshaw with a black-bellied whistling duck.

Private lands are critical for wildlife conservation and access to private lands is critical for wildlife research. These lands not only provide habitat for wildlife, but they provide the stage on which wildlife research is conducted. Few of the projects in this edition of Current Research could have been done without the support of landowners and access to their land. As stated before, allowing wildlife research on your property is a personal, trusting, and gracious act. But, as I now know, it is also a rewarding act that pays forward to promote wildlife conservation. Please enjoy this issue of Current Research and give a nod to the private landowners who made much of this research possible.

All the Best,

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

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COMPLETED RESEARCH

DEER

QUAIL AND UPLAND GAMEBIRDS

HABITAT CONSERVATION AND MANAGEMENT

SHOREBIRDS AND WATERFOWL

BIOLOGY, ECOLOGY, AND MANAGEMENT

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
Alexandria M. DiMaggio, Jacob L. Dykes, Bethany A. Friesenhahn, Dustin A. Golembiewski, Megan M. Granger, Ashley G. Hodge, Michael T. Page, Seth T. Rankins, Kathryn M. Sliwa

Quail Coalition Scholarship in Wildlife Management Graduate Scholarships, South Texas Chapter
Jose S. Avila-Sanchez, Matti R. Bradshaw, Rider C. Combs, Jose G. Cortez, Jr., Alexandria M. DiMaggio, Jacob L. Dykes, Jesse Exum, Bethany A. Friesenhahn, Dustin A. Golembiewski, Geron G. Gowdy, Levi J. Heffelfinger, Mikayla M. House, Austin K. Killam, Jason P. Loghry, Jason V. Lombardi, Alison R. Menefee, Michael T. Page, Zachary J. Pearson, Seth T. Rankins, Maksim Sergeyev, Kathryn M. Sliwa, Brianna M. Slothower, Nicole J. Traub, Amanda M. Veals, Jay A. VonBank, Donal A. Woodard, Rebecca R. Zerlin

Quail Coalition Scholarship in Wildlife Management Undergraduate Scholarships, South Texas Chapter
David Delgado, Megan M. Granger, Tessa M. Green, John E. Herschberger, Lori D. Massey

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

San Antonio Livestock Exposition Scholarship
Matti R. Bradshaw, Linden S. Eli

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

Houston Livestock Show and Rodeo Graduate Fellows in Wildlife Research
Javier O. Huerta, Alison R. Menefee, Edwin A. Valdez

Lon and Leigh Cartwright Graduate Scholarship in Grass Management
Dustin A. Golembiewski

Lon and Leigh Cartwright Undergraduate Scholarship in Grass Management
Eve M. Schrader

Hill Country Quail Coalition Scholarships
Zachary J. Pearson, Kristyn G. Stewart

Endowed Student Scholarships

Robert and Rebecca Palmer Scholarship Fund Graduate Student
Levi J. Heffelfinger, Mikayla M. House, Jason V. Lombardi, Nicole J. Traub, Jay A. VonBank, Donal A. Woodard

Robert and Rebecca Palmer Scholarship Fund Undergraduate Student
Marissa M. Macha, Lori D. Massey, Leanna S. Morin, Joshua Vasquez

A. E. Leonard Undergraduate Student Scholarship in Wildlife Conservation
Tessa M. Green, John E. Herschberger

Phillip M. Plant Endowment for Graduate Scholarships in Wildlife
Jacob L. Dykes, Jesse Exum, Jason P. Loghry, Seth T. Rankins, Maksim Sergeyev, Amanda M. Veals

Endowed Student Fellowships

Sam Walton Fellowship in Quail Research
Geron G. Gowdy

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

Elliot B. and Adelle Bottom Fellowship in Quail Research
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
Aiden B. Branney, Jason V. Lombardi

Jess Y. Womack, II Fellowship in Wetlands and Wetland Bird Research
Jay A. VonBank

Boone and Crockett Club Fellowship in Ungulate Research
Levi J. Heffelfinger

Hixon Fellowships in Deer, Quail, Range Restoration, and Wild Cat Research
Levi J. Heffelfinger, Alec D. Ritzell

Kenneth E. Leonard Fellowship for Livestock-Wildlife Research
Rider C. Combs

Stuart W. Stedman-Faith Ranch Fellowships in Deer Research
Jesse Exum

Mike and Mary Terry 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

Students listed above have participated in various CKWRI research studies and their abstracts are presented throughout the *Current Research* report. We acknowledge the donors of these student scholarships and fellowships on this page.

NEW ENDOWMENTS AND IN MEMORY AND HONOR...

In Memory and Honor...

Many people choose to send unsolicited gifts in honor of cherished friends or family.
In FY2020, we have received memorials and gifts to honor...

Fred Bryant
**Marc A. Canales*
**Lon and Leigh Cartwright*
Cristina de los Santos
John Gabriel
**Henry R. Hamman*
**Bruce F. Harrison*
**Charlie M. Herrington*
**George C. "Tim" Hixon*
**Tio and Janell Kleberg*
Meredith Long
Benjamin Franklin Pitman, III
Alec D. Ritzell
**Spike Robins*
L. Proctor "Terry" Thomas, III
**David Villanueva*
**William E. "Will" Watt, II*
**Anse Windham*

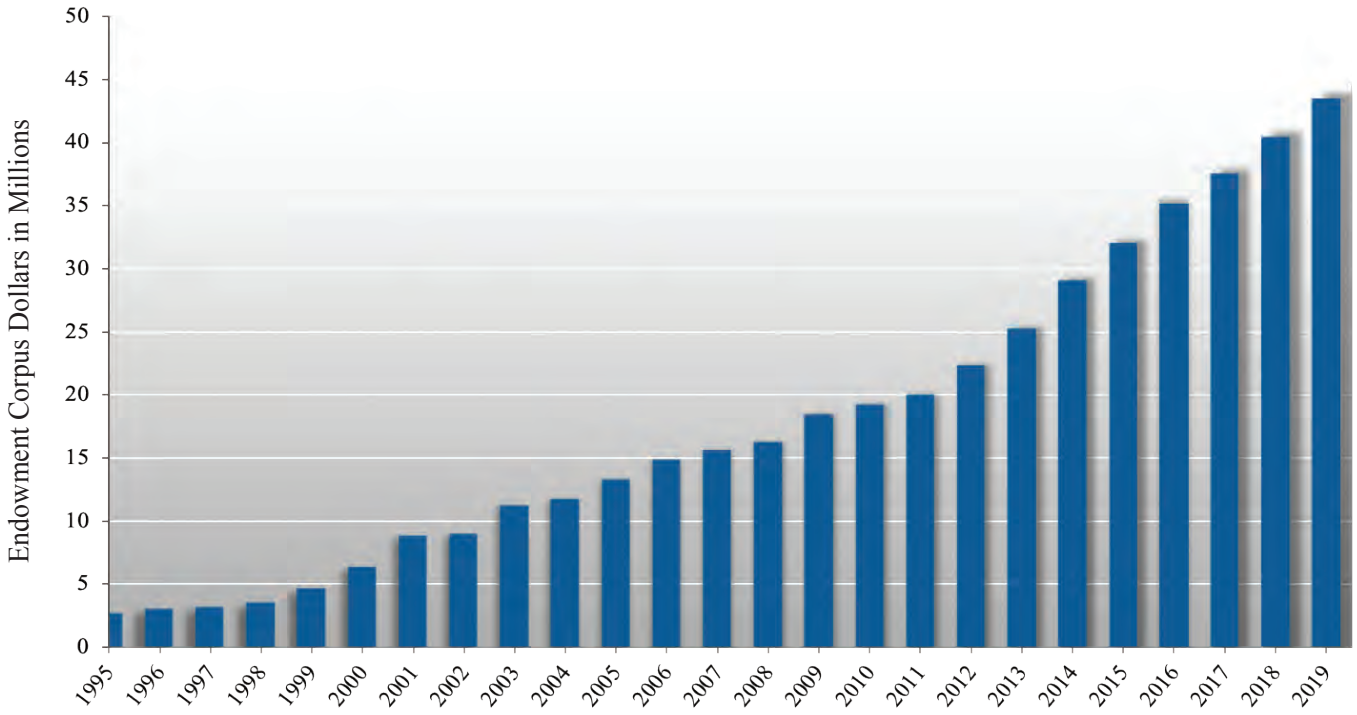
* Also honored in previous years

New Endowments

Celia and Cornelius Dupré Program in Wildlife Education
Phil and Karen Starr Hunke Fellowship in Wild Cat Research
The Benjamin Franklin Pitman, III Endowment for Wildlife Research
Alec D. Ritzell Memorial Fund for Wildlife Research and Education
William E. Watt, II Memorial Fund for Quail Research

Endowment Financials

The Caesar Kleberg Wildlife Research Institute endowments ended the year on December 31, 2019 with a corpus value of $43.5 million and a market value of $54.1 million. CKWRI endowments provided $2.1 million of program funding in 2020.



Corpus Growth Reported in December from 1995 to 2019

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 50 graduate students in our program during the 2019–2020 academic year.

CKWRI Alumni: By The Numbers

252 M.S.

62 Ph.D.

DEGREES GRANTED SINCE 1981

OUR ALUMNI ARE WORKING IN

41 STATES & WASHINGTON D.C.

7 COUNTRIES

OUR STUDENTS REPRESENT

39 STATES & WASHINGTON D.C.

7 COUNTRIES

TYPE OF ALUMNI EMPLOYMENT	
BIOLOGIST	120
EDUCATION	36
ADMIN.	31
RESEARCH	22
STUDENT	7
OTHER	5

TYPE OF ALUMNI EMPLOYER	
STATE AGENCY	61
UNIVERSITY	46
FEDERAL AGENCY	37
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RANCH	14
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OUR STUDENTS

2019–2020 M.S. AND PH.D. GRADUATES

Dillan Drabek, M.S.
Thesis: Grazing Effects on Forbs for White-tailed Deer and Plant Species Richness

Anthony Falk, Ph.D.
Dissertation: Converting Bermuda-grass to Native Warm-Season Grasses in the Blackland Prairie and Coastal Prairies Ecoregions of Texas

Geron Gowdy, M.S.
Thesis: Wildlife and Vegetation Response to a Native-Grassland Restoration

Jason Lombardi, Ph.D.
Dissertation: Factors of Ocelot Occupancy in South Texas

Alison Menefee, M.S.
Thesis: Spatial Ecology of Breeding and Wintering Habitat of Rio Grande Wild Turkeys in South Texas

David Navarro, M.S.
Thesis: Effects of Selective Harvest on the Major Histocompatibility Complex in a Managed White-tailed Deer Population

Anthony Opatz, M.S.
Thesis: Impacts of Agriculture on Pronghorn in the Texas Panhandle

Tiffany Pope, M.S.
Thesis: Potential Transmissions of *Baylisascaris procyonis* to Ocelots and Wildlife Caregivers

Kelly Redmond, M.S.
Thesis: Impacts of Red Imported Fire Ants and Habitat Use of Gamebirds in the Coastal Prairie of Texas

Alec Ritzell, M.S.
Thesis: Quail and Rain: Does Management Matter?

Jose Silverio Avila-Sanchez, M.S.
Thesis: Season of Burn Effects on Forage Standing Crop, Production and Composition of Gulf Cordgrass Vegetation Communities

Kristyn Stewart, M.S.
Thesis: Comparative Habitat Use of Montezuma Quail in the Edwards Plateau and Trans-Pecos Ecoregions of Texas

Jay VonBank, Ph.D.
Dissertation: Migration, Movement, and Winter Ecology of Midcontinent Greater White-fronted Geese

Chase Walther, M.S.
Thesis: Long-term Response of Tanglehead to Prescribed Burning and Cattle Grazing

Justin Wied, M.S.
Thesis: A Remote Sensing Approach to Detecting Old World Bluestems in South Texas

STUDENT HIGHLIGHT

In Memory of Alec D. Ritzell (11/3/1994 – 3/9/2020)

Alec D. Ritzell, a Caesar Kleberg Wildlife Research Institute (CKWRI) graduate student, passed away in March 2020 after a battle against brain cancer. In the fall of 2017, Alec officially joined the CKWRI and began his pursuit of a Master of Science degree in Range and Wildlife Management. For his thesis, Alec studied whether quail management truly mattered on semiarid rangelands. That is, whether management could reduce the drastic fluctuations that bobwhites exhibit in Texas, where populations closely track the ups and downs of rainfall. For the past three years, Alec annually conducted helicopter surveys for quail on more than 80,000 acres in South Texas and more than 30,000 acres in the Rolling Plains. He also interviewed dozens of ranchers, landowners, and wildlife managers regarding their land-management practices so he could quantify quail-management intensity, and relate this to quail density. Alec completed his research and coursework and was scheduled to graduate this past December 2019. Unfortunately, Alec was diagnosed with glioblastoma during the summer of 2019 and thus ensued his fight with cancer. Alec passed away in the comforting love of his family on March 9, 2020.

In December 2020, Texas A&M University-Kingsville posthumously awarded Alec a Master of Science degree. It is with much fondness and love that we remember Alec. He was a steadfast student, committed to his education and research, who availed himself of all opportunities. It did not matter whether it was assisting with our South Texas Charity Weekend fund-raising event or capturing deer for a long-term CKWRI project, Alec was always eager to help. You could count on finding him at nearly all CKWRI events—department seminars, thesis defenses, visitor presentations, and quail banquets. There, he would be present and engaged with his friendly smile, positive attitude, and warm, welcoming persona. This is how we remember Alec in our hearts, and how we wish you will too.

OUR SCIENCE TEAM

Science Team: By The Numbers

PERSONNEL

17 FACULTY

10 RESEARCH STAFF

7 ASST. PROFESSORS OF RESEARCH

PEER REVIEWED PUBLICATIONS

43

116

PROFESSIONAL PRESENTATIONS

RESEARCH GRANTS & CONTRACTS

$4.91 Million

Science Team: Awards and Achievements

The **Outstanding Book Publication Award** was given by the Texas Chapter of The Wildlife Society to Leonard Brennan, Bart Ballard, William Kuvlesky, Jr., and other contributing authors for *The Upland and Webless Migratory Game Birds of Texas*.

The **2019 Outstanding Contribution to Range Management** was awarded to J. Alfonso Ortega-Santos from the Texas Section of the Society for Range Management. This top award is given to individuals recognized in the field for their academic achievements and their accomplishments supporting the cattle and wildlife industry.

The **2019 Best Book in Range and Habitat Management** was awarded by the Texas Section of the Society for Range Management to J. Alfonso Ortega-Santos for *Wildlife Ecology and Management in Mexico*.

The **2019 Texas Environmental Excellence Award** for Agriculture was awarded to the *Texas Native Seeds Program* by the Texas Commission on Environmental Quality and Governor Greg Abbott.

The **2019 Group Achievement Award** was given by The Wildlife Society to the *Texas Native Seeds Program*.

The **Publication Award for Outstanding Digital Media** was awarded by the Texas Chapter of The Wildlife Society to the *Texas Native Seeds Program*.

The **Outstanding Technical Publication** was given by the Texas Chapter of The Wildlife Society to Michael Tewes for his narrative *Conservation Status of the Endangered Ocelot in the United States – A 35-year Perspective*.

RANDY DEYOUNG
ELECTED FELLOW
THE WILDLIFE SOCIETY

FIDEL HERNÁNDEZ
ELECTED FELLOW
THE WILDLIFE SOCIETY

HUMBERTO PEROTTO
OUTSTANDING ACHIEVEMENT
TEXAS SECTION, SOCIETY FOR RANGE MANAGEMENT

MICHAEL TEWES
EDUCATOR OF THE YEAR
TEXAS CHAPTER OF THE WILDLIFE SOCIETY

MICHAEL CHERRY
DISTINGUISHED YOUNG ALUMNUS AWARD
UNIVERSITY OF GEORGIA

NEW INITIATIVES

MEDIA

American Ocelot Film

The film *American Ocelot* tells the story of the most endangered and beautiful wild cat in the United States, a species so secretive that high quality images and video have never been taken, until now. With fewer than 100 individuals remaining in the United States, the ocelot is critically endangered, genetically isolated, and in Texas only exists in two small populations. *American Ocelot* is a glimpse into the lives of our most endangered cat and aims to invigorate ocelot recovery efforts to ensure the long-term survival of the species. It was produced by Fin & Fur Films with generous underwriting provided by the Caesar Kleberg Foundation for Wildlife Conservation, East Foundation, and Karen Hixon in memory of Tim Hixon.

Somewhere West of Wall Street

Television Series/RFD-TV

The CKWRI has joined friend, singer, songwriter, poet, author, and cowboy Red Steagall as a sponsor of his award-winning weekly television show, *Somewhere West of Wall Street*. The CKWRI has 30-second ads throughout the series promoting the Institute. *Somewhere West of Wall Street* focuses on Red's adventures as he travels exploring the American West's most historic ranches, landmarks, history, and trailblazers. Ranching, cattle, horses, and a love of the land are the stars of the show along with our friend, Red.

West of Texas

Television Series/Sportsman's Channel

The CKWRI is the Title Sponsor for *West of Texas*, a unique hunting show distributed on the Sportsman's Channel with an audience of 2.1 million. *West of Texas* (2020) consists of eight, 30-minute documentaries featuring the research being conducted by the CKWRI and why it is relevant to the future of wildlife and conservation. *West of Texas* aims to use hunting as a vector to tell the story of wildlife through the perspective of data-driven research, and those researchers who have dedicated their lives to further prevent the loss of wild habitat. Please visit our website (https://www.ckwri.tamuk.edu/) to learn more about the show.

PUBLICATIONS

Dallas Morning News

Two articles were featured in the Dallas Morning News during 2020 focusing on research conducted by the CKWRI. The first article titled "Why Migrating Birds Need Texas so Badly" centers on the topic of how critical the Texas coast is for migrating birds and highlighted the research of CKWRI's Bart Ballard and his team. The second article titled "The Texas Ocelot Population is Shrinking and Needs Our Help" brings attention to the ocelot research being conducted by CKWRI's Mike Tewes and his team along with promoting the recent film *American Ocelot*.

Texas Farm & Ranch

A quarterly publication of Texas Monthly, Texas Farm & Ranch has a circulation of 140,000 annually and in an ongoing effort to promote the CKWRI and increase awareness among landowners, features several articles surrounding CKWRI research topics throughout the year. This past year, the stories focused on "Estimating Deer Populations" and "Water, Cool Water" written by Charles DeYoung.

Connect **with us on Social Media**

CKWRI PERSONNEL

Scientists and Staff

Ms. 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
Dr. Michael J. Cherry, Assistant Professor
Mr. Seth M. Cook, Research Specialist I
Dr. Charles A. DeYoung, Research Scientist
Dr. Randy W. DeYoung, Professor
Ms. H. Jae Edlin, Research Technician
Mr. Anthony D. Falk, Assistant Director, Texas Native Seeds–South Texas
Dr. Alan M. Fedynich, Professor
Mrs. Sandra L. Fischer, Business Coordinator II
Dr. Aaron M. Foley, Research Assistant Professor
Ms. Carly Folsom, Research Associate
Ms. Bethany A. Friesenhahn, Research Specialist I
Dr. Timothy E. Fulbright, Research Scientist
Mrs. Venie A. Fulbright, Research Associate
Mr. Delmiro L. Garcia, Facilities Specialist II
Mr. Gustavo A. Garcia-Ortega, Research Associate
Dr. Lon I. Grassman, Jr., Research Scientist
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, Associate Professor
Mr. Aaron M. James, Research Associate
Mrs. Nancy T. Jennings, Business Coordinator III
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. Steven A. Llacuna, Administrative Associate V
Mr. Brian Loflin, Lecturer
Dr. Jason V. Lombardi, Research Assistant Professor
Mr. Samuel R. Lutfy, Assistant Director, Texas Native Seeds–Permian Basin
Mrs. Caroline McAllister, Director of Donor Relations
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, Associate Director, South Texas Natives and Texas Native Seeds
Dr. Humberto L. Perotto-Baldivieso, Assistant Professor
Mrs. Shyla E. Rabe, Administrative Coordinator I, Texas Natives Seeds
Mr. Matthew F. Rector, Research Associate
Mr. Ernesto J. Reyes, Research Technician II
Ms. Stephanie A. Reyes, Purchasing Specialist
Dr. Sandra Rideout-Hanzak, Professor
Mr. Marcus A. Rodriguez, Research Technician II
Mrs. Selinda A. Rojas, Purchasing Specialist
Mr. Thomas F. Rose, Purchasing Specialist
Mr. Colin S. Shackelford, Assistant Director, Texas Native Seeds–West Texas
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. Shauntel M. Stahlke, Research Associate
Mr. David J. Starzenski, Research Associate
Dr. Vijayan Sundararaj, Research Assistant Professor
Dr. Ashley Tanner, Research Assistant Professor
Dr. Evan P. Tanner, Assistant Professor
Dr. Michael E. Tewes, Professor
Mrs. Rebecca S. Trant, Director, CKWRI Administration
Ms. Elizabeth L. Walker, Business Coordinator II
Mr. Lucas J. Walls, Research Associate
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. Jose S. Avila-Sanchez
Ms. Chloe E. Bates
Ms. Emily R. Bishop
Ms. AnnMarie Blackburn
Ms. Matti R. Bradshaw
Mr. Aiden B. Branney
Ms. Shelby B. Carter
Mr. Rider C. Combs
Mr. Jose G. Cortez, Jr.
Mr. Daniel A. Crawford
Ms. Alexandria M. DiMaggio
Mr. Dillan J. Drabek
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Mr. Zachary J. Pearson
Ms. Tiffany L. Pope
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Mr. Ramon Saenz, III
Mr. Maksim Sergeyev
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Ms. Lisa D. Zoromski

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Gus T. Canales
Caracol Ranch
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Hawaii Department of Land and Natural Resources
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Mason D. King
Caesar Kleberg Foundation for Wildlife Conservation
Caesar Kleberg Partners Program
Caesar Kleberg Wildlife Research Institute’s Feline Research Program
Caesar Kleberg Wildlife Research Institute’s Invasive Species Program
Chris C. Kleberg
The Richard M. Kleberg, Jr. Center for Quail Research
The Richard M. Kleberg, Jr. Family
Robert J. Kleberg, Jr. and Helen C. Kleberg Foundation
Tio Kleberg
Knobloch Family Foundation
C. Berdon Lawrence
Tim Leach
A. E. Leonard Family Giving Council
The Ken Leonard Endowment
Ken Leonard Fund for Livestock Interactions Research
Kenneth E. Leonard
Steve and Shelly Lindley
Sam Long
Eduardo A. Lopez, USDA APHIS Cattle Fever Tick Eradication Program
Louisiana Department of Wildlife and Fisheries
Manatt Ranch
Travis and Bettina Mathis
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Analyses of Quail Hunting Variables in South Texas

Donal A. 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 is to analyze quail hunting variables in South Texas. The project is taking place on 15,030 acres of East Foundation property in Jim Hogg County. Harvest quotas are prescribed from November survey estimates, with hunts ongoing until harvest quotas are reached. Spatial hunting distributions are recorded using GPS units on trucks and hunting dogs, along with detailed hunting logs.

Fifty-nine hunts (167.6 hours) were conducted during the 2018–2019 hunting season and 74 hunts (258.8 hours) in 2019–2020. Hunting parties covered 65.2 acres per hour during the 2018–2019 hunting season and 62.8 acres per hour in 2019–2020. Hunters encountered 2.7 coveys per hour in 2018–2019 and 2.8 coveys per hour in 2019–2020. The number of bobwhites harvested per covey found was 0.83 in 2018–2019 and 0.90 in 2019–2020. Hunters retrieved a bobwhite for every 5.6 shots during the 2018–2019 season and a bobwhite for every 5.3 shots in 2019–2020. Our 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. (Charlie) Winn Endowed Chair for Quail Research.

California Quail Productivity and Weight from Baja California Norte, Mexico

Leonard A. Brennan, Jaime Navarro, and Donal A. Woodard

Quail population data such as percentage of juveniles in a population (an index of annual production based on the number of birds hatched during the previous nesting season) and body weights can be easily collected from hunter-harvested birds. In this study, we collected data on the percentage of juveniles and body weights of California quail from 21 pastures hunted during January 2020 in the San Vincente Valley and surrounding areas of Baja California Norte, Mexico. The hunters and hunting guides who collected the data from harvested California quail were associated with Club La Misión—a private hunting operation headquartered in the town of San Vicente.

When averaged across all 21 pastures, body weights of adult California quail were about 0.35 ounces greater than juveniles, about a 6.4% difference. This indicated growth of juveniles was about 94%+ complete. Male weights were greatest (average 6.2 ounces, range 5.9–6.6), followed by adult females (5.9 ounces, range 5.6–6.7), juvenile females (5.5 ounces, range 4.9–5.9) and juvenile males (5.5 ounces, range 5.3–6.3). The percentage of juveniles bagged per pasture (a measure of annual population productivity) ranged from a high of 78% (Alberto Rodriguez Pasture) to a low of about 25% (La Delfina Pasture) and averaged 46% over all pastures.

Overall, there was a wide range of variability with respect to the percentage of juveniles in the population at Baja Norte. Body weights of California quail did not vary widely and indicated that juveniles were only about a third of an ounce short of the average adult weight during the first January after being hatched. Future data will allow us to assess these metrics to make comparisons across both space (pastures) and time (hunting seasons).

Cooperative funding provided by Club La Misión, C. C. (Charlie) Winn Endowed Chair for Quail Research, and The Richard M. Kleberg, Jr. Center for Quail Research.

Testing Sustainable Harvest Prescriptions for Northern Bobwhites in South Texas

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

The current harvest rate recommendation for northern bobwhites in South Texas is a 20% harvest of the autumn population, which also includes crippled bobwhites. This harvest rate is based on models of demographic data; however, it requires empirical testing.

The goal of this project is to implement a 20% harvest and compare temporal trends between a hunted population and a non-hunted population. This study is taking place on East Foundation properties in Jim

Hogg County. We have designated a hunted area (15,030 acres) and a non-hunted area (10,813 acres). Bobwhite density estimates are obtained on both areas in November, mid-December, late-January, and March using line-transect distance sampling from a helicopter. Prescribed harvest quotas are calculated from November bobwhite abundance estimates.

The 20% harvest quota on the hunted area was 422 bobwhites for the 2018–2019 hunting season and 852 bobwhites for the 2019–2020 hunting season. The harvest quotas were reached after 59 hunts in 2018–2019 and after 74 hunts in 2019–2020. We found no statistical difference in spring density between our hunted and non-hunted sites. Spring densities in 2018–2019 were 0.15 quail per acre on the hunted area and 0.16 quail per acre on the non-hunted area. In 2019–2020, the spring densities were 0.16 quail per acre on the hunted area and 0.13 quail per acre on the non-hunted area. Our preliminary results indicate that harvest may be a sustainable element of quail management in South Texas.

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. (Charlie) Winn Endowed Chair for Quail Research.

Assessing Distance Sampling for Northern Bobwhite Density

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

The northern bobwhite is an iconic and economically important species, driving the management and financial decisions of many landowners and wildlife managers in South Texas. To guide effective management, accurate population estimates are required.

Beginning in 2008, winter helicopter distance sampling surveys for bobwhites have been conducted annually on the Santa Gertrudis and Norias divisions of the King Ranch. These surveys are used to develop quotas and other management objectives. To ensure consistency of surveys over space and time, it is imperative to assess the accuracy and potential sources of variation.

Surveys for bobwhites were flown with a Robinson R44 helicopter. Pilots were instructed to follow predesigned transects using a Garmin nüvi, and all survey data were collected using a handheld Trimble GPS unit and Trimble rangefinders.

Survey effort was assessed using the 2009–2019 surveys. Flight paths deviated from the transect line an average of 44.9 feet. During this period, 6,834 coveys were observed; mean covey size was 8.5 birds. Coveys were sighted 0 to 321 feet from the flight path with half of the observations occurring within 60 feet of the flight path. Woody cover around covey locations ranged from 0 to 95% and averaged 17.4% with the nearest woody cover averaging 44.6 feet.

How covey locations and detection rates impact the performance and accuracy of helicopter surveys is essential for the refinement of analysis and survey methods for bobwhite populations. Precise and reliable estimates are necessary for the effective management of this important wildlife resource.

Cooperative funding provided by King Ranch, Inc., South Texas Chapter of Quail Coalition, Hill Country Chapter of Quail Coalition, C. C. (Charlie) Winn Endowed Chair for Quail Research, and The Richard M. Kleberg, Jr. Center for Quail Research.

Evaluating Dog-based Estimates of Northern Bobwhite Density

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

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 incorporates GPS tracking systems, distance sampling theory, and pointing dogs—but requires further testing.

Our research conducted on bobwhites involves many aspects of the ecology and management of this gamebird.

We are currently comparing dog-based density estimates of northern bobwhites to those obtained from line-transect distance sampling via helicopter surveys. Our study is taking place on the East Foundation's Buena Vista Ranch (15,030 acres) in Jim Hogg County. Line-transect distance sampling surveys from a helicopter are completed annually. Quail hunts are conducted using pointing dogs, with all dog paths recorded via GPS. The area covered by dogs is calculated using empirical estimates of effective search width (43.3 feet) with all redundancy removed (i.e., repeated coverage).

Our data from 2018–2019 revealed that the redundancy of area covered by individual dogs was 23.7% and redundancy between dogs was 41.3%. The dog-based density estimate was 0.38 bobwhites per acre, and the density estimate from line-transect distance sampling was 0.23 bobwhites per acre.

In 2019–2020, the redundancy of area covered by individual dogs was 24.7% and redundancy between dogs was 42.6%. The dog-based density estimate was 0.37 bobwhites per acre, and the density estimate from line-transect distance sampling was 0.28 bobwhites per acre.

Preliminary results from our data suggest that dog-based density estimates are consistently higher than helicopter-based estimates despite statistical similarities. If the dog-based density estimate method is shown to be reliable, existing hunting programs can acquire density estimates with no additional costs or effort in the field.

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. (Charlie) Winn Endowed Chair for Quail Research.

California Quail Hunting Metrics from Baja California Norte, Mexico

Leonard A. Brennan, Jaime Navarro, and Donal A. Woodard

Quail hunting is a complex activity that involves people, dogs, and guns. There have been only a few attempts to quantify the aspects of quail hunting such as hunter success in relation to the amount of time spent hunting.

We collected California quail hunting data (number of coveys flushed per pasture and number of coveys flushed per hour of hunting effort) from 21 pastures hunted during January 2020 in the San Vincente Valley and surrounding areas of Baja California Norte. The quail hunters and hunting guides who collected these data were associated with Club La Misión, which is a private hunting operation headquartered in the town of San Vicente.

Hunters pursuing California quail near the San Vicente Valley, Baja California Norte, Mexico. California quail are found in fallow crop fields (foreground) and native brush and rangeland vegetation (background).

On average, 3.4 coveys (range 1–5) were flushed per pasture hunted. Time hunted per pasture averaged 5.2 hours (range 2.0–7.5). The number of coveys flushed per hour hunted in each pasture ranged from a high of 1.7 coveys per hour (Batiz Isla Pasture) to a low of 0.3 coveys per hour (Three Marias Pasture) with an average of 0.7 coveys flushed per hour of hunting per pasture.

The number of California quail bagged per hour of hunting ranged from a high of 6.0 per hour (Aqualito Pasture) to a low of 1.8 per hour (Augua Larga Pasture) with an average of 2.6 quail bagged per hour hunted per pasture. Overall, there was a wide range of variability with respect to coveys flushed and resultant hunting success.

This is the first-ever study of its kind to assess California quail hunting metrics. Future data collection will allow us to assess these metrics and make comparisons across both space (pastures) and time (hunting seasons).

Cooperative funding provided by Club La Misión, C. C. (Charlie) Winn Endowed Chair for Quail Research, and The Richard M. Kleberg, Jr. Center for Quail Research.

Brush and Bobwhite Densities in Areas Selected by Quail Hunters

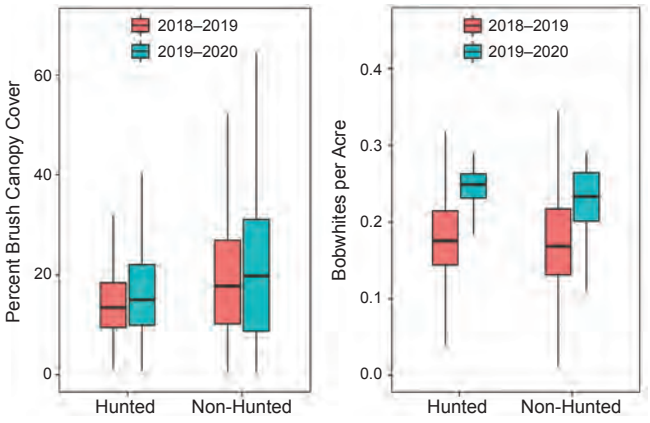
Donal A. Woodard, Leonard A. Brennan, Fidel Hernández, Humberto L. Perotto-Baldivieso, and Neal Wilkins

Quail hunters use a combination of experience, knowledge, and intuition when deciding on areas to hunt or to avoid. In South Texas, many landowners and biologists believe that hunters are selecting these areas based on quail and brush densities.

The objective of this study is to analyze bobwhite density and brush canopy coverage of the areas selected by quail hunters in South Texas. This study is taking place on 15,030 non-baited acres in Jim Hogg County owned by the East Foundation. The study area was segmented into 6,076 subunits, 2.5 acres in size. Bobwhite density per subunit was estimated using density surface models from data acquired during line-transect distance sampling via helicopter. Percent brush canopy cover was estimated from two-foot resolution images from the National Agriculture Imagery Program (NAIP). Hunting distributions were recorded using GPS units placed on trucks and hunting dogs.

Hunting activity took place on 42% of the study area in 2018–2019 and 57% of the study area in 2019–2020. Mean bobwhite density of the subunits exposed to hunting was 0.18 bobwhites per acre in 2018–2019 and 0.24 bobwhites per acre in 2019–2020. The mean brush canopy cover of the subunits exposed to hunting was 14.7% in 2018–2019 and 17.5% in 2019–2020.

The probability that an area was hunted decreased with increasing brush canopy coverage during both the 2018–2019 and 2019–2020 hunting seasons, but was not influenced by local bobwhite densities. Our findings can help landowners and wildlife managers evaluate habitat management practices to optimize the number of huntable acres available for bobwhites in South Texas landscapes.



Percent brush canopy cover and northern bobwhite density on hunted and non-hunted areas during the 2018–2019 and 2019–2020 hunting seasons on the East Foundation's Buena Vista Ranch in Jim Hogg County, Texas.

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. (Charlie) Winn Endowed Chair for Quail Research.

Bobwhite Response to Cattle Grazing on the Sweden Ranch

Bradley K. Johnston, J. Alfonso Ortega-Santos, Leonard A. Brennan, Humberto L. Perotto-Baldivieso, and Fidel Hernández

Range management practices to improve habitat for wildlife by reducing brush and increasing herbaceous plants, coupled with reduced stocking rates, can lead to dense stands of dominant grasses such as four-flower trichloris. A monoculture of four-flower trichloris creates dense and unsuitable conditions for northern bobwhite habitat, as well as reduces plant species richness.

The objectives of this study are to evaluate the use of proper cattle grazing to improve bobwhite habitat as well as develop a management guide that documents how to use cattle in such a way. Cattle grazing can be used as a tool to reduce the density and cover of dominant grasses, thereby allowing other plants to grow. The study area has two pastures totaling 6,000 acres in Duval County, Texas. One pasture will serve as the control while the other will be grazed, as needed, to maintain a stubble height of 12 to 16 inches (optimal for bobwhite habitat).

We placed 10 grazing exclosures within each pasture with an 82-foot transect running off each. Double sampling is completed monthly to determine forage standing crop, and percent cover is recorded along each transect. Forage standing crop, plant species richness, total plant cover, and forage use will be calculated. Additionally, bobwhites will be trapped and fitted with radio transmitters to track their movements and determine nest site selections, breeding season survival, and nesting success. This study has the potential to shed light on how bobwhites respond to an optimal cattle grazing program for managing their habitat in South Texas.

Cooperative funding provided by the Sweden Ranch.

Assessing the Conservation Status of the Endangered Ocelot

Michael E. Tewes

An updated assessment of the ocelot population in the Tamaulipan Biotic Province is being developed because of the ocelot's increasing vulnerability in the United States. The assessment revealed eight to 14 ocelots occur in the Refuge Population of eastern Cameron County. Conversely, over 35 ocelots occur in the Ranch Population of Willacy and Kenedy counties. Due to the conservative estimate, it is likely that the Ranch Population has more than 50 ocelots.

In this assessment, four broad areas of alleged ocelot recovery over the past quarter century were identified as failures in providing a "meaningful benefit" for ocelot recovery. These were (1) land acquisition to create movement corridors between populations, (2) construction of road crossing structures to reduce mortality, (3) habitat restoration to expand the population, and (4) translocations to create new populations.

Additional issues are being explored to broaden the evaluation of ocelot population vulnerability in southern Texas and northeastern Mexico. New approaches for developing effective strategies for ocelot recovery will emerge from the evaluation. This effort will bring attention to the plight of the ocelot with ecologically-sound actions that will produce meaningful ocelot recovery.

Cooperative funding provided by the East Foundation and the Tim and Karen Hixon Foundation.

Determining Ocelot and Bobcat Home Ranges in South Texas

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

Many species exhibit fidelity to certain portions of the landscape, confining their movements to an area typically referred to as a home range. Within this home range, an animal will generally be familiar with locations of landscape features such as water sources or patches of cover, the presence of competitors, and the availability of prey. Understanding the location and characteristics of an animal's home range is vital to proper management. However, the amount of monitoring time necessary to accurately estimate an animal's home range is uncertain.

Our objective is to determine the proportion of the total home range that can be estimated from four, seven, and 30 days of data compared to a full monitoring period (four months). Between 2014 and 2019, we captured and radio-collared 11 ocelots and 16 bobcats on the El Sauz Ranch in South Texas. Locations of the animals were recorded every 30 minutes. Using GPS data, we plotted the home range of each animal based on all locations obtained over four months. We then compared home range size to estimates obtained from four, seven, and 30 days. Results suggest that bobcats typically moved through about 80% of their home range within about 20 days, whereas ocelots took longer.

We will expand the sample size of the number of ocelots to develop more robust conclusions. Understanding how a species moves throughout its range can be used to establish sampling schedules to minimize redundancy and extend sampling periods.

Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute and the East Foundation.

Effects of Habitat Restoration on Bobcat Spatial Ecology

Zachary M. Wardle and Michael E. Tewes

Rangeland conversion, agriculture, and human development have resulted in widespread habitat loss and degradation. Historical increases in human-caused landscape change have resulted in the loss of 95% of native vegetation in the Lower Rio Grande Valley of South Texas. The region is predicted to experience continued rapid development. However, natural revegetation and habitat restoration on rangelands in the region are contributing to increases in small patches of woody cover that may provide benefits to wildlife.

Little is known about the effects of native rangeland restoration on the space use and habitat selection of the bobcat. Bobcats are a widely distributed habitat generalist occupying a broad range of habitat types and can be used to monitor overall changes in habitat conditions. We will monitor GPS-collared bobcats and conduct surveys using motion-activated cameras to study the spatial patterns and habitat use of bobcats at a ranch that has been conducting habitat restoration over the past 10 years. We will evaluate differences in bobcat resource selection and movement in restored versus natural habitat types.

This study will aid in our understanding of how habitat restoration affects bobcat spatial ecology in South Texas. Our findings can be used to provide guidelines for ranch operators intending to restore native habitat that benefits bobcats and other wildlife.

Cooperative funding provided by the Texas Department of Transportation.

Long-term Study of Ocelot Spatial Patterns in Two Different Landscapes

Michael E. Tewes, Jason V. Lombardi, John P. Leonard, Arturo Caso, and Tyler A. Campbell

We have compiled extensive ocelot locations to build a powerful dataset collected over a span of 28 years in South Texas. No other study of the 33 species of small cats has provided nearly the large sample sizes (over 80 ocelots) and quantity of information as our study. We have applied sophisticated analytical methods and modeling to provide an unprecedented glimpse into the ocelot's world of travel.

Our findings indicate ocelot home ranges in the Refuge Population at Laguna Atascosa Refuge occur on small habitat tracts often separated by extensive coastal prairies, wetlands, and mud flats. In contract, ocelots using the East Foundation's El Sauz Ranch occupy extensive habitat connected by healthy rangelands between ocelot groups. These ocelots showed compatibility with cattle ranching operations.

We also found home ranges of male ocelots are significantly larger than home ranges of female ocelots. This difference reflected the two fundamentally distinct reproductive strategies pursued by each sex. Male ocelots typically overlap one, two, or three female home ranges to monitor when the females become reproductively receptive. This requires much movement and energy by a male. In contrast, female ocelots conserve their energy for successful rearing of one to two kittens by using a smaller home range. The mother is more concerned about protecting enough area from other females to have sufficient resources such as prey and denning cover to successfully raise her young.

Our analyses have provided a valuable scientific understanding of ocelot spatial ecology. This information is critical for managing the long-term persistence of ocelots in South Texas.

Cooperative funding provided by the East Foundation and the Tim and Karen Hixon Foundation.

Moon Phase, Habitat Selection, and the Movements of Ocelots and Bobcats

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

For nocturnal animals, visibility is greatly influenced by the moon phases, which may influence activity and habitat selection. However, the effects of varying moon phases may differ across taxonomic groups. Prey species often reduce activity during highly visible nights, whereas predators may increase activity or alter their habitat use. Ocelots and bobcats, two nocturnal predators, may also alter their behavior in response to the phase of the moon. We predict that ocelots would increase use of dense thornshrub to reduce visibility during a full moon. However, as bobcats are habitat generalists, we predict less influence of moon phase on their activity.

To examine the effect of moon phases on movement and habitat selection preferences, we collected GPS data on eight ocelots and six bobcats on the El Sauz Ranch from May 2013 to May 2017. We used models to examine differences in daily movements. To evaluate habitat selection, we performed resource selection analyses to compare land use during periods of high luminosity (±3 days of a full moon) to land use during low periods of luminosity (±3 days of a new moon).

Preliminary results suggest that movements were highest during full moons for both species. Additionally, use of canopy cover was greatest during waxing/waning moons for both species. To develop stronger conclusions, we will need to increase the number of ocelots and bobcats in this study.

The highly nocturnal ocelot appears to increase movements and use of vegetative cover during full moon nights than during darker evenings.

Understanding habitat use patterns is critical for the conservation of ocelots. This study will add to the information on ocelot spatial ecology related to the moon cycle.

Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute and the East Foundation.

Analysis of Ocelot Crossing Structures and Ocelot-Vehicle Collision Sites

AnnMarie Blackburn, C. Jane Anderson, Amanda M. Veals, Michael E. Tewes, David B. Wester, Randy W. DeYoung, John H. Young, Jr., and Humberto L. Perotto-Baldivieso

Wildlife-vehicle collisions can have a substantial influence on some wildlife populations, particularly those species that are imperiled. Ocelot crossing structures (OCS) are designed to reduce the impact of roadway-related deaths by allowing safe passage of wildlife above or below roads.

The ocelot is a federally-listed endangered felid with fewer than 80 individuals occurring in two isolated populations in South Texas. Ocelot-vehicle collisions are considered the greatest known source of mortality for ocelots in the region. Consequently, crossing structures designed for ocelots have been placed throughout South Texas since the 1990s; however, the effectiveness of OCS is unknown.

In this study, we are analyzing landscape characteristics surrounding OCS and comparing those features to patterns observed at nearby ocelot-vehicle collision sites. Specifically, we are quantifying the distribution of woody cover and herbaceous cover surrounding 56 OCS and 26 ocelot-vehicle collision sites at multiple spatial scales and comparing the landscape features between these locations.

Findings from examining the preliminary data suggest that ocelot-vehicle collision sites and OCS sites have similar amounts of woody cover surrounding them, but ocelot-vehicle collision sites have more aggregated woody patches than found at OCS sites 490–820 yards from the road. The OCS locations had 17 to 22% more herbaceous cover than found 1,150 yards from the road, and 3- to 14-acre larger herbaceous patches than 490 yards from the road compared to the ocelot-vehicle collision sites.

Results from this study can help Texas Department of Transportation roadway planners and wildlife conservation personnel understand why ocelots may not be using OCS as designed. Our findings can also be used to place future OCS in locations more likely to be used by ocelots.

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One of several wildlife crossing structures that were built by the Texas Department of Transportation to help ocelots cross underneath State Highway 100 in South Texas.

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

Ocelot Landscape Ecology and Conservation Related to Roadways

Michael E. Tewes, Amanda M. Veals, Jason V. Lombardi, Zachary M. Wardle, Thomas J. Yamashita, and John H. Young, Jr.

We are conducting ocelot studies linked to various aspects of roadways. These studies are generously supported by the Texas Department of Transportation. Our research is providing important data needed to support efforts to reduce ocelot mortality on roads. We will use information on ocelot mortalities that allows us to focus on predicting future road-kill zones and aid in identifying ocelot source populations and dispersion of habitat near roadways. By doing so, we will be able to identify areas that represent a high mortality risk for dispersing ocelots. A plan will be recommended to rescue these individuals before mortality occurs, where ocelots can be moved into a captive breeding program or translocating them to another population.

Cooperative funding provided by the Texas Department of Transportation.

Fine-Scale Assessment of Felid Highway Crossings, Cattle Guards, and Fencing

Jason V. Lombardi, Zachary M. Wardle, Michael E. Tewes, Eve M. Schrader, John E. Herschberger, and John H. Young, Jr.

Rapid human population growth and expansion of infrastructure are threatening mammal populations. The Lower Rio Grande Valley of Texas is among the fastest urbanizing areas in the state, with the human population quadrupling over the last 35 years. As areas in the Lower Rio Grande Valley grow so does the traffic volume of vehicles on ever-expanding primary and secondary roadways.

The use of wildlife crossing structures can be effective in reducing roadway-related wildlife mortalities. As an additional improvement, fencing in combination with wildlife crossing structures is believed to be an effective strategy. However, this has yet to be demonstrated for felids occurring in Texas.

The ocelot is a federally-listed endangered felid in the United States. In South Texas where it occurs, it is particularly imperiled by road-related deaths caused by collisions with vehicles, in addition to negative impacts caused by habitat loss. The isolated Refuge Population in and around Laguna Atascosa National Wildlife Refuge supports about eight to 14 ocelots.

In this study, we are assessing landscape permeability and road-related mortality of dispersing ocelots and bobcats. Motion-activated cameras will be used to monitor five future wildlife-crossing sites on FM 1847 in Cameron County to determine the potential effectiveness of placing these crossing structures, along with cattle guards and fencing. Additionally, we will conduct a fine-scale land cover classification and determine the habitat characteristics of areas used by felids.

© Ben Masters

A motion-activated camera is being set up by research assistant professor Dr. Jason Lombardi to monitor endangered ocelots in Cameron County, Texas.

Findings will enable biologists and Texas Department of Transportation personnel to gain a better understanding of crossing structure usage and the surrounding habitat characteristics. These results can be used to aid landscape conservation efforts for ocelots in the region.

Cooperative funding provided by the Texas Department of Transportation: Environmental Affairs.

Bobcat Movements and Activity Patterns on Livestock Ranches

Zachary M. Wardle, Michael E. Tewes, and John H. Young, Jr.

Understanding the spatial patterns of wildlife populations is essential for those making conservation and land management decisions. Bobcats are habitat generalists and their spatial ecology varies considerably across their range. As a result, they are the most abundant wild felid in the United States having a distribution spanning multiple ecosystems.

We will attach GPS collars with accelerometer sensors on bobcats that are live-trapped on livestock ranches in Willacy County, Texas. The information obtained will be used to evaluate movement and activity patterns. Specifically, we will assess spatial patterns by age, sex, season, time of day, and habitat type. In addition, by combining accelerometer and spatial data, we will be able to examine foraging, reproductive, and territorial behaviors.

By incorporating behavioral and resource selection information, we will have a better understanding of the importance of specific areas within home ranges of bobcats. Our research will provide a deeper understanding of how bobcats use landscape features and habitat types.

Cooperative funding provided by the Texas Department of Transportation: Environmental Affairs.

Wild Felid Health and Disease Assessment on El Sauz Ranch

Ashley M. Reeves, Debra L. Miller, Clayton R. Hilton, Michael E. Tewes, Jason V. Lombardi, and Tyler A. Campbell

Feral cat colonies that have shown increased susceptibility to viral, bacterial, parasitic, and tick-borne pathogens may have negative effects on nondomestic

© Kelsey Carrie

Feline leukemia virus/feline immunodeficiency virus antibody test kits are being used to survey wild felids.

felids that inhabit nearby wildlands. This information, when coupled with evidence of several inbreeding cases within the ocelot population, suggests that the impact on population fitness can be harmful. This is particularly concerning for threatened and endangered species.

Port Mansfield, Texas, contains a large feral cat population that has seen indications of pathogen exposure in recent years. The El Sauz Ranch and surrounding ranches, home to 80% of the known ocelots in the United States, are adjacent to the town of Port Mansfield. Although ocelots do not disperse within seven to eight miles of the town due to lack of preferred habitat, risk of transmission between feral cats and bobcats (a sympatric species with ocelots) remains. An outbreak within this small ocelot population could negatively impact its long-term survival.

To assess the prevalence and potential exposure of diseases in ocelot and bobcat populations, we will test blood collected from both species spanning 1985–2020. Testing will include general health monitoring profiles and common feline viral, tick-borne, parasitic, and bacterial pathogens.

This study will provide wildlife managers with a better understanding of the population's general health and possible risk factors of feral cats to bobcat and ocelot populations. Findings should help in the planning of strategies to aid in reducing or preventing transmission of infectious disease agents among wild and feral cat populations.

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

Ocelot Population Density and Occupancy in the Sierra Tamaulipas

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

Wildlife translocation is a tool used by biologists to reintroduce species to restore populations in former ranges or boost genetic diversity. Ocelots in the Sierra Tamaulipas National Protected Area (STNPA) in northeastern Mexico are genetically similar to those in Texas. This ocelot population has been identified as a source population to genetically enhance ocelots in Texas.

We conducted field research from May–December 2009 on Rancho Caracol and Camotal in Tamaulipas, Mexico to examine how ocelots use woody cover types. We will also estimate population density and size using the latest spatial mark-recapture techniques. If a large enough population is identified, this may be a source for future ocelot translocations into the United States.

Using the seven months of field data collected we documented a potentially robust local population. Ocelots in the northern part of the ranch occurred in large patches of tropical sub-deciduous forest with about eight ocelots per 25,000 acres. Region-wide, the STNPA has potentially 571 ocelots with 397 potentially occurring in the tropical sub-deciduous forests and over 176 in Tamaulipan thornshrub.

Our data show that ocelot occurrence is greatest in areas where the tropical deciduous forest is interspersed with thornshrub. Given the potentially robust size of the population there should be enough ocelots to be translocated from Mexico to the United States to genetically rescue the Texas populations.

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 Spatial Ecology and Wildlife Highway Crossings

Zachary M. Wardle, Jason V. Lombardi, Michael E. Tewes, and John H. Young, Jr.

Roadways are a common landscape feature that can negatively impact wildlife populations through increased mortality from vehicle collisions, habitat loss, and fragmentation. Wide-ranging species with low population densities and reproductive rates are particularly

susceptible to highway impacts. Expanding human development and increasing road-traffic volumes in South Texas have the potential to intensify road effects on bobcat movements, mortality, and habitat selection.

We will attach GPS collars on bobcats and use motion-activated camera surveys on a ranch in Willacy County to study bobcat spatial ecology in relation to U.S. Highway 77. This is a four-lane highway undergoing major upgrades in South Texas. We will also assess bobcat use of three wildlife crossing structures being built along U.S. 77 to reduce wildlife-vehicle collisions. Large- and fine-scale spatial patterns will be analyzed to learn how bobcats structure their movements and interact with the highway, wildlife crossing structures, and other roadways. We will also evaluate bobcat use of habitat patch, corridor, and landscape elements on rangelands surrounding U.S. 77.

This research will lead to a better understanding of the degree to which highways impact bobcat movements. Additionally, how bobcats use the habitat near a major transportation corridor will add to existing information on the ecology of this species.

Cooperative funding provided by the Texas Department of Transportation: Environmental Affairs.

Spatial Ecology of Ocelots in the Rio Grande Valley

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

Various factors can influence animal habitat use including diet, size of the animal, predator-prey relationships, resource quality, territoriality, competition, and mating systems. Habitat use and movements may also differ between sexes. Males often have larger areas, disperse greater distances, and on average, move further than females. Overlap between neighboring males is generally low, whereas a single male may overlap its home range with several nearby females. This suggests that differences between sexes, among other factors, may greatly impact spatial patterns. Furthermore, animals may differ in how they move throughout the landscape, and these movements may vary throughout the day or season.

Our objective is to describe the spatial patterns of ocelots. We captured ocelots on the El Sauz Ranch and fitted each individual with a high-frequency GPS collar to monitor their locations. We will determine differences in movement rates between sexes, time of day, and seasons, and we will use specialized methods to quantify the spatial patterns of ocelots.

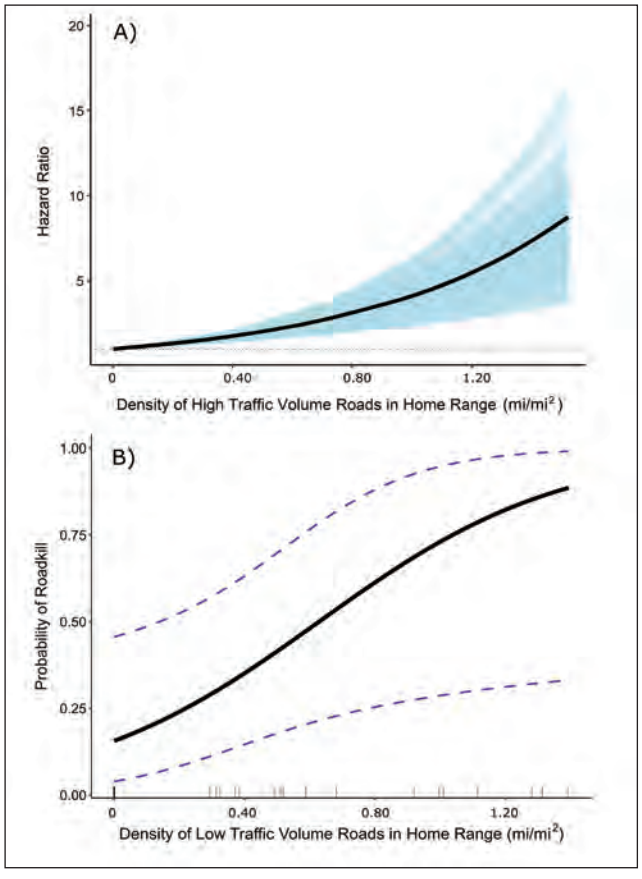
Quantifying overlap between individuals provides an understanding of how ocelots are partitioning the landscape and can provide insight into mating dynamics. Further, a fine-scale understanding of how ocelots are using the landscape can improve conservation strategies for this species.

Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute and the East Foundation.

Consequences of Road Density and Activity on Ocelots

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

Encroaching urban development is a leading cause of ocelot habitat loss, exceeding the rate for natural areas with road networks. Roadways can influence



The effect of increasing road density within ocelot home ranges on (A) the hazard ratio (increasing danger or chance of vehicular impact), and (B) probability of an ocelot being killed on the road.

the spatial ecology and survival of mammalian carnivores, particularly felids. These impacts may threaten the long-term persistence of certain populations.

Our objective is to evaluate the influence of roads on ocelot survival using a long-term telemetry dataset (1982–2001). We hypothesized that road density will negatively influence ocelot survival, particularly transient and dispersing ocelots. We also hypothesized that roads where ocelots are killed will have a higher roadway density in those ocelot's home ranges than those with home ranges located further from roads.

Vehicle collisions accounted for 40% of known ocelot fatalities during the 20-year study. Annual survival rates were 90% for residents and 66% for transients. We evaluated the influence of biological and road-related variables on ocelot survival. Risk of mortality decreased 45% with every increase of 1,300 yards of unpaved roads per 250 acres, likely due to surrounding quality habitat. Mortality risk increased 16% with every increase of 75 yards of high traffic volume roads per 250 acres. Additionally, risk of mortality decreased significantly for resident ocelots. The probability of mortality caused by vehicle collisions increased with greater density of low traffic volume paved roads within an ocelot's home range.

Understanding how roads influence the survival of ocelots can aid in conservation planning and mortality mitigation. Additionally, these data can help guide transportation planners on a landscape scale that will aid ocelots occurring in the region.

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

Large Carnivore Activity and Time Partitioning in Mexico

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

The Sierra Tamaulipas Mountains National Protected Area is a 94,600-acre area located in central Tamaulipas, Mexico. The region has a diverse wild cat community. However, the activity patterns of these felids are not well understood.

From February 2009 to April 2010, we conducted surveys using motion-activated cameras to determine the activity patterns of margay, jaguarundi, bobcat, ocelot, puma, and jaguar on Rancho Caracol and Camotal in the northern Sierra Tamaulipas, Mexico.

Mountain lions have been detected in thornshrub habitat on Rancho Caracol in the Sierra Tamaulipas, Mexico.

We are using new analytical methods to assess the activity patterns and time partitioning within this wild cat community.

This study provides a unique opportunity to examine a diverse felid community within a limited area. Our findings can be used to help researchers gain a better understanding of the factors that influence interactions 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.

Ecology and Behavior of Bobcats at Natal Dens in South Texas

Michael E. Tewes, Zachary M. Wardle, Aidan B. Branney, Tate H. Scott, and Jason V. Lombardi

We are starting a project to examine bobcat den ecology in South Texas. It is difficult to get sufficient sample sizes because den sites are hard to locate. The primary birth period for bobcats in Texas is March and April, although young may be found most months of the year.

During January–March 2021, bobcats will be captured in box traps baited with pigeons in a separate protected compartment, and an ultrasound for fetuses will be performed on sedated females. We will attach GPS collars to pregnant females to collect high intensity, fine resolution spatial data about movements and use patterns of natal dens. These data will reveal spatial patterns before and during the establishment of natal dens.

In addition, we will deploy several motion-activated cameras around den sites to determine litter size and survival of young during the early months following birth. These cameras will also record mother-offspring interactions and behavior. This information is extremely difficult to collect, and we expect it will take several years to develop accurate assessments of patterns observed in this study.

Cooperative funding provided by the Tim and Karen Hixon Foundation.

Evaluation of Ocelot Home Range Using LiDAR

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

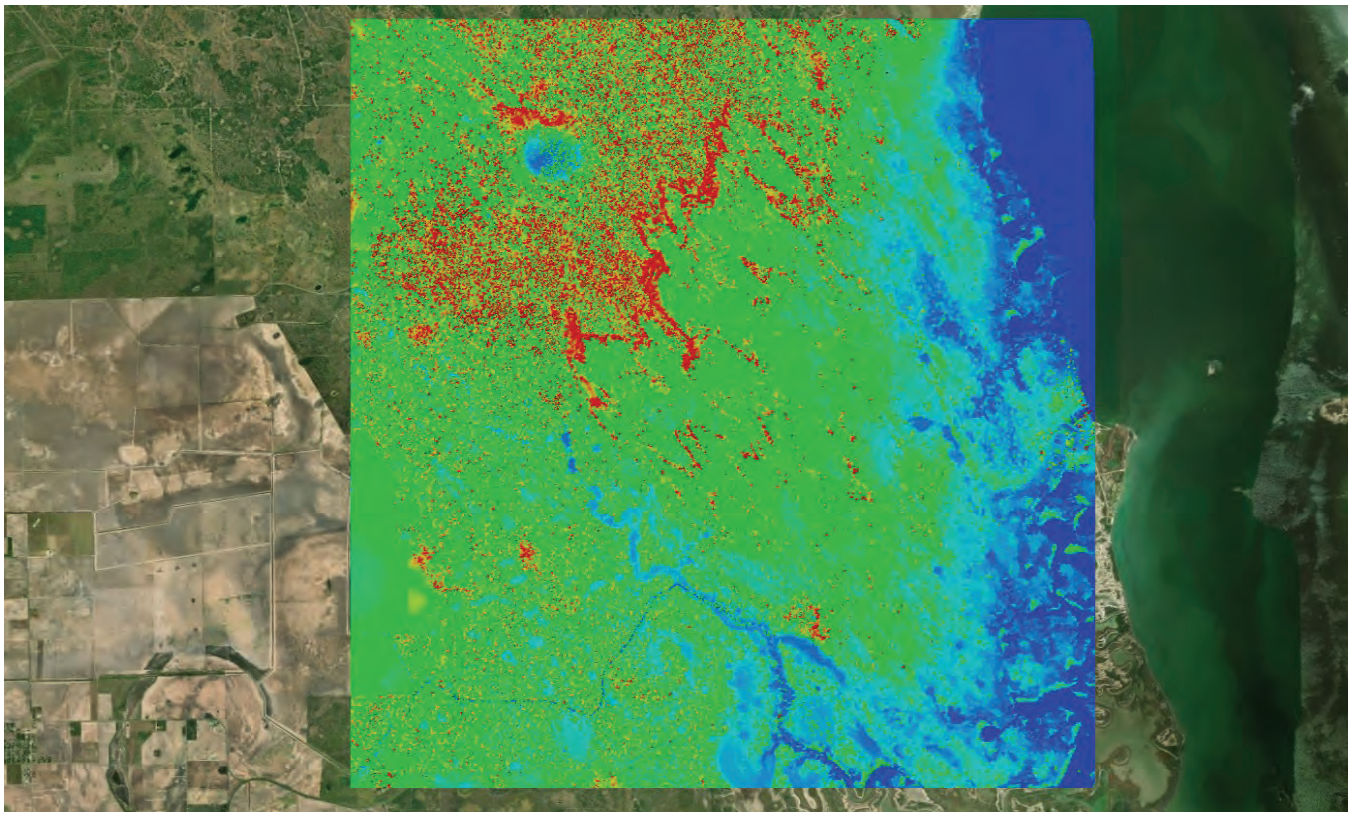
Habitat use by wildlife is influenced by a many factors, including environmental conditions, predator-prey dynamics, and landscape conditions. Wildlife species often use specific areas on the landscape and may depend heavily on certain features. One such species is the ocelot, a medium-sized feline that is closely linked to dense thornshrub vegetation. The availability of this habitat on the landscape is vital to sustaining ocelots.

The last remaining breeding population of ocelots in the United States resides in South Texas. The availability of dense thornshrub vegetation has declined due to urbanization and agriculture, making management of remaining habitat patches critical to the survival of ocelots. Our study is using light detection and ranging (LiDAR) technology to map the landscape and identify habitat features.

We captured ocelots on the El Sauz Ranch and fitted each individual with a GPS collar to determine their home ranges and will use LiDAR data to analyze the cover characteristics within the area. Specifically, we will quantify the density and distribution of dense thornshrub vegetation to determine how ocelots actually use this habitat. Further, we will characterize specific features on the landscape such as den sites for pregnant females and areas used for thermal refuge.

By better understanding the habitat requirements of ocelots, conservation efforts can be focused to preserve existing habitat and restore suitable areas for future recolonization. Our findings can be used to benefit conservation efforts for the species.

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.



Light detection and ranging (LiDAR) imagery of the East Foundation's El Sauz Ranch and surrounding area in South Texas, colored by elevation gradient (low to high elevation: blue, green, yellow, red).

HotSpotter: A Machine Learning Approach to Identify Ocelots and Bobcats

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

Motion-activated cameras have been used with success to detect elusive species. This has allowed researchers to gain a better understanding of population dynamics of various species. Classification and identification of species detected by camera are critical for further analyses, but techniques to do so are limited. Machine learning algorithms, such as HotSpotter, have recently been developed to automatically identify individual spotted cats.

This study is assessing the feasibility of using Hotspotter to identify ocelots and bobcats occurring in South Texas. We conducted surveys using motion-activated cameras on the East Foundation's El Sauz Ranch (28,000 acres) in Willacy and Kenedy counties, Texas. We conducted the surveys at camera stations in the southwestern (13 camera stations) and northwestern (15 camera stations) areas of El Sauz from January 2018 to December 2019.

As this project progresses, it is anticipated that the database will increase to several thousand photographs. Thus, Hotspotter may be able to reduce the time needed to process hundreds of photographs and may yield more precise and reliable identifications. In addition, findings from this study may allow researchers to gain a better understanding of the demographics and population sizes of elusive felids across large geographic areas.

Positive identification of the same bobcat using pattern-recognition HotSpotter software on different photos taken by motion-activated cameras placed on the East Foundation's El Sauz Ranch in South Texas.

Cooperative funding provided by the East Foundation.

Ocelot Survey and Evaluation of Woody Cover Types

Jason V. Lombardi, Michael E. Tewes, Maksim Sergeyev, Tate H. Scott, and Zachary M. Wardle

Distribution of ocelots in Texas is difficult to define due to landowner concerns of having endangered species on their properties. Currently, it is believed that ocelots in the Lower Rio Grande Valley of Texas (LRGVT) are found in two isolated populations in Kenedy and Willacy counties.

Because of habitat loss and road-related mortality in the LRGVT, ocelots have suffered declines in genetic diversity. Therefore, it is necessary to identify new areas where ocelots may be occurring or are likely to occur to better formulate recovery strategies. We have been surveying rangelands in Hidalgo, Willacy, and Cameron counties to assess potential ocelot habitats. We are also assessing and evaluating the woody cover found on these locations using satellite imagery to determine the quality and quantity of preferred cover types.

This study will provide researchers with stronger insights about potential areas where ocelots may occur or have the potential to occur in the future. Subsequently, this information should be helpful for future conservation efforts.

Cooperative funding provided by the Raul Tijerina, Jr. Foundation.

Circuit Theory Estimation of Road Crossings for Ocelots

Amanda M. Veals, Joseph D. Holbrook, Humberto L. Perotto-Baldivieso, AnnMarie Blackburn, Michael E. Tewes, and John H. Young, Jr.

Long-term survival of wildlife populations relies on ecosystems and landscapes that allow movement. Mitigation measures such as wildlife crossing structures can help restore movements of ocelots through road networks across the landscape. Circuit theory is

a tool to test for landscape connectivity, including how landscape features promote or impede the movements of animals. This project will evaluate models of landscape permeability for the endangered ocelot as a function of roads and habitat.

In South Texas, ocelots occupy dense woody vegetation surrounded by a matrix of agricultural lands and roadways. To model ocelot landscape connectivity, we will use a resource selection model of ocelot habitat. Habitat patches identified from the resource selection model, ocelot life history features, and dispersal capabilities will be used in our circuit theory-based models.

We predict the model with the highest resistance to animal movement will have the greatest traffic volume and road density, indicative of a highly fragmented landscape. We will build several circuit theory-based models from the resource selection model and build landscape resistance scenarios. Each habitat connectivity map will represent a degree of sensitivity to movement within the habitat, as well as road density and traffic volume. Additionally, we will assess these connectivity models based on current and projected land use scenarios for the years 2050 and 2100.

The goal of this research is to identify locations for potential road crossing structures based on available habitat to reduce ocelot-vehicle collisions. This information should be useful for transportation planners for managing existing roads and planned roadway development that will aid ocelots in South Texas.

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

Wild Cat Use of Highway 77 Wildlife Crossing Structures

Jason V. Lombardi, Zachary M. Wardle, Michael E. Tewes, and John H. Young, Jr.

State Highway 77 in South Texas is a major transportation corridor expanding in traffic volume and structure as it transitions into Interstate Highway 69. This highway represents a major transportation corridor linking Mexico to Canada. Unfortunately, it passes through rangelands that hold 80% of the known breeding population of ocelots in the United States.

At least five known road-related ocelot deaths have been reported along Highway 77 and several other ocelots have likely perished over the past few years.

Wildlife crossing structure under construction on U.S. 77 near the Yturria Ranch in Willacy County, Texas.

In response to these mortalities, wildlife crossing structures are being built or have been approved for construction by the Texas Department of Transportation. These crossing structures will likely facilitate the movement of ocelots and bobcats across the highway.

We will be using motion-activated cameras to document the presence of felids using crossing structures—information that will help us better understand felid behavior and the effectiveness of the crossings. Additionally, future research using GPS collars on felids may be used to obtain fine-scale movements relative to these crossings and the surrounding areas.

Information obtained will be valuable in guiding the placement of wildlife crossing structures. Because road-related mortality is the primary cause of ocelot deaths and these crossing structures may prove beneficial, findings from our study will be helpful in directing ocelot conservation.

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

Use of Irrigation Canal Bridges by Bobcats and Ocelots

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

Irrigation canals serve an important role in the distribution of water resources on cattle-managed rangelands and croplands in South Texas. However, because of

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Bobcats occur throughout Texas and share habitat with the endangered ocelot in parts of South Texas.

the linear nature of these canals, they likely restrict movement and space use of wildlife such as ocelots and bobcats. Often, single-lane concrete bridges are built in important areas of rangelands to facilitate cattle pasture rotation and vehicle accessibility. Further, these bridges likely serve as wildlife movement corridors or latrine sites for wild animals to mark territorial boundaries.

In summer 2020, we began using motion-activated cameras on the East Foundation's El Sauz Ranch in Willacy County to determine the frequency and use of two irrigation canal bridges by ocelots and bobcats. We will assess whether ocelots and bobcats use these bridges as corridors or as latrine sites for territorial marking and establishing reproductive rights.

Our findings will allow biologists to clarify the importance of these human-constructed structures for felids on South Texas rangelands. Further, this information should aid ranch managers in assessing the maintenance value of existing bridges and the potential utility for construction of additional bridges.

Cooperative funding provided by the East Foundation.

Influence of Extreme Temperature on Ocelot Habitat Use

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

Environmental conditions can greatly influence the distribution of a species. Temperature in particular can be a strong driver in determining the composition of plant and animal communities. Many wildlife species are adapted to a specific temperature range, which is often dictated by a seasonal peak and a seasonal low in temperature.

The ocelot is a Neotropical feline adapted to the warmer temperatures of Central and South America. The northern-most portion of the ocelot's breeding range extends into South Texas. Ocelot distribution northward may be limited because of their intolerance of low temperatures during winter months. Ocelots are generally more active at night when the extreme heat of the day has subsided and are believed to spend their days in dense vegetation, possibly as a means of refuge from the heat.

Our study will examine the role of extreme heat during the summer in determining habitat use and activity patterns of ocelots. We will use GPS data from collared ocelots on the El Sauz Ranch to determine the areas ocelots are selecting on the landscape. Using black globe thermal sensors, we will characterize the thermal attributes of these areas and identify the role of dense vegetation in reducing extreme temperatures during both summer and winter months.

By better understanding the nuances of habitat selection, conservationists can target essential areas on the landscape used by ocelots and ensure that sufficient cover exists to provide thermal escape during extreme temperatures. This study will provide a piece to the overall ocelot conservation puzzle.

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.

Monitoring Changes in Habitat for Ocelots from 1982–2017

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

Habitat ecology is fundamental to studies of population biology, behavior, and landscape ecology and can provide vital information needed by wildlife conservation planners. Thus, studies evaluating long-term habitat selection across multiple decades are important for wildlife and habitat conservation. However, such long-term studies are rare.

To evaluate the importance of private ranchlands for ocelot conservation, we are examining a 35-year

(1982–2017) dataset obtained from radio-collared ocelots. This dataset is being used to assess resource selection and functional responses in habitat use by ocelots as habitat availability decreases over time. We are using satellite imagery of South Texas to quantify changes in availability of cover, and models to examine habitat selection patterns and use for 78 ocelots (40 males, 38 females) at a broad landscape scale.

Ocelots appear to use areas with a high proportion of woody cover across time and areas located farther from paved roads that have a high amount of traffic. Ocelots also have a higher probability of use as the proportion of woody cover increases in their home range. Time variability in habitat availability across broad landscapes seems to have important implications for ocelot conservation.

Habitat selection models allow researchers to understand how changes in habitat availability can impact the occurrence of ocelots. Additionally, spatial and temporal variation in habitat availability at the home range scale likely has a strong influence on the functional responses by ocelots. These insights can advance habitat conservation efforts and roadway network planning to aid ocelots occurring in South Texas.

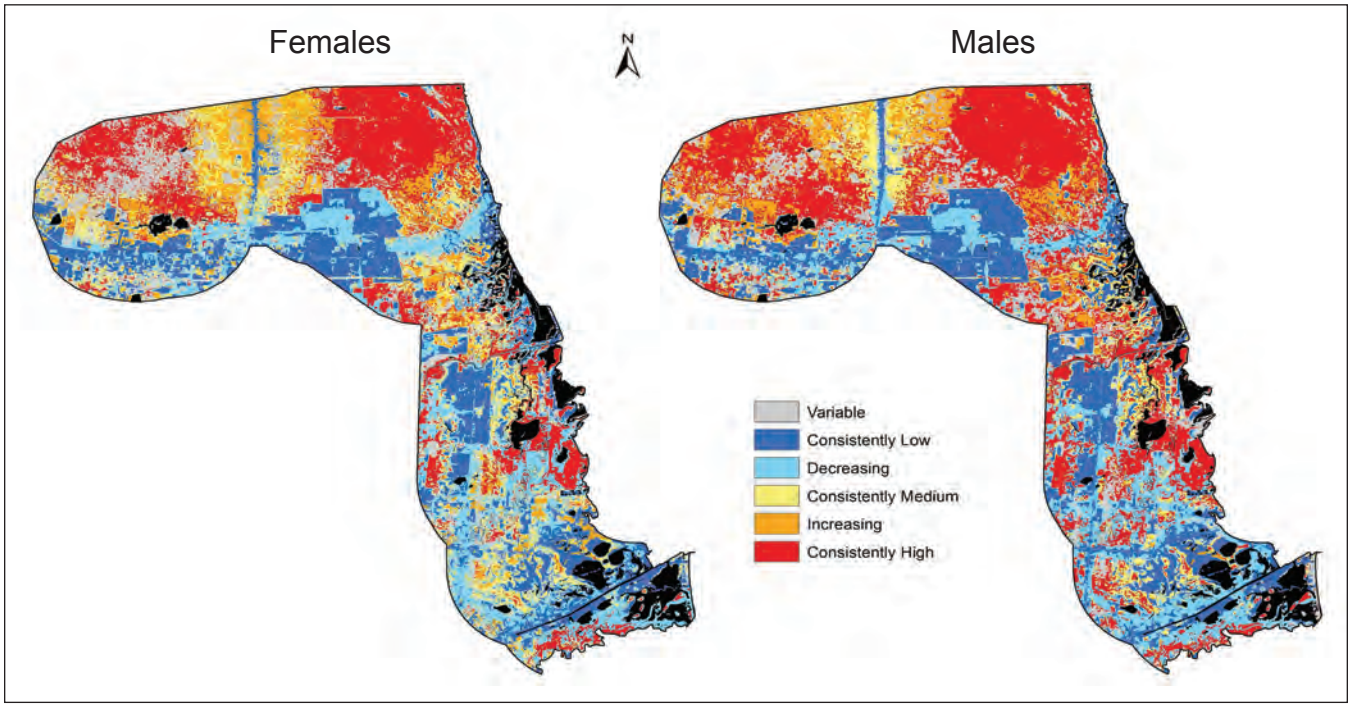
Cooperative funding provided by the Feline Research Program of the Caesar Kleberg Wildlife Research Institute and the Texas Department of Transportation: Environmental Affairs.

Ocelot Habitat Restoration Acceleration in Southern Texas

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

Tamaulipan thornscrub in northern Mexico and southern Texas has brush growing so thick it is nearly impossible to penetrate. This habitat is where ocelots thrive. For many decades, however, landowners in South Texas have used heavy equipment to remove brush from their property. Farming, ranching, and urban/suburban development of the Rio Grande Valley have led to wide-scale brush removal. Consequently, the ocelot has suffered greatly from the effects of human-altered habitat changes in South Texas. It is now difficult for ocelots to travel long distances, have a healthy flow of genes, and move safely across busy roads and highways. Many efforts to restore habitat needed by ocelots have been attempted, but it is a difficult and extremely slow process.

This project focuses on discovering methods to "speed up" the rate of growth for thick brush with many stems that ocelots prefer. We have applied mulching, shredding, and a combination of both treatments to young plants. We are measuring the plants' growth rates and stem counts over time. We are also exploring the effects of browsing on restoration efforts by



Predicted probability of use across time for female and male ocelots in South Texas. From the 1980s to present, we examined areas that were consistently used by ocelots and any identified changing trends of land use over time. Areas in red represent those with consistent habitat favored by ocelots.

enclosing some plants. Our team is testing these treatments on small plants that were naturally occurring, as well as on newly-planted saplings. We are working with a wide variety of brush species commonly found in Tamaulipan thornscrub.

Early results show that our treatments and the browsing effect both significantly impact plant crown area. Our findings are promising signs and could lead to improved habitat restoration guidelines.

Cooperative funding provided by the Texas Parks and Wildlife Department.

Temporal and Spatial Partitioning by Ocelots, Bobcats, and Coyotes

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

Habitat use of a species can be influenced by numerous factors. Among these factors, interactions with other species can be complex and dynamic. Associations between species are often difficult to quantify and may range from cooperative, mutualistic exchanges to antagonistic, competitive interactions.

The Rio Grande Valley in South Texas represents the northern extent of the ocelot range and the southern extreme of the bobcat range. This region is also inhabited by coyotes, and all three carnivore species occupy a similar ecological niche as medium-sized predators. To accommodate this overlap, these species are likely partitioning shared habitat by either time, space, or both.

Dr. Michael Tewes (left) and PhD student Max Sergeyev taking measurements of a coyote prior to its release for the study of interactions among bobcats, ocelots, and coyotes.

Our objectives are to examine habitat selection and activity patterns of ocelots, bobcats, and coyotes and determine the mechanisms by which these species can coexist in South Texas. We captured and collared these species on the El Sauz Ranch and fitted each individual with a GPS collar that collects location data every 30 minutes. From these GPS locations, we will determine movement rates of each species to identify differences in timing of activities. We will then compare spatial distributions and use of microclimates on the landscape to determine the extent of spatial partitioning.

Because ocelots are a species of conservation concern, understanding how potential competitors influence habitat use can play a vital role in managing this species. An ancillary result of this research is to add to our knowledge about the spatial ecology of bobcats and coyotes.

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

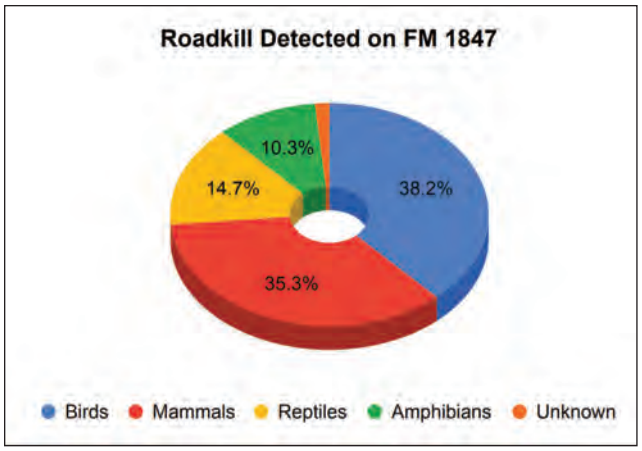
Monitoring Ocelot Mortalities Associated with Roadways

Zachary M. Wardle, Jason V. Lombardi, Michael E. Tewes, Eve M. Schrader, and John H. Young, Jr.

Vehicle-wildlife collisions are important causes of mortality for certain species. This is particularly true in areas with increasing road development and traffic such as South Texas. The endangered ocelot is particularly vulnerable to road-associated mortality and this is the leading cause of death, thereby posing a vital threat to the conservation of this species.

We are conducting wildlife mortality surveys on highway FM 1847 in Cameron County. Wildlife crossings, cattle guards, and fencing will be constructed along the road to reduce ocelot-vehicle collisions. Weekly surveys will be conducted to document felid and other wildlife mortality in relation to construction. Road-kill data will be analyzed across monitoring periods to identify patterns in wildlife mortalities. These include potential changes in animal mortality related to time, location, and construction. We will create maps to identify areas of high mortality and evaluate the surrounding landscape features.

This research will enable state agency personnel and researchers to better understand how different types of road mitigation may affect the rate of vehicle collisions



Preliminary data of wildlife, separated by animal type and percentage, that were killed on FM 1847 in Cameron County, Texas during spring through summer 2020.

involving wildlife. Additionally, these results may help transportation planners decide on road design options and placement locations of wildlife crossings.

Cooperative funding provided by the Texas Department of Transportation: Environmental Affairs.

Predicting Spatial Distribution of Ocelots: Do Time Intervals Matter?

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

Traditional ecological niche models use presence-only data that are often distorted by a lack of true absences, leading to sampling bias. If sampling is biased then it is difficult to determine if species' locations receive an adequate search effort or if certain locations are preferred.

No study has attempted to use GPS telemetry data in an ecological niche model. We conducted the present study to illustrate the ability to use GPS telemetry data. We are evaluating the performance and predictive ability of these types of models to identify the optimal time interval to use for ocelots in Texas.

From 2014–2017, we captured and collared eight ocelots on the El Sauz Ranch in Willacy and Kenedy counties. Preliminary findings indicate that performance and predictive ability of GPS locations at two-hour intervals were comparable to those at 12-hour intervals. However, shorter intervals underestimated or overestimated niche breadth less often than 12-hour intervals. There were similar detectable differences among the time-interval models.

This study illustrates that researchers can integrate high-frequency GPS data into ecological niche models using what's called maximum entropy modeling. Future development of models could enable researchers to use GPS data to understand the patterns and processes that influence ecological niche models of carnivores such as ocelots.

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

Genetic Erosion in Ocelot Semen Traits and Potential Consequences

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

Studies of wild felids found a relationship between decreased genetic variability and decreased quality of semen traits. These findings suggest the possibility of negative effects upon reproduction. Factors that can impact population fitness include spermatozoa deformities, low mobility percentage, low fertilization capabilities, and low spermatozoa concentration.

We previously found a loss of genetic variation in ocelots from 1995–2005 and suspect this has worsened over the last 15 years. We also found inbreeding in two ocelot populations (Refuge Population on Laguna Atascosa National Wildlife Refuge and the larger Ranch Population in Willacy and Kenedy counties).

We will be collecting reproductive samples and performing semen analyses of ocelots in the Ranch Population. Findings will provide new information on the reproductive fitness of ocelots and insight into the impact of decreased genetic variation.

Information from this study can be used to develop assisted reproduction methods and conservation strategies to improve ocelot reproduction. These strategies should reduce the chances of ocelot extirpation from South Texas.

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

Do Plant Nutrients Explain Antler and Body Size in White-tailed Deer?

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

In South Texas, antler and body size of white-tailed deer are influenced by soil type. Smaller deer occur on the sandy soils along the coast and the South Texas Sand Sheet, where soils are comprised of sand that was blown inland from the shoreline of the Gulf of Mexico. This region covers over two million acres of southern Texas. Observations from our long-term study of white-tailed deer populations on the East Foundation ranches in South Texas revealed antler and body size is inversely related to sand content of the soil at finer scales, even within a ranch. The differences in deer size are probably due to nutrition, but it is not clear if the overall amount of forage or the nutritional quality of individual plants limits deer growth in sandy soils.

We have been collecting deer body and antler measurements from deer captured annually on the East Foundation ranches, which span multiple ecoregions and soil types in South Texas. We are also collecting 18 common deer food plants and performing nutritional analyses. The results from these analyses will be combined with long-term deer capture records and forb availability data for interpretation.

Preliminary results suggest there is no difference in forb availability or energy and protein content of plants collected from sites with large and small deer. Variation in energy and protein content is greater between species and seasons than between different soil types. However, sites with larger deer have greater diversity of forage plants. This research highlights the importance of maintaining diverse native rangelands.

Cooperative funding provided by the East Foundation.

Landscape Use by Male Deer after Brush Management

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

Brush encroachment became a problem on southwestern rangelands after decades of intensive grazing and fire suppression. Originally conducted to benefit livestock, brush management is now used to benefit livestock and wildlife. Clearing brush in alternating strips is desirable in that the strips can be cleared and maintained with maximum efficiency. Some natural resource managers have begun to leave brush mottes in the open strips under the assumption that the mottes are beneficial to wildlife. However, wildlife use of the strips or mottes has not been thoroughly investigated.

We are studying the response of white-tailed deer to brush management on South Texas rangelands. In summer 2008, root-plowing was implemented in a strip-motte pattern within a 1,065-acre block of dense mesquite. Mottes and brush outside of root-plowed strips were left undisturbed. After root-plowing, the study site consisted of 39% brush strips, 46% root-plowed strips, 3% brush mottes, and 10% oil development sites. We captured 10 male deer, fitted each with a GPS radio-collar, and monitored their use of habitat types from October 2008 to August 2009.

Preliminary analyses indicate that male deer avoided root-plowed strips in all months except January. Mottes were preferred over brush strips in all months except May. Throughout the study, male deer spent 40% of their time in brush strips, 36% in root-plowed strips, and 8% in mottes.

Leaving mottes during strip disking is time-consuming and can make follow-up treatments costlier, but mottes appear to benefit deer and possibly other wildlife. Understanding how deer respond to brush management can aid in developing management plans and aid land managers considering the cost-to-benefit ratio 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.

Estimating White-tailed Deer Population Sizes Using Drones

Jesse Exum, Aaron M. Foley, Randy W. DeYoung, David G. Hewitt, Jeremy A. Baumgardt, Mickey W. Hellickson, and Humberto L. Perotto-Baldivieso

Management of wildlife populations relies on estimates of population size, recruitment, and sex ratios. In southwestern rangelands, aerial surveys from a helicopter are popular because helicopters are an efficient way to survey large areas. Recently, drones have emerged as an alternative that is safer, cheaper,

and better suited for small ranches than helicopters. However, the relationship between drone counts and other survey methods has not been established.

We are evaluating drone surveys on five South Texas sites that have different numbers of white-tailed deer and exotic wildlife. The drones are equipped with a dual thermal and optical video camera. Heat signatures are detected using the thermal imagery, then identified by species, sex, and age using video imagery. We flew preliminary surveys to evaluate flight protocols during November 2018 and February 2019. Based on those results, we then flew surveys at reduced altitude and speed during February through April 2020. We compared population estimates from drones to estimates from helicopter surveys.

During 2018–2019, 60% (range 33–86%) of thermal signatures were identifiable with optical imagery and observed drone counts were 44% (range 9–84%) of September helicopter counts. During 2020, repeated surveys of one site revealed 85% (range 73–92%) of thermal signatures were identified in optical imagery and observed deer counts were consistent (range 56–65%), suggesting that flying lower and slower improved estimates. Drones offer the potential of a safer, cost-effective survey method for small properties. Ongoing work will result in recommendations for consistent, reliable wildlife surveys using drones.

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

Do Center Pivots Affect Mule Deer Habitat Use?

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

Mule deer population numbers have been steadily increasing in the Texas Panhandle over the past 20 years—an area with extensive agriculture. There are few areas in the United States where extensive cropland and mule deer coincide, and information on how mule deer use and move throughout agricultural areas is limited.

We captured and radio-collared mule deer in three areas throughout the Texas Panhandle. Each area had a different proportion of cropland. We are evaluating what habitats mule deer use, the proportion of deer using cropland, and their home range sizes.

Preliminary findings show male mule deer home range sizes are large and variable regardless of site, averaging 12–16 mi^2. Female mule deer home range size is smaller and less variable regardless of study site, averaging 3.5–4.5 mi^2. The proportion of collared deer that used agriculture was dependent on cropland density. In high and moderate density cropland, 85% of deer used cropland, while only 15% of deer used cropland in the low cropland density site. In terms of habitat use, mule deer spent 7% of their time in croplands during spring and summer and 21% during autumn and winter.

Ongoing analyses suggest that increased cropland use during cooler months is likely from enhanced nutrition of winter wheat and the result of decreased use of shrubland and grassland habitats. Our findings will help define the management scale for mule deer in the Texas Panhandle and other regions where extensive agriculture and mule deer co-occur.

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

Population Dynamics of White-tailed Deer in South Texas

Michael J. Cherry, Randy W. DeYoung, Aaron M. Foley, J. Alfonso Ortega-Santos, David G. Hewitt, Landon R. Schofield, and Tyler A. Campbell

Understanding drivers of population dynamics of deer is key to management. This is particularly important where environmental conditions vary, such as the

Understanding the influence of environmental factors on populations of white-tailed deer can improve management.

drought-prone South Texas rangelands. Adult survival is typically less sensitive to environmental variability than survival and recruitment of young.

Recruitment can vary widely and is often related to dynamic factors including predation, weather conditions, and food availability. The effect of these factors on recruitment and population dynamics is, in part, related to manageable landscape attributes such as vegetation structure, as well as habitat patch composition and configuration.

To better understand how range conditions influence population performance of white-tailed deer, we are conducting a study on the East Foundation's San Antonio Viejo Ranch. The site is a working cattle ranch, which will allow us to assess a deer population in this type of landscape.

We are collecting data to link range conditions to individual doe nutritional condition, reproduction, and survival. We are capturing adult does using aerial net gunning and are measuring body mass and body condition. We are equipping each pregnant doe with a GPS collar and a vaginal implant transmitter, which indicates when a birth has occurred. This transmitter allows researchers to identify birth sites and capture fawns shortly after birth. In addition, we are equipping fawns with expandable radio-collars, which we will monitor to estimate survival and identify causes of death.

Our study will examine linkages between range conditions, grazing, deer nutritional condition, and population performance. This work will further our knowledge of deer population ecology and will help inform deer managers about systems with dynamic variability in environmental conditions such as those found in South Texas rangelands.

Cooperative funding provided by the East Foundation.

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, and John A. Goolsby

Indices of body condition in wildlife allow managers to evaluate range quality, animal health, and the effects of management actions. Ideal condition indices are simple, rapid, and related to the animal's total body fat. Three main condition indices are used in white-tailed deer and other large mammals: (1) the ratio of kidney fat to kidney mass, (2) a body condition score based on flesh around the ribs and hips, and (3) the thickness of fat under the skin on the rump. Each index has strengths and weaknesses. For instance, kidney fat is easy to measure but levels off for animals in good condition. The body condition score is rapid and can be performed with live animals. However, the body condition score is less sensitive to small changes because the observer scores the animal in categories from one to five. Rump fat thickness can index total body fat over a wide range of body conditions, but loses precision below 8% total body fat.

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Body condition indices allow managers to assess animal health and response to management, yet each index has strengths and weaknesses.

In this study, we are comparing condition indices from data collected from 298 female white-tailed deer that were removed from around Falcon Reservoir near Zapata, Texas during March 2020. Our objective is to find a combination of indices that can be used to assess body condition in both live and harvested deer.

Preliminary results from our data collection revealed substantial variation in the amount of kidney fat for deer that had little or no rump fat. Body condition score reflected differences in kidney and rump fat, but was less sensitive. The results of this study will provide insight in improving estimates of body condition in white-tailed deer.

Cooperative funding provided by the USDA Agricultural Research Service.

The Effects of Water Salinity on Dry Matter Intake

Austin K. Killam, Clayton D. Hilton, David G. Hewitt, Aaron M. Foley, and Natasha L. Bell

In the southwestern U.S., surface water is often limited because of frequent droughts. Large mammals often rely on pumped ground water or rapidly evaporating pools of poor-quality water that may contain high levels of salt and dissolved solids. We hypothesized that decreased water quality will have a negative impact on deer by decreasing the amount of dry matter consumed. We are focused on salinity because it is the primary cause of poor-quality water in South Texas.

To evaluate the effect of water salinity on dry matter intake of white-tailed deer in South Texas, we offered water *ad libitum* at varying (1,000, 2,500, 4,000, 6,000, and 7,500 ppm) salinity levels to determine (1) the upper threshold of salinity that white-tailed deer will drink, (2) how water salinity affects daily water intake across season, and (3) how salinity affects daily dry matter intake. Our study is taking place at the Albert and Margaret Alkek Ungulate Research Facility located at the Tio and Janell Kleberg Wildlife Research Park in Kingsville, Texas.

We found daily water consumption varied across treatments and maximum temperatures. Daily water consumption was highest in the highest salinity treatment (7,500 ppm). There was also an increase in consumption in the low and moderate salinity treatments compared to the control treatment across temperatures. We did not observe a change in daily dry matter intake across treatments. Because seasonal variability and droughts can influence animal health and environmental conditions, our study's findings will be valuable to biologists and ranch managers across the United States.

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A white-tailed deer eating protein pellets during the water salinity study at the Albert and Margaret Alkek Ungulate Research Facility in Kingsville, Texas.

Cooperative funding provided by the Albert and Margaret Alkek Foundation.

Behavioral Responses of White-tailed Deer and Cattle to Heat Stress

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

The hot South Texas climate can be dangerous to wildlife. Adaptive behaviors, such as seeking shade or wind or altering activity, are less costly to animals than physiological changes, such as panting or sweating. However, sites with optimum shade and wind are finite, and thus there is potential for competition.

We are researching the response to heat and potential competition between white-tailed deer and cattle at the East Foundation's El Sauz Ranch in South Texas. We placed GPS radio-collars on 30 deer and 10 cattle during spring 2019. Collars record GPS locations of the animals at 30-minute intervals. In addition, we placed 100 black-globe thermometers across the landscape to measure operative temperature, which takes into account both the air temperature and the radiant temperature an animal is exposed to. We developed a predictive temperature map of the study area and investigated how deer movements and habitat selection correlated with temperature. We also compared spatial and temporal overlap between deer and cattle during the hottest periods of the day.

Preliminary results indicated deer preferred woody cover during the hottest part of the day and used more open areas at night. Radio-collared deer and cattle used the same shade resources, but never during the same hour, and they maintained a minimum distance of at least 1,000 yards apart.

The results of this study will further our understanding of wildlife-habitat interactions, deer-livestock competition, and landscape features important in lessening heat stress. Management implications include making improvements in habitat features to decrease heat stress.

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

Mule Deer Mate Search Strategies and Interactive Networks during the Rut

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

Deer often overlap in home range, which results in male competition for mates during the rut. White-tailed deer will use frequent receptiveness checks on females and form a single-pair bond for mating. Little is known about mule deer mating strategy. Evidence suggests they exhibit a harem strategy where a mature buck defends a group of females against other males. Moreover, the rut coincides with migration for some mule deer populations. As a result, migration allows the potential to use different mating strategies.

We are collecting GPS location data on 83 adult males and 86 adult females in the Texas Panhandle (non-migratory) and 146 adult males and 202 adult females in several regions in Utah (migratory). This information will be used to document and quantify the reproductive strategy of mule deer. Because males and females were captured near each other on the study areas, we will be able to use spatial analyses to document interaction patterns between sexes. Further, we will quantify mate-search strategies of males during rut (early, peak, late) and determine how these strategies differ with age and geographic region.

There may be additional attractions facilitating interactions such as agriculture in the Texas Panhandle or migratory behavior in Utah. Depending on resource availability and migratory status, we expect that male mule deer will likely exhibit less roaming and revisitation of areas that females occupy than white-tailed deer males because mule deer are more social. Our study is the first to use location data to explicitly investigate the reproductive strategy of mule deer.

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GPS-collared mule deer were monitored in the Texas Panhandle to evaluate mate search strategies by bucks and document spatial interactions between sexes during the rut.

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

White-tailed Deer Acceptance of Motion-activated Sprayers at Feed Sites

Jeremy A. Baumgardt, Ashley G. Hodge, Randy W. DeYoung, Aaron M. Foley, J. Alfonso Ortega-Santos, Michael J. Cherry, David G. Hewitt, John A. Goolsby, and Adalberto A. Pérez de León

Bovine babesiosis, or Texas cattle fever, is a serious threat to the cattle industry. Spread by cattle fever ticks (CFTs), the protozoan that causes the disease was recognized during the days of the historic cattle trail drives, when local cattle became ill after Texas cattle arrived. CFTs were eliminated from the United States in 1943, and the USDA monitors a permanent quarantine zone along the Texas-Mexico border to prevent re-emergence. White-tailed deer are alternative hosts to CFTs and the ticks are capable of re-infesting treated cattle. The USDA maintains feeders throughout the quarantine zone filled with Ivermectin-treated corn to control tick loads on deer. Feeders are active between February and August to allow a 60-day withdrawal period before the hunting season; deer remain untreated the rest of the year. The USDA has developed a remotely activated sprayer that may allow deer to be treated year-round. The sprayers contain tick-killing nematodes, serving as a biocontrol method.

We set up active sprayers at 25 feeders and inactive sprayers at 16 feeders in the quarantine zone near Zapata, Texas. We maintained each sprayer and filled feeders with non-medicated corn, and we monitored sprayer sites from late-November through the end of January 2020 using motion-activated cameras.

Preliminary results indicate that deer readily used the feeders and were not deterred by the sprayers. Ongoing work will determine the effectiveness of the sprayers on tick loads. The results of this study will have important implications for the control of CFTs on deer and other wildlife.

Cooperative funding provided by the USDA Agricultural Research Service.

Assessing Availability Bias of White-tailed Deer during Helicopter Surveys

Aaron M. Foley, Jacob L. Dykes, David G. Hewitt, Randy W. DeYoung, Landon R. Schofield, and Tyler A. Campbell

Many ranches in South Texas conduct helicopter surveys for white-tailed deer to estimate population size, adult sex ratios, and fawn recruitment. Unfortunately, the number of deer seen underestimates the true size of the population.

Distance sampling is a mathematical method that can account for deer not seen during the survey. It operates under the assumption that all deer on the transect line are seen and detection decreases farther away from the helicopter because of decreased visibility. This is termed 'visibility bias.' It means that the farther away a deer is from the helicopter the lower the probability the deer is seen because it is more likely to be obscured by brush. Distance sampling can correct for deer not seen due to visibility bias. However, a percentage of deer will simply not be seen during a given survey, which is termed 'availability bias.' For instance, a deer bedded down in thick cover may be missed. Availability bias can have a measurable effect on population estimates and varies by time of day and season. For example, the percentage of the population unavailable during a survey may increase from morning to noon as the environment becomes warmer, or more deer are seen during February surveys than during October surveys.

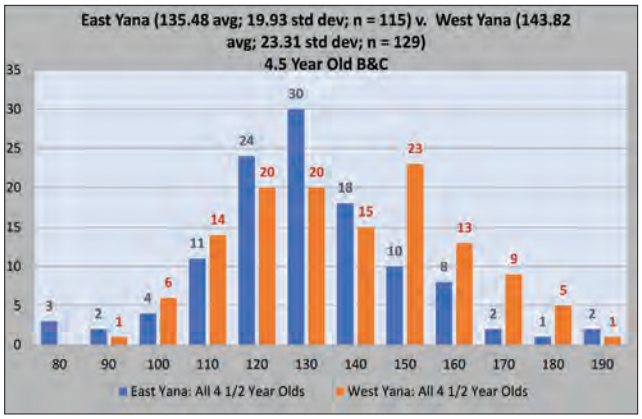
To gain a better understanding of availability bias, we are conducting aerial surveys on the East Foundation's El Sauz Ranch. We are using GPS-collared deer to assess the effects of visibility and availability. Our findings will help in understanding how availability bias affects helicopter surveys and population estimates of white-tailed deer.

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

DMP Pens Effect on Average White-tailed Deer Antler Size

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



Gross Boone and Crockett antler scores for 4.5-year old bucks comparing a DMP-stocked pasture (West Yana) and a control pasture (East Yana) on the Faith Ranch in Dimmit County, Texas.

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 study 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 the Faith Ranch. Fawns are tagged in DMP pens and the control area each year with ear tags specific to year-of-birth. Each fall marked, known-age bucks are captured via helicopter and measured. Data on antler size are then compared within age classes across each pasture.

Many factors affect the results from use of DMPs. This study shows results that can be achieved with a DMP using native deer on the Faith Ranch.

Cooperative funding provided by the Faith Ranch.

How does Shade and Wind Affect Space Use by Deer?

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

Summer temperatures in South Texas prompt animals to change their behavior to cope with the extreme heat. Most animals will seek shade to avoid direct

© Jessica Glasscock

Animals select sites with access to shade and wind to cope with summer heat.

exposure to the sun. However, the type, amount, and location of vegetation can affect the amount of shade available to the animal. Therefore, not all shade is of equal quality.

We are studying the preference of white-tailed deer to differing combinations of shade and wind using an experimental approach at the Albert and Margaret Alkek Ungulate Research Facility. In a captive setting, we can control access to shade and wind compared to a study using deer in the wild. We will place captive deer in an open-air pen and manipulate shade "quality" using commercial shade cloth. Deer will be able to choose locations where there is no shade, or 30%, 60%, or 90% mesh cloth overhead. We will monitor deer choice of shade intensity throughout the day and compare that information to the black globe temperature (a combination of air temperature and heat absorption).

In the second phase of the study, we will block air flow and provide box fans set to different speeds to simulate wind. We will quantify deer preference for shade and wind and determine if there are trade-offs between different levels of shade and different wind speeds. For instance, an individual might tolerate less shade if a certain wind speed provides the necessary thermal benefit.

The results of our study will allow us to better understand how wild deer cope with high temperatures in South Texas. This information can be used to design brush management plans that will provide appropriate thermal cover for white-tailed deer.

Cooperative funding provided by the Zachry Foundation.

Assessing the Mineral Status of White-tailed Deer

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

The mineral requirements of many wildlife species, including white-tailed deer, are poorly understood. Ranch and wildlife managers often assume that wildlife have mineral needs similar to livestock. However, before we can understand the mineral requirements for deer, or how minerals vary by site, season, and management, we must be able to define normal mineral values in healthy deer. Previous research has focused on mineral levels in the liver and has been limited geographically. The levels and variation of minerals in other tissues are poorly characterized. Analyses of other tissues such as blood, antler, or hair would allow the assessment of mineral status in live deer, and are easier to obtain than liver samples.

We are collecting samples from deer captured as part of a long-term study on unmanaged deer populations located on the East Foundation ranches in South Texas. We selected samples from deer representing a range of age and sex classes and geographic areas and analyzed 18 biologically important minerals in hair, antler, and blood serum samples.

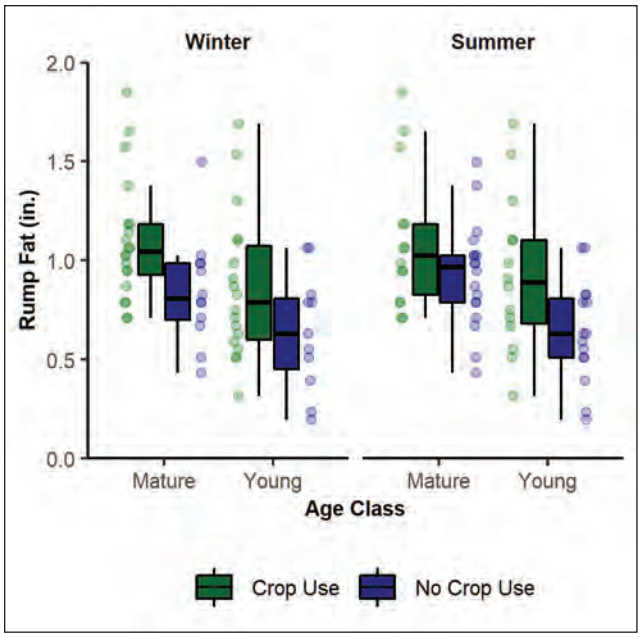
Our preliminary results showed that mineral concentrations from deer in South Texas had greater variation than values reported from other parts of the country. The results of this study will help wildlife managers optimize the mineral nutrition of white-tailed deer. Our study also highlights the need for further research to fully understand what are the normal mineral concentrations in white-tailed deer and how these concentrations vary in response to an animal's physiological state and environment.

Cooperative funding provided by the East Foundation.

From Fallow to Fat: Agriculture Effects on 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

Habitat fragmentation comes in many forms. The most prolific form of habitat alteration in the Great Plains region of the United States is conversion of



The influence of winter (left) and summer (right) cropland use on rump fat for mule deer in the Texas Panhandle. Rump fat is measured with ultrasonography and is a good indicator of overall body condition. Both mature (greater than three years old) and young (one to two years old) age classes had greater rump fat when using cropland.

native rangeland to row crop farming. Understanding how wildlife react to these landscape alterations is important for developing effective conservation and management strategies.

We are evaluating how agriculture affects mule deer in the Texas Panhandle. We have captured, measured, and collared 312 individual adult males, females, and fawns across several sites and years. Specifically, we are testing how the use of cropland by mule deer affects population health parameters such as body fat, body mass, lactation rates, and antler size. Additionally, we will assess how cropland use, habitat characteristics, and body size measurements influence adult and juvenile survival.

Our preliminary findings suggest that the use of cropland fields during the summer had a positive influence on body fat, body mass, and antler size across all age classes for males but had no effect on females. Additionally, we have evidence that lactating females use cropland more than non-lactating females in areas where forage crops are available. Overall, annual survival is high (about 90%) and stable, and adult male and female survival does not appear to be driven by an individual's use of cropland.

Establishing an adaptive management plan for the mule deer population in the Texas Panhandle will prove crucial as human-caused alteration of the landscape continues. Our research will provide much of the information needed to improve the management of this valuable resource.

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

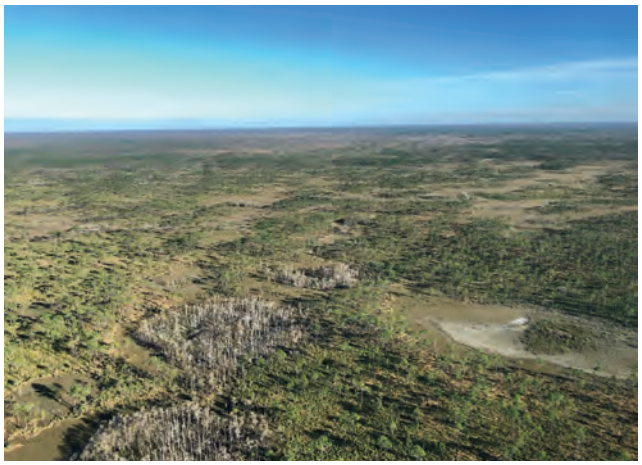
Analyses of White-tailed Deer Populations during Florida Panther Recovery

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

White-tailed deer in South Florida are a driver of substantial conservation funding and are the primary prey of the endangered Florida panther. Therefore, deer are an important cultural, economic, and ecological resource in South Florida.

Data suggest white-tailed deer 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 change during the past several decades. Florida panthers have increased following genetic rescue efforts. Recent estimates suggest that the Florida panther population exceeds 200 individuals. In addition, Florida black bear populations have increased, and coyotes and Burmese pythons have colonized South Florida and represent potential predators to white-tailed deer. However, the relative effects of



View of Big Cypress National Preserve during the dry season. In this system, deer and Florida panther interactions appear to driven by water levels.

hydrology, hunting, and predators on deer populations remain unknown.

We are analyzing long-term monitoring 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 population trends are related to changes in hydrology, habitat conditions, hunter harvest, and panther recovery. Understanding the drivers of past declines may provide insight for management recommendations aimed at maintaining sustainable deer populations in South Florida.

Cooperative funding provided by the USDI National Park Service.

Movements of White-tailed Deer along the Texas-Mexico Border

Ashley G. Hodge, Jeremy A. Baumgardt, Randy W. DeYoung, Michael J. Cherry, J. Alfonso Ortega-Santos, Aaron M. Foley, David G. Hewitt, John A. Goolsby, and Adalberto A. Pérez de León

There is growing concern about controlling cattle fever ticks (CFTs) in the Texas-Mexico border region. These ticks can carry a *Babesia* parasite that causes serious illness in cattle. CFTs were eradicated from the United States in the 1940s and a permanent quarantine zone was established along the Texas-Mexico border to prevent their re-occurrence.

Ranchers in the border region have historically experienced outbreaks of CFTs that were managed through treatment or removal of cattle. Recently, some infestations have proven difficult to manage because of the presence of white-tailed deer. Deer are alternative hosts for CFTs and can serve as a reservoir that is difficult to treat with medications. Part of the difficulty in treating white-tailed deer and other wildlife is that these animals are not contained by ordinary livestock fencing. Furthermore, deer can make long-distance movements, thereby having the potential to spread CFTs beyond the property where they originally became infested.

In this study, we are tracking white-tailed deer movements on International Boundary Water Commission lands surrounding Falcon Lake, Texas. The deer densities are high because of low hunting pressure, and the deer help to maintain infestations in the area. In February 2020, we captured and fitted 100 deer with satellite GPS radio-collars set to take locations hourly, and monitored their movements.

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Deer movements may complicate management for cattle fever ticks in South Texas.

Preliminary data revealed that 15% of the GPS-collared deer crossed the border into Mexico and returned at least once, which represents a potential route of CFT invasion. Our findings will help in understanding the role deer play in outbreaks of CFTs and aid in the development of better management plans.

Cooperative funding provided by the USDA Agricultural Research Service.

Space Use and Movements of White-tailed Deer Following Capture

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

A net-gun fired from a helicopter is a safe and efficient technique to capture white-tailed deer in South Texas rangelands. We assume that deer do not leave their home range when pursued by the helicopter and that their capture site is within their home range.

After capture, researchers often transport the deer to a central location for data collection, which can be several miles from the capture site. Deer are released at this location, assuming that they soon return to their home range. Surprisingly, there is little information on deer movement behavior before or after capture, or the time until deer return to their home range.

We captured 54 white-tailed deer on the East Foundation's El Sauz Ranch and fitted each with a GPS collar that recorded each deer's location every 30 minutes. We monitored movements following release

of each deer from the data collection location and compared post-capture home range to their capture site.

Preliminary data revealed that deer were transported up to three miles from their capture site to the data collection location. Upon release, deer returned to their home range within 26 hours; females took longer (28 hours) on average than males (24 hours). While travelling back to their home range, deer moved four times faster than their normal speed of movement within their home range. In addition, we found that the helicopter did not cause deer to flee their home range, deer maintained high site fidelity, and all captured deer returned to their home range within six days.

Overall, it appears that the helicopter net-gun technique has little long-term impact on the behavior of white-tailed deer. Our findings add additional information about the ecology of white-tailed deer in South Texas rangelands.

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

Long-term Study of White-tailed Deer on East Foundation Lands

Aaron M. Foley, David G. Hewitt, Randy W. DeYoung, Timothy E. Fulbright, J. Alfonso Ortega-Santos, Michael J. Cherry, Kory R. Gann, Michaela F. Rice, Seth T. Rankins, Jacob L. Dykes, Landon R. Schofield, and Tyler A. Campbell

The East Foundation was established in 2007 from the estate of Robert C. East to promote land stewardship through ranching, science, and education. Since 2011 the East Foundation has sponsored a long-term study called the "deer capture project" that embodies this mission. Each autumn, students from Texas A&M University-Kingsville, Texas A&M University-College Station, Sul Ross State University, Tarleton State University, Texas Tech University, Stephen F. Austin State University, and Southwest Texas Junior College assist with capture of white-tailed deer on four East Foundation ranches. The student volunteers gain valuable experience by recording body and antler size data and learning to collect blood and tissue. Graduate students use these data to test hypotheses regarding the influence of nutrition, rainfall, soil, and age structure on deer populations.

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Long-term studies help us understand the effects of the South Texas environment on white-tailed deer.

The deer populations are not managed and not hunted and, thus, serve as valuable baselines to compare with intensive management programs. An insightful aspect of this study is collecting data from the same individual over time. On the Santa Rosa Ranch, 98 of 468 individuals have been recaptured up to four times. On the El Sauz Ranch, 284 of 812 individuals have been recaptured up to six times. On the San Antonio Viejo Ranch, 274 of 1,710 individuals have been recaptured up to five times. On the Buena Vista Ranch, 114 of 671 individuals have been recaptured up to four times. We have recaptured several individual deer up to eight and nine years apart. This type of longitudinal information will help us better understand life-history traits of white-tailed deer in the variable South Texas environment.

Cooperative funding provided by the East Foundation.

Prescribed Fire and White-tailed Deer Maternal Behavior

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

Predators affect prey populations by killing individuals as well as also affecting prey behavior. These effects depend on the regularity of predator-prey interactions and their outcomes. Features of prey, such as age and sex, can affect vulnerability to being killed and vulnerability can differ across space based on habitat management practices. Management actions often alter the location and value of resources, which can affect prey vulnerability. Thus, prey species must make decisions that maximize food intake while minimizing exposure to risk.

This study focuses on how prescribed fire affects the behavior of female white-tailed deer and how those behaviors relate to fawn survival. We are

working at the Jones Center at Ichauway, the approximately 30,000-acre quail plantation in southwestern Georgia, owned by the Woodrow Foundation. Using motion-activated camera data and GPS telemetry data, we will explore how prescribed fire and predation risk influence female white-tailed deer 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.

Influence of Agriculture on the Genetic Structure of Mule Deer

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

Habitat loss and fragmentation pose a threat to wildlife conservation worldwide. In the Great Plains region of the United States, including portions of the Texas Panhandle, conversion of land for agricultural use is one of the main drivers of habitat fragmentation. Although habitat fragmentation can be a detriment to native wildlife, some species, such as mule deer, seem to benefit from agriculture. Mule deer numbers in the Texas Panhandle have steadily increased during the past 30 years, but there is little information on how the use of farmland affects mule deer populations at the landscape scale. We are investigating how agricultural habitat fragmentation affects the spatial organization of mule deer populations in the Texas Panhandle.

Genetic studies are underway on mule deer in the southwestern Texas Panhandle to evaluate relatedness and structure of the expanding population.

As part of a long-term study on mule deer movements, we collected tissue samples from 314 mule deer across three study sites having varying degrees of habitat fragmentation. We extracted DNA and are using 11 microsatellite DNA markers to determine how related animals are arranged within each study site. Knowledge of spatial genetic attributes of populations can be used to make inferences about movements and dispersal patterns. For instance, if mule deer from a wide area congregate on agricultural fields, we expect their average relatedness to be low. Conversely, if agricultural food resources or fencing inhibit dispersal, we expect average relatedness to increase.

The results of our study will reveal fine-scale responses of mule deer to a fragmented landscape. Our findings will have implications for the management and conservation of these charismatic large mammals.

Cooperative funding provided by the Texas Parks and Wildlife Department.

Population Dynamics of White-tailed 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 the reintroduction of prescribed fire and timber harvest. 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. Motion-activated cameras are often used to monitor deer populations in forested areas of

eastern North America. Our study seeks to validate a new monitoring method by conducting a camera-based study and a traditional population dynamics study.

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 shortly after their birth. We captured and monitored 53 fawns, using expandable very high frequency (VHF) tracking collars. We are monitoring 138 cameras deployed across the site from May–September to individually identify fawns based on their unique spot patterns.

In 2019, we estimated 12-week survival of fawns to be 29.4%, with the sharpest decline occurring in the first 20 days of life. We have cataloged over 2,750 photos 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).

Removal of White-tailed Deer to Control Cattle Fever Ticks

Ashley G. Hodge, Jeremy A. Baumgardt, Randy W. DeYoung, Michael J. Cherry, Aaron M. Foley, J. Alfonso Ortega-Santos, David G. Hewitt, John A. Goolsby, and Adalberto A. Pérez de León

Cattle fever ticks (CFTs) are vectors for a *Babesia* parasite that causes cattle fever, which can be fatal to livestock. CFTs were eradicated from the United States in the 1940s. A permanent quarantine zone is monitored for CFTs along the Texas-Mexico border.

Despite vigorous control efforts, CFTs are expanding their range outside the quarantine zone. Recent outbreaks have been attributed to the presence of white-tailed deer, which can serve as alternate hosts. A reduction in deer should reduce the overall number of hosts and, thus, the number of CFTs. However, the response of deer to population reduction is not well understood. If deer increase their movements and home ranges, CFT loads might also increase.

We are evaluating population reduction of white-tailed deer on the International Boundary Waters Commission lands surrounding Falcon Lake near Zapata, Texas. Population densities of deer are high and much of the land is inaccessible to hunting. This results in high numbers of deer, many of which are capable of crossing to Mexico and returning with CFTs. We captured and fitted 100 deer with satellite GPS radio-collars during February 2020. We removed 298 non-collared does during March 2020 and monitored how the collared deer responded.

The cattle fever tick may be spread by wildlife such as white-tailed deer and nilgai in South Texas.

Preliminary results indicate deer have highly variable home ranges in this region, though many does had comparatively smaller home ranges than seen in other populations in the South Texas region. The results of this study will have important implications for the management of CFTs.

Cooperative funding provided by the USDA Agricultural Research Service.

TxDOT and *Texas Native Seeds Program* Collaboration

Forrest S. Smith, Dennis K. Markwardt, Shyla E. Rabe, Keith A. Pawelek, Anthony D. Falk, Colin S. Shackelford, Samuel R. Lutfy, John R. Bow, Douglas L. Jobes, Tyler C. Wayland, and Travis Jez

The *Texas Native Seeds Program* (TNSP) and the Texas Department of Transportation (TxDOT) have enjoyed a 20-year-long collaboration. We have worked together to commercialize native plant seed sources resulting in revision of TxDOT's seeding specifications for over two-thirds of the state. TNSP staff work closely with TxDOT's Vegetation Management Team to address agency needs. TxDOT provides input on plant selections for upcoming seed releases. TxDOT is one of Texas' largest seed buyers, and their specification of TNSP seed releases is critical for our success.

In the last year, we focused on developing better seed supplies of pollinator plants, advising TxDOT on several specialty seed mixes, bringing an annual cool-season native cover crop to market, and on making selections of native grasses for future use in East Texas and the Coastal Prairies. The TNSP team is also working with TxDOT personnel to install test plantings to study the performance of recent seed releases to guide TxDOT's future seeding specifications.

The use and the specification of native plants for revegetation of roadsides are important to providing habitat for wildlife, thereby minimizing the use of exotic grasses and positively influencing native plant seed markets in Texas. Collaboration of the TNSP and TxDOT has been an extremely fruitful one, and we look forward to continuing success.

Cooperative funding provided by the Texas Department of Transportation.

East Texas Natives Project—Collection and Evaluation of East Texas Native Plants

Tyler C. Wayland, Jacob L. Sparger, Douglas L. Jobes, Keith A. Pawelek, Robert A. Shadow, and Forrest S. Smith

The revegetation of oil and gas pipelines, transmission line rights-of-way, and highway roadsides are all examples of large-scale native plant restoration opportunities in East Texas. One of the largest challenges facing such efforts is the lack of commercially available, locally-adapted native plant seed sources. We are working to solve this problem by collecting, developing, and commercializing regionally-adapted native plant seed for restoration projects across the East Texas region.

The *East Texas Natives Project* has now made over 530 native plant seed collections from 59 counties in East Texas. In 2020, we established two additional evaluation sites: Boggy Slough Conservation Area in Trinity County and Riverby Ranch in Fannin County. The project now maintains four unique evaluation sites, which provide the opportunity for evaluations in all major ecoregions of East Texas. These sites are used to evaluate and select the best performing plant populations of each species to be released for large scale commercial production. Native plants under evaluation include Indiangrass, silver bluestem, purpletop tridens, and rattlesnake master. The *East Texas Natives Project* collection and evaluation process will facilitate the development of widely adapted native plant seeds for the pineywoods, oak woods and prairies, and blackland prairie ecosystems of East Texas.

Cooperative funding provided by Ellen Temple, Joan and Rufus Duncan Memorial Fund, Amanda Haralson and Thomas Livesay, Jim Brown, Susan Temple, the Winston 8 Land and Cattle, Cynthia and George Mitchell Foundation, Pineywoods Foundation, East Texas Communities Foundation, Texas Department of Transportation, USDA Natural Resources Conservation Service, and the U.S. Forest Service.

Examining Seedbanks in Stock-Piled Top Soils

Dustin A. Golembiewski, Anthony D. Falk, Sandra Rideout-Hanzak, and David B. Wester

Stock-piling topsoils can be a useful management technique to aid in the restoration of areas disturbed by natural resource extraction. Topsoil is collected and piled in a nearby location to be reapplied when the extraction process is complete. These piles of topsoil can sit stagnant for many years before reapplication.

This greenhouse study complements a long-term field study examining restoration success of topsoils at varying depths within a stock-pile, post-restoration. Segregated layers of the stock-pile were laid out in separate strips, as well as a control layer consisting of subsurface soils that previously composed a berm surrounding the frac pond. Each surface was divided into 15 plots. Three seeding treatments were used: (1)

a mix of native grasses, (2) a mix of native grasses and a cover crop, or (3) no added seed. Each plot was randomly assigned a seeding treatment.

Two years post-restoration a composite soil sample was taken from each of the plots. Each sample was placed in a separate greenhouse tray. Each tray was watered and monitored daily; seedlings were identified as they emerged. Plots seeded with only the mix of native grasses had a more robust seedbank. This result reflects what has been observed at the field site to an extent. The control surface contained on average 157 seedlings per square yard, whereas our stock-piled surfaces produced fewer than 56 seedlings per square yard. These densities reflect initial emergence under ideal greenhouse conditions. We will explore this result further in a greenhouse study examining restoration success of subsoils from a different frac pond.

Cooperative funding provided by Alston and Holly Beinhorn.

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-Santos, 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 objective is to develop a pasture-scale sampling methodology to estimate forage mass in rangelands using 3D models derived from drones. The objectives of this research are to (1) develop a protocol for sampling forage standing crop at the pasture-scale and (2) compare field-based and drone-based forage estimation methods. The field-based estimation methods we will compare are traditional clipping and weighing and the traditional double sampling method, with the double sampling method using the drone to collect visual estimations. To accomplish these objectives, we will fly the drone at 150 feet and 300 feet above ground level over predetermined transects. The obtained imagery will be used to develop a 3D model to quantify vegetation height.

Our findings will provide information on the practical use of drones for forage estimation. This type of information can be used for the collection of many samples using a non-destructive and inexpensive method to estimate forage standing crop for grazing animals. We expect that with this approach we will be able to collect a larger number of samples than in the field, thereby providing improved estimates of forage standing crop available to livestock and wildlife.

Cooperative funding provided by the USDA Natural Resources Conservation Service and the Rotary Club of Corpus Christi (Harvey Weil Sportsman Conservationist Award Trust).

Restoring Native 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, there has been a rapid increase in the development of large-scale solar energy facilities for both industrial and public consumers. In 2019, we were approached by a large energy company who had recently developed a 200-acre solar farm in Goldsmith. Their goal was to restore the site to suitable habitat for pollinators and wildlife, while also reducing soil erosion to benefit the functionality of the solar farm.

We advised the energy company on the use of a nurse crop of winter wheat, seeded in late fall 2019, to be followed with planting a diverse mix of native grasses and forbs in spring 2020. Soil remediation, such as caliche removal and disking where heavy compaction was present, was also completed. In addition, erosion-prone areas were hydroseeded with a

The use of native plant seeds to restore pollinator and wildlife habitat in solar farms is being studied by *Texas Native Seeds Program* personnel.

cotton byproduct and a nutrient amendment to facilitate optimum plant establishment. Results this spring were positive, with a healthy stand of winter wheat and a diverse and robust native forb response. Over the coming years, we will document performance of this restoration effort and report the results.

This project will serve as an example of the benefits of restoration projects in the region in conjunction with solar energy development. We hope these efforts will encourage other solar farm operators to undertake similar efforts throughout Texas.

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

Strategies for Restoring Tallgrass Prairies in Northeast Texas

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

Native tallgrass prairies are a threatened ecosystem that is increasingly difficult to find. The land that supports tallgrass prairies makes very productive farmland, and has been used as such for hundreds of years. In contrast to farmland, the rich diversity of tallgrass prairies provides important ecosystem services that should be preserved through enhanced restoration. The first step in ecosystem restoration is the selection of locally-adapted seed sources—and this information is lacking in northeast Texas.

The *East Texas Natives Project*, a component of the *Texas Native Seeds Program* operated by the CKWRI, is helping to restore 3,000 acres of tallgrass prairie in the Red River Valley on the Riverby Ranch located in Fannin County, Texas. This land is being used as part of the mitigation required for the 16,000-acre Bois d'Arc Reservoir being built nearby. Of these 3,000 acres, 250 acres have been set aside for experiments to determine the adaptation of commercial native seed varieties and to assess the performance of selected native seed mixes.

© Emily Bishop

We are investigating methods to restore tallgrass prairies with locally-adapted grasses and forbs in northeast Texas.

We are using 30 varieties of native grass seed along with mixtures of native grasses and forbs to determine which seed varieties should be used for the most effective restoration. One planting occurred in October 2019 and another in June 2020. We will monitor plant establishment and compositional dynamics in over 630 research plots. Our results will be used to inform individuals with similar tallgrass prairie restoration projects in northeast Texas, and help guide future seed source development efforts in the region.

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

Update on the Activities of the Statewide *Texas Native Seeds Program*

Forrest S. Smith, Shyla E. Rabe, Keith A. Pawelek, Anthony D. Falk, Colin S. Shackelford, Samuel R. Lutfy, John R. Bow, Douglas L. Jobes, Tyler C. Wayland, Liisa L. Hewitt, and Robert Obregon

The *Texas Native Seeds Program* (TNSP) continues to make significant progress in developing locally-adapted native plants for Texas. We also continue advancing knowledge about restoration methods. In 2011, TNSP expanded from the original *South Texas Natives Project* to Central and West Texas. Today, TNSP operates at the statewide scale with additional regional projects in the Permian Basin-Panhandle, East Texas, and the Coastal Prairies. In 2019, in recognition of the success and growth of the program, TNSP received the Texas Environmental Excellence Award for Agriculture from the Texas Commission on Environmental Quality and Governor Greg Abbott. We also received The Group Achievement Award from The Wildlife Society in 2019.

Throughout the state, TNSP staff continue working to collect seed of native plant populations, evaluate regionally important native plant species, and make available commercial seed releases to increase supply of locally-adapted native plant seeds. To date, over 45

native plant seed sources have been commercialized through the various projects operating as part of TNSP.

We are actively engaged in conducting restoration research in all areas of Texas. Currently, several thousand acres of restoration research plantings are being monitored. In addition, our staff have had the ability to provide native plant seed mix recommendations to a number of large-scale restoration efforts in 2019 and 2020. These included two of the largest pipelines being built in Texas, each impacting thousands of acres. The TNSP will continue working to improve the ability of private landowners, industry, and agencies to restore and conserve the native plants of Texas.

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

© Anthony Falk

Research is being conducted in conjunction with the Texas Military Department to determine effective pollinator seed mixes for use in the Blackland Prairie region.

Restoration of Pollinator Habitat on the Martindale Army Airfield

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

South Texas Natives Project (STNP) personnel in collaboration with the Texas Military Department have been working to restore pollinator habitat to 100 acres of fallow land surrounding the Martindale Army Airfield in San Antonio. The goal is to create low maintenance, permanent native vegetation cover that would provide habitat for pollinators and reduce maintenance and bird strike issues at the airfield.

The initial phase of the project involved several herbicide applications to control the weeds resulting from previous agricultural use. This phase occurred between spring 2017 and spring 2018. After the residual seed bank was controlled, STNP personnel seeded the site in autumn 2018 with a 37-species mix of commercially-produced, locally-adapted grasses and forbs.

Sampling a year after planting has shown that several grasses and forbs developed by STNP are performing well at this Blackland Prairie site and seeded plant density is approaching the accepted threshold for success. In particular, a number of the late successional grass species such as big bluestem, little bluestem, and sideoats grama are performing very well. Flowering species that have performed well from the seed mix include Texas bluebonnet, pink evening primrose, and mealy blue sage.

We will monitor the site for two years to document the performance of the restoration effort, and to track any increase in the late successional species over time. Results from this project will help guide future seed mix recommendations that benefit pollinators at other Blackland Prairie sites near San Antonio.

Cooperative funding provided by the Texas Military Department.

Developing Native Seed Supplies for the Coastal Prairies Region of Texas

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

The Coastal Prairies and Marshes ecoregion of Texas is unique because of its history of large-scale agriculture production, prairie grasslands, and the current metropolitan growth. One threat to wildlife and native habitat conservation in the region is habitat loss. The lack of native plant seed sources for restoration projects limits addressing this loss.

We are collecting seed within an 18-county area. Seed collections are placed 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 soil types. Species being evaluated include little bluestem, yellow Indiangrass, silver bluestem, purpletop tridens,

and rattlesnake master. Top performing populations will be identified for commercial seed production. In addition, two collections of knotroot bristlegrass have entered this phase of the project after being evaluated from 2018–2020.

Providing quality native plant seed sources for restoration and reclamation projects plays an important role in wildlife habitat conservation and restoration. In addition to native plant seed source development, personnel from the *Coastal Prairie Native Seed Project* are also working to provide technical guidance to landowners and managers across the region, and to educate the public on the importance of native plant restoration efforts.

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.

Determining Crude Protein in Tanglehead Using Drones

Rider C. Combs, J. Alfonso Ortega-Santos, Humberto L. Perotto-Baldivieso, Sandra Rideout-Hanzak, David B. Wester, Douglas R. Tolleson, Michael T. Page, Alexandria M. DiMaggio, and Justin P. Wied

In recent years, advancements in the use of drones in scientific research have provided new avenues to collect data. This study is testing the application of drones to provide critical nutritional information of rangeland plants in South Texas. Our objective is to determine the relationship between crude protein in tanglehead and the imagery collected using a drone.

Flights will be conducted on a 10-acre tanglehead monoculture plot on a ranch in Jim Hogg County. Prior to each flight, patches of tanglehead will be mowed once a week for five weeks and GPS locations of individual plants will be recorded. This will provide us with known growth stages of grass for analysis.

By knowing the growth stages, it will ensure that as each monoculture matures at different stages, the amount of crude protein content can be documented. Using the drone to collect aerial imagery, we will obtain a greenness color value of the individual marked plants. After the flight is complete two, 2.7 ft^2 areas will be clipped per mowed plot, individually bagged, and sent off to a forage lab for percent crude protein analysis. Through statistical analysis and building on other research, we aim to develop a method to estimate crude protein percentage in plants in different growth stages. This information will aid in determining supplementation needs for cattle.

© Rider Combs

Phantom IV Pro RTK drone landing after an image acquisition mission in a rangeland pasture.

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

Update on 20 Years of Progress of the *South Texas Natives Project*

Anthony D. Falk, Keith A. Pawelek, Robert Obregon, Liisa L. Hewitt, and Forrest S. Smith

The *South Texas Natives Project* (STNP) is celebrating its 20th year of operations in 2020. As STNP hits this milestone, we are continuing to develop new seed releases for use in South Texas. We have also worked with commercial seed dealers to increase commercial seed quantities, and continue to conduct research focused on native plant restoration techniques that can be used by landowners, industries, and agencies.

The STNP, and the now statewide *Texas Native Seeds Program*, has finalized two plant releases in the past year. While we continue to make new releases, we have also maintained our focus on producing larger seed stocks to meet the growing demand from commercial seed companies. As native plant seed demand has increased in South Texas, so has commercial grower interest, which requires greater amounts of foundation seed to be produced by the STNP. Much of the recent demand for native plant seeds in South Texas is related to construction of new oil and gas pipelines.

Along with seed production, STNP staff continue to collect data on several large-scale and long-term restoration projects. The goals of these projects are to evaluate the performance of our seed releases in new locations and to help refine restoration methodology, resulting in proven recommendations for practitioners. Particular areas of focus have been pollinator habitat restoration and restoration of sandy soils in the South Texas Sand Sheet. New projects in 2020 will continue our focus on invasive grass control and explore the role of cover crops in restoration seedings.

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

Developing a Downtown Midland Native Plant Demonstration Garden

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

The Permian Basin is the largest oil and gas producing region in the United States. As such, it has become home to some of the industry's largest companies. Concho Resources, Inc. has partnered with the *Permian Basin-Panhandle Native Seed Project* to establish and maintain a native plant and restoration demonstration garden to showcase commercially available species for restoration projects in the region.

The garden was established in spring 2018, and it contains six species of native wildflowers and 21 native grasses that are available or in development. Two species of native wildflowers were added to the garden in spring 2020. Each species is displayed in 10-foot squares with five-foot walking rows in-between. The garden gives people an idea of the growth habits of the plants 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.

© Samuel Lutfy

Educational efforts are being conducted by *Texas Native Seeds* and Concho Resources, Inc. using a native plant garden in downtown Midland.

Cooperative funding provided by Concho Resources, Inc.

Long-term Response of Tanglehead to Prescribed Burning and Grazing

Alexandria M. DiMaggio, J. Alfonso Ortega-Santos, Humberto L. Perotto-Baldivieso, Chase H. Walther, Sandra Rideout-Hanzak, and David B. Wester

Tanglehead is a native grass found throughout South Texas that has become invasive. It creates dense stands and chokes out other plants that are important for wildlife. Patch-burn grazing is a method that involves burning portions of the pasture to provide more nutritious forage. Cattle concentrate in these areas and begin to change the plant community through disturbance. We have been monitoring 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.

We selected a tanglehead-dominated pasture in Jim Hogg County. Plots of about 10 acres were treated with prescribed burning in 2016 and 2019. This site has been continuously grazed at a stocking rate of about one animal unit per 24 acres. Tanglehead coverage, forage use, plant species richness, total plant cover, and forage standing crop are monitored monthly.

We expect plant species richness will be increased by reducing the cover of tanglehead through concentrated cattle grazing in the burned plots. We hope our study can provide a method for landowners in South Texas to manage tanglehead while providing forage for cattle and improving habitat for wildlife.

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

A Photo Guide to Plants of the Coastal Prairies Region of Texas

Dexter Peacock, Douglas L. Jobes, Elliot P. Tucker, and Forrest S. Smith

Understanding what plants occur on a property can serve multiple purposes for a landowner. Whether it is for enjoyment's sake or to better understand the interactions of wildlife and their habitat, a simple to use and detailed photographic guide for plants in the Coastal Prairies region of Texas is needed. Using photographs and easy to read descriptions, this guide will be an especially useful tool for those who are not schooled in traditional botanical terminology and scientific vocabulary.

Photographs of common plants are currently being collected and organized while a more comprehensive species collection list for grasses, forbs, shrubs, and trees is being compiled. Plants included in the guide will be categorized by their physical appearance, and each plant entry will include photographs at various stages of the plant's life cycle. Significant collaboration will occur within the region, and landowner participation will play an important role in the development of this guide.

Educational and outreach efforts are an important tool that can encourage and assist landowners of the region. By correctly identifying native plants, those interested can begin to understand the importance of protecting and promoting the imperiled landscape of the Coastal Prairies region of Texas. Our work will continue to aid the *Texas Native Seeds Program* and the *Coastal Prairie Native Seed Project* by fostering new relationships and expanding our outreach opportunities.

© Douglas Jobes

Landowners and *Texas Native Seeds Program* personnel are collaborating to publish a field guide to the common vegetation of the Coastal Prairies region.

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

Soil Organic Carbon Effects on Rangeland Productivity

Douglas J. Goodwin, J. Alfonso Ortega-Santos, Humberto L. Perotto-Baldivieso, Douglas R. Tolleson, and William E. Fox

It has been reported that soil organic carbon is a primary driver of biologically active soil systems. These soil systems are important to grazing land productivity and may contribute to the mitigation of climate change. However, few studies have shown the direct relationships of soil organic carbon on soil dynamic properties, herbaceous production, or diversity on rangelands in the southern Great Plains.

There is a need for robust tools and techniques to quickly, affordably, and accurately measure soil properties. A method used to lower costs is spectroscopy, which measures the reflectance of light in specific wavelengths to estimate soil properties. Our objectives are to (1) assess the effectiveness of estimating soil organic carbon using visible, near, and mid-infrared spectroscopy and (2) understand soil organic carbon's influence on properties that influence grazing land production, such as soil water holding capacity and plant productivity. To determine these relationships, 14 similarly managed grazing land operations in southern Oklahoma and northern Texas were sampled.

Preliminary results suggest a positive relationship between traditional soil organic carbon analysis methods and less expensive spectral techniques. Additional analyses are being conducted on soil dynamic properties and herbaceous variables.

Cooperative funding provided by the Noble Foundation.

Licensing the Production of Native Seed Releases

Keith A. Pawelek, Forrest S. Smith, and Janie Hurley

In recent years, the strategy to bid out production and licensing of new seed releases has become the primary seed commercialization model of the

Texas Native Seeds Program (TNSP). This allows seed producers to have a fair chance at producing a seed release through our program. In addition, it also allows our program the ability to maximize production of the releases being licensed, decrease the amount of seed needed to supply commercial growers, and set production and quality standards. Seeking production without the use of licenses has typically resulted in a minimum of three years before any seed reaches the commercial market.

Ten new seed releases were licensed to the commercial seed growers in 2018, with seed being sent out and commercial production beginning in 2019. In one growing season, all 10 new releases were successfully produced by our seed industry partners. Seed of those releases should be available to consumers in 2020. In 2021, TNSP plans on licensing five additional native seed releases to help supply ecotypic seed sources for use across Texas.

Commercialization of native seed releases is a major reason for the success of the TNSP. Seed production licenses are a useful tool in achieving the program's mission, and to achieving our ultimate goal of enabling the successful restoration of native plant communities to benefit wildlife in Texas.

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

Ecology and Management of Whitebrush in Texas

Evan P. Tanner, Edwin A. Valdez, and Megan K. Clayton

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 help reduce coverage. Such treatments look to promote other desirable plant species for wildlife populations. Recently developed herbicides have created new ways to control for this species, though research in field settings is needed to better understand what promotes application success. Furthermore, limited knowledge on the basics of whitebrush ecology exists. Such information would provide researchers and managers with a complete approach to addressing management concerns related to this species.

We will collect seeds from whitebrush plants at study sites in Frio, Uvalde, and Webb counties, and establish a greenhouse study to quantify elements of the basic reproductive ecology of whitebrush. We will also establish research plots at these sites in which whitebrush stands will be treated with newly developed herbicides at varying application rates across both dormant and growing seasons. These approaches will help to determine the most effective chemical treatments to control dense stands of whitebrush across Texas rangelands. Site treatments will begin in fall 2020 and will continue until fall 2022. Results from this research will provide rangeland managers and scientists with new knowledge and management options related to the control of this native, yet locally invasive shrub species so that more desirable plants may be promoted throughout Texas shrublands for wildlife populations.

A study plot in Uvalde County where whitebrush mortality was monitored one year after herbicide treatment.

Cooperative funding provided by the Houston Livestock Show and Rodeo, Bayer, Corteva Agriscience, and Texas AgriLife.

National Fish and Wildlife Foundation *West Texas Native Seed Project* Research

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

The *West Texas Native Seed Project* and the *Permian Basin-Panhandle Native Seed Project* have begun a new project funded by the National Fish and Wildlife Foundation (NFWF). The 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 support existing efforts of the *West Texas Native Seed Project* to develop new seed sources for habitat restoration across West Texas. Funding will help with farm operations for new plant evaluations and seed production for new plant releases. NFWF funding will provide partial support for two assistant director positions and a full-time technician position employed through project partners at Sul Ross State University in Alpine. Funding from the Pecos Watershed Conservation Initiative will also help in the development of best practices guidelines for restoration in West Texas. Twenty acres of new restoration research plantings will be installed in the region through the project. 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 Ranches and the Sierra la Rana Development, Stan Smith, and the Railway Ranch.

When Can We Fly a Drone for Vegetation and Wildlife Surveys?

Annalysa M. Camacho, Jesse Exum, Humberto L. Perotto-Baldivieso, J. Alfonso Ortega-Santos, Aaron M. Foley, Randy W. DeYoung, and Shad D. Nelson

Drones are becoming an increasingly popular tool for vegetation mapping and wildlife surveys. Compared to traditional monitoring methods, drones can provide improved accessibility and safety in rough terrain, and can cover the same areas repeatedly. Drones are used with thermal infrared cameras to detect and monitor wildlife. Thermal and multispectral cameras are useful to evaluate landscapes and vegetation composition, respectively. However, the quality of data acquired by these sensors is dependent on daily and seasonal weather variations. For instance, it becomes harder to detect wildlife as the ambient temperature approaches animal body temperature. Therefore, drones will be most efficient during the seasons or times of day that ambient conditions enable the sensors to operate with maximum effectiveness.

It is important to predict the daily and seasonal windows that optimize data collection. The objectives of our research are to (1) determine the best time of year and (2) determine the best time of day to conduct aerial surveys and imagery acquisition in South Texas

© Humberto Perotto-Baldivieso

Graduate student Annalysa Camacho flying a drone over a South Texas rangeland to map vegetation cover for forage mass estimation.

using drones. We have acquired 30 years (1990–2019) of average monthly temperature data and hourly temperature data for 53 South Texas counties. Using monthly temperatures, we have generated isotherms to identify temperature zones as a basis to find optimal conditions for drone flights throughout the year. We will use hourly temperature data to evaluate the best time of day within selected months to recommend drone data acquisition. Our research findings will provide ecologists and natural resource managers useful information for acquisition of data using drones.

Cooperative funding provided by the National Science Foundation and Dallas Safari Club Foundation.

Genomic Analysis of Common Texas Native Grasses

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

Texas Native Seeds Program (TNSP) personnel are involved in the collection and evaluation of native plant material for developing plants adapted to specific regions in Texas. In our previous field research, plant differences have been found. However, the impact of seed origin in relation to these differences is poorly understood. The objective of this study is 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 populations consisting of 53 little bluestem, 12 silver bluestem, and six blue grama plants. The project produced 508 million sequences for an average of 5.6 million sequences per plant. Sequence analysis is being conducted at Texas A&M University-College Station.

We will use the data obtained to identify plant population structures that will help guide decisions for future plant releases based on geographic location. We have also begun to look at the microbiome of little bluestem while isolating microbial genetics from little bluestem populations. We created sequencing libraries from 40 sequenced bacterial communities and 40 fungal communities from the plants. These microbial community samples are being processed in labs at Texas A&M AgriLife in Stephenville. Results from this research should improve plant selection and restoration success throughout Texas.

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

Restoration of a Frac Pond in the Western Rio Grande Plains

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

Advances in explorative and extractive technologies have facilitated the growth of the natural resource industry in Texas and throughout the nation. The extraction of oil and gas can take a toll on local habitats, thereby influencing biodiversity and ecosystem functions. A common recommendation to enhance restoration post-extraction is stock-piling topsoil.

Restoration of native vegetation to areas previously used as frac ponds is one of the most challenging aspects of restoration associated with oil and gas operations.

Our study area, a retired fracking pond in Dimmit County, Texas, was restored in 2017 with stock-piled topsoil collected prior to construction. We segregated the existing stock-pile into three layers that were 4.5 feet in thickness and distributed these layers (along with a fresh topsoil surface and a non-amended surface) in separate strips over the pond. Each of the five surfaces was seeded with a mixture of (1) 13 native grasses, (2) 13 native grasses plus an annual warm-season grass cover crop, or (3) non-seeded.

A site is generally considered 'restored' when it achieves a density of two to five desirable plants per square yard. Two years post-restoration, seeded grass densities averaged up to 15 plants per square yard when considering all surface and seeding treatments, up from five plants per square yard the previous year. We also found that seeding enhanced plant density for the "top" layer of stock-pile as well as the non-amended surface.

We will continue to monitor and analyze plant density as well as species composition. We will also collect soil samples to be analyzed for chemical content and soil microbial community composition. Our goal with this research is to assess the recommendation of stock-piling topsoil following soil disturbance.

Cooperative funding provided by Alston and Holly Beinhorn.

Commercial Seed Production of *Texas Native Seeds Program* Releases

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

Commercial producers were able to make great progress with their production of ecotypic plant releases developed by the *Texas Natives Seeds Program* (TNSP) this past year. Ten new germplasm releases will enter the commercial market in fall 2020 thanks to the hard work of our seed industry partners over the past two years. With many big projects underway in Texas, especially oil and gas rights-of-way seeding, highway rights-of-way seeding, and private restoration, there was a shortage of supply of many native plant seeds during 2019–2020. To combat this supply shortage, commercial growers have increased production acreage of many species in 2020.

Over 20,000 pounds of seed from releases developed by TNSP was produced during the 2019 growing

© Keith Pawelek

Assisting with and facilitating large scale commercial seed production of locally-adapted native plants is a key function of the *Texas Native Seeds Program*.

season. This marks a slight decline in production, which reflects the challenges of meeting the demands of the growing native seed market. This reduction in production was due primarily to weather and growers needing to cycle out older production in the same growing season. If current conditions hold, there should be well over 50,000 pounds of seed produced in 2020. Several harvests have already been made and the seeds are being cleaned.

In many areas of Texas, diverse mixes of locally-adapted native plant seed mixes are now available for use. Because of the added seed production in 2020 many areas in Texas will have seed that can be used for restoration projects. Since demand for many of these native plant species is still outweighing the supply, it is highly recommended that one should consider pre-ordering for upcoming seeding projects to ensure seed will be available.

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

Quail Ranch Native 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. Results of this research will help inform public and private business operators on best practices for restoration. These projects also help to define the areas of adaptation of each seed product.

The *Permian Basin-Panhandle Native Seed Project* has partnered with Concho Resources, Inc. to develop 20 acres of plantings on the Quail Ranch, located in Upton County. The plantings include two separate 10-acre sites. Each site was no-till drilled with native plant seed mixtures containing 15 species. Each site also includes five acres enclosed with rabbit-proof fencing to study the impacts of rabbit 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 three years after planting. In seeded areas where herbivory was allowed, the invasive species, Lehman lovegrass, dominated the vegetation and the seeded species were negatively impacted or eliminated entirely by rabbit grazing. In the future, larger scale plantings, or ones 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.

Cover Crop Considerations to Enhance Pipeline Restoration

Brianna M. Slothower, Anthony D. Falk, Terry Blankenship, Sandra Rideout-Hanzak, Veronica Acosta-Martinéz, Forrest S. Smith, and David B. Wester

Pipelines in South Texas play a crucial role in distributing natural gas. When a pipeline is placed into the ground, the soil surface is left exposed. This creates an opportunity for invasive plants to establish and push out desirable plant species. In earlier research, we found that an annual grass cover crop not only reduced exotic grass biomass following pipeline installation, but also did not affect native grass biomass. These results suggest complicated plant-to-plant interactions that warrant further research to understand the underlying mechanisms involved.

We have designed an experiment that will study interactions between cover crops, native grasses, and invasive grasses as affected by season of planting along a pipeline in San Patricio County. Seeding will take place in summer 2020 when conditions are less than ideal as well as in late fall 2020 when conditions

are more favorable. The summer-seeding cover crops will be millet and cowpeas, and the winter-seeding cover crops will be oats and hairy vetch. Both plantings include a mix of 11 native grasses. We will monitor plant establishment dynamics and the changes in species composition in permanently-located sampling areas. A second component of this study will explore the role of native grass species richness on establishment dynamics by testing the hypothesis that strategically-selected mixes of fewer native species are as effective in competing with invasive grasses as native mixes with higher species richness. Our results will be used to develop guidelines for pipeline restoration.

Cooperative funding provided by L. H. and P. M. Stumberg.

Valley Crossing Pipeline Creates Pollinator Corridor

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

The installation of a new pipeline is associated with both positive and negative concerns for private landowners. Financial gain through payments for easements is one benefit. However, invasive species introduction and erosion issues may outweigh these benefits. Restoration using locally-adapted native plants may help reduce these concerns.

We worked with Kenedy County landowners and Enbridge Energy Partners to develop a locally-adapted native plant seed mix consisting of 19 species to restore wildlife and monarch/pollinator habitat on a 200-foot wide by 56-mile long section of easement for the newly constructed Valley Crossing Pipeline.

South Texas Natives Project (STNP) staff are collecting vegetation data on and off the rights-of-way to evaluate how well the reseeding worked. Eighteen months after the seeding, vegetation cover on and off the rights-of-way are nearly identical. This indicates overall efforts to reestablish vegetative cover to the rights-of-way have been successful, particularly since this area of South Texas has historically been difficult to reestablish vegetation following soil disturbance.

Vegetation composition across most of the rights-of-way has been affected more by the past or neighboring vegetation than by the seed mix, especially where invasive grasses occur. The seed mix has performed well in less sandy soils. However, some of these same areas have shown increases in invasive grasses in comparison with the surrounding landscape. We will continue to collect data to track long-term changes in vegetation communities over time and make management recommendations for this and other pipeline projects impacting the South Texas Sand Sheet.

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

Pollinator Habitat Restoration at Camp Bowie Training Center

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

In October 2019, staff of the *Central Texas Native Seed Project* (CTNSP) began a restoration project with the Texas Military Department at the Camp Bowie Training Center in Brown County. The objective was to increase pollinator plants in a grassland dominated

Native seed mix totaling 275 pounds was applied to 42.5 acres at Camp Bowie Training Center in 2019.

Common Name	Seed Variety	Seed Mix (by PLS)
Awnless bushsunflower	Plateau	6.0
Black-eyed susan	-	6.5
Clammyweed	Zapata Rio Grande	18.0
Cowpen daisy	-	0.5
Deer pea vetch	Hoverson Germplasm	7.0
Drummond phlox	-	1.5
Engelmann daisy	Eldorado	13.5
Greenthread	-	8.2
Gregg's mistflower	-	0.3
Hookers plantain	-	7.0
Illinois bundleflower	Sabine	36.7
Indian blanket	STN	21.2
Lemon mint	-	4.0
Maximillian sunflower	Aztec	8.1
Mexican hat	-	6.5
Orange zexmenia	Goliad Germplasm	5.4
Partridge pea	-	36.2
Plains coreopsis	-	6.5
Prairie acacia	Rio Grande	11.2
Prairie bundleflower	-	2.0
Prairie verbena	-	4.0
Purple coneflower	-	1.5
Purple prairie clover	Cuero	8.1
Redseed plantain	STN-496	8.0
Smooth seeded wildbean	-	3.0
Standing cypress	-	10.1
Texas bluebonnet	-	24.6
Tahoka daisy	-	0.5
Tropical sage	-	1.2
Zizotes milkweed	Mariposa	0.3

by Texas wintergrass by seeding native forbs and legumes, which are beneficial to both wildlife and pollinator species.

Eighty-five acres were prepared for seeding using mowing and herbicide treatments. In April 2020, a native plant seed mix consisting of 31 species was seeded using a no-till seed drill. Monitoring will be conducted to determine how well different plant types perform in relation to soil type, planting date, site preparation, location, and seed mixture percentages. Data will be collected next year to capture the seasonal differences in cool and warm season plants. Additional information will be collected to evaluate how each plant type performed compared to its relative percentage of the seed mix.

Findings from this study will be used to better understand which native plants work best for a pollinator seed mix in Central Texas. This information will allow CTNSP personnel to make improved seeding recommendations for landowners.

Cooperative funding provided by the Texas Military Department.

Winter vs. Summer Burning in the Gulf Prairies and Marshes

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

Gulf cordgrass, seacoast bluestem, and gulfdune paspalum are often found in the Gulf Prairies and Marshes ecoregion of South Texas, and they are important habitat for some wildlife species. When these grasses are not managed, old growth accumulates and inhibits the growth of other grasses and forbs. This results in low plant diversity. Historically and naturally, grasses in the Gulf Prairies and Marshes ecoregion are adapted to periodic fires. However, in recent years, fire return intervals (FRI) may be different than before European settlement. This change in FRI changes plant structure and composition, and it is compounded by overgrazing or poor management.

We are applying prescribed fire with FRIs of three and five years while keeping season of burn constant, either winter burn or summer burn. We will monitor and sample plant density and nearest neighbors of plants to determine changes in plant communities and relationships. The overall objectives of our study are to determine changes in plant diversity, structure, and composition of these communities with varied

Undergraduate student Juan Elissetche lighting a gulf cordgrass pasture with a drip torch during a winter burn.

combinations of FRI and season of burns. We also want to determine what other species or plant groups benefit from the presence or absence of gulf cordgrass, seacoast bluestem, or gulfdune paspalum. Lastly, we want to determine if relationships between neighboring plants change when we vary season of burn and FRI. This study will allow us to refine fire season and FRI recommendations based on various plant community objectives in the Gulf Prairies and Marshes.

Developing Multispectral Signatures for South Texas Grasses

Annalysa M. Camacho, Michael T. Page, Melaine Ramirez, Humberto L. Perotto-Baldivieso, J. Alfonso Ortega-Santos, Forrest S. Smith, Anthony D. Falk, Dwain Daniels, Tony Kimmet, and Shad D. Nelson

Multispectral sensors have become part of the drone toolbox for vegetation monitoring in the last five years. Compared to traditional vegetation monitoring and identification practices, drones may provide an alternative method that will allow repeated low altitude monitoring and allow the least amount of disturbance to the landscape. Multispectral sensors can capture five spectral bands (red, green, blue, red edge, and infrared), which can be analyzed to identify plant species. The combination of very high spatial resolution (less than 1-inch pixels) data acquisition, increased spectral resolution, and on-demand data collection can potentially help in the assessment of grass cover composition over larger areas of rangelands.

Our objective is to create spectral signatures for native grasses in South Texas. To achieve this objective, we plan to acquire data from the *Texas Natives Seeds Program* and the E. "Kika" de la Garza Plant Material Centers' monoculture plots to build a digital library of spectral signatures. Flights will be conducted to assess spatial and phenological variability. Once these libraries are built, we will acquire data from pastures across South Texas and we will assess the feasibility of quantifying species composition using multispectral sensors mounted on drones.

The results of this study may provide an excellent tool to identify, monitor, and quantify the presence of native grass species in the South Texas landscape. We will then use these approaches to expand our analyses to other regions in Texas.

Cooperative funding provided by USDA Natural Resources Conservation Service, National Science Foundation, and the Rotary Club of Corpus Christi (Harvey Weil Sportsman Conservationist Award Trust).

Development and Release of Native Seed Supplies for Central Texas Restoration

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

Central Texas Native Seed Project's (CTNSP) goal is to develop locally-adapted native plant seed sources. This is accomplished through collecting, evaluating, selecting, increasing, and eventually releasing native plant populations that can be mass produced commercially. CTNSP personnel collect native plant seed in 67 counties encompassing several ecoregions. Evaluations are conducted at the Texas A&M AgriLife Research Center near Stephenville, the USDA Natural Resources Conservation Service James E. "Bud" Smith Plant Materials Center near Knox City, and the Sandbrock Ranch near Aubrey.

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Indiangrass at the USDA NRCS Plant Materials Center is being evaluated by the *Central Texas Native Seed Project*.

In 2019, new plant evaluations consisted of 60 populations of Indiangrass and 22 populations of gayfeather at the Stephenville, Knox City, and Aubrey locations. Data collected include growth measurements, plant characteristic rankings, seed production, and seed quality analysis. Past evaluations of seep muhly and sideoats grama grown at these sites resulted in the selection of the best-performing populations. These populations will be placed into seed increase plots, with release expected in one to two years.

Advanced evaluations will be conducted on selected populations as they are grown for seed increase in field plots at the Stephenville location. Seed harvested will then be distributed as Selected Texas Native Germplasm by the *Texas Native Seeds Program* to commercial seed companies. These and several other upcoming releases (hairy grama and tall grama) will result in a greater diversity of commercially available native plant seed sources for reclamation and restoration efforts in Central Texas.

Cooperative funding provided by the Texas Department of Transportation, USDA Natural Resources Conservation Service, Sandbrock Ranch, Lee and Ramona Bass Foundation, Texas AgriLife Research, Horizon Foundation, and Stillwater Foundation.

Restoring Native Rangelands in the Edwards Plateau

Evan P. Tanner, Molly E. O'Brien, David G. Hewitt, Forrest S. Smith, John R. Bow, and David B. Wester

Diverse native rangelands are important for wildlife conservation, livestock production, native pollinators, soil health, and erosion control. Past land use and contemporary disturbances reduce native plant cover and degrade the productive potential of rangelands. The development of commercially available, locally-adapted native plant seed sources has been a approach used for native rangeland restoration throughout Texas. However, seed mixes are lacking within areas of the Edwards Plateau. Furthermore, restoration methods can often be specific to a site or region. Thus, local techniques may enhance restoration success.

We will collect seeds from grass and forb species at sites in Menard County, Texas that have the potential for inclusion in native seed mixes for rangeland restoration in the Edwards Plateau. We will also establish plots in fallow agricultural fields to test seed mixes, planting and site preparation methods, and timing of planting on restoration success. Plant and arthropod biomass and biodiversity data will be collected for both pre- and post-treatment periods to assess floral and faunal responses to our experimental restoration treatments. Site treatments will begin in fall 2020 and will continue until fall 2022. Results from this research will provide new locally-adapted seed sources and will provide critical information necessary for landowners in Central Texas who wish to restore degraded rangelands and agricultural fields.

Cooperative funding provided by AEG Dos Ranches, LLC and facilitated through the Texas Ecolab Program.

Update on the Activities of 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) began operating in November 2017. PBPNSP's mission is to develop commercially available native plant seed sources for use in the Permian Basin and Panhandle regions and to engage the energy industry in the use of native plant seed in restoration and reclamation projects.

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Collection of native seeds from the Permian Basin and Panhandle of Texas will allow the development of locally-adapted native seed supplies for these regions.

Recent objectives include obtaining seed from native grasses and wildflowers of interest. Roughly 400 collections have been made from private and public lands. They are being planted for evaluation and selection at the Railway Ranch near Odessa, USDA Natural Resources Conservation Service's Knox City Plant Materials Center, and Texas Tech University's Quaker Avenue Research Farm in Lubbock.

Other objectives include educational and community outreach and developing partnerships with the energy industry and landowners in the Permian Basin. Concho Resources, Inc. has participated with PBPNSP in research plantings, developing 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 who have impacted thousands of acres in the region.

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

Using Drones to Define Thermal Cover at the Landscape Scale

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

High summer temperatures can be lethal to wildlife. Consequently, animals are forced to seek shade or wind to remain cool. Although heat is a common element of the South Texas climate, there has been little consideration regarding thermal cover for wildlife. In fact, most assessments of habitat quality for wildlife are based on food and hiding cover, and do not explicitly consider thermal cover. Overall, our knowledge of what makes good thermal cover or how to assess thermal cover at the landscape scale is lacking.

Recent advances in technology have the potential to change the way we survey landscapes. Drones are now routinely used for wildlife population estimation, damage management, and mapping vegetation communities. Drones equipped with thermal cameras offer the potential to map the thermal landscape for wildlife by taking advantage of the fact that ground temperature

and temperatures detected from the air are similar due to temperature diffusion through vegetation.

In this study, we are flying drones equipped with thermal cameras over an array of black-globe thermometers in South Texas rangeland. The black globe thermometers measure operative temperature (all sources of heat an animal is exposed to). We will fly the drone over the target area at 2-hour intervals at an altitude of 300 feet and collect over 100 thermal images per flight. We will compare the thermal images to the data from the black globe array across the study site to validate the relationship between ground temperature and thermal imagery. The results of this study may provide a rapid and cost-effective means to identify and monitor thermal cover in the future.

Cooperative funding provided by the Zachry Foundation.

Evaluation of the genetic lineage of Indiangrass populations across Texas will help develop ecologically appropriate native plant seed releases of this important native grass.

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

Activities conducted by the *Texas Native Seeds Program* (TNSP) present a unique opportunity for the study of the genetic lineages of Texas' native plant species and to further our understandings of ecotypic variation across the state. In early 2019, TNSP staff moved forward with a statewide evaluation of Indiangrass, which contained roughly 80 unique accessions collected from across Texas, as well as previously released varieties of the grass. We are collaborating with The University of Texas at Austin's Juenger Lab to complete these evaluations.

The Juenger Lab has significant experience in conducting genetic studies of switchgrass, Hall's panicum, and other native grasses. Since Indiangrass is one of the "big four" prairie grass species of the North American Tallgrass Prairies, it has been studied in-depth and has baseline genetic information available that makes it easier to work with than less-studied species. There is also significant conservation and restoration interest in this species.

In September, emerging leaf tissue samples were collected from roughly 80 accessions and immediately sent on ice to the lab for processing. Those samples underwent DNA extraction, PCR and chloroplast tagging, followed by DNA sequencing. Afterwards, sequencing data were cleaned and compiled by computer software, then organized into matriarchal lineage "tree" models where significant divergences in the genetic code among accessions can be observed. These results will be used to make regionally-appropriate seed selections of Indiangrass to benefit restoration efforts across Texas.

Cooperative funding provided by donors to the Texas Native Seeds Program and the Juenger Lab at The University of Texas at Austin.

Effects of Duration of Burial on Viability of Native Grass Seeds

Brianna M. Slothower, Anthony D. Falk, Terry Blankenship, Sandra Rideout-Hanzak, Veronica Acosta-Martinéz, Forrest S. Smith, and David B. Wester

Restoration of areas that are disturbed by energy extraction and transportation face many challenges, such as weather and establishment of unwanted species including non-native grasses. To improve chances of success, many landowners invest heavily in the purchase of locally-adapted native grass seeds. Depending on season of seeding and prevailing climatic conditions, however, it is commonly observed that plant emergence is delayed. What is the fate of seeds that have been buried in the soil?

We are initiating an experiment that will document changes in seed viability and germination of seeds that have been buried in the soil to replicate seeding. Seed pouches (made of fine-mesh polyester screen) will be filled with 100 seeds of each of 11 native grasses

and four cover crops of known viability and buried in soil along a pipeline in San Patricio County, Texas. Pouches will be extracted one, two, six, nine, and 12 months following burial. We will determine the number of remaining seeds in each pouch, their viability, and their germination potential.

This research will help us understand what happens to buried seeds, and will help document which species can develop transient or persistent seed banks. Additionally, this information will help us to develop recommendations about the need for reseeding if conditions following the initial seeding are not conducive to emergence and establishment success.

Cooperative funding provided by L. H. and P. M. Stumberg.

Collection and Development of Native Seed Sources with Texas NRCS

Forrest S. Smith, Keith A. Pawelek, Anthony D. Falk, Robert Ziehr, John Reilley, Robert A. Shadow, Brandon Carr, Colin S. Shackelford, Tyler C. Wayland, Douglas L. Jobes, Samuel R. Lutfy, and John R. Bow

Locally-adapted native seed supplies are a fundamental resource needed for successful restoration and revegetation. In much of Texas, commercial quantities of appropriate native plant seeds are lacking. To address these seed shortages and develop needed germplasm seed releases of desired species, staff of the *Texas Native Seeds Program* (TNSP) and the USDA Natural Resources Conservation Service (NRCS) Plant Materials Centers (PMC) in Kingsville, Nacogdoches, and Knox City are collaborating through a series of Cooperative Ecosystem Studies Unit projects supported by Texas NRCS.

© Douglas Jobes

Cooperation between *Texas Native Seeds Program* and USDA NRCS personnel has allowed expansion of efforts to develop native seed supplies for all regions of Texas.

In the past year, staff of the TNSP and the PMC added 400 new native plant collections from across Texas to the PMC inventory for future research. In support of evaluation and seed increase research, 42,500 plants of various native species were grown in greenhouses of the PMC and TNSP. Evaluation and selection studies for 11 native plant species were started in the last year. These studies include 354 unique native plant populations comprised of common grasses and several desired pollinator plants.

In 2020, additional evaluations were started. These evaluations included Arizona cottontop and Canada wildrye for northwest and West Texas, purpletop tridens and rattlesnake master for the Coastal Prairies and East Texas, and Lindheimer tephrosia for South Texas. Finally, seed increase efforts were undertaken for 35 native species, resulting in the production of over 370 pounds of seed of previously released or soon to be released native plants. This seed will be provided to qualified commercial growers to use for commercial production to improve seed supply for consumers across Texas.

Cooperative funding provided by the USDA Natural Resources Conservation Service Texas Cooperative Ecosystem Studies Unit.

Developing Deep Learning Methods for Classifying Wildlife Habitat

Taylor S. Trafford, Michael T. Page, Justin P. Wied, Humberto L. Perotto-Baldivieso, and Jeremy A. Baumgardt

Recent advances in remote sensing have paved the way for artificial intelligence algorithms to improve classification approaches for land cover. Within these approaches, "deep learning" is a method that uses multiple layers of information for feature identification and patterns. It is fast, flexible, and reliable, and it can provide results that can be repeated with multiple imagery subsets.

Deep learning accumulates machine intellect during its applications by exposing the deep neural networks to large amounts of data. This can save time and effort, compared to the current pixel-by-pixel image classification approaches. Our goal is to create complete workflow to classify aerial imagery from the National Agricultural Imagery Program on an operational scale.

Our objectives are to (1) create a functional code model, (2) evaluate the accuracy of our image classification algorithm, and (3) expand image classification to ongoing research sites. Using these approaches, we expect to be able to perform image classifications with greater than 95% accuracy, which is higher than pixel-by-pixel methods.

Upon completion, we will be able to deliver classified imagery faster than what is currently being produced. This will allow us to classify images from drones, satellites, LANDSAT, and other platforms. In addition, it will provide a tool to researchers at the CKWRI with a unique ability to generate land cover data for wildlife habitat studies.

Cooperative funding provided by the South Texas Chapter of Quail Coalition and USDA Agricultural Research Service.

Irrigated seed production of native plants selected for release facilitates commercial seed availability.

Update on the *West Texas Native Seed Project*

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

Significant progress toward the development of locally-adapted native plant seed supplies for West Texas was made in 2019 and 2020. Thirty-eight accessions of hairy grama, 11 accessions of narrowleaf globemallow, and 10 accessions of tobosa grass were planted for evaluation at the Sierra la Rana Plant Evaluation and Research Facility in Alpine and the Railway Ranch Plant Evaluation and Research Facility near Odessa. Data collection will continue through 2020 before selected accessions are planted in seed increase fields for eventual commercial release. Twenty-three species have now been evaluated, or are presently undergoing evaluation, for West Texas.

Twelve species for grassland restoration in West Texas are now in seed increase fields for commercial release. These include eight grasses (black grama, blue grama, Hall's panicum, hooded windmill grass, sand dropseed, sideoats grama, silver bluestem, and whiplash pappusgrass) and four forb or shrub species (cowpen daisy, Gregg's mistflower, skeletonleaf goldeneye, and Tahoka daisy).

Three seed releases have been completed and are currently in commercial production: Brewster Germplasm sideoats grama, Permian Germplasm whiplash pappusgrass, and Santiago Germplasm silver bluestem. Plans are in place for the additional releases of sand dropseed and cowpen daisy in 2020. Seed collections for West Texas are also ongoing to support future seed selections for the region. Presently, over 1,400 native seed collections have been made.

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

Prescribed Fire and Butterflies in Coastal South Texas

Rebecca R. Zerlin, Jose S. Avila-Sanchez, Sandra Rideout-Hanzak, David B. Wester, and Tyler A. Campbell

We owe one out of every three bites of food we take to pollinators. Pollinators help plants reproduce by moving pollen from one part of a flower to another. There are over 200,000 species of pollinators worldwide, which pollinate almost all the world's plants, including about 75% of the major agricultural crops. Most pollinator species are insects, such as beetles, bees, and butterflies. Texas has the most recorded butterflies of any state at over 450 species observed. With this many pollinators, land managers should look for ways to provide better habitats for these species.

One method is the use of prescribed fire. Humans have historically used fire to clear out brush and debris, remove certain invasive species, and encourage new

© Rebecca Zerlin

A painted lady butterfly nectaring on the flowers of a common lantana in southern Texas.

plant growth. With major insect population declines over the past three decades, pollinator conservation is becoming more important to our everyday lives.

The purpose of this study is to look at the effects of prescribed fire on butterfly populations. Located on a ranch in southern Texas, our field site consists of 16 plots ranging from 500 to 1,200 acres that are burned in different seasons (winter and summer) and time intervals (long-term, short-term, and no-burn). Butterfly surveys are being conducted monthly to see how the butterflies respond to the different burns. Our results will aid, not only in pollinator conservation, but insect conservation as well.

Cooperative funding provided by the East Foundation.

Native Seed Development for the East Texas Understory

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

Over the next 20 years, national forests in East Texas will experience an increase in land disturbance resulting from oil and gas activity. This increase highlights the need for a reliable supply of regionally-adapted native plant seed sources for effective reclamation of disturbed sites. We have partnered with the U.S. Forest Service and the USDA Natural Resources Conservation Service East Texas Plant Materials Center to provide the seed needed to support native plant restoration efforts in the region. The commercial production of native plant seed helps to provide the quality and quantity of seed needed to meet restoration demands in East Texas.

Our focus is on the collection and evaluation of native understory species to determine the best performing plant populations for commercial production. We are also working to increase the availability of current source-identified seed varieties to help meet immediate supply demands. The goal is to enable successful restoration by providing quality seed sources best suited for the region. Native plant seed produced from this partnership will help to restore disturbed sites and increase the quality of habitat for wildlife in the piney woods and blackland prairies of East Texas.

Cooperative funding provided by the U.S. Forest Service, Ellen Temple, USDA Natural Resources Conservation Service, and the numerous private donors to the East Texas Natives Project.

Examining the Use of Frac Pond Subsoil for Restoration of Native Grasses

Dustin A. Golembiewski, Anthony D. Falk, Sandra Rideout-Hanzak, and David B. Wester

Oil and gas extraction sometimes requires the construction of frac ponds. When a frac pond is dug, the displaced soil is piled into berms surrounding it to provide for water containment. These berms can be several yards tall. Prior to creating these berms, the topmost one to two feet of surface soil is often stock-piled in a nearby location to be reapplied when the extraction process is complete. This topsoil generally is considered a better substrate for restoration than subsurface soils because of its higher organic matter and resident seed bank.

We have documented that subsoil material recovered from the berm surrounding a frac pond is able to support a diverse plant community when seeded with desirable grasses, contrary to what was predicted and what often is seen in practice. Favorable plant establishment was observed soon after restoration, and data collected three years post seeding document stable plant communities comprised of many native grasses.

Using similar frac pond subsoil from a nearby site in Dimmit County, Texas we will conduct a greenhouse study to further explore plant establishment dynamics in the subsoil material that is used during frac pond construction. We will compare subsoils to stock-piled surface soils and monitor native grass

seedling emergence under greenhouse conditions. Together with data that characterize the physical and nutritional aspects of these two growth mediums, this information will provide further insight into our goal of assessing the efficacy of stock-piling topsoils.

Cooperative funding provided by Alston and Holly Beinhorn.

Evaluating Mesquite Canopy Height Using Drones

Michael T. Page, Victoria M. Cavazos, Hunter Carroll, Kiri Baca, Rider C. Combs, Humberto L. Perotto-Baldivieso, Melaine Ramirez, J. Alfonso Ortega-Santos, Dwain Daniels, and Tony Kimmet

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 is to test the feasibility of using drones to estimate structure and distribution of mesquite on the landscape. The specific objectives are 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. Digital photogrammetry software was used to process the images to create 2D and 3D outputs. These images will be used to evaluate and perform analyses for honey mesquite distribution and canopy heights.

We plan to use artificial intelligence to classify honey mesquite distribution using data derived from drones, and compare our results to satellite imagery classification. This information will be useful to rangeland managers to quantify and monitor honey mesquite encroachment, and for wildlife studies to quantify woody cover properties not captured by traditional satellite imagery alone.

Cooperative funding provided by the USDA Natural Resources Conservation Service and the Rotary Club of Corpus Christi (Harvey Weil Sportsman Conservationist Award).

Restoration of Native Grassland on the South Texas Sandsheet

Anthony D. Falk, Keith A. Pawelek, Bart Dupont, Jimmy Rutledge, and Forrest S. Smith

Native grass restoration of the iconic Wild Horse Desert of the South Texas Sand Sheet has proven to be difficult in the past due to the soils, climate, and lack of commercially available, locally-adapted native species. *South Texas Natives Project* staff, in collaboration with the El Coyote Ranch, are attempting to restore 120 acres of native grassland habitat impacted by the installation of an electrical transmission line.

We tested two seed drills specifically designed for planting native plant seed. The drills were used to plant a commercially available mix of locally-adapted species developed by the *South Texas Natives Project*. The first technique uses a Truax flex II native seed drill, and the second uses a Trillion drop seeder. Both planters have seed boxes that are designed to handle chaffy native plant seed. The flex II drill has planting units that place the seed into the soil, while the Trillion drops the seed on the ground and uses cultipackers to press the seed into the soil.

Preliminary results indicate that there are no differences between the two planting methods. Two years after seeding, plant density reached 0.5 seeded plants per square foot, and we measured increases in the percent basal cover of seeded vegetation to nearly 30%.

We plan to continue collecting data for another year. Additional restoration research dealing with former oil and gas pads and invasive grass control is also underway as part of our collaboration with the

Restoration of native plant communities impacted by energy transfer is a critical conservation concern being addressed by the *South Texas Natives Project*.

El Coyote Ranch. Results from our study will help inform those interested in restoration projects on the South Texas Sand Sheet.

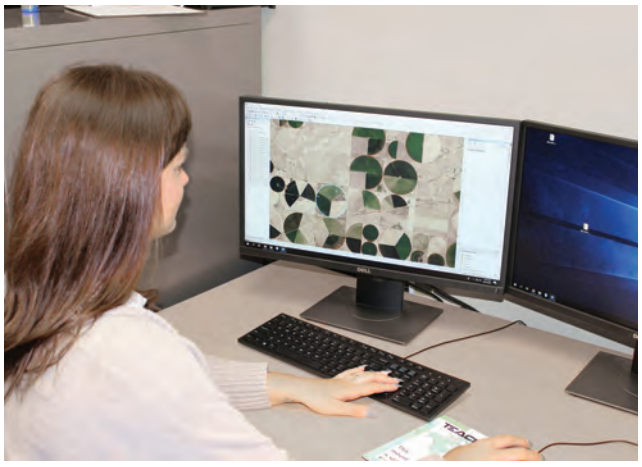
Cooperative funding provided by the Lee and Ramona Bass Foundation and the many generous donors to the South Texas Natives Project.

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 agriculture focused on sorghum, cotton, 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 is 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. We observed that total agricultural area decreased from 2004 to 2012 by 6%, and then increased after 2012. The number of fields followed a similar change (8% reduction between 2004 and 2012) as total agricultural area. Once the review of data from 2019 is completed, we will quantify the amount and spatial distribution of land cover data by sub-ecoregion and county for each year.



© Humberto Perotto-Baldivieso

Undergraduate student Shae Diehl digitizing crop land cover using USDA National Agriculture Imagery Program aerial photography.

Our findings will provide a detailed picture of spatial and temporal dynamics of land cover changes over the past 15 years. The information obtained will also provide insight to the effects of rangeland fragmentation and its potential impact for wildlife species of the Texas Panhandle region.

Cooperative funding provided by the Texas Parks and Wildlife Department.

The Sandbrock Ranch Native Grassland Restoration and Demonstration Project

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

In its second year of a restoration project with the Sandbrock Ranch, the *Central Texas Native Seed Project* (CTNSP) has seeded 200 acres in the Blackland Prairie of northcentral Texas back into native grassland. The objectives of the restoration project also include the establishment of demonstration plots of native plants used in the restoration. CTNSP staff provided written support to manage seed mixtures, collected data on plants, and monitored the growth of native grassland seed mixes. These results will be used to make restoration recommendations for the northcentral Texas region.

Along with large-scale restoration plantings, CTNSP staff established seed source evaluation plots of sideoats grama and seep muhly at the Sandbrock Ranch. Selections of top performing plants were made based on data collected on plant performance from this site compared to other sites with the same plants in Knox City and Stephenville. These selected plant populations will be increased and released for commercial seed production for use in restoration efforts.

With the completion of these restoration projects, CTNSP will be leading educational outreach efforts to create greater awareness of the importance of native grasslands in the Blackland Prairie. Restoration findings will also be distributed to landowners, agencies, and the public in northcentral Texas to aid in restoration efforts.

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

Spread of Tanglehead with Patch Burning and Grazing

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

Over the past 15 years tanglehead grass has been increasing its spread throughout native South Texas rangelands. According to the literature, this is likely due to reduced grazing pressure and the resilience of this species to droughty conditions. As tanglehead continues to increase and form monocultures, it threatens ground bird habitat.

The objective of this study is to determine the rate of spread of tanglehead under four treatments. The study area is a 236-acre pasture on a ranch south of Hebbronville, Texas in the South Texas Sand Sheet. Three 10-acre prescribed patch burns were implemented in the 236-acre pasture in February 2019. Ten head of cattle are continuously grazed on the non-burned areas and the patch burns. Over the course of two years, the effects of the treatments will be measured on 60 individual tanglehead plants. Half of the individuals will be excluded from grazing by fencing each plant. Measurements include visually estimating percent cover of bare ground, litter, tanglehead foliar cover, and other species foliar cover all within a 2.7-ft^2 area surrounding the individual tanglehead plants. Tanglehead seedlings, seed heads per plant, and plant basal circumference will also be recorded. With the information gained in this study, we aim to quantify how fast an area with sparse tanglehead becomes a dense monoculture under our different treatment combinations. Findings from this study will provide ranchers with another set of tools to encourage diverse plant species needed for wildlife habitat while maintaining a profitable cattle operation.

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

Restoration Research at the Railway Ranch in the Permian Basin

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

A dramatic expansion of energy infrastructure in the Permian Basin and Panhandle regions of Texas has resulted in tens of thousands of acres of degraded rangeland that are potentially available for habitat restoration. While new seed releases are in development, there is a need for the study and promotion of successful planting methodologies with the currently available seed sources from the region.

Studies are being conducted at the Railway Ranch in the Permian Basin to test native plant restoration methods and controlling rabbit damage to newly emerging plants.

In addition to the many recommendations our program makes and our ability to monitor restoration activities, we have been able to install two research projects 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 five acres seeded with a native plant seed mix of 20 species. In each replicate, two methods of seeding are being compared (Trillion broadcaster and Truax no-till native seed drill). In addition, a number of exclosures in each planting area have been installed that will allow us to test for the potentially negative effects of rabbits on restoration success. Data for the first year have been collected and analyzed, and data from the second year are being collected.

Initial results between sites with exclosures and sites with no exclosures suggest that herbivory has negatively affected the success of the seedings. In addition, use of the no-till drill resulted in greater plant establishment than the broadcaster. Further research into nurse crops for stand establishment protection and other ways to curb rabbit herbivory may benefit native plant restoration efforts in the region.

Cooperative funding provided by Stan Smith and the Railway Ranch.

Community Dynamics of Migratory Shorebirds in the Laguna Madre

Jason P. Loghry and Bart M. Ballard

The Laguna Madre is an ecologically rich hypersaline lagoon that supports large numbers of shorebirds during migration. However, the migratory shorebird community has yet to be adequately quantified or characterized. Thus, we initiated a study to better understand the importance of the Laguna Madre as a stopover site for shorebirds during spring migration.

We will conduct biweekly surveys from late-February through May 2020 and 2021 to determine abundance and species composition of migrating shorebirds. Surveys will be conducted using an airboat, and each survey will cover about 165 miles of tidal flat habitat. For each flock encountered, overall abundance, species composition, and location will be recorded. Shorebird abundance will be determined through a combination of direct counts and visual estimation of large flock sizes. Species composition will be determined by direct identification during counts of smaller flocks or video recordings of larger flocks.

Preliminary results during our first year of surveys suggest that peak abundance occurred in early April 2020 with over 300,000 shorebirds tallied; dunlin and western sandpipers were the most numerous species. An understanding of abundance, timing of migration, and areas of use for migrating shorebirds in the Laguna Madre will provide critical information to enable resource managers to reduce impacts to shorebirds from increasing development in the region.

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

Spring Migration Strategies of Northern Pintails

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

The continental population of northern pintails remains below management objectives despite improved breeding habitat conditions over the last three decades. Pintails wintering in different regions are subject to varying stressors during winter, survive at different rates throughout winter, and migrate through markedly different landscapes during spring migration. Also, pintails spend large portions of their annual cycle in nonbreeding areas compared to other species. Thus, factors outside the breeding season may have large impacts on their populations.

We plan to investigate winter ecology of pintails in different wintering regions in North America, as well as compare spring migration strategies of pintails departing from different wintering areas. Also, we propose to investigate linkages between migration strategies and nesting success, and identify critical stopover areas for pintails migrating from various wintering areas.

We captured 143 female pintails and placed tracking devices on them during our first field season. Capture areas included the Louisiana coast, Texas coast, Texas Panhandle, New Mexico, Arizona, and Central Valley of California. About 200,000 locations and over one million accelerometer samples have been recorded from females with tracking devices. Accelerometers allow us to understand behavior of birds remotely. Our results will strengthen our knowledge of non-breeding ecology of pintails and help answer questions important to resource managers.

Cooperative funding provided by the Texas Parks and Wildlife Department, U.S. Fish and Wildlife Service, and Ducks Unlimited, Inc.

Assessment of the Breeding Mottled Duck Survey Along the Western Gulf Coast

Vijayan Sundararaj, Bart M. Ballard, Kathy K. Fleming, and Daniel P. Collins

The breeding population of the mottled duck in Texas and Louisiana has shown a decline over the last four decades. A range-wide breeding survey was designed and started in 2008 to assess annual changes in population size. A transect survey is conducted from an airplane to cover the large geographic range of the mottled duck in a short time during peak nesting. However, the ability to detect mottled ducks from an airplane varies among cover types such as coastal marsh, agriculture fields, and rangeland. Parts of the transects are surveyed from a helicopter to help correct for this difference in detection, which is assumed to facilitate observing all ducks available. A visibility correction factor is then derived from the ratio of the helicopter and airplane survey counts.

Because of high variability in the survey results over the years, we are evaluating aspects of the survey to identify sources of variation. We will analyze the effects of several environmental variables such as vegetation cover, amount of wetland area, and drought severity on the variation in aerial survey results. Our aim is to understand those factors that cause variation in the annual survey counts and adjust the design of the survey to reduce their effects, thereby gaining better estimates of breeding mottled ducks.

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

Factors Affecting Settling Patterns of Breeding Northern Pintails

Matti R. Bradshaw, Kevin J. Kraai, Daniel P. Collins, J. Dale James, James H. Devries, Mitch D. Weegman, and Bart M. Ballard

Capturing ducks for nesting studies has traditionally focused on areas where biologists thought females would nest. However, this could bias our assessment of breeding ecology as our predictions on where birds are distributed during breeding may be different from what occurs.

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.

We placed 143 tracking devices on female pintails across their winter range in North America during late winter 2019–2020 to allow an unbiased settling of birds on the breeding areas. We plan to place another 180 tracking devices on female pintails during winter 2010–2021. 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 United States.

Cooperative funding provided by the Texas Parks and Wildlife Department, U.S. Fish and Wildlife Service, and Ducks Unlimited, Inc.

Identifying Key Stopovers for Migratory Shorebirds

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

Migrating birds manage their time and energy for a timely arrival on breeding areas in optimal body condition. During migration, time is spent on stopover sites where birds rest and refuel before making the next leg of their journey. Thus, distribution and quality of stopover sites are critical to successful migration.

Often, we don't have a clear understanding of how human-induced changes to stopover sites impact migratory birds. This is primarily 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 propose to attach automated tracking devices to three species of shorebirds during winter along the lower Texas coast prior to the bird's departure on spring migration. From the location data, we will estimate several metrics that will help us understand migration strategies employed by the different species. We will then relate variation in the migration metrics to the bird's estimated reproductive success on their breeding areas.

Information from our study will help us identify important stopover sites used by migratory shorebirds. This information 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. Kleberg, Jr. and Helen C. Kleberg Foundation.

Surveys to monitor migrating shorebirds are conducted in the vast expanse of tidal flats of the Laguna Madre.

Population Structure and Reproduction of Nilgai Antelope in Southern Texas

Megan M. Granger, Landon R. Schofield, Scott E. Henke, Clayton D. Hilton, and Tyler A. Campbell

The nilgai antelope is a large Asian antelope endemic to India, Pakistan, Bangladesh, and Nepal. Nilgai were introduced into Texas approximately 100 years ago. Today, their numbers in Texas exceed the numbers from their native range. Nilgai are documented hosts of cattle fever ticks, and because of this, they have been implicated as hosts that could potentially cause the reintroduction of cattle fever into southern Texas. Therefore, knowledge of nilgai ecology, behavior, and reproduction in southern Texas holds great importance to potentially keeping this once-devastating livestock disease in check.

Our objectives will be to determine the population structure, age, density, sex ratio, and reproductive capability of nilgai antelope in southern Texas. Data will be gathered from aerial surveys and from fortuitous harvests. Tooth wear patterns will be compared to cementum annuli and crown-lingual measurements to develop an aging system for nilgai. Reproductive data will include follicle counts, crown-rump length measurements, fetal sex, feti per cow, and live births to determine nilgai reproductive potential. Our study will add to the knowledge base of one of the most prolific invasive ungulate species in southern Texas.

Cooperative funding provided by the East Foundation.

Quantifying Wild Pig Damage to Crops Using Drone Imagery

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

Wild pigs cause about $1.5 billion dollars each year in damage to agricultural crops in the United States. However, it can be challenging to identify and quantify pig damage from the ground, especially in the larger agricultural fields. Remote sensing technologies, such as drones, are becoming a widely available tool in wildlife management and can be used to map properties, conduct wildlife surveys, and monitor agricultural fields for pest damage. Consequently, we are using drone imagery to assess wild pig damage to crops in Delta County, Texas during 2019–2020.

We flew a drone in parallel transects at an altitude of 300 feet to monitor wild pig damage in five corn fields. We assessed damage during four plant growth stages: planting, vegetative, milk/blister, and dent/mature. We merged drone images from each growth stage into a single, field-wide image to provide an accurate estimate of damage and compared drone estimates to ground surveys and to spatially explicit estimates of crop yield during harvest. We are also evaluating a machine-learning algorithm that can automatically classify the drone imagery.

Ongoing work will focus on developing a practical means for detecting and monitoring crop damage, with the goal of quantifying the amount and timing of damage. The methods developed in our study can be used by farmers to time damage mitigation when it will have the greatest effect, and to estimate the cost-to-benefit ratio of damage control efforts.

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.

Elk Abundance and Herd Demographics in Virginia

Heather N. Abernathy, David M. Kalb, Braiden A. Quinlan, Emily D. Thorne, W. Mark Ford, and Michael J. Cherry

Elk were once widely distributed across eastern North America including the Appalachian Mountains of Virginia. However, unregulated hunting resulted in wide spread extirpation of elk during the 19th century and the last elk was harvested in Virginia in 1855. The Virginia Department of Game and Inland Fisheries attempted to restore elk in the early 1900s, but failed. By the 1970s, they terminated protection for remaining elk. In 1997, Kentucky began restoring elk in the eastern portion of the state, including areas along the Virginia-Kentucky border. Consequently, elk from Kentucky began to disperse into Virginia, West Virginia, and Tennessee. In 2011, Virginia established the Elk Restoration Program in Buchanan, Dickenson, and Wise counties.

Many of the goals stated in the Virginia Elk Management Plan require estimates of herd abundance and demographics. Careful monitoring of populations

is especially important when managers seek to balance finely controlled harvests with other sources of mortality. Minimum counts are commonly used to estimate the abundance of small populations. However, these methods generally underestimate abundance and lead to an overly conservative harvest. Therefore, we are developing a method to estimate spatial variation in density and herd demographics of elk. Our approach will be used by managing agencies to monitor abundance, sex ratios, and recruitment of the growing elk herd in western Virginia.

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

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 Adalberto A. Pérez de León

The cattle fever tick (CFT) can transmit the *Babesia* protozoan to cattle, which causes bovine babesiosis. Control efforts have eliminated CFTs in the United States, except along the Texas-Mexico border. Livestock producers along the border must follow strict protocols for the transport and treatment of cattle, but the presence of wildlife has presented an additional challenge for CFT eradication.

Nilgai, an exotic antelope from India, are believed responsible for recent outbreaks of CFTs in South Texas. Introduced in the 1930s, more than 30,000 free-ranging nilgai occur in region. Nilgai have large home ranges (up to 13,865 acres), and can travel miles outside their home ranges. Since nilgai are not attracted to feed sites, medicated bait is useless; new methods are badly needed to deliver CFT treatments to nilgai.

We are evaluating remotely activated sprayer systems designed for treatment of CFTs on nilgai. The sprayers discharge a solution containing a tick-killing nematode, which is an effective nontoxic biocontrol for CFTs. Because nilgai use openings under fences to move between ranches, we deployed 120 sprayers at established fence crossing sites to determine if these sites are a feasible place to target nilgai. We marked 50 individual nilgai with ear tags and fitted 30 with satellite GPS radio-collars. We will analyze nilgai fence crossing behavior and their receptiveness to the sprayers using motion-activated cameras and the data obtained from the GPS locations.

The sprayers have the potential to treat nilgai for CFTs. This study will provide valuable information on nilgai fence-crossing behaviors and determine if fence crossing sites can be used for delivering treatments to control CFTs.

Cooperative funding provided by the USDA Agricultural Research Service.

Monthly Pronghorn Home Ranges in the Texas Panhandle

Dakota R. Moberg, Victoria M. Cavazos, Anthony P. Opatz, Timothy E. Fulbright, Randy W. DeYoung, David G. Hewitt, Warren C. Conway, Humberto L. Perotto-Baldivieso, and Shawn S. Gray

Pronghorn behavior is influenced by forage availability and disturbance in the landscape. There is very little information on the spatial and temporal distribution of pronghorns in the Texas Panhandle. Therefore, the goal of this project is to compare the spatial and temporal distribution of pronghorns in two contrasting landscapes: Dalhart, Texas area, which is an agriculture-dominated landscape, and Pampa, Texas, which is a rangeland-dominated landscape.

We hypothesize that male pronghorns will have larger home ranges than females and that home ranges in Pampa will be larger than in Dalhart because of the differences in the predominant habitat. To achieve our goal, we used GPS data collected from 64 pronghorns (32 males and 32 females) evenly distributed across the study areas. Location data from the GPS collars were

A pronghorn crossing a dirt road between two fallow fields in a landscape dominated by center pivot agricultural fields north east of Dalhart, Texas.

used to calculate monthly home ranges (50% home range and 95% home range) using a density estimator. We compared average monthly home range values between males and females and between study sites. Once we complete the monthly home range database, we will quantify the proportion of home ranges within crops and rangelands for each collared pronghorn. These monthly analyses will provide a more detailed insight on seasonal trends, as well as how much and when pronghorns are using agricultural fields.

Cooperative funding provided by the Texas Parks and Wildlife Department.

Assessing Bird Populations on the East Foundation Ranches

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

Bird surveys have been conducted on East Foundation properties since 2010. Both breeding and non-breeding bird surveys have been conducted on three of the properties belonging to the East Foundation in South Texas, specifically San Antonio Viejo, El Sauz, and Santa Rosa.

The non-breeding bird surveys were conducted from August–April to document species occurrence, richness, and abundance using transect surveys. During May and June, breeding bird surveys are being conducted to document bird species occurrence, richness, and abundance.

A scissor-tailed flycatcher rests on a fence on East Foundation's Santa Rosa Ranch. During the spring, scissor-tailed flycatchers are present in large numbers.

The East Foundation properties have a unique mix of avian species and vast diversity of landscape types because of their varying locations. Both Santa Rosa and El Sauz are a part of the Gulf Coast Prairies and Marshes ecoregion. Of the ranches, Santa Rosa contains the most diversity as far as avian habitat. Typically, El Sauz presents the largest species richness, despite not being the largest of the three ranches. This is likely because of its proximity to the Gulf Coast. However, recently, Santa Rosa has surpassed El Sauz in avian abundance. San Antonio Viejo is a part of the South Texas Plains ecoregion. Vegetation strongly influences avian distributions and dynamics. Therefore, it is important to assess how environmental changes are impacting species in long-term datasets such as ours.

Cooperative funding provided by the East Foundation and the C. C. (Charlie) Winn Endowed Chair for Quail Research.

Wild Pig Movements and Crop Selection throughout an Agricultural Landscape

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

The wild pig is a destructive, invasive species that is spreading across the United States. In Texas alone, there are more than 1.5 million wild pigs, and they are present in all but one county. Wild pigs are very good at adapting to different environments and to human pressure, which makes controlling their populations difficult. In agricultural areas, crop damage by wild pigs is a major source of lost income for farmers.

For wild pig control to be successful, it is important to learn more about pig movements and habitat preferences. We captured and fitted 30 adult wild pigs with satellite GPS radio-collars in Delta County, Texas during January–February 2019 and 2020. The area is a mosaic of row-crop agriculture, primarily corn, intermixed with pasture and woodlands and it has a high wild pig population that causes significant damage to crops. We recorded hourly locations from each collared pig for eight months. We plan to analyze the daily and monthly locations relative to the growth stage of corn crops. This will give us information on temporal movement patterns, home range sizes, habitat selection, travel corridors, and the crop stages most vulnerable to pig depredation.

Preliminary analyses suggest that home ranges of male wild pigs are larger than home ranges of females, and that wild pigs select corn fields during the mature stages when grain is available. Otherwise, they avoid these fields.

Ongoing analyses will determine if wild pigs travel long distances to access crops. In addition, we will identify important resting cover for wild pigs that forage on crops. The results of this study will allow landowners to design better control methods to alleviate wild pig damage to their crops.

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.

Movements and Habitat Selection of Nilgai in South Texas

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

The cattle fever tick (CFT) can transmit the *Babesia* protozoan to cattle, which is a major threat to the livestock industry. The United States has been free from CFTs since the 1940s, except for the permanent quarantine zone along the border between Texas and Mexico. Cattle producers in the zone follow strict protocols for transporting cattle and treating cattle for CFTs. However, CFT-infested wildlife can complicate eradication efforts by traveling outside the zone.

The nilgai is an exotic species introduced to South Texas in the 1930s and can be infested with CFTs. Their population has rapidly increased to over 30,000 free-ranging nilgai in Texas. Research on nilgai is limited, but previous studies reported they have large home ranges and can make long-distance movements. This is a problem for control of CFTs.

In March 2019, we fitted 30 nilgai in Cameron County, Texas with satellite GPS radio-collars that collect hourly locations for each nilgai. We will use the data collected to calculate nilgai home range sizes, quantify long-distance movements, and determine habitat selection.

Preliminary results indicate nilgai have large and highly variable home ranges: males, median = 1,712 acres (range 187–11,557 acres); females, median = 1,307 acres (range 71–13,865 acres). Two young female nilgai made separate long-distance movements, traveling over 23 miles beyond their capture location. Our findings suggest that nilgai can travel great distances without regard to artificial boundaries, thereby putting the United States at greater risk for the reemergence of CFTs. New information from our study about nilgai movement behaviors and habitat selection will help define focal locations for targeted nilgai-CFT treatments.

Researchers examining a nilgai for cattle fever ticks before placing a GPS radio-collar on the animal to track its movements within South Texas.

Cooperative funding provided by the USDA Agricultural Research Service.

Distribution of Pronghorns over Space and Time

Dakota R. Moberg, Victoria M. Cavazos, Anthony P. Opatz, Timothy E. Fulbright, Randy W. DeYoung, David G. Hewitt, Warren C. Conway, Humberto L. Perotto-Baldivieso, and Shawn S. Gray

The space-time cube is a model that can help us understand patterns on the landscape across space and time. This cube can provide information as to whether wildlife movements have distinctive patterns across the landscape through time. 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-dominated landscape. We selected pronghorns because their behavior is influenced by forage availability and landscape disturbance. We created space-time cubes for each individual GPS-collared pronghorn using a monthly step time. Once the analyses are completed, resulting patterns will be 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. We are currently classifying these patterns according to land cover information in relation to agriculture and rangeland. This will help us understand the temporal dynamics of pronghorn's spatial distribution.

Once we have identified pronghorn patterns of space and time within agricultural crops, we will identify the specific crop and growth stage within these areas using remote sensing imagery. Our analysis will provide insights into whether pronghorns are using agricultural fields, when they are using them, and how they may be using them.

Cooperative funding provided by the Texas Parks and Wildlife Department.

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

Cattle fever ticks (CFTs) can transmit the *Babesia* protozoan to cattle, which is a serious threat to the cattle industry. Outbreaks of babesiosis were common throughout the southern United States until the mid-1940s, when CFTs were eradicated from the region. However, the ticks remain common in Mexico, and the USDA maintains a permanent quarantine zone along the border to prevent re-infestation.

Recently, CFTs have spread north of the quarantine zone in South Texas, facilitated by nilgai antelope. Nilgai were introduced into South Texas in the early 1900s. Presently, over 30,000 free-ranging nilgai roam throughout the region.

Treatments for wildlife often rely on medicated feed or bait, but nilgai do not respond to this method. The USDA has developed a motion-activated sprayer system to treat nilgai for CFTs. The sprayers are placed at wildlife fence crossings, as nilgai prefer to push underneath fences rather than jump over. The sprayers emit a solution of water and nematodes when activated. The nematodes are microscopic roundworms native to the area that typically live in the soil, and are an effective, nontoxic biocontrol method for ticks. When these nematodes encounter ticks, they will parasitize and kill them.

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Motion-activated sprayers containing nematodes in a water solution are placed at fence crossing sites to treat nilgai for cattle fever ticks.

In 2019 and 2020, we deployed sprayers on five ranches in Cameron County. We monitored each sprayer site with a motion-activated camera and captured nilgai before and after a 3-month treatment period to collect and count ticks. If the sprayer method proves viable, this will provide a badly needed weapon for the control of CFTs on nilgai and possibly other wildlife.

Cooperative funding provided by the USDA Agricultural Research Service.

Effect of Hydromorphone in Reducing Perceived Pain by American Alligators

Scott E. Henke, Clayton D. Hilton, Cord B. Eversole, Tiffany L. Pope, Javier O. Huerta, and Matthew Cruz

The American alligator is an iconic reptile species that is associated with wetland ecosystems. Because of the American alligator's unique status in the United States, they can often be found in zoos, aquaria, and other tourism facilities.

Alligators have typical clutch sizes of 25 to 45 eggs and the young, when they hatch, remain together as a related cohort during their hatching year. Individual

growth rates are enhanced if they maintain social bonds with their siblings during the first two years. However, space requirements needed by individual alligators increase with age and aggression between siblings occurs, resulting in bite wounds.

Anesthesia, such as ketamine, has been used during invasive procedures to clean and repair wounds at zoos and aquaria, but long-term pain relievers for American alligators needed during their recovery period are lacking. We propose to investigate the effects of hydromorphone in the reduction of perceived pain by American alligators. We propose to use the percent response method of the Von Frey filament test to assess alligator reaction before and after the administration of the analgesic drug. If hydromorphone is successful, it can potentially become a component of the standard medical procedure when captive alligators become injured.

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 and 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 causing disturbance through loud vocalizations and threatening human property and health through their droppings.

In this study, we are estimating rose-ringed parakeet abundance in Kauai to evaluate the annual population growth rate. In addition, we monitored a culling effort from March–July 2020 to evaluate the number of birds culled per unit of effort, determine age and sex ratios, take morphological measurements, and assess whether culling at roost sites causes roost abandonment.

We estimated the 2020 population to include over 10,500 parakeets, despite the removal of over 7,000 individuals in the preceding 15 years. Preliminary results of the roost culling analysis indicate more than 40 parakeets can be removed per shooter per hour of effort, and that likelihood of roost abandonment appears to be reliant on initial roost size. These studies will be incorporated into an integrated pest management plan to reduce the invasive rose-ringed parakeet population and related impacts on Kauai.

The introduced rose-ringed parakeet is an invasive species that is causing severe crop damage on Kauai, Hawaii.

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

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 of the 56 counties of the Texas Panhandle. Their behavior and movements are easily influenced by the quantity and quality of forage as well as landscape features and human activity. However, there is limited information on the ecology and movement behavior of pronghorns in this area. The two study areas within the Texas Panhandle are near Pampa and Dalhart. Our objectives are 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 are analyzing 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. Pronghorns may require large amounts of connected land to maintain their population. The barriers to movements by pronghorns may cause loss of connectivity and have potential negative effects on population abundance.

The information obtained will provide a better understanding about the spatial and temporal dynamics of pronghorn movements across the landscape. Our analysis will provide important insights about the effects of human infrastructure, agriculture as barriers, and potential impacts caused by fragmentation.

Cooperative funding provided by the Texas Parks and Wildlife Department.

Effects of Aerial Shooting on Movements and Home Range of Wild Pigs

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

As an exotic species, wild pigs are legal to hunt year-round in Texas, which makes them a desired species for recreational hunters. Farmers and ranchers also remove wild pigs in an attempt to protect their crops and resources from damage. Aerial shooting of wild pigs is an increasingly popular, yet expensive, method for both recreation and damage control. However, wild pig response to aerial control methods has rarely been quantified.

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Understanding how wild pigs respond to control efforts can improve management.

In February and March 2020, we worked with Texas Wildlife Services personnel to monitor the effects of aerial shooting on wild pig population size and wild pig movement patterns in Delta County. The region contains croplands interspersed with pasture and woodland. Wild pigs are numerous in the area, and farmers suffer significant damage to crops and pasture lands.

We trapped and fitted 30 adult wild pigs with satellite GPS radio-collars to monitor their movements. We then established a grid system of motion-activated cameras to estimate the population size before and after aerial shooting. We flew the entire area on three occasions prior to crop planting season and removed as many wild pigs as possible during each flight. We will use the population estimates and number of wild pigs removed per flight to determine the effectiveness of aerial shooting. We will also compare the helicopter flight path to the locations of GPS-collared pigs to determine how they moved and responded during the flights. The results of this study will allow farmers, ranchers, and animal control specialists to assess the cost-to-benefit ratio of aerial shooting for the management of wild pig 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.

Immune System Variation in Nilgai from South Texas

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

The nilgai antelope is an exotic species from India that has flourished in South Texas since their introduction in the 1930s. Nilgai have become a management concern in the Rio Grande Valley of Texas because they are a suitable host for the cattle fever tick (CFT). The presence of CFTs in Texas threatens cattle herds with bovine babesiosis, a disease that can be devastating to U.S. livestock producers. Nilgai may spread ticks during long-distance movements and have been implicated in recent outbreaks of CFTs.

Genetic diversity can influence how well a population responds to pathogens and disease. Populations founded by few individuals, such as nilgai in South

Populations founded by few individuals may have low genetic diversity and increased susceptibility to disease.

Texas, often have low genetic diversity, making them more susceptible to disease. The major histocompatibility complex (MHC) is responsible for the recognition of pathogens and is one of the body's defenses against disease-causing pathogens.

In this study, we are analyzing the genetic diversity of the nilgai MHC. If nilgai have low genetic diversity of the MHC, they may be more susceptible to CFT infestations. To test the effectiveness of immune response, we will compare tick loads to the MHC diversity of nilgai captured in Cameron County, Texas.

Our preliminary results show nilgai have low MHC diversity compared to related species, with only seven unique gene variants, or alleles, occurring in the population. Understanding the genetic diversity and immune response of nilgai will help us determine if some individuals are more susceptible to CFTs than others. Our continued research will provide information on nilgai-tick interactions that can be used to aid in controlling CFTs.

Cooperative funding provided by the USDA Agricultural Research Service.

Genetic Variation in the Prion Protein Gene of White-tailed Deer

David Navarro, Randy W. DeYoung, Aaron M. Foley, Charles A. DeYoung, Don A. Draeger, Tyler A. Campbell, Julie A. Blanchong, and James M. Reecy

Chronic Wasting Disease (CWD) is a fatal neurodegenerative disease spread by a contagious form of the prion protein. Its ability to spread through both individual contact and environmental reservoirs has made CWD a major management concern for North American species of deer. Currently, there is no cure for CWD, but some white-tailed deer are more resistant to infection due to genetic mutations in the prion protein gene. The mutations associated with partial resistance are rare. However, most studies have focused on deer from the northern United States, and the frequency of these genetic variants in other populations is unknown. We sequenced the prion protein gene in four regions of the white-tailed deer's geographic range not previously sampled: South Texas, Iowa, North Carolina, and Northern Mexico.

- We observed six mutations that change the amino acid sequence of the prion protein gene and may influence its function, four of which were not previously reported in any species of deer.
- A mutation at codon 96 of the protein associated with partial resistance was rare in northern white-tailed deer.

The number and frequency of white-tailed deer that had a mutation at codon 96 of the prion protein gene. The mutation causes a change in the amino acid from glycine to serine and the resulting protein appears to confer partial resistance to chronic wasting disease. The frequency of the mutation varies geographically.

Location	Individuals	Glycine → Serine
Santa Rosa, TX	14	5 (35.7%)
San Antonio Viejo, TX	18	17 (94.4%)
El Sauz, TX	15	13 (86.7%)
Buena Vista, TX	15	12 (80%)
King Ranch, TX	19	17 (89.5%)
Comanche, TX	12	7 (58.3%)
Iowa	17	5 (29.4%)
North Carolina	12	2 (16.7%)
Coahuila, MX	15	4 (14.3%)
Sonora, MX	13	0

- Our results reveal a high frequency of the codon 96 mutation in white-tailed deer from the South Texas region, but low frequency in Iowa, North Carolina, and Mexico.
- The findings of our study reveal that presence and frequency of mutations in the prion protein gene are poorly characterized in white-tailed deer, and they underscore the importance of genetic sampling by geographic region for making informed management decisions.
- In South Texas, high prevalence of the codon 96 mutation may influence the spread of CWD and efforts to control the spread of disease.

Cooperative funding provided by the Comanche Ranch and the East Foundation.

Consumption of Feed Containing Ground Juniper by Deer and Feral Pigs

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

The pinyon-juniper woodland is one of the most widely distributed rangeland types in the world. Fire limitation and overgrazing have played primary roles in the increased encroachment of woody plants on rangelands. Juniper, a native invasive shrub, can degrade rangeland production. Research aimed at using juniper to lower the cost of livestock feed supplementation has shown that it can effectively be used as a roughage replacement in feedlot diets of ruminant livestock, including cattle, sheep, and goats.

Juniper contains compounds that act as defenses to herbivory. Ruminants, including white-tailed deer, have developed mechanisms for coping with these potentially toxic compounds. Non-ruminant species, such as the feral pig, may not have these capabilities. Therefore, our goals were to evaluate preference and intake of supplemental pellets containing ground blueberry juniper, including all tree parts except roots, by free-ranging white-tailed deer and feral pigs.

Four supplements were designed that differed by source and percentage of roughage in the diet: alfalfa 15%, alfalfa 30%, blueberry juniper 15%, or blueberry juniper 30%. To evaluate consumption by white-tailed deer and feral pigs, we used trail camera video data from four supplemental feeding sites located on the Welder Wildlife Refuge in Sinton, Texas.

- Percent roughage in the diet did not affect intake by feral pigs.
- There was no clear effect of percent roughage by type for white-tailed deer.
- The inclusion of ground juniper did not decrease supplementation loss due to consumption by non-target species such as feral pigs.
- Inclusion of ground juniper could potentially help to reduce production cost of supplemental pellets but further research on deer health and performance is necessary.

Genetic Diversity in the Immune System of White-tailed Deer

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

The major histocompatibility complex (MHC) is a genetic region that is important in the recognition of pathogens. Genetic diversity at the MHC can provide immune protection from a range of pathogens. This is supported by the increased susceptibility to disease in populations with low genetic diversity in the MHC. White-tailed deer populations appear to have high diversity at MHC genes, but studies have only been conducted in a portion of their geographic range.

To further understand genetic variation at the MHC, we sampled white-tailed deer in South Texas and obtained DNA sequences of the MHC. We compared our results to genetic variation discovered in previous studies. We also compared white-tailed deer DNA sequences to those of closely related species to understand evolutionary relationships at the MHC.

- We observed 22 unique alleles (different forms of the gene) in the South Texas deer population; 11 alleles were previously unreported.
- Evolutionary relationships between white-tailed deer alleles suggest that alleles vary by geographic region, but some are genetically similar and may respond to the same type of pathogens.
- Comparisons across species revealed that most alleles were unique to each species. However, some alleles were shared by multiple species. This may result from the retention of ancient alleles or convergent evolution in response to similar pathogens.
- Our findings suggest that MHC variation in white-tailed deer is poorly characterized. Knowledge of the genetic diversity and evolutionary relationships among MHC alleles will aid in our understanding of how populations respond to pathogens, with implications for prevention of disease.

Cooperative funding provided by the Comanche Ranch.

Limitation of Dietary Energy Affects Size of White-tailed Deer

Levi J. Heffelfinger, Ryan J. Reitz, Deanna Pfeffer, David B. Wester, David G. Hewitt, and Randy W. DeYoung

Population performance as reflected by body condition, reproductive output, and survivorship are tightly linked to nutrient availability. Therefore, regional population demographics in white-tailed deer can vary dramatically. The specific limitation responsible for variable body condition and population metrics is assumed to be a consequence of overall nutrient availability by region, but this has not been directly tested in an experimental setting.

We tested how dietary energy affects development and body size of white-tailed deer by raising three cohorts (309 deer) born 2012–2014 in captivity at the Kerr Wildlife Management Area. At weaning, fawns were assigned to one of two treatments: (1) low energy diet or (2) standard energy diet, while keeping protein content the same. We recorded feed consumption for cohorts, sex, weight, body condition (for animals over 0.5 years old), skeletal size, and antler size of males annually for each individual until the age of 5.5 years.

- Males and females exhibited lower body weight and body condition score throughout all ages

© David Hewitt

Captive white-tailed deer enable scientists to study the effects of digestible energy on deer growth, body size, and antler characteristics.

greater than 0.5 years old on the low energy diet compared to the standard energy diet.
- We observed no differences in skeletal size between treatments except for adult male body length, which was shorter for the low energy diet treatment.
- Male antler size was smaller across all age classes on the low energy diet.
- Feed consumption of the low energy diet was greater for both sexes compared to the standard energy diet.
- Geographic differences in deer body and antler size can likely be explained by differences in digestible energy content of the diet.

Cooperative funding provided by the Texas Parks and Wildlife Department.

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

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

The white-tailed deer is a valuable sport hunting species in South Texas, and often coexists with cattle on most ranches. Cattle grazing has been used to improve habitat, and the grazing optimization hypothesis has been used to predict increases in forage productivity at moderate levels of grazing intensity. Additionally, cattle preference for grasses may favor the productivity of forbs for white-tailed deer by reducing competition. However, cattle grazing can also damage wildlife habitat if not used correctly. Even though grazing herbivores consume primarily graminoids, forbs are eaten as well.

© J. Alfonso Ortega-Santos

Herbivores avoided low productive sites for grazing, which has important implications for estimating stocking rates to avoid competition among deer, cattle, and other herbivores.

Results of studies of grazing effects on graminoids and forbs in a semiarid climate have been inconsistent. Therefore, the objectives of this study were to determine how grazing affects forb standing crop production for white-tailed deer and to determine plant species richness throughout the study sites.

We selected six 6,183-acre study sites located on the East Foundation ranches in South Texas. Fifty 16-ft^2 grazing exclosures were placed randomly on the study sites. Forage standing crop was determined by collecting grasses, preferred forbs, and non-preferred forbs; plant species richness was also determined at each sampling point.

- Although this study was conducted for eight years, the legacy effect from overgrazing by cattle and wildlife and the worst drought since the 1950s likely was not a long enough period to see a herbivory impact on forbs preferred by deer.
- The grazing optimization hypothesis may work on landscapes in climax plant community conditions, but not in sub-climax rangelands.
- Herbivores avoided less productive sites. The implication is that estimation of correct grazeable area is vital in calculating a correct stocking rate. This finding represents a significant contribution to grazing management in South Texas.

Cooperative funding provided by the East Foundation.

First Record of Chorioptic Mange in White-tailed Deer

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

Chorioptic mange is a contagious skin disease of herbivorous mammals caused by the common cattle itch mite or Texas itch mite. Chorioptic mites are surface-dwelling mites that cause hair loss and an oozing skin rash usually on the lower limbs. These mites can also be found on the scrotum, resulting in lower fertility of males.

Chorioptic mites are known to occur on domestic animals, such as dairy and beef cattle, sheep, goats, and horses, and wildlife species, such as reindeer, serow, moose, and gazelles. Four hundred twenty-nine white-tailed deer were captured for research purposes

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The deer pictured had patchy areas of hair loss and reddened skin along the insides of the rear legs, which is an indicator for *Chorioptes* spp. mite infestation.

in companion studies from which we conducted skin scrapings on deer that exhibited signs of mange.

- Of the deer captured, 29 (7%) displayed signs of hair loss and reddish-colored, oily, and thickened skin on their necks, hindquarters, and inner thighs of their back legs.
- Skin scrapings of two deer (7% of sample) that showed signs were positive for *Chorioptes* mites.
- DNA analysis revealed that mites were *C. texanus*, a species that typically infests wildlife.
- Our study documents the first known case of chorioptic mange in white-tailed deer. It is possible that deer can serve as a reservoir host and increase the spread of the disease throughout livestock herds that inhabit the same area.

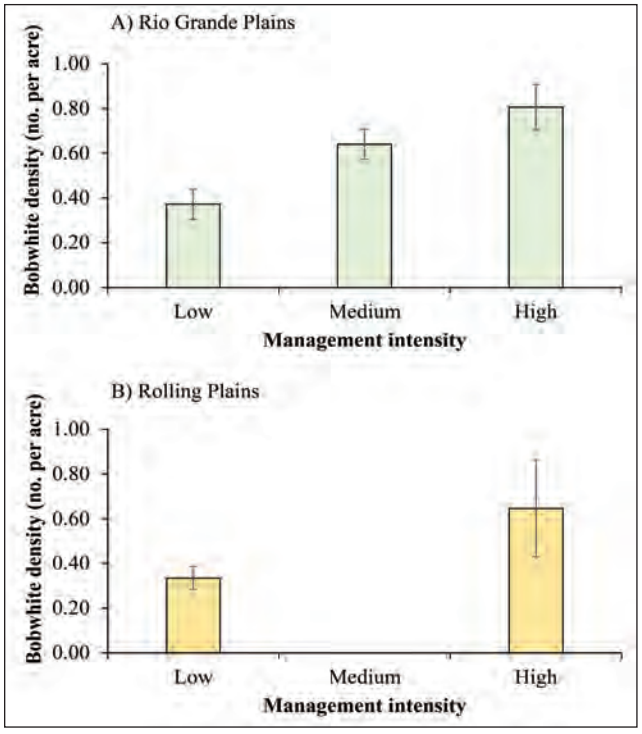
Quail and Rain: Does Management Matter?

Alec D. Ritzell, Fidel Hernández, Eric D. Grahmann, John T. Edwards, Dale Rollins, and David B. Wester

Quail populations fluctuate dramatically in relation to rainfall. Managers have attempted to minimize the boom-and-bust nature of quail populations through management. However, because rainfall can account for 70 to 90% of the variability in regional quail populations, the effectiveness of management has been questioned. Our objective was to determine if management could stabilize bobwhite populations in the face of variable rainfall.

We conducted helicopter surveys in the Rio Grande Plains (11 sites) and Rolling Plains (four sites) of Texas during each winter 2014–2018. We quantified quail management on each site via landowner surveys and documented annual rainfall. We used three sources of data (quail density, management intensity, and rainfall) to evaluate the importance of management in maintaining quail densities on semiarid rangelands.

- Bobwhite density fluctuated dramatically during the 5-year period in both ecoregions. In the Rio Grande Plains, bobwhite density increased to a high of 0.81 bobwhites per acre (2016) and decreased to a low of 0.35 bobwhites per acre (2018). In the Rolling Plains, bobwhite density increased to a high of 0.82 bobwhites per acre (2016) and decreased to a low of 0.04 bobwhites per acre (2018).
- Bobwhite density tended to increase with increasing management intensity. However, bobwhite density increased significantly with management intensity in the Rio Grande Plains, whereas it appeared to increase numerically in the Rolling Plains, but it was not a significant increase.
- Management can increase bobwhite density. However, management cannot eliminate completely inter-annual fluctuations of bobwhites.



Northern bobwhite density (number per acre) as a function of quail management intensity in the (A) Rio Grande Plains and (B) Rolling Plains, Texas 2014–2018.

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

Insect Availability to Foraging Northern Bobwhites in South Texas

Nicole J. Traub, Tessa M. Green, Horacio E. Rodriguez, and Alan M. Fedynich

Insects are often overlooked by wildlife biologists. However, they are crucial to bobwhite chicks and nesting hens for their protein needs. Therefore, it is necessary we gain a better understanding about the insects available to bobwhites. We surveyed consumed insects and field-collected insects to provide a more thorough understanding of the insects available to foraging bobwhites.

Insects were collected using sweep nets during the summer months of 2018 and 2019 on South Texas ranches to determine summer insect availability. Additionally, we examined the crop contents of bobwhites from the 2016–2017, 2017–2018, and 2018–2019 hunting seasons to determine whether insects are being consumed during the winter and, if so, identify the insects.

- We collected 1,130 insect individuals (representing 10 taxonomic orders and 43 families) during summer 2018 and 725 (eight orders and 39 families) during summer 2019.
- The three most abundant orders in the 2018 summer field collections were Orthoptera (grasshoppers,

crickets, and locusts), Hemiptera (true bugs: aphids, leaf-hoppers, cicadas, and shield bugs), and Lepidoptera (butterflies and moths). In 2019, the three most abundant orders were Orthoptera, Hemiptera, and Coleoptera (beetles).
- We collected 652 insect individuals (10 orders) from the crops of hunter-donated bobwhites. Coleoptera, Orthoptera, Lepidoptera, Hemiptera, and Hymenoptera (ants, bees, wasps) were found in each of the three hunting seasons.
- Findings from our study provide important information regarding insect consumption and availability to bobwhites during summer and winter months in South Texas.
- Land management practices that increase and maintain habitats to sustain high invertebrate abundance and diversity should be beneficial to bobwhites in South Texas.

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

Spatial Analysis of Wild Turkey Habitat in South Texas

Alison R. Menefee, Humberto L. Perotto-Baldivieso, William P. Kuvlesky, Jr., Leonard A. Brennan, J. Alfonso Ortega-Santos, Michael T. Page, Julia K. Burchsted, and David B. Wester

Ellipsoids derived from telemetry data can be used to assess daily habitat use when integrated with land cover data derived from satellite imagery. Our goal was to assess the feasibility of using ellipsoids to quantify landscape structure for wildlife habitat. Our specific objectives were to identify the geometry of ellipsoids that can be used to quantify landscapes.

We simulated landscapes and clipped them using known ellipsoid shapes. We then compared the landscape metrics of our clipped areas with our simulated landscapes. We used these results to select ellipsoids derived from wild turkey telemetry data to evaluate landscape structure during the breeding and wintering seasons in South Texas. We used telemetry data from a study conducted on female wild turkey home ranges on the King Ranch in 2004 and 2005. We then classified National Agriculture Imagery Program imagery to assess landscape structure.

- Percent woody cover was lower during the breeding season (40%) than the wintering season (54%).
- Wild turkeys used larger, more aggregated and interconnected patches of woody cover during the wintering season than during the breeding season.
- Landscape simulations facilitate the understanding of how landscape sampling strategies may be affected by sampling shape models.
- The integration of wildlife telemetry data with landscape ecology approaches and remote sensing were important in identifying spatial patterns used by wild turkeys.

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

Comparative Habitat Use of Montezuma Quail in Texas

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

In Texas, Montezuma quail are found in the Edwards Plateau and the Trans-Pecos Mountains and Basins. Two juniper species characterize these ecoregions, Ashe (Edwards Plateau) and alligator juniper (Trans-Pecos). Ashe juniper has increased considerably in the Edwards Plateau over the past several decades leading to a decline in usable space for Montezuma quail, whereas alligator juniper is common throughout the western United States, but does not appear to negatively impact the species.

Our objectives were to (1) compare Montezuma quail habitat use at the micro-scale (52-foot radius)

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Montezuma quail in the Edwards Plateau have been negatively affected by the encroachment of Ashe juniper.

and macro-scale (1,150-foot radius) between the two ecoregions and (2) quantify the influence of juniper species on important vegetation characteristics for Montezuma quail. During summer 2018–2019, we collected vegetation data at used and available points to determine selection or avoidance behavior of Montezuma quail.

- Montezuma quail used the two juniper species differently. At the micro-scale, Montezuma quail avoided areas with more than 20% Ashe juniper cover in the Edwards Plateau, but selected areas with 8–50% alligator juniper cover in the Trans-Pecos.
- At the macro-scale, Montezuma quail avoided areas characterized by large, contiguous patches of Ashe juniper.
- The effects of juniper on Montezuma quail habitat also differed by juniper species. Ashe juniper negatively influenced grass height, grass cover, forb cover, and forb species richness, whereas alligator juniper did not.
- Land managers should reduce dense stands of Ashe juniper to create usable space for Montezuma quail in the Edwards Plateau. Management of alligator juniper presently is not necessary in the Trans-Pecos given its current density.

Cooperative funding provided by Texas AgriLife Reversing the Quail Decline Initiative, Texas Parks and Wildlife Department, and The Richard M. Kleberg, Jr. Center for Quail Research.

Northern Bobwhite Response to Control of Red Imported Fire Ants

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

The population decline of northern bobwhites on the Texas Gulf Prairie is largely attributed to habitat loss. However, red imported fire ants occur throughout the region and are considered a possible factor contributing to the decline.

The objectives of our study were to determine the influence of red imported fire ants on bobwhites by comparing bobwhite nest success, survival, and density between sites treated with fire ant poison bait and control sites (no poison ant bait). Our study was conducted on three ranches in Goliad and Refugio counties. Each ranch contained two paired experimental units that consisted of a treatment and control site (1,235 acres each). The treatment sites received an aerial application of fire ant bait (Extinguish Plus) during April 2018. We estimated mound density by counting fire ant mounds and using distance sampling. We used radiotelemetry to monitor bobwhite nest success and survival, and we estimated bobwhite densities using distance sampling via helicopter surveys.

Red imported fire ants were observed scavenging on hatched eggs of a northern bobwhite.

- Fire ant mound density decreased through time on both treatment and control sites. However, fire ant mound density was lower on treatment sites than control sites indicating that the insecticide was effective at decreasing fire ant mound density.
- Bobwhite survival, nest success, and density did not differ between the control and the treated sites either pre-treatment (2017) or post-treatment (2018), thereby indicating no benefit from the fire ant control treatment.
- Collectively, we did not find conclusive evidence of an effect of fire ants on bobwhites in the Texas coast. However, bobwhite populations were low in this region during the study, which influenced our ability to trap many bobwhites and monitor many nests. It may be possible that repeated, annual treatments for fire ants are necessary for a benefit to accrue and be observed in bobwhites.

Cooperative funding provided by the Coastal Bend Bays and Estuaries Program, U.S. Fish and Wildlife Service, Steve and Jon Lindley, and The Richard M. Kleberg, Jr. Center for Quail Research.

A 3-Year Study of Parasites in Northern Bobwhites from South Texas

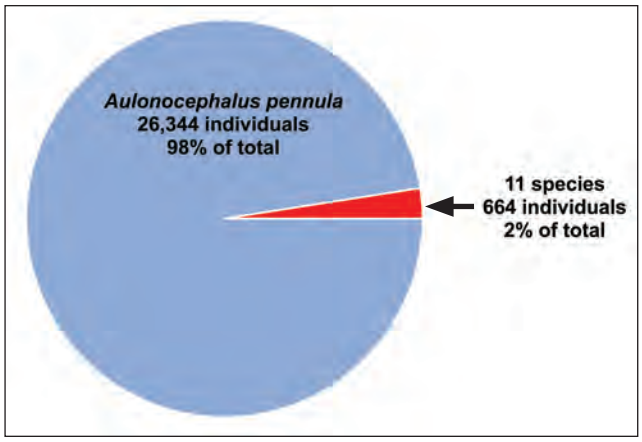
Nicole J. Traub and Alan M. Fedynich

The bobwhite is a game species of ecological, economic, cultural, and recreational importance in Texas. Unfortunately, bobwhite populations are experiencing a long-term decline throughout the state. The underlying cause of the bobwhite population decline has been attributed to habitat fragmentation and loss. However, despite management efforts, bobwhites have continued to decline, indicating other potential causes may be involved. To learn more, we conducted a 3-year helminth parasite survey of 436 hunter-harvested bobwhites from South Texas.

- We found and identified 27,008 parasite individuals, representing 12 parasite species.
- Three nematode species known to be harmful to bobwhites were found: *Oxyspirura petrow*i (eyeworm), *Dispharynx nasuta* (proventricular worm), and *Tetrameres pattersoni* (proventricular worm).
- The cecal nematode, *Aulonocephalus pennula*, was the most numerically dominant parasite (80% of birds infected and 98% of total worms found) , followed by *T. pattersoni* (11% infected and 0.5% of total worms) and *Oncicola canis* (4% infected and 0.5% of total worms).
- The remaining nine parasite species (seven cestode species, *D. nasuta*, and *O. petrowi*) are considered rare, occurring in less than 3% of the bobwhite sample. The eyeworm, considered to be a problem in some regions of Texas, only infected four of 436 bobwhites (less than 1% prevalence; only one worm per infected host).
- Findings indicate that the parasite community in bobwhite populations in South Texas is species-poor and numerically dominated by a single nematode species, *A. pennula*.
- Additionally, we suspect that *A. pennula* infections are not influenced by environmental factors that cause fluctuations in bobwhite populations and that the eyeworm and other potentially pathogenic parasites infect only a small percentage of bobwhite individuals in South Texas.

© Larry Gilbert

A study conducted by graduate student Nicole Traub examined 436 bobwhites for parasites that were donated by South Texas hunters during three consecutive years.



Helminth species, number of individuals, and percent of total individuals found in 436 bobwhites from South Texas that were donated by hunters over a period of three years.

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

Habitat Use by Northern Bobwhites in the Gulf Coast Prairie of Texas

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

The northern bobwhite is one of the most studied gamebird species. Although extensive information exists on its habitat requirements, the Gulf Coast Prairie is a region for which conflicting information exists regarding habitat use. Anecdotally, biologists question whether the general attributes that characterize bobwhite habitat across Texas apply to this region. Our objective was to quantify bobwhite habitat use in the Gulf Coast Prairie and compare this use with known vegetation attributes for the species in Texas.

We conducted this study on three ranches (2,471-acre study plots on each) in Goliad and Refugio counties. We monitored bobwhite habitat use via radiotelemetry during April–August 2017 and 2018, and we collected vegetation data (percent woody cover, grass cover, and forb cover) at bobwhite locations and paired, random locations for comparison purposes. We then used these data to develop a continuous selection function model to identify habitat-suitability bounds for the species.

- Bobwhites selected areas with greater than 38% woody cover, greater than 73% grass cover, and greater than 43% forb cover at the point-of-use scale. This habitat use lies within the suitability bounds found for bobwhites elsewhere in Texas.
- Therefore, bobwhites in the Gulf Coast Prairie do not appear to be unique in their use of habitat but rather possess habitat requirements that are characteristic of the species in Texas.

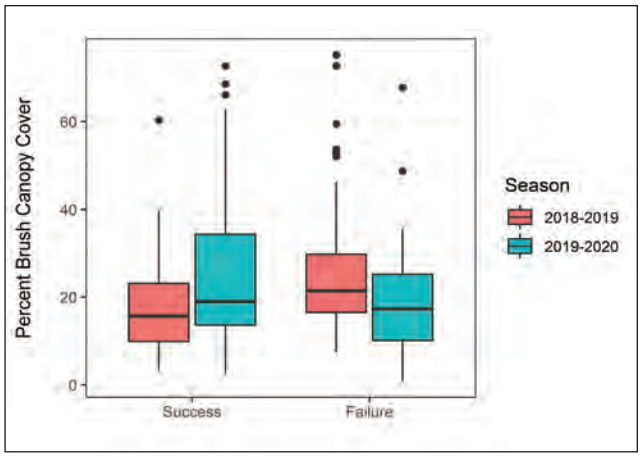
Cooperative funding provided by the Coastal Bend Bays and Estuaries Program, U.S. Fish and Wildlife Service, Steve and Jon Lindley, and The Richard M. Kleberg, Jr. Center for Quail Research.

The Effects of Brush Cover on Trap Site Success for Northern Bobwhites

Micayla E. Pearson, Donal A. Woodard, Leonard A. Brennan, David B. Wester, and Andrea Montalvo

The objective of this study was to determine the effect of brush canopy coverage on trap site success for northern bobwhites. The study occurred on the East Foundation's San Antonio Viejo Ranch. Trap sites were randomly selected along main access roads within the designated study area. We obtained percent of brush canopy coverage surrounding each trap site using classified 2016 National Agriculture Imagery Program (NAIP) imagery.

Brushed in quail trap used to determine brush densities used by northern bobwhites.



Percent brush canopy coverage of successful and unsuccessful trap sites for northern bobwhites by year (2018–2019 and 2019–2020) on the San Antonio Viejo Ranch in Jim Hogg County, Texas.

In total, we baited and trapped at 100 individual sites in 2018–2019 (December 2018 to April 2019) and at 125 individual sites in 2019–2020 (October 2019 and January 2020). We found that mean brush canopy coverage of all trap sites was 23% (range 1–75%). We captured 65 northern bobwhites at 25 trap sites in 2018–2019 and 377 northern bobwhites at 67 trap sites in 2019–2020.

- Mean brush canopy coverage was 19% at successful trap sites and 25% at unsuccessful trap sites in 2018–2019.
- Mean brush canopy coverage was 24% at successful trap sites and 19% at unsuccessful trap sites in 2019–2020.
- The probability of trap site success decreased with increasing brush canopy coverage in 2018–2019.
- We found no significant influence of brush canopy coverage and trap site success in 2019–2020.
- We hypothesized that a variety of factors could influence trap site success, such as fluctuations in bobwhite density, intervals between baiting, annual timing of trapping, and overall acclimation to bait on a historically non-baited ranch.
- In conclusion, researchers may increase the efficiency of trapping northern bobwhites in early

spring and during years with relatively low densities by selecting trap sites in areas with less than 20% brush canopy coverage.

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. (Charlie) Winn Endowed Chair for Quail Research.

Use of Constructed Roosts by Wild Turkeys in South Texas Landscapes

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

Rio Grande wild turkeys are an upland game species with high economic value in South Texas. Lack of natural roosts may limit wild turkey movements and the overall population. Constructed roosts may provide that habitat requirement.

Integrating landscape structure and vegetation composition at multiple spatial scales helped us to identify constructed roost characteristics between used and unused sites. The specific objectives of this research were to (1) compare the vegetation composition of used and unused constructed roosts on a local scale and (2) to quantify landscape structure at multiple spatial scales around constructed roosts as a function of distance.

We sampled 32 constructed roosts across South Texas once during the middle of the breeding and wintering seasons for 2018 and 2019. We downloaded and classified satellite imagery to assess spatial structure between used and unused sites. We used buffers in 60-foot increments from each roost to determine land cover surrounding each roost.

- Fine scale landscape cover did not differ between used and unused sites.
- Used roost sites exhibited a higher percentage of woody cover during the breeding season (71%) than the wintering season (63%) within 120 feet of the roost site.
- During the wintering season, percentage of woody cover was higher at used (71%) than at unused sites (65%) within 120 feet of roost sites.
- We observed that wild turkeys preferred sites that had continuous woody cover as distance from the roost increased.

Our study examined what landscape features facilitated use of constructed roosts by Rio Grande wild turkeys in South Texas.

- Understanding land cover spatial patterns is important to providing management recommendations for constructed roost site locations.

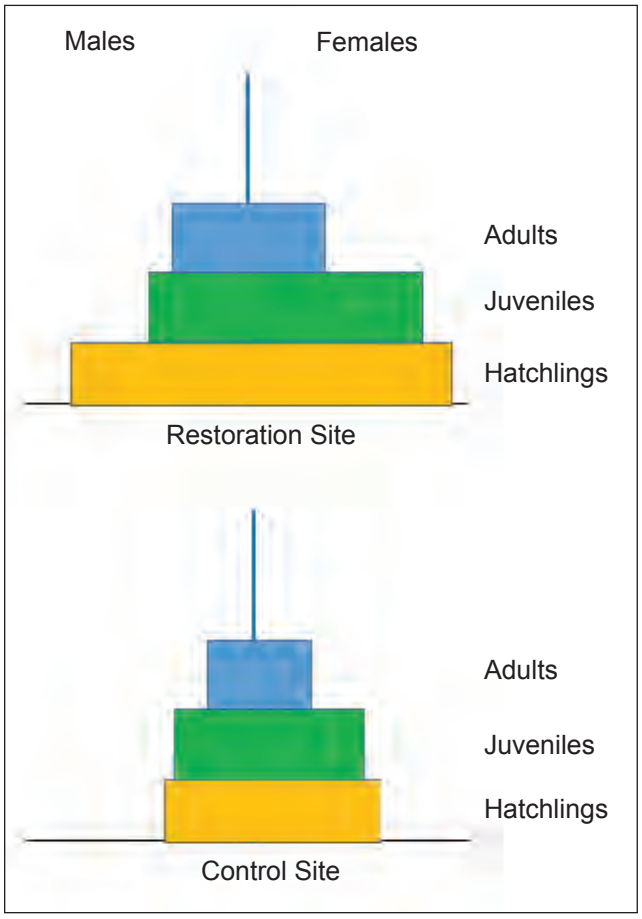
Cooperative funding provided by Las Huellas Association of South Texas, Hoffman HC 30 Ranch, El Veleno Ranch, Bass ranches, and Zacatosa Ranch.

Effects of Habitat Restoration on Texas Horned Lizards and Their Prey

Javier O. Huerta, Scott E. Henke, David B. Wester, Victoria M. Cavazos, Evan D. Rangel, Fidel Hernández, Geron G. Gowdy, Ellart J. Vreugdenhil, Brandon J. Palmer, Eric D. Grahmann, Timothy E. Fulbright, Michael W. Hehman, Humberto L. Perotto-Baldivieso, and Randy L. Powell

Texas horned lizards were once numerous and widely distributed across Texas, but their numbers have drastically declined, and their distribution has become patchy. Non-native grasses have infiltrated areas where Texas horned lizards occur. Restoring habitat back to native grasses has been suggested as a means to halt the decline of the Texas horned lizard, which has been listed in Texas as a threatened species.

In 2013, a 300-acre area on the Hixon Ranch was converted from a near monoculture of buffelgrass back to native plant species. The abundance of Texas horned lizards, harvester ants (the main prey of Texas horned lizards), and the red imported fire ant was monitored on the restoration site and on a nearby non-native grass site as a comparison in 2018 and 2019.



Age structure pyramids for Texas horned lizards displaying greater stability on the restoration site than the control site.

- Texas horned lizards were abundant on both the restoration and comparison sites with a density of about one lizard per 2.5 acres.
- Adult sex ratios differed between the two sites with more males occurring on the restoration site, while more females occurred on the comparison site.
- The sex ratio of juveniles did not differ between the two sites; however, more young were produced on the restoration site during 2018 than 2019.
- Harvester ants were twice as abundant on the restoration site with a density of 5.6 mounds per acre as compared to 2.6 mounds per acre on the comparison site. However, red imported fire ants also were more abundant on the restoration site with 5.6 mounds per acre, as opposed to 0.4 mounds per acre on the comparison site.
- The openness of habitat created by the restoration process provided harvester and red imported fire ants with suitable habitat to colonize, compared to the denser vegetative cover of the comparison site.
- Adult Texas horned lizards appeared to prefer the comparison site; whereas, adult females selected the restoration site for nest locations, potentially to provide greater cover from predators and with a greater abundance of harvester ants to facilitate hatchling development and survival.

Cooperative funding provided by the Hixon family and the Arthur Seeligson Conservation Fund.

A Photo Guide to Plants of the South Texas Sand Sheet

Dexter Peacock and Forrest S. Smith

The conservation and management of native plant communities in the South Texas Sand Sheet are important to private landowners and to sustaining the plentiful wildlife of the region. However, prior to our publication, there was no specific manual of the common vegetation of the region, making plant identification for land management purposes difficult. To address this need, we began work in 2015 on a book to assist landowners, hunters, and researchers in identifying the common vegetation of the Sand Sheet. This work was published and released by Texas A&M University Press in November 2019.

- The guide includes photos and descriptions of 200 of the most common native and exotic grasses, flowering plants, vines, cacti, and woody plants found in the South Texas Sand Sheet.
- Plants in the book are organized with the non-botanist in mind, and are grouped by plant type, flower color, or physical appearance, instead of by botanical classification.
- Information on the use of each plant by wildlife and livestock is provided if known, along with basic management considerations.
- The first printing of the book sold out three months after release. Additional copies are anticipated to be available for purchase through Texas A&M University Press by end of 2020.

Cooperative funding provided by the Caesar Kleberg Partners Program, Rowan Companies, Texas A&M University-Kingsville's Perspectives on South Texas Book Series, and the Dan L Duncan Endowment.

Texas Native Seeds Program Pipeline Prairies Initiative Webpage

Forrest S. Smith, Shyla E. Rabe, Keith A. Pawelek, Anthony D. Falk, Colin S. Shackelford, Samuel R. Lutfy, John R. Bow, Douglas L. Jobes, and Tyler C. Wayland

Restoration of native plant communities following installation of new pipelines is a major land management need across Texas. Because of increased oil and gas production, many new pipelines are being built that extend from the Permian Basin and Eagle Ford Shale regions to the Gulf Coast of Texas. Selection of the appropriate native plant seed mixes for restoration can be difficult because of the need to use locally-adapted seed sources and because of commercial seed supply issues. To provide pipeline companies and landowners with timely information on commercially available native plant seeds to use for upcoming projects, we developed a new web-based tool to provide needed seed mixture recommendations.

- The new web tool includes a map where with three mouse clicks users can select a county-level seed mix recommendation for major soil types in any region of Texas.
- After identifying the county and soil type of the project, a PDF file is provided with a recommended seed mix and *Texas Native Seeds Program* regional contact information for further technical guidance.
- This web page was used over 3,200 times by spring 2020 after going live in October 2019.
- Of those using the website tool, 86% were new users to our website.
- In recognition to its importance in helping restoration efforts, the pipeline prairies tool and associated webpage received the 2020 Outstanding Electronic Media Award from the Texas Chapter of The Wildlife Society.

Cooperative funding provided by donors to the Texas Native Seeds Program and the Dan L Duncan Endowment.

Season of Burn Effects in Gulf Cordgrass Communities

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

The Gulf Prairies and Marshes ecoregion along the coast of Texas is home to a productive bunchgrass, gulf cordgrass, which has potential to provide valuable forage for livestock and habitat requirements for native wildlife. As gulf cordgrass matures, it becomes rank, less nutritious, and less desirable to cattle. Fire is a tool used to remove this old growth and rejuvenate the plant life, promoting the production of tender shoots and improving overall forage quality.

In this study, we applied prescribed burning during winter and summer in patches dominated by gulf cordgrass. Our main objective was to determine the optimal season of prescribed burning for managing gulf cordgrass grasslands.

Gulf cordgrass has volatile oils that make it excellent fuel for high intensity prescribed fires.

- We found gulf cordgrass plant mortality was at its highest (22%) after summer burning. However, regardless of burn season, higher peak fire temperature and increased duration of heat over 149°F increased the amount of dead gulf cordgrass.
- At 90 days after burning, gulf cordgrass production was not different between seasons. After 90 days, gulf cordgrass recovered to pre-burn yields sooner after winter burning, with higher yields than summer burn patches.
- Native, warm-season grasses, forbs, and small shrubs increased dramatically following burning, increasing plant diversity for at least 12 months following winter burns, while summer burn patch diversity stayed high roughly 18 months.
- For most variables we studied there were few meaningful differences. Regardless of season, burning enhanced the production and quality of forage for livestock and increased diversity of wildlife habitat.

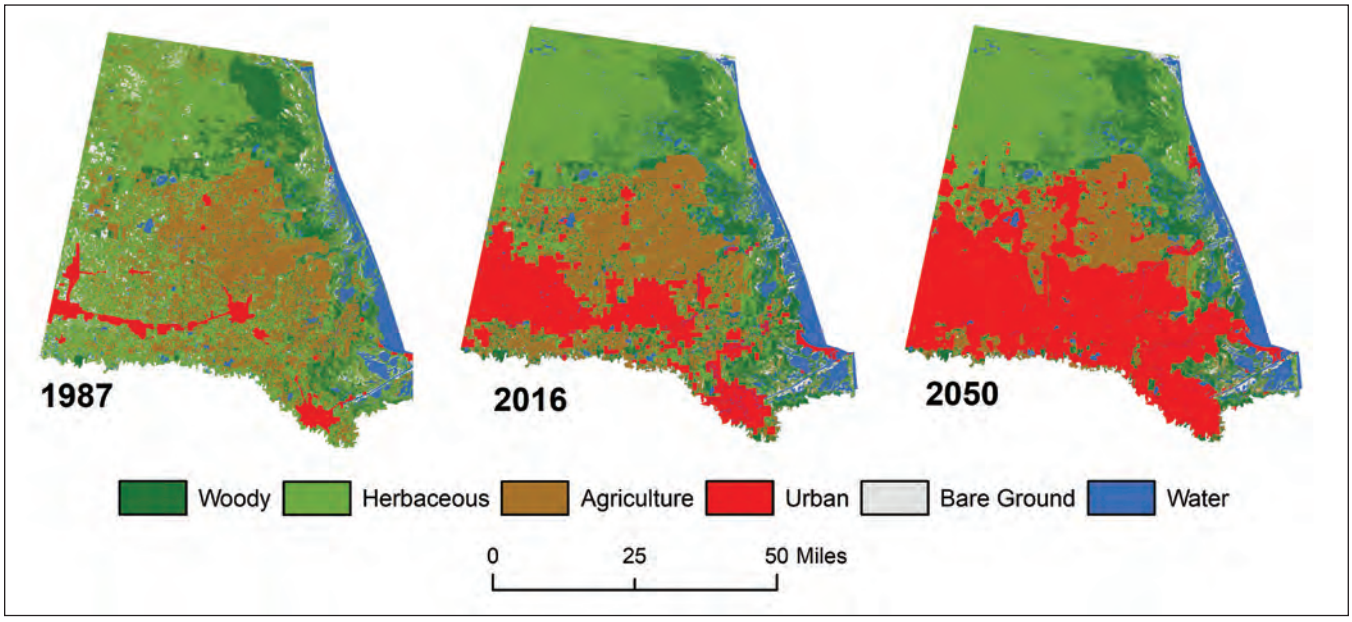
Land Cover Trends in South Texas and Implications for Wild Cats

Jason V. Lombardi, Humberto L. Perotto-Baldivieso, and Michael E. Tewes

The Rio Grande Delta and surrounding rangelands in Texas have become one of the fastest growing urban areas in the United States over the last 35 years. We assessed how land cover trends contributed to the large-scale processes that have driven land cover change since 1987. We classified LANDSAT imagery from 1987 through 2016 to quantify rates of land cover change. We then used housing density scenarios to project changes in the quantity and spatial distribution of woody cover until 2050 and the potential effect of the changes on wild felid habitat.

- Since 1987, woody cover increased 4% along with habitat patch and edge density, whereas straight-line distance between habitat patch and average habitat patch area decreased.
- Woody encroachment of small patches (less than 2.5 acres) was the leading cause of woody cover increase by a magnitude of four.
- By 2050, urban space will be the dominant landscape type and at least 49,500 acres of woody cover may be lost, thereby affecting felid populations in South Texas.
- Our findings provide valuable information for predicting future woody cover fragmentation and its potential impact on the connectivity of wild felid populations. Such information should aid landscape-scale conservation measures for the federally-listed endangered ocelot.

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



Rate of urbanization from 1987 to 2050 based on EPA housing density models, indicating rapid population increases in the Lower Rio Grande Valley that has potential impacts on native felid populations in the region.

A Management Bulletin on Eagle Ford Shale Habitat Restoration

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

Restoration of native wildlife habitat impacted by Eagle Ford Shale (EFS) oil and gas and pipeline development is a concern in South Texas. Landowners, industry operators, and other constituents need information gained from our research to make decisions about restoration.

We summarized 10 years of restoration and habitat management research conducted in the EFS by CKWRI personnel and our cooperators. The summary resulted in a management bulletin that was published in summer 2020.

- CKWRI Management Bulletin 9 includes 24 pages dealing with legal considerations, types of wildlife habitats, disturbance in the EFS, and restoration best practices based on our research.
- The document has color photographs of successful habitat restoration in the EFS, examples of the habitat types impacted, EFS disturbances, and exotic grasses of concern.
- Information is also provided on native plant seeding and lists of available seed sources and vendors.
- This publication is available in hard copy and posted in digital format on the CKWRI (https://www.ckwri.tamuk.edu/publications) and the *Texas Native Seeds Program* (https://www.ckwri.tamuk.edu/research-programs/texas-native-seeds-programs-tns) websites.

Cooperative funding provided by Peter and Fran Swenson and the Dan L Duncan Endowment.

Vegetation and Wildlife Response to Native Grassland Restoration

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

Non-native, invasive grasses impact biodiversity. Buffelgrass was introduced from Africa and is a prolific seed disperser, displacing native vegetation, and creating dense monocultures. These monocultures have been shown to reduce diversity of plants, birds, butterflies, and small mammals. Native grassland restoration may offer a way to mitigate the negative effects of non-native grasses.

Butterfly diversity increased on the restoration site following establishment of native grasses and forbs.

Our objective was to determine if plant and wildlife diversity increased following restoration of a buffelgrass-dominated area to native grassland. We conducted surveys for plants (March, June, and October), birds (June and December), butterflies (October), and small mammals (March) on a restoration site and a control site during pre-restoration (2013–2014) and post-restoration (2018–2019).

- Native plant diversity increased from 39 species pre-restoration (2013) to 64 species post-restoration (2019), whereas it was lower and remained relatively constant (28 species) on the control site.
- Wildlife diversity increased as native plants became established on the restoration site.
- Diversity of breeding birds increased from 20 species pre-restoration (2014) to 31 species post-restoration (2019) on the restoration site. Whereas, diversity remained relatively constant (about 20 species) on the control site.
- Butterfly species increased from nine species pre-restoration (2014) to 14 species post-restoration (2019) on the restoration site, but remained stable (about nine species) on the control site.
- Native grassland restoration is possible and can result in greater plant and wildlife diversity. However, the effort, resources, and patience necessary for success are great.

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

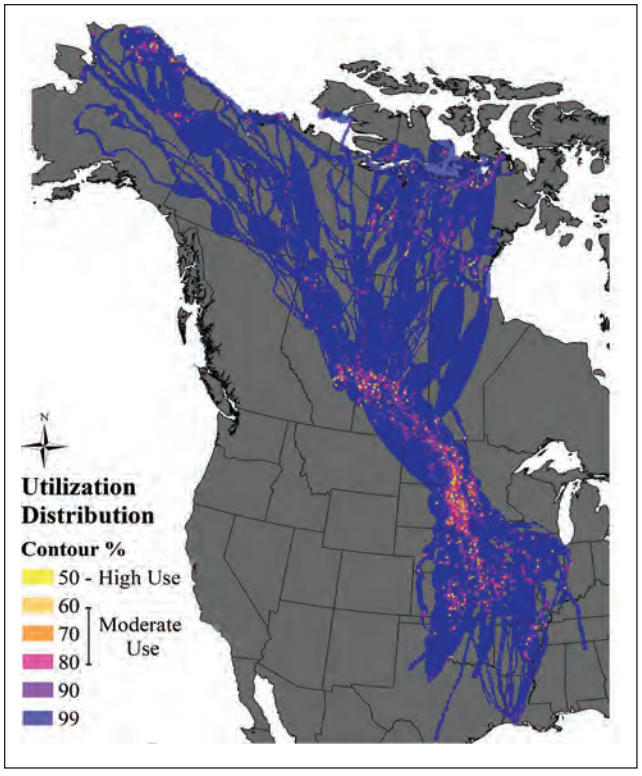
Migration Strategies of Greater White-fronted Geese

Jay A. VonBank, Kevin J. Kraai, Paul T. Link, Mitch D. Weegman, Daniel P. Collins, and Bart M. Ballard

Spring migration characteristics within migratory bird populations can affect breeding success. In recent years, greater white-fronted geese have altered their major staging areas during spring migration. It is unknown what the consequences of this change are to migration strategies and breeding success. Assessing migration metrics of individuals during spring migration may allow insight into how migration strategy affects reproductive success. We used movement data from 56 greater white-fronted geese marked with tracking devices to determine how migration metrics influenced breeding performance. In addition, we identified highly-used areas during spring migration.

- Overall, 55% of all marked greater white-fronted geese attempted to breed, and 71% of the attempts were successful.
- We detected geographic variation in the effects of migration metrics on breeding attempts and success between greater white-fronted geese in the eastern (e.g., Nunavut, Canada) and the western (e.g., Alaska) portions of the breeding range.
- Greater white-fronted geese breeding in the western portion of the breeding range arrived 18 days earlier, had longer pre-nesting durations, and initiated nests earlier than geese in the eastern portion of the breeding range.
- Migration metrics did not differ between failed and successful breeders in the western portion of the breeding range, but successful breeders arrived and started nesting earlier than failed breeders in the eastern portion of the breeding range.
- Regions of South Dakota, North Dakota, and Saskatchewan were the most highly used staging areas during spring migration.
- Identification of critical staging areas during spring migration allows conservation planners to prioritize management efforts in highly-used areas.

Cooperative funding provided by the Texas Parks and Wildlife Department.



Stopover intensity of 62 greater white-fronted geese during spring migration from 2016 to 2019.

Winter Movements and Energy Expenditure in Greater White-fronted Geese

Jay A. VonBank, Mitch D. Weegman, Paul T. Link, Stephanie A. Cunningham, Kevin J. Kraai, Daniel P. Collins, and Bart M. Ballard

Greater white-fronted geese winter in ecologically distinct regions and have shifted their distribution northeastward over the past 20 years. These geese continue to winter in historical wintering areas, as well as newly occupied areas. Rates of movement between regions and energy expenditure within those regions are unknown. We used movement data from 97 white-fronted geese to determine the movement rates among wintering regions. We also determined if wintering in newly occupied regions was more energetically expensive than other regions.

- White-fronted geese exhibited greater daily movements early in the winter period and decreased movements as winter progressed.
- White-fronted geese made frequent and large-scale movements throughout their wintering range at rates greater than expected.
- Movements during winter were greatest towards newly occupied regions and away from historical wintering regions.

- Energy expenditure was up to 55% greater in newly occupied wintering regions than historical regions.
- The high rate of interchange among wintering regions by white-fronted geese suggests that management decisions during the nonbreeding period should consider the composite wintering range.

Cooperative funding provided by the Texas Parks and Wildlife Department.

Modeling Foraging Habitat for Shorebirds in the Laguna Madre

Mikayla M. House, Bart M. Ballard, David B. Wester, Humberto L. Perotto-Baldivieso, and Selma N. Glasscock

Conservation and management of wildlife habitat along the lower Texas coast must be able to respond to the continued population growth and urban development projected for the area. The identification of important habitat required by wildlife species is one way to understand impacts from future threats.

Our goal was to develop a model that delineates areas of foraging habitat for shorebirds throughout the Laguna Madre. This is particularly relevant because the Laguna Madre is one of the most important stopover sites for shorebirds in the Western Hemisphere. As long-distance spring migrants, shorebirds must be efficient at securing food during their long journey north. Shorebirds forage in shallow wetlands. Thus, water depth, substrate type, and vegetation cover are important variables in their selection of sites.

- We used several publicly available geospatial datasets as well as variables from weather stations surrounding the Laguna Madre to develop our models.
- Our models explained 75–90% of the variation in location of foraging habitat in the Laguna Madre.
- Wind direction, wind duration, barometric pressure, and tide level were important factors in explaining variation in location of foraging habitat.
- We identified six areas in the Laguna Madre that provide large amounts of foraging habitat.
- The final models can be used by wildlife managers to prioritize areas for conservation of shorebirds given the potential for future development in and around the Laguna Madre.

Cooperative funding provided by the Robert J. Kleberg, Jr. and Helen C. Kleberg Foundation, Rob and Bessie Welder Wildlife Foundation, and Coastal Bend Audubon Society.

Winter Behaviors and Habitat Transitions in Greater White-fronted Geese

Jay A. VonBank, Toryn L. J. Schafer, Stephanie A. Cunningham, Mitch D. Weegman, Paul T. Link, Kevin J. Kraai, Christopher K. Wikle, Daniel P. Collins, and Bart M. Ballard

Greater white-fronted geese in North America have undergone a large-scale shift in winter distribution. Where individuals decide to winter may depend on how they behave within habitats. We studied how behavior and environmental variables influenced how individuals used habitats. We attached tracking devices to 56 white-fronted geese and monitored them over two winter periods.

- Geese transitioned among habitats differently depending on behaviors they performed. The effect was present for similar habitats, such as agricultural crops for feeding and wetlands for roosting.
- Geese transitioned among habitat types differently depending on what geographic region they were in across their winter range.
- Geese transitioned among habitat types with a higher probability during daytime, specifically during afternoon hours than other times.
- When temperatures were low, geese transitioned to agricultural crops that provide greater energy needed during cooler temperatures.
- Using behavioral data to support habitat use studies can better inform biologists on how wildlife are using habitats.

Cooperative funding provided by the Texas Parks and Wildlife Department.

A greater white-fronted goose fitted with a solar-powered GPS tracking device.

Habitat Preferences of Nilgai Antelope in Southern Texas

Megan M. Granger, Landon R. Schofield, Scott E. Henke, Humberto L. Perotto-Baldivieso, Clayton D. Hilton, and Tyler A. Campbell

The nilgai antelope is a large invasive ungulate that was first introduced into Texas during the 1920s. In their native distribution of India and Pakistan, nilgai occur in scrub forests and grassy plains. Although they prefer herbs and grasses, nilgai also eat woody plants in the dry tropical forests. Therefore, nilgai can be direct competitors with cattle and white-tailed deer. Because cattle and white-tailed deer have great economic importance in southern Texas, it is crucial to understand the role that nilgai play within the ecosystem. Therefore, our objective was to determine habitat use and preferences of nilgai antelope in the semiarid region of southern Texas.

Aerial surveys were conducted each winter during 2017–2020. Nilgai were categorized as bulls, cows, and juveniles and habitats as coastal, shrublands, grasslands, woodlands, bare ground, and urban.

- Bulls preferred shrubland habitats and were neutral in preference to the other habitat types.
- Cows preferred shrubland and woodland habitats and avoided grasslands and bare ground areas.
- Calves mainly preferred shrublands and avoided grassland habitats, but overall, their use of habitat shifted between years.
- Additional studies are needed to refine nilgai habitat preferences by examining habitat distribution, interspersion, and juxtaposition. Doing so will provide greater understanding of nilgai in southern Texas and their role in competition with native wildlife and livestock.

Cooperative funding provided by the East Foundation.

Potential Transmission of Parasites to Ocelots from Common Predator Scats

Tiffany L. Pope, Scott E. Henke, David B. Wester, and Clayton D. Hilton

Parasites can cause harmful effects that reduce survival at the individual and population levels. Some parasites reduce nutrient absorption or blood cell activity, while others invade the tissues of their host. Wildlife can be exposed to direct life cycle parasites from contaminated scats or, upon scat decay, exposure of contaminated ground.

The ocelot is listed as an endangered species by the federal government and exposure to parasites can be damaging to individuals and their populations. Therefore, our objectives were to (1) identify mammalian scats that occur in known ocelot territories, (2) determine gastrointestinal parasite eggs present in mammalian scats, and (3) assess the potential transmission and harm to ocelots.

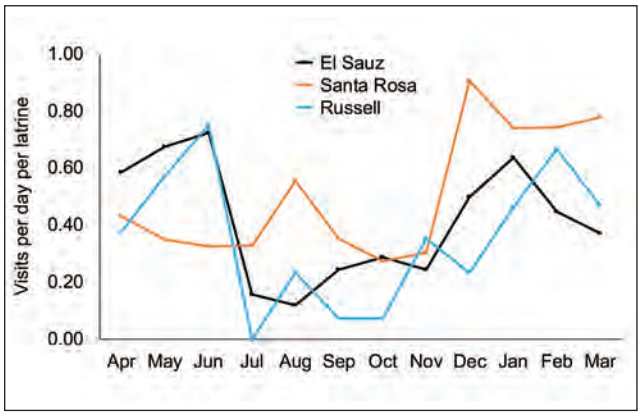
- We collected 160 scats, of which 96, 17, and one were identified by DNA as originating from coyotes, bobcats, and gray foxes, respectively. An additional 46 scats could not be identified to species by DNA methods.
- Although raccoons were present on the study area, raccoon scats were not located or were among the scats whose DNA would not amplify.
- Sixty percent of scats had parasite eggs.
- Nine helminth species and one mite species were identified from scats.
- Of the parasite eggs identified in the scats, *Toxascaris leonina* and *Ancylostoma* spp. (hookworms) can pose a health risk to ocelots, especially to kittens.
- The health status, especially of species listed as threatened and endangered, should be monitored regularly to aid in identifying potential mortality factors. In addition, measures should be taken to reduce potential threats to these populations resulting from the spread of parasites.

Latrine Ecology of Nilgai in South Texas Rangelands

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

Nilgai antelope were introduced to Texas rangelands during the 1920s–1940s. Nilgai have since expanded into much of coastal South Texas and northern Mexico.

Little research has been conducted on nilgai ecology in either their native range in India or their introduced range in Texas. One poorly understood aspect of nilgai ecology is the use of latrines (repeated defecations at



Average visits per day at nilgai latrines at the El Sauz, Santa Rosa, and Russell ranches in South Texas during April 2018–March 2019. Visits were recorded by motion-activated cameras for two weeks of each month (10 cameras at El Sauz, 10 at Santa Rosa, and four at Russell).

a given location). We studied nilgai latrines at three sites in South Texas during April 2018–March 2019 using motion-activated cameras.

- We found nilgai latrines to be abundant, with no apparent correlation to specific vegetation communities, and were dynamic in persistence and visitation rates.
- Nilgai latrine densities were greater than estimated population sizes, indicating nilgai must use multiple latrines; latrines were visited every two to three days on average.
- Latrines were mainly (70%) visited and defecated on (92%) by adult bulls; visitations often (75%) occurred during evening or night.
- The greatest frequency of visits and number of latrines occurred during the peak in the nilgai breeding season from December–February. Photographs and genetic analysis of feces indicate repeated visits from the same individuals.
- We conclude that latrines are used by dominant bulls for territory marking and display of social dominance to both nilgai cows in estrus and subordinate bulls. Nilgai cows likely use latrines to communicate reproductive status.
- This study was the first assessment of the role of latrines for nilgai social communication. Findings provide basic ecological information on nilgai movements and behaviors, which will be useful in creating management plans for this species in their introduced range of South Texas.

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

Development of an Anesthetic Protocol for American Alligators

Clayton D. Hilton, Scott E. Henke, Cord B. Eversole, Tiffany L. Pope, Javier O. Huerta, and Andrew Lowery

Prior to beginning studies with animals, researchers must go through a review process via their Institutional Animal Care and Use Committee (IACUC) to ensure that animals will not be harmed or unjustifiably stressed. IACUCs require the use of the most current methods available and that the research does not duplicate work that has been completed elsewhere. Often, animals must be anesthetized so they do not become unduly stressed during the experimental procedure.

The American alligator was once federally listed as an endangered species within the United States. Populations have rebounded because research focused on their biology and ecology, which allowed for the development and implementation of successful management plans. However, a safe and reliable anesthesia protocol has not been developed for this species.

Ketamine has been used for many years, but results are variable and the effects can last for days. Recently, dexmedetomidine has been suggested to work in combination with ketamine. This drug would reduce the amount of ketamine needed for anesthesia, thus reducing the negative aspects of ketamine, and the effects of dexmedetomidine can be reversed using atipamezole, whereas the effects of ketamine must wear off gradually. In this study, we gave dexmedetomidine plus low-dose ketamine to American alligators and monitored their responses to stimuli while asleep.

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Pain-relieving drugs will aid captive alligators in their recovery when they are injured during aggressive encounters with other captive alligators.

- The time from being awake to being asleep was short and responses to stimuli were absent.
- Recovery was short and predictable and there were no negative after-effects of the anesthetics.
- This study found that the combination of dexmedetomidine and low-dose ketamine produces safe and reliable anesthesia that can be recommended as the protocol of choice for American alligators.

Fenceline Ecology: Animal Use of Fence Crossings in South Texas

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

Surprisingly, there is limited research on how wild animals react to fences, especially fences intended to enclose livestock or mark property boundaries. Of the research conducted on the effects of fencing on wildlife, the focus has been on large game animals or long-distance migrants.

Wildlife often cross fences at defined fence crossings, since they prefer to go underneath rather than over fences. These crossings have bottom fence wires pushed up or missing, often with a depression of soil underneath. We monitored 20 fence-crossing sites through net-wire livestock fences at two cattle ranches in South Texas during April 2018–March 2019 with the aid of motion-activated cameras.

- We documented 10,889 attempted crossing events, of which 6,271 (58%) were successful. Overall, livestock and 14 species of wildlife were identified from the photographs.
- We found that the average crossing site received three to four crossing events per day, but this varied among locations.
- Peaks in crossing activity corresponded with typical daily and seasonal patterns of animal movements.
- Larger crossing sites had higher crossing rates. Crossing densities and sizes were dependent on fence condition and maintenance, and crossings were often reestablished at or near the same location after fence repairs.
- This is one of the first and most extensive studies of animal species using fence crossings. Knowledge of contact and movement rates of animals between

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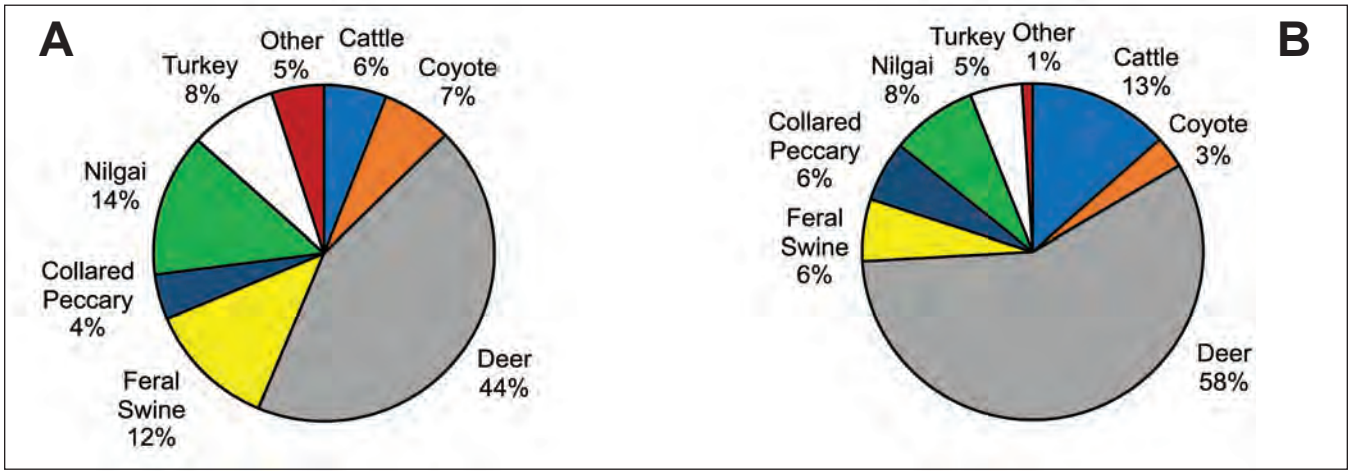
Fence crossing sites made beneath net-wire fencing are used by white-tailed deer, feral pigs, nilgai antelope, javelina, and many other species in South Texas.



Species composition of fence crossing events at the East Foundation's El Sauz Ranch (A) and Santa Rosa Ranch (B) in Willacy and Kenedy counties, Texas during April 2018–March 2019. Motion-activated cameras were placed at 10 randomly selected fence crossing sites at both ranches.

private landholdings will aid in the creation of preventative disease control measures and help us understand the impact of net-wire livestock fencing on animal movements.

Cooperative funding provided by the Las Huellas Association of South Texas and the USDA Animal and Plant Health Inspection Service National Wildlife Research Center.

Will Wild Nilgai Learn to Use Feeders from Feeder-Conditioned Nilgai?

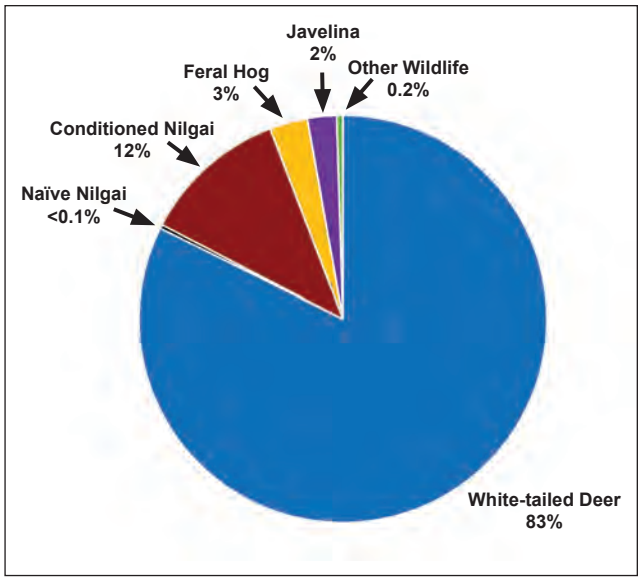
Jeremy A. Baumgardt, Kathryn M. Sliwa, Taylor N. Cramer, Erika L. Rodriguez, Randy W. DeYoung, J. Alfonso Ortega-Santos, David G. Hewitt, John A. Goolsby, and Adalberto A. Pérez de León

Bovine babesiosis is a livestock disease transmitted by the cattle fever tick (CFT). Babesiosis has severe impacts on the cattle industry, which has led to the formation of the Cattle Fever Tick Eradication Program. CFTs were eliminated from the United States in the 1940s, but remain common in Mexico. Therefore, the Eradication Program established a permanent quarantine zone along the Mexican border. Recent infestations of CFTs outside the quarantine zone are probably transmitted by wildlife, as white-tailed deer and nilgai are known hosts for CFTs.

White-tailed deer readily use feeders, thereby allowing treatments via medicated corn. However, free-ranging nilgai are not attracted to feed or bait, and there is no method for treating CFTs on nilgai. Captive-raised nilgai use feeders, so we developed a study to determine if wild nilgai could learn to use feeders by watching captive-raised nilgai.

We established four feeders in the 250-acre South Pasture facility at Texas A&M University-Kingsville. We captured six free-ranging nilgai and released them into the pasture in June 2019. In September 2019, we purchased six captive nilgai accustomed to using feeders and released them into the pasture. We maintained feeders with pelleted feed and monitored feeders with motion-activated cameras through mid-December.

- Wild-caught nilgai did not use feeders during June–September. Once introduced, the captive-raised nilgai regularly used the feeders.
- Wild-caught and captive-raised nilgai regularly interacted and formed social groups.
- Individual wild-caught nilgai were often observed to follow captive-raised nilgai to the feeders, but never used the feeders.



Percentage of photos for each species or group from over 126,000 photos collected at four feeders September through December. Of the 84 photos of wild nilgai at the feeders with the captive-raised individuals, wild nilgai were never observed eating the feed.

- Conditioning wild nilgai to use feeders does not appear to be a viable strategy for delivery of medicated feed for CFT control.

Cooperative funding provided by the USDA Agricultural Research Service.

Spatial Structure of Woody Cover and Ocelot Habitat Use

Jason V. Lombardi, Michael E. Tewes, Humberto L. Perotto-Baldivieso, Jose M. Mata, and Tyler A. Campbell

About 80% of the known breeding population of ocelots in the United States occurs on cattle-managed rangelands in northern Willacy and southern Kenedy counties in South Texas. Past studies have indicated that ocelots in South Texas select for woody habitat patches that contain extremely dense thornshrub and require large patches of woody cover to survive. Landscape features have been used to explain ocelot habitat use in fragmented areas. However, our knowledge of ocelot habitat use in less-fragmented rangelands is lacking. During 2011–2018, we used motion-activated cameras on the East Foundation's El Sauz Ranch to monitor seasonal habitat use of ocelots relative to landscape structure, configuration, and various other factors.

- We observed ocelots were less likely to be detected during drought.
- Seasonal habitat use and detection were positively influenced by larger mean habitat patch area and lower landscape shape values (the perimeter to shape ratio of the habitat patch). This indicates a preference for areas with a lower degree of fragmentation across the study area.
- As habitat patches become larger, they merge over time and form larger woody areas, which promotes ocelot habitat use.
- Brush management needs to be strategic as habitat patch area and shape are limiting factors for promoting ocelot habitat use on cattle ranches.
- Our results demonstrate the ability to use landscape features to discern the effects of spatial structure of vegetation communities relative to ocelot use.

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

Assessing the Use of Texas Horned Lizard Scat to Determine Lizard Size

Javier O. Huerta, Scott E. Henke, David B. Wester, and Stephen L. Webb

The Texas horned lizard is an iconic reptile species of the southwestern U.S. Their populations are declining throughout most of their distribution. Because of this, Texas horned lizards have been listed as threatened or protected in many states.

Texas horned lizard scat can provide population-level information needed to aid in conserving this species.

State biologists must assess populations of Texas horned lizards to evaluate the trend of their numbers. However, because of low population numbers, cryptic coloration, and hiding ability, Texas horned lizards can be difficult to locate. Often, when searching for Texas horned lizards, their scat can be found, which indicates presence. In addition, we wanted to test whether scat of Texas horned lizards can be used to estimate lizard size, which in turn, provides an estimate of lizard age.

Scats were collected from known-age and known-size Texas horned lizards throughout southern Texas. Relationships between scat length and lizard snout-to-vent length (SVL) were determined.

- Linear relationships between scat length and lizard length were determined with 90% accuracy.
- Lizard size (SVL) can be used to estimate age class (i.e., hatchling, juvenile, adult), which then can be used to determine reproductive maturity.
- Scat can be used to gain information about the population structure of Texas horned lizards instead of just lizard presence alone.
- Texas horned lizard scat provides another source of information to determine needed data concerning the population status of this symbol found in the western United States.

Cooperative funding provided by the Hixon family.

Effect of Prescribed Fire on the Viability of Raccoon Roundworm Eggs

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

The raccoon roundworm is a large nematode that resides in the small intestine of raccoons and is a zoonotic parasite that can infect humans, wildlife, and domestic animals. If eaten, even accidently, larvae can affect eye, brain, and nerve tissue, potentially causing blindness, paralysis, and death.

Previous studies have found that a single infected raccoon can contaminate approximately one acre per year. In addition, roundworm eggs remain viable and percolate little within the soil column over two years in the southern Texas environment regardless of soil texture, soil moisture, and sun exposure. Studies also found a minimum temperature of 140°F was needed to kill roundworm eggs. Therefore, we hypothesized

that prescribed fire may be successful in killing raccoon roundworm eggs.

We placed aliquots of 1,000 viable raccoon roundworm eggs on the soil surface and at a depth of one inch inside the burn area at zero, two, four, and six feet from the fire's edge of 30 ft x 30 ft grass plots that consisted of either low or high fuel loads. We also placed raccoon roundworm eggs inside 3-ft^2 circles of bare ground on the leading edge, in the center of the circle, and on the trailing edge of the fire in similar plots.

- Prescribed fire killed raccoon roundworm eggs on the soil surface up to two feet from the fire's edge in plant communities with high fuel loads, but was ineffective at a soil depth of one inch.
- Low fuel loads killed only 50% of roundworm eggs on the soil surface at the fire's edge, but eggs farther away from the fire and eggs under the soil surface were unaffected by fire.
- Prescribed fire can be used to reduce the quantity of raccoon roundworm eggs on the soil surface within an environment, but it will not be effective in eradicating the parasite eggs.
- Research needs to continue to determine how to halt the spread of this emerging parasitic disease.

Influence of Sun Angle, Moonlight, and Temperature on Felid Movements

John P. Leonard, Michael E. Tewes, Jason V. Lombardi, David B. Wester, and Tyler A. Campbell

Ocelots and bobcats in South Texas show a substantial overlap in diet and habitat use. We explored patterns of coexistence of ocelots and bobcats to identify partitioning of time and space. We investigated the influence of sun angle, moonlight, and maximum daytime temperatures on the movement rates of eight co-occurring ocelots and six bobcats using GPS locations and accelerometer data. We demonstrated that accelerometer data could be used to predict movement rates, providing a continuous measure of animal activity to supplement GPS locations.

- Ocelots showed a strong nocturnal activity pattern with the highest movement rates at night, whereas bobcats showed a dawn and dusk (crepuscular) activity pattern.
- Although bobcat activity levels were reduced during the day, they were higher than ocelot diurnal activity levels.

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Ocelot activity is greatest at night, particularly during periods of low moonlight. Conversely, daytime movements decrease during peak daytime temperatures.

- During warmer months, bobcats were more active on nights with higher moonlight. In contrast, ocelots were most active during periods of low moonlight.
- Ocelots reduced diurnal activity on hotter days.
- Our results indicate that ocelot and bobcat coexistence in South Texas can be partially explained by time partitioning. However, both felids showed periods of overlapping activity during nocturnal and crepuscular periods.

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PARTING SHOTS

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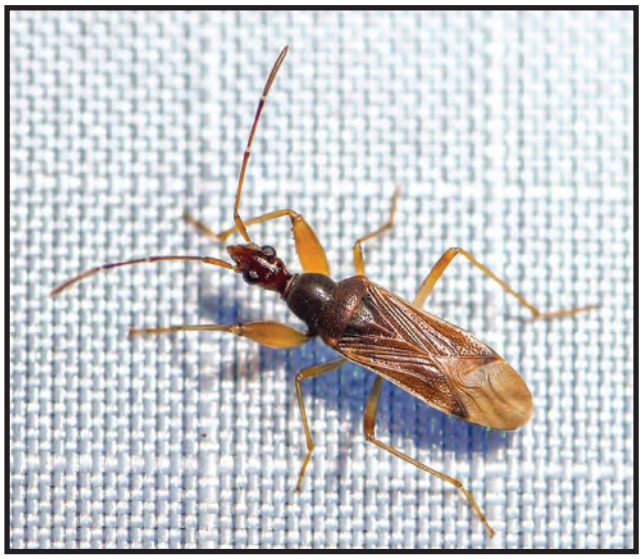
The Texas tortoise (*Gopherus berlandieri*) is the smallest of the four North American tortoises and is listed as a threatened species in the state of Texas.

© Aidan Branney

The grey-headed flying fox (*Pteropus poliocephalus*) is the largest bat found in Australia, occurring in forests of coastal regions of Queensland and New South Wales.



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The long-necked seed bug (*Myodocha serripes*) is almost 1/2 inch in length, found in southwestern through northeastern North America, and a pest of strawberries and St. John's wort.

Graduate students and faculty working for the Caesar Kleberg Wildlife Research Institute spend a lot of time outdoors. They see amazing sights and capture some of these through the lens of a camera. This year we solicited photographs from students and faculty and had them judged by students in the Wildlife Photography Program at Texas A&M University-Kingsville taught by Brian Loflin. Enjoy these parting shots.

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