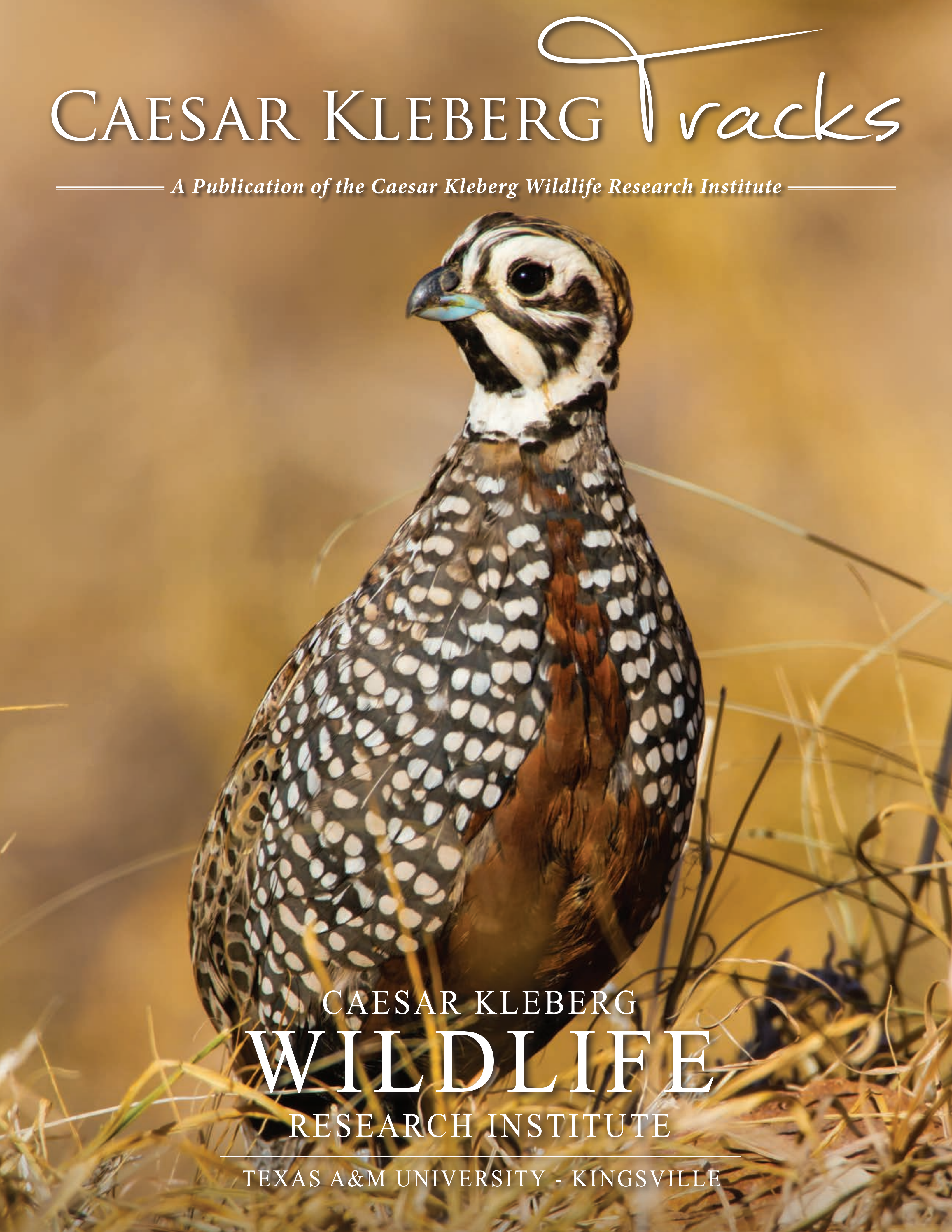
Caesar Kleberg Tracks

A Publication of the Caesar Kleberg Wildlife Research Institute



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Caesar Kleberg Tracks

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Learn More About CKWRI

The Caesar Kleberg Wildlife Research Institute at Texas A&M University-Kingsville is a Master's and Ph.D. Program and is the leading wildlife research organization in Texas and one of the finest in the nation. Established in 1981 by a grant from the Caesar Kleberg Foundation for Wildlife Conservation, its mission is to provide science-based information for enhancing the conservation and management of wildlife in South Texas and related environments.

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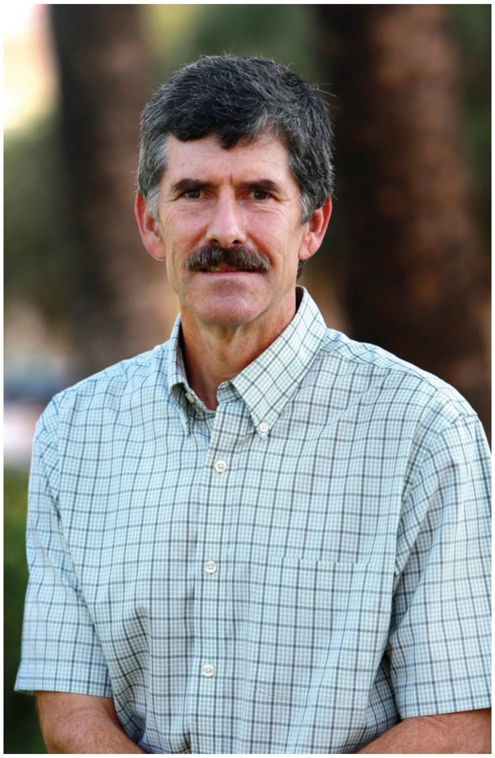
From the Director



One of the lures of the outdoors is spending time alone with only the sounds of wind and wildlife. Many people in today's hectic, hyper-connected world treasure such peaceful moments. In fact, wildlife biologists often chose their profession because they relished time alone in the out-of-doors. In addition, scientists are often seen as lone wolves, quietly stalking the truth in their lab or in front of their computer. So, as wildlife scientists, CKWRI researchers may be expected to be especially introverted.

Given these stereotypes of wildlife biologists and scientists, why are the by-lines in this issue of Tracks magazine so long? There are articles with 2, 6, 7, and even 13 authors. One article has a single author but it describes 35 years of personal connections between the author and Mr. Frank Yturria, a South Texas rancher with a special place in his heart for ocelot conservation.

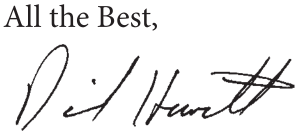
There are three reasons why these articles have so many authors. First, authorship is earned by being essential to the study. Modern wildlife research often requires several types of expertise to address the complex ecological and conservation issues, resulting in a large number of authors.

The second reason for multi-author by-lines is that most CKWRI research is conducted by graduate students. Graduate education is a critical part of the CKWRI mission and the reason why our alumni are so successful. These students' proving ground is not a written test in the classroom but the challenges, frustrations, and rewards of conducting a full-blown scientific study and communicating the results. Because many CKWRI studies are long-term and multidimensional, there are often a large number of graduate students involved by the time the study is complete and a corresponding large number of co-authors on articles.

The third reason articles by CKWRI scientists have multiple co-authors and describe close personal relations with members of the conservation community is that our scientists and students genuinely enjoy working together, sharing ideas, working collaboratively to address research and conservation challenges, and engaging the wildlife managers and landowners who can use the information we produce. Science is competitive and broad collaborations are not common. However, scientists at the CKWRI understand the power of balancing competition and collaboration. The results are highlighted in this edition of Tracks and our other publications.

You as a consumer of CKWRI research are an essential part of the team necessary to manage and conserve our natural resources. Use what you learn to increase your appreciation of our natural world and to do what you can to make sure Texas wildlife continues to thrive.

All the Best,



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

LEARN MORE

Read about a new plant identification book available from TAMU Press, on page 23.

Behavior and Movements of Nilgai Antelope: Implications for Management of Cattle Fever Ticks

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

Nilgai antelope are native to India, Nepal, and Pakistan. Nilgai were introduced to Texas during the 1920-40's and have since expanded into much of coastal South Texas and parts of northern Mexico; current populations number over 30,000 free-ranging nilgai. Nilgai are challenging quarry and can be hunted year-round, and thus provide a significant economic and recreational benefit to ranching operations. Although nilgai are nearing the 100-year anniversary of their introduction, there is surprisingly little known about behavior and movements of nilgai in Texas or their native range.

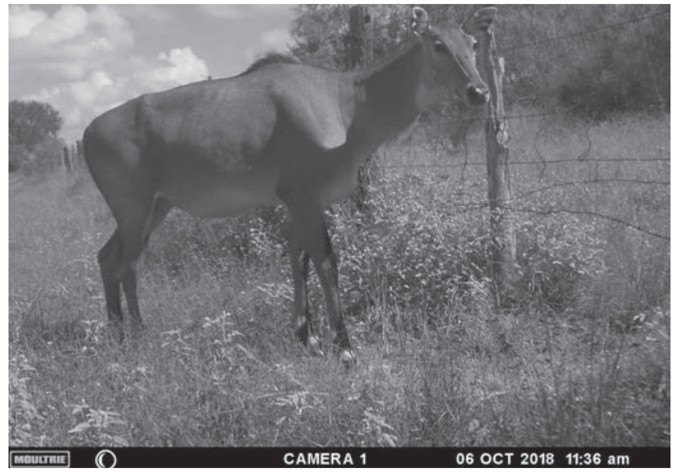
Photo by Lisa Zoromski

Recent outbreaks of cattle fever ticks in the Lower Rio Grande Valley have brought nilgai behavior into the spotlight, as managers scramble to cope with a very unique human-wildlife conflict. Few outside of South Texas have heard of the cattle fever tick, yet this tiny arachnid presents a multi-billion dollar threat to the U.S. cattle industry via their ability to spread bovine babesiosis. Cattle fever ticks arrived in the Americas with the Spanish in the 1600's, but it wasn't until much later that the role of the tick in babesiosis, or "Texas cattle fever" was recognized. Cattle fever ticks were eliminated from the U.S. by the 1950's, and the USDA has maintained a permanent quarantine zone along the southern border to prevent re-infestation from tick-endemic areas in Mexico.

The cattle fever tick spends its entire life on a single host; as the name implies, the tick prefers cattle. However, the ticks can survive on white-tailed deer, and seem to like nilgai antelope as well. Tick infestations in cattle can be managed with a combination of husbandry and acaricides, but wildlife greatly complicate tick eradication efforts. Deer can be treated via medicated bait or corn. Unfortunately, nilgai do not respond to bait and there is currently no reliable means to treat free-ranging nilgai for ticks. This is a major challenge for the management of cattle fever ticks because nilgai appear to be an important reservoir for re-infestation of South Texas ranches.

The USDA-ARS is testing remotely activated sprayers as a treatment measure for wildlife. However, the sprayers must be positioned in locations that nilgai use frequently. Nilgai make latrines, or large dung piles, that are noticeable along unpaved ranch roads wherever nilgai are present. Nilgai also prefer to cross underneath fences rather than jump, and use established crossing sites, areas where the

Trail cameras catch various Nilgai at fence crossing sites.



bottom fence wire is pushed up or missing, with animal runways beneath. Therefore, latrines and fence crossings are potential sites to target for treatment of ticks on nilgai.

We studied nilgai behavior and use of latrines and fence crossings on 3 South Texas ranches using trail cameras during 2017–2019. We recorded 10,101 animal visits at latrines. Surprisingly, only 15% were nilgai visits, as other species of wildlife either investigated the latrine or passed near or over latrines on roads or trails. We found latrines to be abundant on the ranches studied, with about one latrine for every 3–7 acres. Although latrines on ranch roads were more visible, surveys of rangelands revealed nilgai latrines also were abundant off-road. Latrines were used mainly by individual adult bulls, and only occasionally by cow-calf groups. Over the course of 1 year, we never recorded defecations by sub-adult bulls. Adult bulls visited latrines every 2–3 days on average, and defecated on the latrine about once per week. Most nilgai visits to latrines occurred at night. Trail cameras revealed some interesting insights into nilgai behavior, as we documented a fight between two adult bulls at a latrine site, as well as three mating events. Latrines appear to be important for social communication, serving to mark the territory of adult bulls, and provide a venue for cows to advertise their reproductive status.

Lisa Zoromski checking a nilgai latrine site.

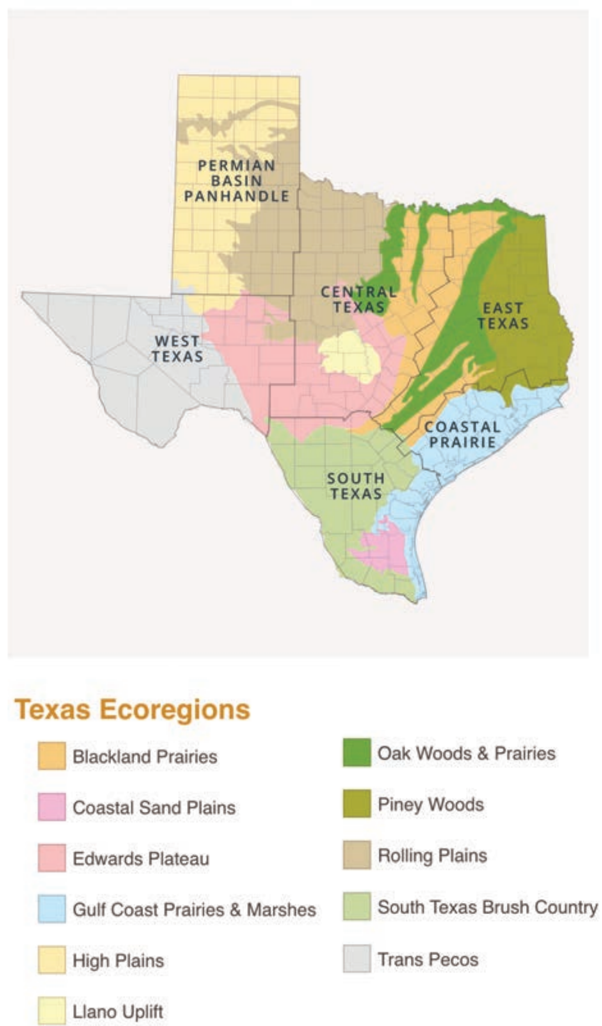
We documented 10,889 attempted fence crossing events, 58% of which were successful. Overall, 14 species of wildlife used fence crossings. White-tailed deer and nilgai comprised about 50% and 10% of crossing events, respectively. In terms of nilgai, fence crossings were used equally by bulls and cows, and a given crossing was visited on average about once every 2–3 days. The number of crossing events was proportional to the size of the crossing, where larger crossings received greater use. Attempts to patch the holes in fencing created by animal crossings were usually short-lived, as feral pigs or nilgai often created another hole in the fence nearby within a few months. Visits to both latrines and fence crossings peaked during December–March, corresponding with a peak in nilgai breeding season.

Overall, the number and visitation rates of latrines suggests that dung piles will be an inefficient means for the sprayer treatment. Fence crossings were used by both sexes and all age classes of nilgai and may be a better target site for the sprayer treatment than latrines. However, there must be suitable fencing and fence crossings present for this technique to work. With additional funding from the USDA-ARS, we are investigating a large-scale deployment of remote sprayers at fence crossings in the Lower Rio Grande Valley. We will determine how many individual nilgai are treated at fence crossing sites with the aid of individually tagged nilgai. We are also investigating nilgai movements and home ranges using satellite GPS radio-collars. We will determine the efficacy of the sprayer treatments by re-capturing tagged nilgai and comparing tick loads to un-treated nilgai. The results of this research will have important implications for the management of cattle fever ticks in the South Texas region.

This study was funded by the Las Huellas Organization of South Texas, with additional support provided by the USDA Agricultural Research Service, and the East Foundation.

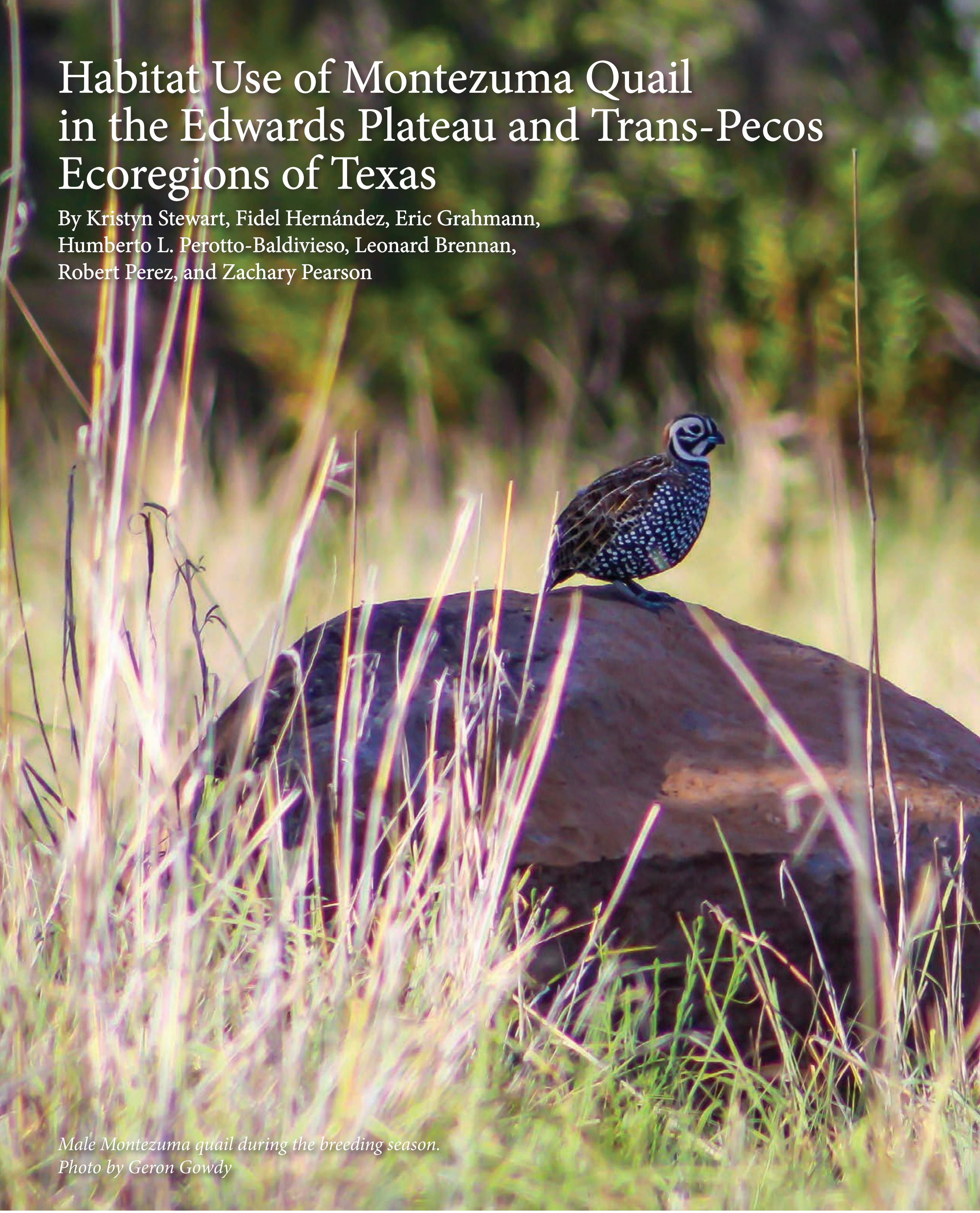
Interactive Seed Mix Map Now Available

The map is a new addition to the CKWRI website where you can now locate a custom seed mix that is made specific to your area. Visit the Texas Native Seeds Program page at www.ckwri.tamuk.edu to check it out!



Habitat Use of Montezuma Quail in the Edwards Plateau and Trans-Pecos Ecoregions of Texas

By Kristyn Stewart, Fidel Hernández, Eric Grahmann, Humberto L. Perotto-Baldivieso, Leonard Brennan, Robert Perez, and Zachary Pearson



Male Montezuma quail during the breeding season.
Photo by Geron Gowdy

One of the most unique species of New World quails inhabiting North America can be found in Texas. With vibrant coloration to contrast its cryptic nature, and strong elongated feet, the Montezuma quail possesses a unique life history compared to other quails (Figure 1). Across their geographic distribution, Montezuma quail are found at varying elevations in pine-oak woodlands and savannahs, typically involving mountainous terrain. In Texas, two populations are located in the Trans-Pecos Mountains and Basins (Figure 2A) and Edwards Plateau (Figure 2B) ecoregions, with the latter containing possibly the smallest and least studied population. Their cryptic nature and association with rugged terrain contribute to the lack of knowledge on the species.

Figure 2
Examples of Montezuma-quail habitat in the A) Trans-Pecos and B) Edwards Plateau ecoregions of Texas.

The Edwards Plateau, or Texas Hill Country as it is often called, is an ecoregion with shallow soils, rocky hills, and elevations ~1,600 ft. above sea level. A key woody species found in this ecoregion is Ashe Juniper, an evergreen conifer, which has been encroaching for the past century. This encroachment is due to several factors including fire suppression and overgrazing. Ashe Juniper forms dense colonies across the landscape, eliminating key grasses and forbs crucial to the survival of Montezuma quail. In the southwestern portion of the Edwards Plateau where Montezuma quail are found, landowners have started clearing Ashe Juniper in recent decades, which has led to increased sightings of Montezuma quail and, in turn, increased interest in the species by the public. Consequently, we initiated two studies in collaboration with the Texas Parks and Wildlife Department during the 2000s that were focused on the development of a survey method for Montezuma quail and the factors that could influence its detection and presence. Once we knew how to survey the landscape for the species, we then began a study specifically to address how Ashe Juniper influenced habitat use of Montezuma quail in the Edwards Plateau.

This study began in spring of 2018 on two private ranches and Kickapoo Cavern State Park in Edwards and Kinney counties. One objective of our study was to capture Montezuma quail and place backpack transmitters on them to track survival and their use of the landscape. We attempted captures during April–August of 2018 and again during March–August of 2019. Call-back surveys were used to detect individuals by playing a male buzz call and a female descending call, in attempts of eliciting a response from a wild bird. Once a response was received, we attempted capture through several methods (small-animal hand net gun, pointing bird dogs and hand nets, or the use of pen-reared Montezuma quail and a trap). To determine habitat use of Montezuma quail, we collected vegetation data at used and random locations. This allowed us to make comparisons between what was available to Montezuma quail and what they were using. We collected data on Ashe Juniper density, canopy cover, and height, as well as metrics on forbs and grasses.

During the first year of study (2018), we had no successful captures of Montezuma quail in the Edwards Plateau, but we did have multiple sightings and responses that resulted in the collection of 13 used locations. Due to this small number of observations, we expanded our efforts in our second year (2019) to include the Trans-Pecos ecoregion in order to compare habitat use of Montezuma quail between the relatively small, isolated population in the Edwards Plateau to the larger, more established populations in the Trans-Pecos. We selected the Davis Mountains Preserve to serve as our West Texas study site because Alligator Juniper is prevalent in this region, and we were interested in determining if habitat use differed between areas that contained juniper but differed in the species present. We collected the same vegetation metrics in the Trans-Pecos that were collected in the Edwards Plateau.

Based on the vegetation data collected to date, we have documented that Montezuma quail are using juniper differently in the two ecoregions. Preliminary analyses suggest that Montezuma quail in the Edwards Plateau avoid sites when Ashe Juniper is greater than 20% canopy cover (Figure 3A) and greater than 6 ft. in height (Figure 4A). In the Trans-Pecos, however, Montezuma quail select sites where Alligator Juniper is greater than 12% canopy cover (Figure 3B) and between ≈6–23 ft in height (Figure 4B).

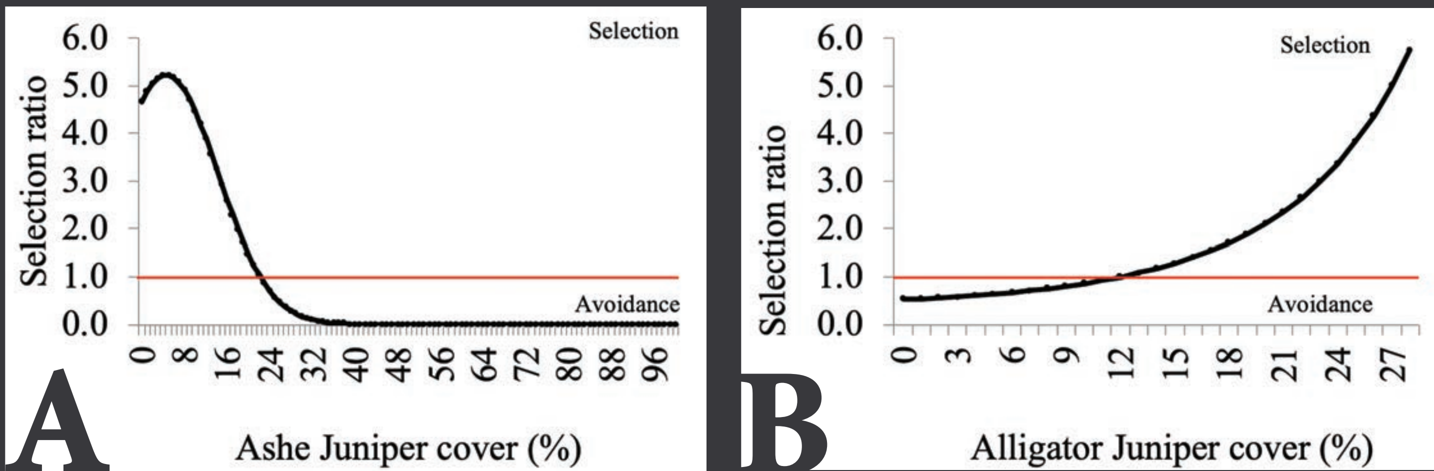


Figure 3
Habitat suitability bounds of Montezuma quail for A) Ashe Juniper cover in the Edwards Plateau, and B) Alligator Juniper cover in the Trans-Pecos. Montezuma quail selection is indicated when values occur above the red line, and avoidance when values occur below the red line.

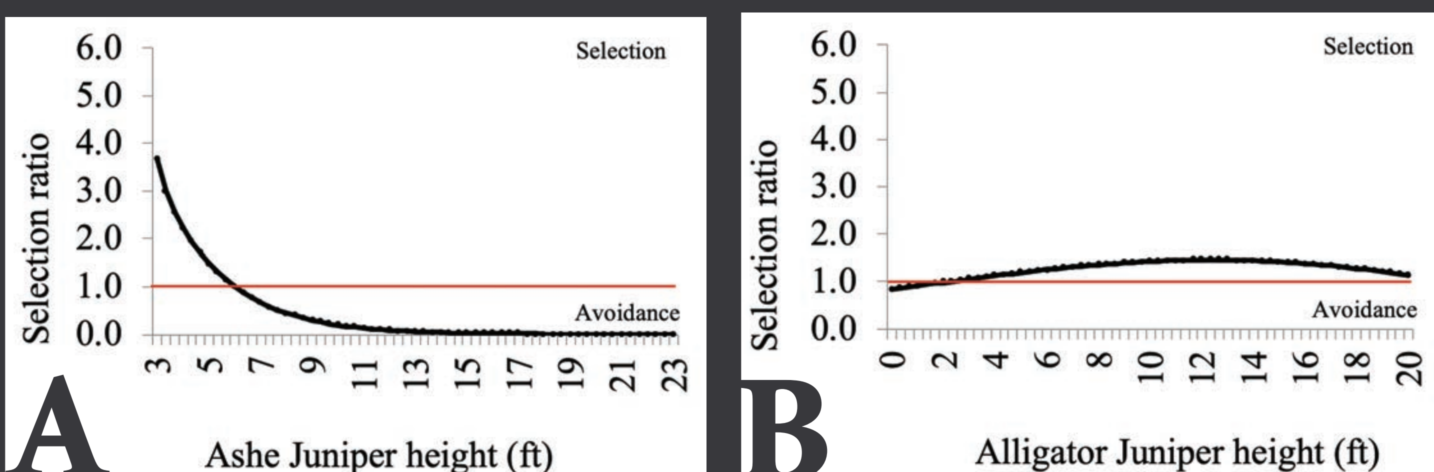


Figure 4
Habitat suitability bounds of Montezuma quail for A) Ashe Juniper height in the Edwards Plateau, and B) Alligator Juniper height in the Trans-Pecos.

We were surprised to learn that habitat selection by Montezuma quail differed between the two populations, depending on which species of juniper was present. That is, we documented that Montezuma quail tended to avoid Ashe Juniper in the Edwards Plateau, but tended to select Alligator Juniper in the Trans-Pecos. For the Edwards Plateau, these findings suggest that removal of Ashe Juniper to levels below 20% cover at a given point is necessary to create Montezuma-quail habitat.

However, these results are preliminary, and data are still being collected. Through this research, we hope to quantify the bounds of suitability of Montezuma quail for Ashe Juniper and, in the process, provide landowners and managers with concrete prescriptions for creating and managing Montezuma-quail habitat in the Edwards Plateau.

The Yturria Family and Ocelot Conservation: A 35-Year Story of Success

By Michael Tewes

Perhaps the most meaningful success story for ocelot conservation that I have been connected to followed my initial visit with Mr. Frank Yturria in 1983. He graciously spent the afternoon showing his beautiful ranch to a young 26-year-old graduate student from the Caesar Kleberg Wildlife Research Institute. I had captured the first ocelot for research in the preceding year on a nearby ranch.

Before the visit, I had examined aerial photographs and identified two key tracts of dense thornshrub suspecting they may harbor ocelots. I was excited when we drove to the spot where a thin brush corridor crossed a ranch road, and Mr. Yturria mentioned observing ocelots cross at that location. This site was exactly where I would expect to see an ocelot.

> I HAVE DONE MY PART TO HELP THE OCELOT.
>
> NOW, I WANT YOU TO DO YOUR PART.
>
> -Mr. Frank Yturria

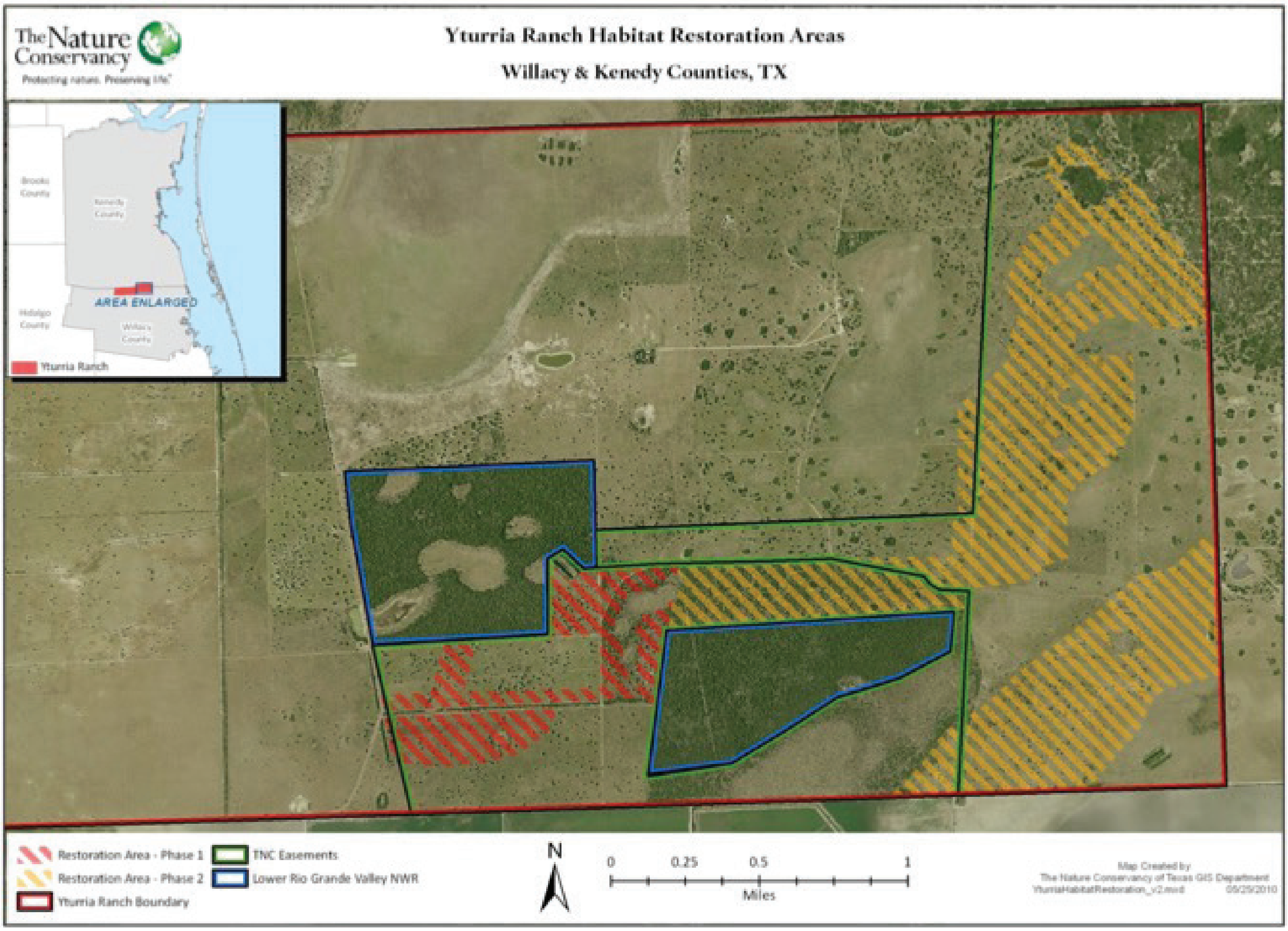
I could also see the ponderous bulldozer slowly clearing the two remaining brush fragments covering the last 500 acres of the historically recognized "El Jardin." The English translation of "The Garden" was a local term referring to the tangle of extremely dense thorny brush that covered much of the Rio Grande Delta prior to the agricultural period. The fertile alluvial soils deposited over eons by the Rio Grande provided the nutrients to grow this dense cover used as prime habitat by ocelots.

Once the railroad was laid in 1904, and the Port of Brownsville constructed in the 1930's, agricultural crops could be exported to distant markets. Thus, the El Jardin or brush garden was rapidly converted to extensive farmland leaving less than 1% of the area still covered with ocelot brush.

When I described the importance of these relict patches of thornshrub for ocelot conservation, Mr. Yturria responded, as quoted in his biography (Yturria 2018, pg. 474), "So I said, 'Well, then, I'll stop clearing brush." This moment in 1983 also began an incredibly successful story of the achievements made by a single landowner committed to ocelot conservation.

The family generously allowed my team to monitor ocelots with radio telemetry and cameras over three and a half decades. As many as 15 ocelots within one year were found on the ranch. We have documented several young ocelots born on the Yturria Ranch. We tracked male ocelots as they dispersed to establish territories in surrounding areas, and young female ocelots which tended to stay in or near the territory where they were born. This dispersal pattern is typical for ocelots, and many of the other 30 species of small wild cats found around the world. Based on our research, we also believe this "source population" serves as the "heart beat" to keep nearby populations

Former graduate student, David Shindle, is handing a sedated ocelot over the Yturria fence to Michael Tewes for examination. (Shindle has subsequently been working on the endangered Florida panther for the past 20 years).



Red and yellow striped lines indicate Yturria Ranch Habitat Restoration Areas in Willacy and Kenedy Counties, Texas.

replenished with young ocelots. For example, we have documented several ocelots, using camera trapping or genetic identification, that initially occurred on the Yturria Ranch and later were found on the East Ranch a few miles away. Understanding the movement ecology of ocelots on the Yturria Ranch is critical for our team to develop effective management strategies.

In 1989, Mr. Yturria established a conservation easement of 510 acres to maintain the rare dense brush on these two small tracts. The original easements were connected and expanded by the Nature Conservancy with two larger easements of 698 acres in 2007 and 1,300 acres in 2009. Although these two recent easements were open rangelands, typically not the best cover for ocelots, their location confers great potential for habitat restoration. They lie at the heart of this ranch ocelot population which I believe supports over 80% of the ocelot population in the U.S. In 2014, Mr. Yturria dedicated much of the remaining portion of his ranch to a conservation easement, totaling about 10,000 acres.

Fewer than 80 ocelots live in extreme southern Texas. Typically only about 7-14 ocelots occur in the "refuge population" at Laguna Atascosa National Wildlife Refuge, a population that has been disconnected from the ocelots in Mexico for many generations. And the rapidly expanding urban areas and increasing road traffic in Cameron County will further isolate this small population.

A sedated ocelot being held by Michael Tewes at Yturria Ranch.

In stark contrast, there are more than 35 ocelots using the "ranch population" in Willacy and Kenedy counties. These felines have access to more connected habitat surrounded by healthy rangelands. The land ethic and dedication to promote ocelot recovery continues today. We are all fortunate that the Yturria Family continues their legacy of helping this natural treasure of the animal kingdom.

Thiry-five years after my first visit with Mr. Yturria, I accompanied him in July 2018 to Washington, D.C. At age 95, Mr. Yturria passionately argued at different federal offices for habitat restoration to help recover the ocelot population. I will always remember Mr. Yturria assertively telling the head of the U.S. Fish and Wildlife Service that "I have done my part to help the ocelot. Now, I want you to do your part."

Mr. Yturria passed away only four months later. Indeed, he has done his part.

ONLINE

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Restoring Quail Habitat: Long-term Research on the Hixon Ranch

By Timothy E. Fulbright, Ellart J. Vreugdenhil, Brandon J. Palmer, Geron G. Gowdy, Javier O. Huerta, Benjamin R. L. Olsen, Eric D. Grahmann, Fidel Hernández, David B. Wester, Michael W. Hehman, Forrest S. Smith, Anthony D. Falk, and Scott E. Henke

Buffelgrass and Old World bluestem are non-native grasses that did not originate in North America and were brought here for erosion control and to provide livestock forage. Unfortunately, these grasses also degrade habitat for northern bobwhites and scaled quail. Quail have a hard time walking through them because they form thick stands. They also reduce food supplies because they suppress forbs (weeds) that produce seeds and harbor insects that quail like to eat.

Buffelgrass and Old World bluestems have been planted across South Texas. They have spread from areas where they were planted, replacing native grasses and forbs in the process. They are highly competitive, and are often just about the only grass visible on landscapes they take over. Reducing abundance of non-native grasses is difficult.

We initiated a research project in 2008 to try to replace non-natives with native plants. Our objective was to restore quail habitat on a site overrun by buffelgrass and Old World bluestem. In September 2008, we brainstormed with researchers from agencies and ranch managers with experience in invasive grass management to develop innovative treatments to reduce non-native grasses.

We initiated a series of pilot studies on small plots on the Hixon Ranch following the 2008 meeting. We tested treatments including combinations of mowing followed by herbicide application, moldboard plowing, prescribed fire, and planting of seeds from local varieties of native plants. Traditional treatments including application of herbicides such as Fusilade, seedbed preparation and sowing native plant seeds, and prescribed fire did not reduce these grasses when we applied them as individual treatments. Repeated discing followed by planting of native plants adapted to the local area appeared to have promise. We found that this strategy eventually depleted the non-native grass seeds in the soil.

We expanded our small-plot studies in 2013 to test how our strategy of seed depletion followed by planting native plant seeds worked on a 300-acre 'restoration' site dominated by non-native grasses.

Buffelgrass on the restoration site in 2013 before treatments.

We also designated a similar area that was covered with non-native grasses as an experimental 'control.' We gathered pre-treatment data during 2013 to document soil seed bank characteristics and vegetation on both study sites.

In February 2014, we burned the restoration site to remove the thick growth of non-native grasses and then we disced in April 2014. We repeated discing after rains in January, May, June, and July 2015. Discing three times reduced buffelgrass seeds in the soil by 91% but did not reduce seeds of Old World bluestem. We applied glyphosate plus 2, 4-D in March, June, August, and September 2016. We applied herbicides instead of discing to kill non-native grass seedlings so that the soil would firm before we drill seeded.

We drill-seeded native grasses, forbs, and sub-shrubs on the restoration site in September 2016. We put together three seeding mixes, each adapted to one of the three major soil series in the restoration area. We put 64 to 70 plant species in the seed mixes depending on the soil series. We used seed mixtures with a large number of species to improve chances of plants taking hold under a variety of soil and moisture conditions and to enhance competition with non-native grasses.

Canopy cover of non-native grasses on the restoration area has remained near 0% since planting compared to more than 40% on the control. We periodically spot-spray and hand-pull buffelgrass and Old World bluestem plants that emerge on the restoration site to help keep it free of non-natives. One important lesson we have learned is that restoring native vegetation where non-natives were once abundant is an on-going process. Although we greatly reduced the non-native seeds in the soil, some remain. In addition, animals, vehicles, and other carriers disperse new seeds onto the site. Converting non-native grass stands to natives, therefore, requires a long-term commitment to maintenance.

Native grass cover was 23% on the restoration area by March 2019, compared to 0% on the control. Canopy cover of native grasses on the restoration area was similar to that in areas of native vegetation on the ranch. Canopy cover of native forbs in March 2019 was 70% compared to only 10% on the control.

We mechanically removed single woody plants and clusters of woody plants that had non-native grasses underneath their canopies. We left some mesquite clusters on the restoration area to provide cover for quail. We planted seedlings of native shrubs and cacti in a pattern so that any quail in the study area would have woody cover within its flight distance. Woody cover on the restoration area was about 15% in March 2019.


Drill seeding native grass seeds on the restoration site in 2016.

We kept track of use of the restoration and control areas by bobwhites from 2013 until September 2018. Bobwhite used the restoration area less in 2018 than they did before we began the restoration. In 2013, 6 out of 8 bobwhites we collared with transmitters concentrated their home ranges within the restoration site. After the treatments were installed, only 1 out of 10 bobwhite home ranges were centered in the site. Reasons bobwhites did not use the restoration area as much after treatments include the following: grasses and forbs were still coming up and likely provided insufficient vegetation; tracking of bobwhites occurred in the summer when temperatures are high and potentially fatal, particularly to chicks; and lastly, since woody plant seedlings require several years to grow, thermal cover and hiding cover for quail were lacking, resulting in lower use than anticipated.

We are determining effects of restoration on other wildlife species as well. Breeding bird diversity on the restoration area increased from seven species in 2015 to 31 in 2018. Likewise, butterflies increased from 6 species in 2015 to 15 species in 2018. Texas horned lizards are abundant on both the restoration and control sites. The estimated population density is one lizard per 2.5 acres. However, population structure differs between the two sites. The restoration site has more hatchling and juvenile lizards. Harvester ants, the main prey of Texas horned lizards, also are more abundant on the restoration site compared to the non-native control site. It is possible that female horned lizards selected the restoration site as nursery habitat to lay their eggs in.

Over the six-year period from initial burning and discing in 2014 until 2019 the cost of conducting the restoration was about $611/acre. The total costs of discing and aerial herbicide applications were $33,670 and $11,510 respectively. Restoration is expensive; however, compared to buying wildlife habitat the cost is reasonable.

A horned lizard on the restoration site.

Our research resulted in several recommendations for restoring native vegetation in areas dominated by buffelgrass and Old World bluestems:

- The initial step is to moldboard plow unless the field is too rough, otherwise use deep discing, and then disc or apply glyphosate every time seedlings come up until few or no seedlings are detected to exhaust the seeds in the soil.
- Once the soil seed bank lacks non-native seeds, plant a diverse mixture of locally-adapted seeds of native plants.
- Autumn (September – October) is preferable for planting based on our experience.
- Restoration is restricted to sites that can be cultivated, such as old fields or areas that have been root plowed and root raked.
- Continuous maintenance for the life of the restoration is essential. In the absence of spot-spraying and hand-pulling, non-natives will eventually re-establish.
- Restoring native vegetation results in greater wildlife diversity within two years following treatment.
- Native vegetation restoration is expensive, but it is cheaper than buying new habitat.

Drone Heat Sensing Capabilities for Wildlife Ecology

By Aaron Foley and Jesse Exum

Figure 1
Two white-tailed deer detected during nighttime drone surveys with thermal imagery.

Drones, or Unmanned Aerial Vehicles (UAVs), have become extremely popular during recent years. Drones are frequently used by construction companies, search and rescue operations, and for recreational purposes. Wildlife researchers have recently begun using drones as a research tool to survey terrain that is difficult to access on foot. Further, drones are quiet, which minimizes disturbance of wildlife. Additionally, drones are safer for humans than small aircraft and helicopters that are typically used for aerial surveys. The data collected by drones are used for various reasons such as estimating population sizes, quantifying habitat characteristics, and wildlife and habitat monitoring.

Another neat thing about drones is the ability to attach different types of sensors; optical, thermal, and infrared cameras are available in either video or still-image modes, and scientists can use both optical and thermal cameras on the same drone. In this article, we will discuss the different ways that scientists have used thermal cameras on drones to collect data and how CKWRI scientists are incorporating these technologies into their wildlife research programs.

One popular application of drone-based thermal cameras is locating wildlife. In Colorado, drones with infrared sensors were successfully able to determine whether leks (breeding grounds) were occupied by sage grouse. In Germany, roe deer fawns are susceptible to mortality by farm implements during the mowing season. Because fawns are well camouflaged, the use of optical cameras would prove difficult to detect fawns. Thus, scientists used thermal cameras to locate fawns prior to mowing, which in turn reduced mortality rates. The number of benefits of locating animals via thermal imagery is limitless.

Locating wildlife via drones can also be used to generate population estimations. For example, scientists were curious about whether drone counts or ground counts would be a better way to estimate the population size of sandhill cranes on a wildlife refuge in Colorado. Using drones near birds may be dangerous due to potential mid-air collisions so researchers used thermal cameras during nighttime drone surveys when cranes were at their roost sites. Interestingly, drone counts were only 5% different than ground counts. This autumn, scientists at CKWRI will be using drones fitted with thermal cameras to determine if roosting bobwhite coveys can be detected and whether this information can be used to create population estimates. If drones are capable of generating population estimates then the need to use helicopters for quail surveys may be reduced which has safety and financial implications.

Another case study of using drones to estimate population sizes occurred in Canada. Scientists compared population estimates of woodland caribou conducted via drones with infrared sensors, ground counts, and DNA analysis of fecal pellets. Population estimates were comparable between the 3 methods, but precision was higher for drone counts and DNA analyses. Currently, scientists at CKWRI are using a combination of thermal and optical cameras on 5 ranches in South Texas to determine whether drones can be used to generate population estimates of white-tailed deer. The combination of thermal and optical cameras is being used because it is very difficult to detect animals in the brush via optical footage alone; thus, the thermal camera is being used to detect animals while the optical camera is being used to identify species (Figure 1). Repeated daytime and nighttime drone estimates will be conducted to determine if counts are consistent. Further, population estimates will be compared with trail camera surveys and helicopter surveys to determine if drone population estimates are comparable. If drones generate viable population estimates, then drones could be useful to survey white-tailed deer in areas where the use of aircraft is limited (suburban areas and smaller ranches).

There are some limitations of conducting wildlife surveys with drones such as battery life or the inability to fly during moderate inclement weather (wind, fog, rain). However, many scientists consider these limitations to be outweighed by the advantages. Footage or images can be reviewed repeatedly, which reduces the eye fatigue associated with real-time surveys. Computers can be used to automatically review the footage. For instance, researchers in Australia compared ground-based and drone-based counts of radio-collared koalas. The thermal imagery acquired by drones were processed by an automated detection software (artificial intelligence) and relative to ground-based counts, the probability of detection of koalas was higher (68-100%).

Counting or observing wildlife is not the only useful drone application. The data collected from thermal imagery can be used to determine the proportion of landscape that may be thermally limiting to certain wildlife species. For instance, bobwhites can tolerate temperatures up to 102°F. Researchers at CKWRI used thermal imagery collected from drones to quantify temperature of the landscape and found that during October, only 13-24% of a study site near Hebbronville during 2-4 pm was below the tolerance limit of bobwhites. The high proportion of the study site not thermally suitable for bobwhites has implications for population dynamics of this popular game bird. Quantifying the thermal environment can also be extended to include numerous wildlife species.

Drones also have applications for agricultural areas. Quantifying damage of row crops (e.g., corn) often requires one to walk through the field to locate damaged sites – a big task if the field is hundreds of acres! Drones can be used to obtain overhead photographs and post-processing can be used to measure the amount of crop damage. Scientists at CKWRI are currently using this technique in eastern Texas (Figure 2) with the goal of quantifying the economic loss of crop depredation and comparing that cost with the cost of feral pig control. One interesting thing is that drone imagery was able to locate areas where pigs rooted up recently sowed corn seeds (Figure 3).

Figure 2 - *Overhead shot of a cornfield. Note the sections that were damaged by feral pigs. Photo by Bethany Friesenhahn.*

With the rising popularity of drone-based wildlife ecology, we at CKWRI are excited about the increased access to a wealth of data. As with all new technology that has arisen during the last 1-2 decades that benefit wildlife research (GPS radio-collars, trail cameras, etc.), there are a number of experiments we need to conduct to determine the pros/cons of drones relative to other traditional data collection methods.

Figure 3 - *Row crops just after planting. Note the areas (dark lines within red boxes) where feral pigs recently rooted for seeds. Photo by Bethany Friesenhahn.*

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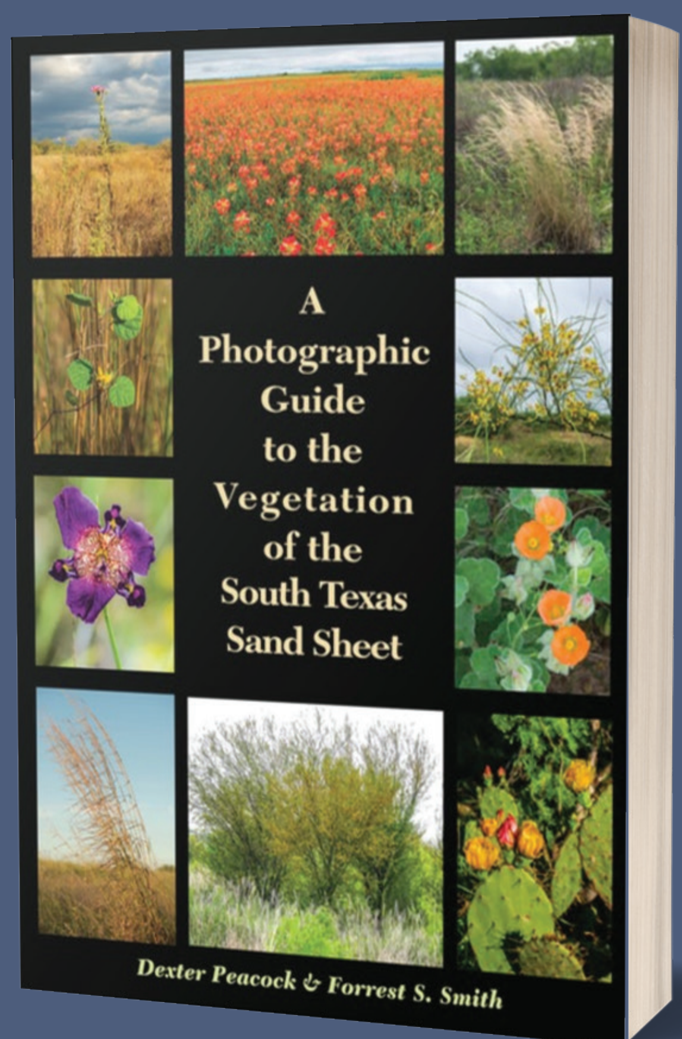

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