Texas Cooperative Fish and Wildlife Research Unit

ESTABLISHED IN 1988

What We Do

The Texas Cooperative Fish and Wildlife Research Unit is part of the National Cooperative Research Units Program that resides within the U.S. Geological Survey. The Texas Unit was established in 1988 and first staffed in 1989. Our mission is to conduct and facilitate research, train graduate students, and provide technical service on natural resource issues of interest to cooperators and the public. Natural resources addressed by our unit range from endangered species to invasive species to game species. Our research utilizes concepts and approaches from the fields of animal ecology, physiology, toxicology, conservation and environmental science, and structured decision-making.

Unit activities are guided by a coordinating committee consisting of Texas Tech University, Texas Parks and Wildlife Department, The Wildlife Management Institute, U.S. Fish and Wildlife service, and U.S. Geological Survey.

https://www1.usgs.gov/coopunits/unitAboutUs/Texas

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Undergraduate students
Unit scientists employed or advised a total of 16 undergraduate technicians and research students during the present reporting period.

Project Highlights

Names of investigators, funding sources and amounts, and project performance periods can be found in the FY21-22 Financial Report. Please use project number for cross reference. Unassigned projects refer to research efforts and major writing projects not associated with a specific funded project.

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RWO 98: Structure and Connectivity of Mid-Continental Snowy Plovers (Completed FY 22)

Negative population trends of snowy plovers *(Charadrius nivosus)* have been documented for the Southern Great Plains (SGP). However, there is a paucity of data concerning population connectivity of snowy plovers on the SGP, where breeding habitat can be spatially disjunct, ranging from 10-600 km apart. Such breeding habitat distribution, coupled with precipitation stochasticity and low snowy plover abundance at sites in Texas and New Mexico, may elevate risks of regional extirpation, and

population persistence probability may be quite low. We used the Motus Wildlife Tracking Network to track snowy plover movements across 6 sites on the SGP of Texas, New Mexico, and Oklahoma in 2017 and 2018.We also performed breeding season surveys in Texas and used 20-year survey data from 2 National Wildlife Refuges (NWR; one in New Mexico, one in Oklahoma) to assess current population trends, relative abundances, and detection probability across the SGP landscape. Trend data from Salt Plains NWR in Oklahoma indicate a stable population of ~4500 plovers during the past decade. However, this stability at Salt Plains NWR contrasts with long term declines of breeding snowy plovers on the SGP of Texas (44%) and at Bitter Lake NWR in New Mexico (63%). Within breeding season movements of snowy plovers during 2017 and 2018 suggest that Salt Plains NWR is not connected to Texas saline lakes nor Bitter Lake NWR populations. Furthermore, only 2 individuals moved from Bitter Lake NWR to Texas, revealing these populations are weakly linked and that some degree of isolation exists. Relatively frequent movements of plovers to one of the study site saline lakes in the SGP of Texas may be indicative of higher-quality breeding and foraging habitat for regional snowy plovers due to the occurrence of consistent freshwater artesian springs at that site. Overall, such potentially low population connectivity may warrant further investigation into the genetic underpinning of small, isolated and potentially threatened subpopulations.

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RWO 100: Changes in Avian and Plant Community Composition and Structure Following Prescribed Thinning in Pinyon-Juniper Woodlands (Active)

Pinyon-juniper woodlands are an extensive vegetation community found throughout the western United States. Climate and land use practices have expanded these woodlands into grasslands. Federal and state agencies are engaged in tree removal and thinning to reduce fuel loads and restore historic stand structure. Conversely, the high proportion of avian pinyon-juniper specialists included on national and state lists of concern has created a need to balance thinning targets with conservation of these woodland-obligate bird species. We have partnered with the U.S. Bureau of Land Management and the U.S. Fish and Wildlife Service to study how avian community composition and structure changes in concert with vegetation community change following thinning prescriptions at two geographically distinct pinyon-juniper woodlands in central New Mexico. We stratified our random sampling into thinned and un-thinned plots and conducted point count surveys during the breeding seasons of 2018 - 2022 at a site in Lincoln County, NM and in 2018 – 2020 at a site in Socorro County, NM. We have observed 90 species across both sites, with over half determined as moderate or high conservation concern in the State of North America's Birds 2016. This project is ongoing as a long-term study to understand time-lags associated with both avian and vegetation response to landscape level management actions.

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RWO 102: Development of an Effective Survey Methodology for Detection and Monitoring of Texas Kangaroo Rats (Active)

The Texas kangaroo *rat* (*Dipodomys elator;* TKR) is endemic to the East Central Texas Plains and Southwest Tablelands ecoregions in north-central Texas. It is a rare, nocturnal rodent, making it an especially challenging species to obtain reliable estimates of population size or change. Existing surveys have primarily been by spotlight along roads; however, this presents a very biased interpretation of presence and habitat use. Other density estimates, such as those derived from burrow counts are valuable as an index only. There is an urgent need to develop a reliable, repeatable survey method that allows reliable estimates of population sizes and how they respond to management actions. We are initiating a study that,

through experimentation and field test trials, will allow us to assess novel approaches to surveying for the Texas kangaroo rat. If successful, it will result in a new approach that will be suitable for nocturnal application, reliable, repeatable, and based on detection probabilities so that population abundances may be estimated. We are testing and comparing the established driving spotlight road survey (as baseline) with new methods including walking spotlight road surveys, walking spotlight open field surveys, driving thermal imaging monocular surveys, and walking road and open field surveys using a thermal imaging monocular. To date we have been conducting validation trials with Ord's kangaroo rats as a surrogate at the Matador Wildlife Management Area near Paducah, TX.

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RWO 103: Assessing Risk for Westward Expansion of Zebra Mussels to Guide EDRR Strategies (Active)

Early detection to help contain and prevent the spread of zebra mussels westward continues to be a high national priority. Zebra mussels are representative of nonindigenous aquatic species (NAS) with devastating economic, recreational, and environmental impacts that are under watch as a problematic species across the U.S. Zebra mussels continue to expand their range westward and first arrived in Texas in 2009. Since then, they have continued to spread across the state, and if current trends persist, this invasion front may eventually reach New Mexico. Our study aims to assess the invasion risk of Texas and New Mexico's water bodies. Our in-progress objectives are to (1) evaluate habitat suitability of water bodies in Texas and eastern New Mexico to estimate the potential for zebra mussels to be established and (2) identify water bodies most critical to potential zebra mussel spread. We have gathered publicly available water quality information, boat ramp locations, boat registration data, and status of zebra mussel infestation in reservoirs across Texas and New Mexico. In May and August of 2022, we collected supplemental water quality data for important predictors of habitat suitability (e.g., calcium) at locations without publicly available data. Boater travel times and distances for recreational trips between water bodies are under analysis. This will allow us to assess roadway connections and highlight water bodies that may act as hubs and stepping-stones for the spread of zebra mussels using network analysis. By providing data and decision support tools on invasion risk our goal is to facilitate early detection and mitigation strategies that may ultimately lower the cost associated with zebra mussel impacts.

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RWO 104: Species Distribution Modeling and Native Fish Conservation Area Prioritization to Guide Landscape-level Conservation (Active)

Integrated watershed-based conservation networks have become a primary tool for multi-species aquatic conservation across large geographic areas. In Texas, collaborative efforts between Texas Parks and Wildlife Department, University of Texas, and other partners resulted in an initial Native Fish Conservation Area network of 20 prioritized watersheds for the conservation of fish species of greatest conservation need (SGCN). Although the inception of this network has been successful for project planning and implementation, development of this effort highlighted geographic areas that were under-sampled or that required baseline ecosystem assessments of habitat, water quality, and biotic communities. Since 2013, monitoring and detailed biodiversity assessment

(i.e., Bioblitzes) have provided additional data through the Fishes of Texas Project and additional support for management and conservation recommendations. Given the

additional information, there is a need to update distributions and predicted occurrences of fish species, especially SGCN, and refine sub-watershed prioritization. Our objectives are to develop updated species distribution models, refining hierarchical spatial prioritization of the NFCA network, and coordinate supporting datasets and research products with conservation stakeholders and collaborative partners. We have received access to and began processing updated species occurrence data from the Fishes of Texas Project and have been brainstorming and outlining approaches for NFCA priorities with research partners. Research resulting from the development of these products will address relationships between environmental factors and species occurrence, how modeling approaches influence predictions for species-environment relationships in a conservation framework, and how various conservation objectives (e.g., protect or restore habitat condition, maintain dispersal corridors, etc.) affect the ranking and selection of geographic priority areas. This process will add a critical step in aligning conservation objectives to project planning, and guide efforts to identify current research needs.

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TPW 40: Assessing Distribution and Occupancy Patterns of Riparian Avifauna in the Trans Pecos Region of Texas (Completed FY 22)

Riparian areas in the Chihuahuan Desert Ecoregion are identified as a priority for conservation in Texas. It is also an objective of the Texas Parks and Wildlife Department to work toward the recovery of threatened, endangered, and high-priority species associated with riparian systems. In the Chihuahuan riparian zones this includes the federally threatened western yellow-billed cuckoos (*Coccyzus* americanus occidentalis) and the state threatened common black-hawk (*Buteogallus anthracinus*), gray hawk (*Buteo plagiatus*), and zone-tailed hawk (*Buteo aldonates*). However, little quantitative data are available for riparian obligate birds in the region. In 2018 and 2019 we studied the distribution, relative abundance, and community structure of avifauna among 8 riparian systems of the Trans Pecos region. Estimating nesting abundance and productivity of diurnal raptor species. Larger riparian woodlands had greatest bird diversity, and cavity nesting species tended to be absent from smaller woodlands. Tree sizes, heights, and density also substantively influenced species gradients. Consistent with this, we found substantive differences in height and diameter of nest trees and grove density used by different raptor species, indicating resource partitioning among the species for nesting habitat within riparian woodlands. This suggests even age riparian systems are not adequate for occupancy of this suite of raptor species; rather a mixed-age and structure of riparian woodlands is important for continued presence of these raptors, and larger woodlands increase overall avifaunal diversity and abundance. These results will provide management agencies with data to make informed decisions for

identification of priority areas for conservation and restoration.

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TPW 41: Influence of Woody Vegetation Patterns on Scaled Quail Demographics (Completed FY 22)

Semi-arid landscapes, including those in the Texas Rolling Plains, have undergone shifts in vegetation structure over the past century, resulting in irregular, dense stands of woody vegetation in areas that were once predominantly mixed grasslands. While there has been a growing body of literature and interest in scaled quail, more research was needed to understand if scaled quail population declines in the Texas Rolling Plains were correlated to changes in woody species encroachment and habitat fragmentation. We captured 187 scaled quail and deployed 43 GPS-transmitters that gathered location data. We calculated home range size of 27 scaled quail and collected 4,560 drone images to estimate habitat selection. The overall accuracy of the drone images being classified as the correct vegetation community based on ground truthing was 85.65%; average home range size was 91 acres. Grassland comprised the largest percentage of landcover type within home ranges at an average of 54% followed by succulents (12%), bare ground (10%), and woody vegetation (8%). Scaled quail selected similar habitat among ranches and temperature was a better predictor of habitat selection in winter compared to vegetation. Scaled quail were flexible and used various types of cover in winter. Vegetation and microclimate did influence one another, and areas that were composed of more bare ground and woody vegetation were warmer. However, our results indicated woody vegetation and bare ground within the home range both negatively influenced overwinter survival (~57%), but fine scale vegetation and microclimate did not. Our findings support previous assessments that suggest the woody vegetation encroachment phenomenon is contributing to the decline of scaled quail in the Texas Rolling Plains, and management designed to reduce woody vegetation and increase native warm season bunchgrasses will be beneficial for scaled quail, grassland songbirds, and other native wildlife on the Texas Rolling Plains.

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TPW 43: Distribution and Habitat use of Kisatchie Painted Crayfish in Northeast Texas with Investigation of Multi-scale Environmental Influences on Crayfish Community Structure (Completed FY 22)

Few observations exist for the Kisatchie Painted Crayfish (*Faxonius maletae*; KPC) within the Big Cypress Creek drainage in northeast Texas, and little else is known about its distribution, habitat use, or population structure. Therefore, we conducted comprehensive crayfish surveys and habitat assessment across northeast Texas (beyond known collection sites) to address data deficiencies.

Overall, at 74 sites across ten Texas counties within and adjacent to known KPC range, eight crayfish species were encountered across 35 of these sites (= 47.3% of total), including 13 KPC individuals across seven sites (9.5%), including two where KPC had not been observed before. Stepwise multiple logistic regression indicated that conductivity and availability of exposed root masses positively related to KPC presence, although neither factor was statistically significant on its own. Neither nonmetric multidimensional scaling nor Canonical Correspondence Analysis revealed patterns between presence of KPC and other crayfish species. Overall, although our surveys successfully identified two novel occurrences of KPC in Texas, occurrence data remain limited for the species, challenging the ability to understand drivers of its distribution. However, given the depth of this survey, we are confident that KPC is not "data deficient" but instead has compelling evidence of a limited range

and small population size. This work in currently in preparation for publication.

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TPW 44: Pilot Study – Understanding the Distribution and Relative Abundance of Cormorants in Texas (Completed FY 21)

Over the last decades, there has been an increasing conflict between conservation of cormorants and perceived and real predatory impacts they pose to managed fisheries. This has been exacerbated by increases in cormorant populations across North America. Continentally, the majority of these conflicts have been in the northern Great Lakes states and in the southeastern United States.

More recently there is a common perception that populations of double-crested (*Phalacrocorax auritus*) and neotropic (*Phalacrocorax brasilianus*) cormorants are increasing in Texas and creating a conflict with fish stocking and fishery management in public waters. We assessed the historic and current distributions of cormorants in Texas, seasonality of presence, and if relative abundance of cormorants at water bodies is related to stocking schedules. We used Christmas Bird Count data to assess population changes in Texas over the last 50 years. We found no statistical evidence of an expansion of double-crested cormorants in Texas but there was a significant but non-linear increase in abundance across 5-year blocks. In contrast, we found evidence of significant increases in both range and abundance of neotropic cormorants. We used before and after surveys to assess cormorant presence at neighborhood fishing lakes that were and were not stocked. We found no change in presence of cormorants at non-stocked lakes but a significant and rapid change in presence following stocking at stocked lakes.

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TPW 45: Ecology of Devils River Minnow *Dionda diaboli* in an Invaded Stream-riparian Ecosystem (Active)

Streams ecosystems are impacted by multiple stressors that simultaneously erode the quality and quantity of freshwater habitats, often to the detriment of aquatic species. Groundwater dominated streams in semi-arid and arid landscapes face additional threats such as water extraction, altered flow regimes, encroachment of invasive species, and reduced water quality (e.g., salinity, pollution, turbidity), which collectively alter aquatic environments in ways that stress populations of native fishes and the food resources they rely upon. San Felipe Creek, which is listed as critical habitat for Devils River Minnow (DRM) *Dionda diaboli* and is one of only three known remaining populations in Texas, has been degraded by many of these stressors including the presence of invasive fishes (e.g., armored catfish *Hypostomus* sp.) and riparian vegetation (e.g., Giant reed *Arundo donax*). There is interest by partners to address these concerns and restore riparian habitats along San Felipe Creek. However, the impacts of these invasive species on food web dynamics as they relate to priority species such as DRM is lacking. This project is working to inform efforts to prioritize the management of riparian vegetation and invasive fishes. The study is addressing key information gaps laid out in the recovery plan concerning the ecology of federally threatened DRM by quantifying the diet habits of numerically dominant fishes and availability of basal food resources. Food web dynamics are being compared between stream reaches within and without invasive *Arundo*.

Sampling has been ongoing since 2021 and accumulated data is currently being analyzed.

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TPW 46: Dimensions of diversity in urban fisheries: Examining habitat, fish, and anglers to inform the management of Texas Community Fishing Lakes (Active)

Urban fishing programs have been developed as a strategic approach to manage underserved fisheries. Effective management of these urban fisheries requires a basic understanding of both ecological and human dimensions, which entails integrative study approaches. Traditional fisheries approaches (aquatic biology of freshwater systems) coupled with human dimensions methodologies provide a means of holistically examining the importance of catch and non-catch related factors that are important to urban anglers and those interested in recreational angling. This study has been examining multiple dimensions of small urban fisheries of Texas to better understand the interactions of anglers, fish, and habitat. Community Fishing Lakes (CFL) in Lubbock and DFW metroplex are being sampled to quantify the availability and quality of littoral and shoreline habitats and the diversity of fish assemblages. Concurrently, recreational anglers are being interviewed to quantify the quality of angling experiences, fishing tendencies (i.e., harvest, catch-release, fishing effort), and other angler demographics. Collectively, assessments of habitat, fish, and people will help identify best approaches for enhancing urban fisheries and indirectly benefit broader initiatives aimed at recruiting new recreational anglers. Preliminary analyses have revealed limited submerged and shoreline vegetation in many small lakes. Analysis of the relationships between habitat, fish, and angler attributes are ongoing.

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TPW 47: Assessing Texas Kangaroo Rat Habitat Connectivity, Management and Monitoring Protocols (Active)

The Texas kangaroo rat (*Dipodomys elator*) is a rare species endemic to the Central Great Plains and Southwest Tablelands ecoregions in north-central Texas. Due to substantial reduction in distribution and suspected population declines, the species has been petitioned for federal protection under the Endangered Species Act and is ranked as a G2 - imperiled (global ranking) and S1 – critically imperiled (state ranking) species. We propose a study addressing three important steps in the effort to conserve the species. First is to conduct experimental vegetation manipulations to determine feasibility and effectiveness of restoring, enhancing, or creating usable habitat for Texas kangaroo rats. Second is to assess movement patterns and dispersal of Texas kangaroo rats, especially the success of getting dispersal of individuals into restored areas from proximal occupied areas. Third is to model connectivity and environmental resistance to dispersal of Texas kangaroo rats within and among the known occupied clusters; such a model would allow targeted application of habitat restoration or creation. This project has been in a 'pilot status' due to delays in funding and obtaining access to private lands. We have been working on 1) identifying landowners who will allow access and habitat manipulations for this study and 2) a means to track movements of tagged animals to assess their response to habitat restoration efforts. We have contacted landowners that may allow us to start field work this fall. We are also working on a grid system to use pit tags for tracking movements of kangaroo rats rather than much heavier and larger radio/GPS collars. We anticipate full initiation of this project in fall 2022.

TPW 48: Evaluating resilience and vulnerability of fish assemblage structure to intermittent flow (Active)

Growing human populations, irrigation water demands, and plans to increase water storage capacity intensify the need to understand how fish respond to drought to establish realistic targets for managing populations and at-risk species. The purpose of this project is to address species resilience and vulnerability to drying events to provide fish-habitat association and distribution data that could be used to inform Native Fish Conservation Area planning and instream flow recommendations in the middle Colorado River basin. Our main objectives are to (1) document timing, duration, and severity of stream drying and resumption of flow in intermittent reaches using modified temperature and light loggers, (2) determine fish-habitat associations and fish assemblage structure across seasonal flow conditions and between perennial and intermittent reaches, (3) examine differences in fish recruitment across a gradient of drying severity and (4) characterize fish species and guilds most susceptible to seasonal drying events. The objectives will be accomplished in four tributaries of the Colorado River over two dry seasons (summer) and following the resumption of flow (fall-spring).

In the summer of 2022, we have deployed stream temperature, intermittency, and conductivity (STIC) loggers to consistently monitor streamflow and conducted two fish assemblage and habitat surveys across sites in June and August. Information on species responses with respect to the severity and extent (spatial and temporal) of drying will provide evidence-based inferences about how projected increases in climate- or anthropogenically driven intermittence may influence recruitment dynamics and fish assemblage structure, including fish species of greatest conservation need.

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TPW 49: Food habits of SGCN fishes to inform habitat assessment and restoration in the Red River basin (Contract Pending)

The ecology of many prairie stream fishes is not well understood, despite long recognition that these fishes are negatively affected by stream flow alterations, habitat degradation, fragmentation, and invasive species. River regulation and degraded riparian habitat due to salinization and invasive species have the potential to diminish resource heterogeneity that supports riverine food-webs of prairie fishes. The primary objectives of our study are to (1) characterize spatial and temporal variation of Red River Shiner, Red River Pupfish, Plains Minnow, and Prairie Chub food habits, (2) determine the degree to which aquatic (autochthonous) and terrestrial (allochthonous) resources are utilized, and (3) describe age and growth of selected Red River fish populations. Fishes will be sampled across multiple locations to assess how spatial and environmental variation influences food habits. We will examine the predominant sources of energy that supports the growth and productivity of prairie stream fishes of the Red River basin. Information from this project will aid conservation efforts by identifying broad habitat types (instream, riparian)

that support Red River Shiner and other prairie fish growth and production in the Upper Red River. This fundamental ecological information will describe baseline conditions and identify species-specific traits that can be used

to evaluate consequences of habitat change and for predictive modeling.

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TPW 50: Deer and Elk Ecology Within the Trans-Pecos and Panhandle CWD Zones of Texas (Contract Pending)

Chronic wasting disease (CWD) is a fatal neurological disease of cervids propagated as malformed prion proteins that are shed from infected individuals in body fluids. The disease spreads via animal-to-animal contact, or uptake from infectious prions deposited in the environment. Chronic wasting disease was detected in mule deer in the Hueco Mountains of Trans-Pecos Texas in July 2012 (Texas Parks and Wildlife Department and Texas Animal Health Commission 2012). Texas Parks and Wildlife Department (TPWD) and Texas Animal Health Commission (TAHC) immediately enacted a disease-management plan aimed to determine the geographic extent and prevalence of CWD and reduce risks of the disease spreading out of the affected region. The disease has since been detected in free-ranging mule deer, white-tailed deer, and elk in Dallam and Hartley counties, located in the northwest Panhandle. Infected individuals probably expanded the range of the disease via natural movements from endemic areas in neighboring states. Texas cervids are not migratory but may make large seasonal movements. In free-ranging populations, natural movements and dispersal are a primary influence on spread of CWD. Adult males usually have the highest rates of infection, while most dispersal events involve young males. Landscape features affect movements and dispersal of cervids, and may concentrate, impede, or funnel animal movements. Cervid movements in these regions are not well understood, and management or containment strategies require relevant, geospatially explicit data on animal movements relative to landscape features. Our study will involve individual-based longitudinal data, including movement from early life to adulthood, amd factors influencing annual survival. We will use demographic and behavioral data to parameterize simulation models to explore how cervid density and demographics, as well landscape patterns influence the disease dynamics under various future scenarios. Our results will enable adaptive management plans incorporating movement and demographic factors with the spread of CWD.

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OA 90: Avian Community Response to Brush Control on the Welder Wildlife Refuge - Phase II (Completed FY 21)

Grassland obligate birds are experiencing widespread population declines across North America, largely due to loss of prairie grasslands. This has led to widespread prairie restoration effort. The Texas coastal prairie has experienced extensive brushland encroachment and efforts to restore coastal prairie grasslands and the natural avian communities has been given little attention compared to other regions. We partnered with the Welder Wildlife Foundation to assess coastal prairie restoration efforts on the Welder Wildlife Refuge, in San Patricio County, Texas. Our study is a before-after control-impact investigation of the temporal patterns of avian communities change in relation to chemical and prescribed fire brush control. Additionally, we used greater roadrunners *(Geococcyx californianus)* as a focal species for more specific habitat use assessment. Roadrunners requires a combination of open areas for foraging and brush for perches and nesting, but little quantitative data are available for roadrunner habitat selection, especially at the interface of prairies and brushlands of the Gulf Coast. Our goal was to understand how prairie restoration efforts can contribute toward grassland bird community recovery, while also accounting for species, such as the roadrunner, which require a mixture of vegetation communities. We conducted vegetation sampling along a 30-meter transect in June-July of 2018 ,2019, and 2020 at 29 sample sites each within both the control and treatment plots. We found that woody vegetation canopy communities varied by plot and herbaceous cover community was most impacted by the application of prescribed fire. We found that herbicide application in conjunction with prescribed fire can be a successful in reducing woody vegetation canopy cover while increasing native graminoid cover. When assessing the avian communities between a control plot and an herbicide and prescribed fire treated plot, we found alpha diversity was highest within the control plot. Detections of birds in the scrub habitat guild was highest in the control plot in contrast to the treatment plot where

the grassland habitat guild had the highest number of detections. Avian community structure varied in response to woody vegetation canopy cover and graminoid cover. When focusing on our roadrunner habitat study, we found roadrunners selected for bare ground and avoided riparian and water landcover types at the 1st order. At the 2nd order, roadrunners selected for bare ground and avoided riparian and water land cover types. For the 3rd order they used all land cover types proportionally with the exception of the water land cover type which they avoided. The removal of woody vegetation may benefit roadrunners on the Welder Wildlife Refuge considering that at the first and second order roadrunners are selecting for bare ground. Overall, the reduction in brush cover comes with an increase in forage production. Increased forage production will allow for higher stocking rates and ultimately a larger profit if the land manager decides to stock cattle. However, for long term management plans, finding a balance between conservation goals, restoration efforts, and financial gain by both ecotourism and cattle production, will require cost-benefit analysis by landowners.

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OA 91: NWI SWIFT Environmental Assessment and Monitoring Study (Active)

The Scaled Wind Farm Technology (SWiFT) program at the Reese Technology Center (RTC) is a research facility for research and development of improved wind energy generation. As part of their compliance program, we have been conducting 1) monthly surveys of avian species on and adjacent to the RTC to assess long-term changes in relation to wind energy infrastructure development and 2) a long-term study of American kestrels (*Falco sparverius*) populations and factors that influence nesting success and productivity. Our data collection from avian surveys is allowing assessment of seasonal and annual variations in abundance of birds in different guilds.

This will facilitate long term assessment of abundance, diversity, richness, and

overlap among years, and assessing these in context on variance in weather patterns (e.g., drought, extreme temperatures). We have also found that kestrels in our study area have some of the highest nest success and productivity rates reported in North America, and that approximately 25-35% of pairs produce a second brood of nestlings. Further, through collaborations, we have determined that American kestrels in the Southern High Plains are genetically distinct from other regions of North America.

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OA 93: Burrowing Owls and Wind Energy Development (Completed FY 22)

Burrowing owls (*Athene cunicularia*) are a small owl species that is of substantial conservation concern across their breeding distribution in the prairies and steppes of North America. Burrowing owls not only nest in, but seasonally migrate the length of, the Great Plains. These landscapes have become areas of rapid wind energy development, and there are cases in which wind turbines have resulted in direct mortality of burrowing owls. Of avian species experiencing mortality due to collision with wind turbines, raptors, such as burrowing owls, appear to be the most vulnerable and may experience proportionally greater population level influences through direct mortality or habitat loss associated with wind energy development. We partnered with Consolidated Nuclear Security, LLC through the Department of Energy, and with the Idaho Cooperative Fish and Wildlife Research Unit, to attempt to understand burrowing owl habitat use and movement patterns in context of wind energy development on breeding areas in Texas, and migratory pathways across the Great Plains.

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OA 95: Nest Site Selection and Nest Survival of Avian Communities in Pinyon-Juniper Woodlands Undergoing Thinning Prescriptions (Active)

Pinyon-juniper woodlands are an extensive and biologically important vegetation community across the western United States and have been

found to have the highest diversity of wildlife, highest density of nesting birds, and the highest number of bird species throughout the year compared to other upland habitats in the West. However, due to land-use patterns, pinyon- juniper woodlands have expanded beyond their historical distribution. In response, land management agencies have enacted removal or thinning actions to restore landscapes. A key issue is that many obligate and semi-obligate pinyon-juniper associated bird species show declining population trends, and many are included on lists of conservation concern maintained by various agencies and groups. There is a clear need to better understand how prescribed treatment of pinyon-juniper woodlands influences the local avifauna and attempt to balance competing management objectives of grassland restoration and pinyon-juniper bird conservation. We are studying changes in nesting density, site selection, nest survival, and estimates of productivity among the avian community in treated and untreated pinyon-juniper woodlands. The resulting data will better inform land and wildlife managers on what level of thinning and removal provide the maximum benefit for avian communities and meet the broader objectives to restore grass and woodland habitats in New Mexico and across this habitat type in the Southwest United States.

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OA 96: Development of Environmentally Friendly Methods to Control Harmful Algal Blooms (Active)

Prymnesium parvum (golden alga) is a harmful algal species that produces compounds highly toxic to fishes and other gill-breathing aquatic organisms. In the USA, *P. parvum* blooms were first reported in 1985 in the Pecos River, and they have now spread throughout much of Texas and the sunbelt states. The ecological impacts of *P. parvum* blooms have been severe but, unfortunately, effective field control methods for this species are unavailable. The goal of this research is to develop environmentally friendly methods to control *P. parvum* blooms. Our previous research showed that crude leachate obtained from the invasive riparian plant giant reed (*Arundo donax*) and certain allelochemicals found in this plant (e.g., ellipticine) are highly potent inhibitors of *P. parvum* growth. Our present research aims to evaluate the species specificity (biocidal spectrum of activity) of leachate and ellipticine. The justification of this research is that methods to control harmful algae ideally should have minimal effects on nontarget organisms. Our research is still in progress, but preliminary observations suggest that at concentrations that inhibit growth of *P. parvum*, leachate stimulates growth of the common green alga, *Chlorella sorokiniana*. Also, exposure to leachate did not affect survival of the common planktonic crustacean, *Daphnia pullex* but it delayed its reproductive development. Ellipticine acutely inhibited growth of *C. sorokiniana* but this effect was temporary—the alga was able to resume growth after a few days of exposure. In addition, ellipticine had no apparent effect on survival or reproduction of *D. pullex*. Tests are pending with a diatom alga and a fish species. A full assessment of the species specificity of giant reed leachate and ellipticine will be done once all tests are complete.

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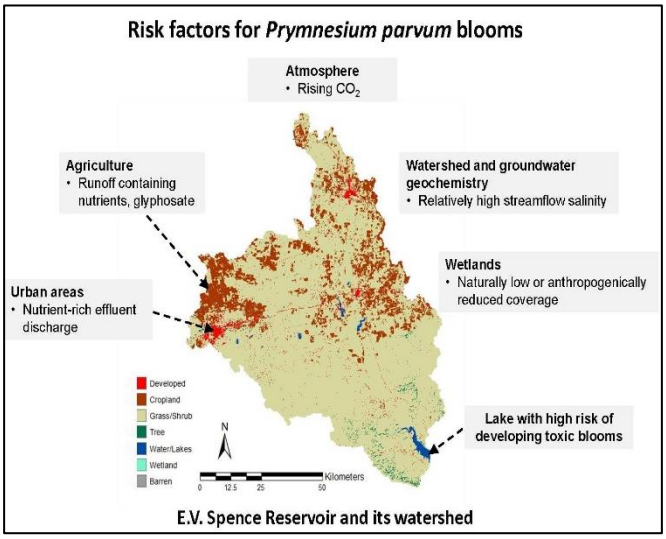
OA 97: Air, land, and water variables associated with the first appearance and current spatial distribution of toxic *Prymnesium parvum* blooms in reservoirs of the Southern Great Plains, USA (Completed FY 22)

This study examined the association of air, land, and water variables with the first historical occurrence and current distribution of toxic *Prymnesium parvum* blooms in reservoirs of the Brazos River and Colorado River, Texas (USA). One impacted and one reference reservoir were selected per basin. Land cover and use variables were estimated for the whole watershed (WW) and a 0.5-

km zone on either side of streams (near field, NF). Variables were expressed in annual values. Principal component and trend analyses were used to determine (1) differences in environmental conditions before and after the 2001 onset of toxic blooms in impacted reservoirs (study period, 1992-2017), and (2) traits that uniquely discriminate impacted from reference reservoirs (2001-2017). Of thirty-three variables examined, two positively aligned with the reoccurring appearance of blooms in impacted reservoirs (air CO_2 and herbicide Glyphosate) and another two negatively aligned (insecticides Terbufos and Malathion). Glyphosate use was observed throughout the study period but a turning point for an upward trend occurred near the year of first bloom occurrence. While the relevance of the decreased use of insecticides is uncertain, prior experimental studies reported that increasing concentrations of air CO_2 and water Glyphosate can enhance *P. parvum* growth. Consistent with prior findings, impacted reservoirs were of higher salinity than reference reservoirs. In addition, their watersheds had far lower wetland cover at NF and WW scales. The value of wetlands in reducing harmful algal bloom incidence by reducing nutrient inputs has been previously recognized, but wetlands can also capture pesticides. Therefore, a diminished wetland cover could magnify Glyphosate loads flowing into impacted reservoirs. These observations are consistent with a scenario where rising levels of air CO_2 and Glyphosate use contributed to the establishment of *P. parvum* blooms in reservoirs of relatively high salinity and minimal wetland cover over their watersheds.



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OA 98: Pilot Project – Home Range and Habitat Use of Zone-tailed Hawks (Active)

The zone-tailed hawk *(Buteo albonotatus)* is a medium sized bird of prey with a broad yet patchy distribution across the southwestern United States, where it is purported (but not confirmed) to be migratory, through parts of Mexico and Central America where it is considered resident. Zone-tailed Hawks are known to occupy a diversity of land cover types and elevations, found from low desert riparian zones to high elevation pine forests. Ecologically, they are one of the least understood and studied raptor species occurring in North American. In Texas they are protected as a threatened species, but this listing is largely based on a lack of quantitative data, perceptions of small populations, and risk of habitat loss due to degradation and loss of riparian woodlands. However, little quantitative data are available regarding the species breeding density and reproductive success across its distribution in the southwestern United States. The lack of information regarding its population size, nesting ecology, success, and habitat selection hampers identification of conservation

needs and management actions. We deployed GPS transmitters on two male zone-tailed hawks in the Trans Pecos in June of 2021 and monitored their breeding season home ranges, migration timing and duration, and wintering locations. One bird did not survive winter and was lost in Guatemala. In spring 2022 hawk 375 returned to its 2021 breeding area. These are the first quantitative data obtained on home range size, movements, and habitat use for the species. We will attempt to deploy an additional 7 donated GPS and GSM transmitters during the spring and breeding season of 2023.

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OA 99: Avian Community Response and Focal Species Survival to Treatment of Pinyon-Juniper Woodlands (Active)

This project is an expansion and continuation of RWO 100. Pinyon-juniper woodlands are an extensive vegetation community found throughout the western United States, where climate and land use practices have significantly altered woodland range and density. This expansion has created federal and state agency interest in tree removal and thinning with the goals of reducing fuel loads and restoring historic stand structure. Conversely, the high proportion of avian pinyon-juniper specialists included on national and state lists of concern has created a need to balance thinning targets with conservation of these woodland-obligate bird species. We have partnered with the U.S. Bureau of Land Management and the U.S. Fish and Wildlife Service to study how avian community composition and structure changes in concert with vegetation community change following thinning prescriptions at two geographically distinct pinyon-juniper woodlands in central New Mexico. In addition to avian community surveys, we have been conducting a mark-recapture study of juniper titmice and gray flycatchers to assess their response to prescribed thinning. Juniper titmice are year-round resident, cavity nesters, and primarily frugivorous whereas gray flycatchers are seasonal migrants, open-cup nesters, and primarily insectivorous. Both are species of conservation concern and represent different aspects of habitat requirements of pinyon-juniper woodlands. This project is ongoing as a long-term study to understand time-lags associated with both avian and vegetation response to landscape level management actions.

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OA 100: Influence of the carbonate system and nutrient levels on growth of *Prymnesium parvum* (Active)

Recent studies have indicated that in phosphorus (P)- and nitrogen (N)-rich inland waters, carbon could become a growth-limiting nutrient during intense algal blooms due to the high rates of carbon fixation and its depletion in water. These observations have implications for a full understanding of the potential effects of rising air CO_2 levels on harmful algal blooms. Namely, as air CO_2 levels rise, the gradient between air and water (dissolved) CO_2 concentration will become steeper during bloom development thus increasing the air-to-water CO_2 flux. In turn, this increased flux may partially compensate for carbon limitation and further enhance bloom intensity.

A previous study in our laboratory showed that maximum population density of the toxic alga, *Prymnesium parvum* cultured in P- and N-rich media is positively correlated with air CO_2 concentration. However, the study did not consider the influence of nutrient levels, or the concentration of dissolved inorganic carbon (DIC) or status of the carbonate system (e.g., levels of

dissolved CO_2). The present study will determine the effects on *P. parvum* growth of different concentrations of air CO_2 (current, 417 ppm; projected future, 800 ppm) using media of low (F/8) or high (F/2) P and N levels combined with low (50 mg/L), medium (100 mg/L), or high (150 mg/L) initial concentrations of total alkalinity (as $CaCO_3$). In addition to growth endpoints (growth rate and maximum density), we will measure pH and total alkalinity at different times during culture and estimate DIC and dissolved CO_2

concentrations using available algorithms (CO2SYS Excel). This information will help determine surface water conditions under which *P. parvum* bloom intensities may be enhanced by the rising levels of air CO_2.

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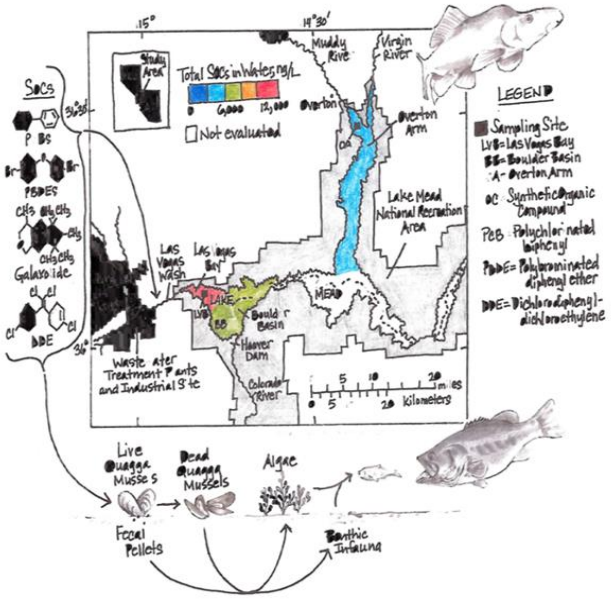
Unassigned Project: Movement of Synthetic Organic Compounds in the Food Web after the Introduction of Invasive Quagga Mussels (Dreissena bugensis) in Lake Mead, Nevada and Arizona, USA (Completed/Published FY21; Goodbred et al., 2021)

Introductions of *dreissenid mussels* in North America have been a significant concern over the last few decades. This study assessed the distribution of synthetic organic compounds (SOCs) in the food web of Lake Mead, Nevada/Arizona, USA and how this distribution was influenced by the introduction of invasive quagga mussels. A clear spatial gradient of SOC concentrations in water was observed between lake basins downstream of populated areas and more rural areas. Within the foodweb, trophic magnification factors (TMF) indicated statistically significant biomagnification for nine, and biodilution for two, of 22 SOCs examined. The highest value recorded was for PCB 118 (TMF, 5.14), and biomagnification of methyl triclosan (TMF, 3.85) was also apparent. Biodilution was observed for Tonalide® (0.06) and Galaxolide® (0.38). Total SOC concentration in quagga mussels was higher than in three pelagic fishes. Also, 19 of 20 SOC examined in Largemouth Bass *(Micropterus salmoides)* had substantially lower concentrations in 2013, when quagga mussels had become well established, than in 2007/08, soon after quagga mussels were introduced. Estimates of SOC concentrations in the water column and quagga mussels suggest that a considerable portion (~10.5%) of the SOC mass in the lake has shifted from the pelagic to the benthic environments due to quagga mussel growth. These observations suggest that benthic species, such as the endangered Razorback Sucker *(Xyrauchen texanus)*, may be experiencing increased risk of SOC exposure. In addition, stable isotope analysis (carbon and nitrogen) indicated a decrease in the nutritional value of zooplankton to consumers (e.g., Razorback Sucker larvae) since quagga mussels became established. These changes could affect Razorback Sucker larval survival and recruitment. Results from this study strongly suggest that the introduction of quagga mussels has greatly altered the dynamics of SOCs and other processes in the food web of Lake Mead.



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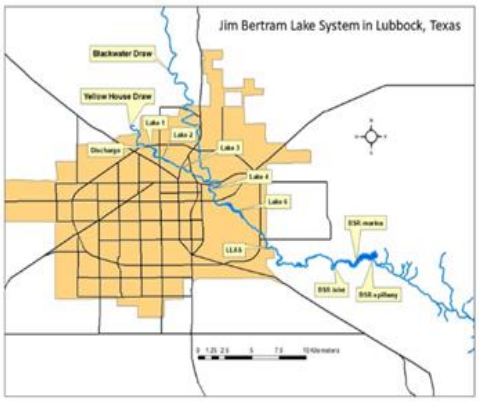
Unassigned Project: Water Quality Associations and Spatiotemporal Distribution of the Harmful Alga *Prymnesium parvum* in an Impounded Urban Stream System (Completed/Published FY21; Clayton et al., 2021)

The Jim Bertram Lake System consists of several stream impoundments within the City of Lubbock, Texas (USA). Baseflow in the upstream reach is dominated by nitrogen-rich-treated wastewater. While toxic blooms of *Prymnesium parvum* have occurred in this system for 2 decades during fall or winter-spring, little is known about water quality variables that facilitate blooms or the alga's spatiotemporal distribution. Water quality associations were examined monthly over a 1-year period. Total phosphorus was largely below the detection limit, suggesting that the system is phosphorus limited. Algal abundance was low during the assessment period and associations were determined using multiple logistic regression. Algal incidence was negatively associated with temperature and positively with organic nitrogen and calcium hardness. These findings conform with earlier reports but positive associations with the latter two variables are noteworthy because they have not been widely confirmed. Spatiotemporal distribution was evaluated in fall and winter-spring of three consecutive years. *Prymnesium parvum* incidence was higher in the upper than in the lower reach, and detections in the lower reach occurred only after a dense bloom developed in the upper reach contemporaneously

with stormwater runoff-associated flooding. Thus, the upstream reach is a major source of propagules for downstream sites. Because urban runoff is a source of phosphorus and its nitrogen: phosphorus ratio is lower than prevailing ratios in the upper reach, what triggered the bloom was likely relief from phosphorus limitation.



This study provided water quality, geographic and hydrological indices that may inform prevention and control methods for harmful algae in nitrogen-enriched urban systems.

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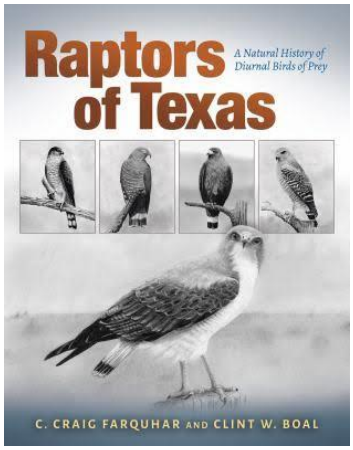
Unassigned Project – Raptors of Texas: A Natural History of Diurnal Birds of Prey (CompletedFY21/Published FY22; Farquhar and Boal, 2022)

This book co-authored by Craig Farquhar (Texas Parks and Wildlife Department, retired) and Clint Boal (TX-CFWRU) was published by Texas A&M Press in April 2022.



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Unassigned Project – Toxic Algae in Inland Waters of the Conterminous United States—A Review and Synthesis (In progress)

Harmful algal blooms are a major concern in the United States and around the globe. They disrupt the ecological integrity of affected water bodies and the toxins they produce pose a health risk to terrestrial biota and humans. Recent cyanobacterial blooms in lakes in and around Austin, Texas, were linked to the death of several dogs and led to increased awareness and concern about harmful algae in the state. This article will provide a comprehensive review of the biogeography and ecology of major toxigenic algal species found in inland waters of the USA, the ambient


Fish kill caused by *Prymnesium parvum* bloom (Lubbock Canyon Lakes, Fall 2020)

conditions that facilitate or drive their toxic blooms, the potential for biologically or anthropogenically driven expansions of their range or intensification of their blooms, bloom control or prevention methods, and other topics. The intended audience for this article includes scientists and land and water managers. Contributors to this article include USGS scientists from the Texas Unit, New York Water Science Center, and Upper Midwest Water Science Center.

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Unassigned Project – Intermittent River Research Coordination Network (IRRCN): Integrating Intermittent River Ecology and Hydrology (In progress)

The purpose of this Research Coordination Network (RCN) is to organize a series of expert workgroups that will synthesize the growing body of research on intermittent river hydrology and ecology. This research is important because intermittent rivers are often overlooked or excluded from water management plans due to uncertainty about their hydrologic and ecological importance. Workgroups formed by this RCN will produce generalized frameworks that can explain how intermittent river hydrologic and ecologic systems work, including characterization of flow-regimes, synthesis of biodiversity and ecosystem datasets, and integrated conceptual and process-based ecohydrology models. This RCN award is funded by the National Science Foundation to Daniel Allen at Pennsylvania State University. The Texas Unit is contributing to the RCN through working groups and publications including “Designing environmental flows from a river network perspective,” “Just add water: Wetting characteristics influence biogeochemical and ecological responses to the return of water in non-perennial streams,” and “Macroinvertebrate-flow model development using long term data from Sycamore Creek."

Proposed Projects

We are responsive and opportunistic in conducting research and providing technical support of relevance to unit cooperators within the research expertise of unit scientists. The list below includes specific or general projects being considered for FY23.

Terrestrial projects

Do eyeworms increase predation of bobwhite? (Boal)

Community structure and species distribution of owls – proposals in development (Boal)

Crested caracara breeding range expansion and association with livestock production – proposals in collaboration with USFWS and Texas AgriLife (Boal)

Reducing crop pest impacts to the Texas wine industry – proposal in development (Boal)

Wildlife Friendly Lubbock: a community outreach program for urban wildlife education – project development starting with local Lubbock entities (Boal)

Wintering ecology of northern harriers and short-eared owls; diurnal and nocturnal grassland raptors of conservation concern (Boal)

Aquatic projects

NRT – HDR: Convergence research of wildlife, environmental, and computational science and engineering – proposal to be submitted to The National Science Foundation; specific focus of proposal is harmful algae (Patiño)

Assessment of *Gila pandora* in Little Aguja Creek (Davis Mountains), Texas (Collins, Rogosch)

Water quality, hydrological thresholds, and landcover influence as a framework for exploring water scarcity in a period of aridification across the Southern Great Plains (Patiño, Rogosch)

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Mather, M.E., J.M. Smith, K.M. Boles, R.B Taylor, C.G. Kennedy, S.M. Hitchman, J.S. Rogosch, and H.M. Frank. 2021. Merging scientific silos: Integrating specialized approaches for thinking about and using spatial data that can provide new directions for persistent fisheries problems. Fisheries. https://doi.org/10.1002/fsh.10645

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Morris, S.A., C.W. Boal, and R. Patiño. 2021. Assessing cormorant populations and

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Boal, C.W. 2021. Patterns of water use by raptors in the Southern Great Plains. Annual Meeting of The Raptor Research Foundation, Boise, ID. 8-14 Oct. 2021. (Contributed Oral)

Boal, C.W. 2021. Raptors of the Southern Great Plains: an exploration of how birds of prey have responded to a 150 years of landscape change. Keynote Presentation, Annual Meeting of the New Mexico Ornithological Society (virtual), Mar. 2021. (Invited Oral)

Boal, C.W. 2021. Raptors of the Trans Pecos Rios. Keynote Presentation for the 2021 Birding the Border Festival, Del Rio TX. Apr. 2021 (Invited Oral)

Boal, C.W., S.A. Morris, D.A. Haukos, and B.A. Grisham. 2021. Variance in clutch size and egg morphology of lesser prairie-chickens across a climate gradient. 28th Annual Conference of The Wildlife Society (virtual), 1-5 Nov. 2021. (Contributed Oral)

Boehm, H., and J. Rogosch. 2022. Best practices for improving DEIJA in the fisheries employment hiring process. Oral Presentation. American Fisheries Society Annual Meeting, Spokane, WA. Aug. 21-25, 2022 (Invited Oral)

Davidson, T., C. Boal, and C. Borgman. 2022. Comparative nesting habitat and nest survival of avian communities in thinned an un-thinned pinyon-juniper woodlands. Annual Meeting of the Wilson Ornithological Society, Santa Fe, NM. 18-20 July 2022. (Invited Oral)

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Harried, B., C. Paukert, J. Rogosch, and J. Westhoff. 2022. Lack of standardized methods inhibits inference from fish thermal preferences and climate adaptation. Joint Aquatic Sciences meeting, Grand Rapids MI. (Contributed Oral)

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Patiño, R. 2021. Distribution, environmental associations, and bloom control methods for the harmful algal species *Prymnesium parvum* (golden alga). U.S. Geological Survey, Oklahoma-Texas Water Science Center, Texas (webinar). (Invited Oral)

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Rivera, A., L. Schilder, and C. Boal. 2022. Changes in avian community structure in response to prescribed thinning of pinyon-juniper woodlands. Annual Meeting of the Wilson Ornithological Society, Santa Fe, NM. 18-20 July, 2022. (Invited Oral)

Rogosch, J.S. and C. Paukert. 2020. How do we measure success of restoration to meet this centuries' biggest challenges to global inland fish and fisheries? World Fisheries Congress, Adelaide, Australia. October 16 2020. - CANCELLED (Invited Oral)

Rogosch, J.S., H.I.A. Boehm, K. Ivey, R.W. Tingley III, E.B. Webb, K.D. Wright, and C.P. Paukert. 2021. Assessing restoration effectiveness: a review of river restoration. Texas Chapter of the American Fisheries Society, Virtual Meeting. February 2-4, 2021. (Contributed Oral)

Rogosch, J.S., T. Birdsong, J. Broska, D. Buckmeier, D.P. Bunting, A. Cohen, G. Garrett, D. Hendrickson, K. Mayes, N. Smith. 2022. Species distribution modeling and Native Fish Conservation Area prioritization to guide landscape-level conservation. Texas Chapter of the American Fisheries Society. May 17-19, 2022. (Invited Oral)

Rogosch, J.S., Archdeacon, T.P., and S. Davenport. 2021. Population trends and trade-offs in long-term dynamics of a prairie stream fish community. American Fisheries Society, Annual Meeting. Nov. 6-10, 2021 (Invited Oral)

Rogosch, J.S., T.P. Archdeacon, and S. Davenport. Fish population dynamics and conservation strategies in a communally important aridland river. Joint Aquatic Sciences Meeting. May 14-22, 2022 (Contributed Oral)

Tábora-Sarmiento, S., R. Patiño, C. Portillo-Quintero, and C. Coldren. 2022. Air, land, and water variables and their association with the onset and distribution of toxic blooms of *Prymnesium parvum* in reservoirs of the Southern Great Plains, USA. Annual Meeting of the Texas Chapter of the American Fisheries Society, Hunt, Texas. (Contributed Oral)

Watson, K.A., C.W. Boal, and J.D. Ray. 2021. Risk of Swainson's hawks encountering wind turbines across their global range. Annual Meeting of the Raptor Research Foundation, Boise, ID. Oct. 2021. (Contributed Oral)

Watson, K.A., C.W. Boal, and J.D. Ray. 2021. Survival and behaviors of juvenile and adult Swainson's hawks. Annual Meeting of The Raptor Research Foundation, Boise, ID. Oct. 2021. (Contributed Oral)

Watson, K.A., C.W. Boal, and J.D. Ray. 2022. Risk of Swainson's hawks encountering wind turbines across their global range. Annual Meeting of the Texas Chapter of The Wildlife Society, Marble Falls, TX. 24-26 Feb. 2022 (Contributed Oral)

Wright, K., J. Rogosch, H. Boehm, K. Ivey, C. Paukert, E. Webb, and R. Tingley III. 2022. Assessing river restoration: are we effectively addressing contemporary challenges facing inland freshwater fish Joint Aquatic Sciences Annual Meeting, 14–20 May 2022. Grand Rapids, MI. (Contributed oral)

Awards FY 21-22

Staff

Clint Boal

- USGS Excellence in Science Award, U.S. Geological Survey Cooperative Research Units Program, April 2021
- President's Award, Raptor Research Foundation, Dec. 2020
- Dean's Research Grant Award, College of Agriculture Science and Natural Resources, Texas Tech University, Nov. 2020.

Reynaldo Patiño

- Special Thanks for Achieving Results (STAR) Award, U.S. Geological Survey Cooperative Research Units Program, 2021, 2022

Students

Mousumi A. Mary

- Summer Research Award, Department of Biological Sciences, Texas Tech University, Jun 2022

Sophie Morris

- Outstanding Undergraduate, Natural Resources Management, Texas Tech University, May 2022
- Overall Outstanding Undergraduate Student, Davis College of Agriculture Science and Natural Resources, Texas Tech University, May 2022

Ariana Rivera (undergraduate student)

- Texas Tech University Outstanding Student in Wildlife, Texas Chapter of the Wildlife Society, Feb. 2021

Christopher Rodriguez

- Research Presenter Award, CISER: Center for the Integration of STEM Education and Research, Texas Tech University, April 2021
- Outstanding Presenter, Undergraduate Research Conference, Texas Tech University, April 2021
- Collin Caruthers Memorial Scholarship, Texas Chapter of The Wildlife Society, Feb. 2021

Shisbeth Tábora-Sarmiento

- Travel Award, Texas Chapter of the American Fisheries Society, May 2022

Katheryn Watson

- First place recipient for the Clarence Cottam Award for outstanding student presentation at the Texas Chapter of The Wildlife Society, Feb. 2022.