41st Annual Gopher Tortoise Council Meeting

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Gulf Shores, Alabama

ORAL PRESENTATION ABSTRACTS

Protecting Conservation Lands through Grass Roots Activism

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As development pressures increase throughout Gopher Tortoise range, impacts to protected conservation lands for roadway routes, utility corridors and other "linear facilities" are becoming more common. Even legally binding agreements and permanent Conservation Easements may need to be defended to prevent destruction or degradation of critical Gopher Tortoise habitat. With habitat loss being one of the most serious threats to Gopher Tortoise conservation efforts, it is essential that private citizens, Non-Governmental Organizations (NGOs), scientists and local leaders work together to preserve natural areas and to intervene when necessary to ensure that protections remain in place, permanently, as intended. Existing protections cannot be taken for granted as the parties to the original agreements may seek to modify the legal documents to accomplish land use changes. In this presentation, the examples used to illustrate the relevant concepts are drawn from lessons learned by the Friends of Split Oak Forest in their ongoing efforts to protect Split Oak Forest Wildlife and Environmental Area (SOFWEA). SOFWEA is a Mitigation Park in Orange and Osceola, Counties, Florida that was established in 1994 (under the Preservation 2000 program administered by Florida Communities Trust). SOFWEA has been managed by the Florida Fish and Wildlife Conservation Commission (FWC) as refuge for various imperiled species including Gopher Tortoises. SOFWEA is currently in the path of proposed alignment(s) for the Osceola Parkway Extension which is in the Project Development and Environment study phase by the Central Florida Expressway Authority. The discussion will focus on the "grassroots" efforts to protect SOFWEA's natural communities from outside harm. Undertaken in earnest in 2017, the ongoing work is based on a three pronged approach of education, advocacy, and litigation. In addition to general strategy, the speakers will share insights and challenges of mobilizing and training an all-volunteer team to become effective advocates.

Evaluation of Electric Fences to Exclude Predators on Gopher Tortoise Translocation Sites

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Newly translocated gopher tortoises (*Gopherus polyphemus*) likely face greater predation than natural populations due to a lack of immediate refugia (burrows) and greater mobility during acclimation to a novel environment. There are many predators of gopher tortoises, but coyotes (*Canis latrans*) are often the most significant threat to adult gopher tortoises, along with raccoons (*Procyon lotor*) and domestic dogs. We evaluated the effectiveness of predator exclusion at Nokuse Plantation, a 55,000 acre preserve in northwest Florida, using different combinations of silt and electric fencing (5000- 6000 volts) over the past 13 years. Predation rates were determined by regularly searching recipient sites for gopher tortoise shells and assigning cause of death (predation/no predation) based on type of damage/injury to the shell. Because juvenile gopher tortoises are often completely consumed by mammalian predators, we did not attempt to measure predation rates of juveniles (CL < 180mm). From 2007-2019, 260 adult tortoises were confirmed predated, representing 8.1% of total adult tortoises released at Nokuse. Predation on adult gopher tortoises was greatly reduced by electric fences; 169 (65%) were predated in sites without electric fencing whereas 91 (35%) were predated in sites with electric fencing. These results demonstrate that electric fencing is an effective option to reducing predation on adult gopher tortoises. For an average enclosure (80 acres/7000 ft perimeter), silt fencing costs $0.87/ft, while adding a self-contained electric fence system will cost an additional $1.13/ ft. After silt fence removal, we recommend keeping electric fences in place (by modifying the wire configuration to allow unimpeded movement of tortoises), thus maintaining an area of reduced predation to a core population of adults and juveniles. Despite the increased cost of electric fences, they must be considered when the long-term goal of a translocation program is to establish viable gopher tortoise populations.

Development of a Habitat Suitability Model to Guide Gopher Frog Management in Georgia

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Efficient and effective management of threatened and endangered species requires knowing where taxa occur, identifying areas of suitable or restorable habitat, and choosing actions that are likely to improve persistence among managed populations. All of these elements of effective conservation require information that is not readily available or is costly to generate when needed. This problem is particularly acute for rare or cryptic species, like the gopher frog (*Rana capito*), that are challenging to detect and often distributed among isolated sites within fragmented landscapes. As a result, predictive models are critical to guide decisions. We developed and compared habitat suitability models that integrate wetland and upland variables at local and landscape scales using gopher frog occurrence data for ponds throughout Georgia. Factors affecting suitable habitat for the gopher frog in Georgia were assessed using a GLM framework and logistic regression, and the top performing model was used to project habitat suitability for gopher frogs across a suite of ponds at Alapaha River Wildlife Management Area (Alapaha). Habitat attributes at the pond, 100 m, and 1 km scales were included in the top model, with cover by forbs and grasses within the pond a strong predictor of gopher frog presence. The model projections accurately identified the single known gopher frog pond at Alapaha as having the highest probability of gopher frog presence. The model also identified as highly suitable several ponds where there is high confidence that gopher frogs do not currently occupy those sites. This apparent overprojection of suitable ponds at Alapaha likely relates to hydroperiod and the presence of predators, factors not included in the suitability model, thus demonstrating the need to integrate hydroperiod data into habitat suitability models for gopher frogs and other priority amphibians.

Health and Density Effects on Overwintering Behavior of Translocated Gopher Tortoises in Northwest Florida

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Gopher tortoises (*Gopherus polyphemus*) are listed as threatened throughout most of their range and are facing population declines as a result of direct habitat loss and fragmentation. Translocation of tortoises from lands that will be destroyed by development has become an important tool for conserving this species. Temperature plays an important role in tortoise health, as tortoises can thermoregulate and induce a fever response to fight illness by altering their behavior, such as emerging to bask. This behavioral shift is most noticeable during the winter, when tortoises are thought to be relatively inactive. We investigated the overwintering behavior of healthy (H) translocated gopher tortoises and tortoises "at risk" (AR) for developing disease, determined through health assessment, at two release sites during the 2016-17 inactive season using temperature loggers epoxied to the carapace. The sites were a high density site (DB1; 18 tortoise/ha) and a medium density site (SR1; 7.7 tortoises/ha). Overwintering onset, duration, and termination were determined for 23 tortoises representing 10 donor sites from seven Florida counties. Ten tortoises (three H, seven AR) did not overwinter. For overwintering tortoises, onset occurred between 12 November 2016 and 25 January 2017, and termination occurred between 18 February and 20 March 2017. AR tortoises had shorter overwintering periods (mean=83 days) than H tortoises (mean=101.7 days) overall ($p=0.006$). DB1 tortoises had shorter overwintering periods (mean=83 days) than SR1 tortoises (mean=109.6 days) with combined health groups ($p=0.02$). Larger differences can be seen with separation of both health group and site, with H tortoises in SR1 demonstrating the longest overwintering durations ($p=0.007$). Though overwintering behavior is most affected by health status, tortoise density has an additional effect on overwintering behavior. Lack of overwintering during the cooler months may result in further decreased health and body condition, potential cold stunning, and an increased risk for predation.

***J. Larry Landers Student Research Award recipient**

Analysis of FWC Gopher Tortoise Relocation Permit Records 2009-2019 to Identify Locations, Acreage and Animals Impacted by Land Development in the State of Florida

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Gopher tortoises are threatened with extinction due primarily to habitat loss. Relocation permits replaced incidental take permits in Florida in 2009. We analyzed the Florida Fish and Wildlife Conservation Commission relocation permit data from 2009-2019 to document the impact of development in Florida on gopher tortoise populations and habitat in the state. We looks specifically at the amount and location of habitat effected (by county and region), the number and age class of tortoises relocated. Our presentation will quantify these data in regards to total acres of gopher tortoise habitat lost to development, the numbers of adult and juvenile and hatchling gopher tortoises relocated. We'll also show the data from each county, region and inland or coastal location. These data do not include the habitat loss and tortoise relocations that already have been permitted but whose relocations have not yet been reported or completed. The dataset provided by the Division of Habitat and Species Conservation of the Florida Fish and Wildlife Conservation Commission is rich with additional information that can help us better document the effects of current land development practices in the state of Florida. These findings have serious implications for survival of the species and effectiveness of relocations as a mechanism to address species extinction due to development in the state of Florida.

Gopher Tortoise (*Gopherus polyphemus*) Habitat Associations and Population Demographics on Working Forest Landscapes

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Gopher tortoise (*Gopherus polyphemus*), a keystone species in southern pine (*Pinus* spp.) ecosystems, are listed as threatened under the Endangered Species Act in the western portion of their range. Much of the private land where tortoise occur is managed primarily for timber production. Tortoise ecology on these private, working forests remains poorly understood. Therefore, we are examining habitat conditions associated with tortoise activity on working pine forests in Washington Parish, Louisiana and Perry County, Mississippi. We used line transect distance sampling (LTDS), vegetation, and mark-recapture surveys to evaluate working forest conditions suitable for tortoise. During

2017 and 2018, we surveyed 74 (200 m) LTDS transects, detected 372 burrows, and captured 88 individuals. At the Washington Parish site, distance sampling models predicted a density of 0.11 (95% CI: 0.06–0.24) burrows/ha, and burrow location was positively correlated with an increase of sandy soils and decrease in basal area. At the Perry County site, distance sampling models predicted a density of 1.31 (0.79–2.23) burrows/ha, and burrow location was positively correlated with an increase in basal area and increase in understory vegetation density; soil conditions were not evaluated at this site due to low variation in soil types. The Perry County site appears to have a stable population with multiple age classes and tortoise distributed within forest stands. However, our results from the Washington Parish site concur with past studies and indicate a ~30-year trend of an adult-biased population with low recruitment that is mostly constricted to utility right-of-ways and roadsides. Despite a dynamic history of forest management, including prescribed burning, longleaf pine (*P. palustris*) planting, and midstory control, the primary factors beyond soil type and habitat conditions created through forest management that are limiting recruitment remain unknown and appear to have broad-scale effects beyond our study area.

Temporary Exclusion and Natural Repatriation of Gopher Tortoises on a Linear Utility Corridor

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Conscientious relocation from development sites can be used as a mechanism to restore and maintain secure, viable populations of gopher tortoises (*Gopherus polyphemus*). Temporary exclusion is an on-site relocation permit option for tortoises in Florida, primarily intended for the installation or maintenance of linear utility corridors including natural gas pipelines. Tortoises that have been temporarily displaced by construction activities can repatriate the right-of-way (ROW) following habitat restoration. Little data are available to document the effectiveness of this relocation option. Therefore, we monitored tortoise and burrow density, natural repatriation of temporarily excluded animals, and habitat suitability for two years following exclusion and habitat restoration along a natural gas pipeline ROW in Marion County, Florida. Following a 6-month exclusion period in 2016-2017, habitat restoration was initiated, and tortoises were able to return to the ROW. Tortoise density in the ROW has steadily increased following

habitat restoration from 0.10 tortoises/ha in 2018 to 0.43 tortoises/ha in 2019. Only 1 of 34 (3%) temporarily excluded tortoises was found within the right-of-way during 2019 trapping efforts. Following restoration, the ROW consisted of herbaceous field dominated by weedy and pioneer species and primarily comprised of Poaceae (34.7% cover) and Asteraceae (16.5% cover), taxa that are frequently consumed by gopher tortoises. Our preliminary results suggest that the ROW provides suitable burrowing and foraging habitat, and tortoises are emigrating into the restored ROW from adjacent areas.

Using Integrated Population Models to Describe Demography and Evaluate Population Viability of *Gopherus polyphemus*

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In southeastern North America, the federally Threatened gopher tortoise (*Gopherus polyphemus*) is a hypothesized keystone species with a significant role in regulating diversity of animals in the diverse but imperiled longleaf pine ecosystem. However, poor forest management practices during the 20th century are thought to have decreased habitat quality and caused population declines of *G. polyphemus* throughout much its range, and northern populations of *G. polyphemus* have been hypothesized to be currently inviable. Here, we evaluate demography and population viability of *G. polyphemus* in southern Alabama in the context of a landscape-scale experimental manipulation of forest management practices. We collected 29 years of mark-recapture and burrow survey data from six replicate populations in Conecuh National Forest in a randomized, paired design; three populations were experimentally manipulated with growing-season prescribed fire and forest thinning practices, while three control populations were unthinned and subjected to dormant season fires. We built a multi-state integrated population projection model to infer sex- and stage-specific apparent survival, recruitment, and abundance while accounting for imperfect detection in a Bayesian framework. Apparent survival was greater for adult females and males than juveniles and for populations managed with growing-season fire compared to control populations. Observed and projected abundance suggested stable population trends of populations with growing-season fire regimes and declining trends for control populations. Our

results suggest that growing-season fire may promote population viability of *G. polyphemus*, and that dormant season fire regimes and thick pine forests cause population declines of tortoises and likely the entire longleaf pine ecological community.

Gopher Tortoise Exploration and Conservation through Teacher Education

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As the state reptile of Georgia, the gopher tortoise is not only a keystone species, but as such is an important sentimental species for all Georgia elementary students to learn about. In this presentation, you will hear how the Kennesaw State University *Experiential Teacher Project* collaborates with the Georgia Nature Conservancy to engage elementary education students, a classroom teacher, and two faculty members in hands-on field science activities designed to examine the gopher tortoise population and habitat within a long-leaf pine forest. This applied research initiative seeks to expand the knowledge and spark the interest of classroom teachers regarding conservation and field science. As an endangered species in Georgia, it is critical to expand the awareness and conservation action needed to protect this special species. Before young children can be inspired, we first must inspire current and future teachers so they can bring science to life for children and instill a conservation mindset within young children that can last a lifetime. This project fosters an understanding of the importance of the gopher tortoise (*Gopherus polyphemus*) as a keystone species by allowing the student teachers to observe gopher tortoises within their native habitat in long-leaf pine forest in middle Georgia and to postulate purposes for their empirical observations. Observations also document the commensal burrow organisms through the use of game cams installed on 18 gopher tortoise burrows in Moody Forest. This project also seeks to further understand the conservation relationship of longleaf pines to the prosperity of the gopher tortoise. Participants will describe the research being conducted as well as how the study findings are converted into educational resources that will become free through an online repository for all elementary educators.

Assessing Stability of Gopher Tortoise Populations through Line-Transect Distance Sampling

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Most surveys of gopher tortoises use a standard line-transect distance sampling (LTDS) protocol to find tortoise burrows and estimate site-wide populations. Size scales with age into early adulthood; thus, managers rely on estimated size distributions to make inferences about the age structure of a population. However, juvenile populations are frequently underestimated due to size-related detectability, and estimated size distributions are skewed towards larger animals. Consequently, assessment of population stability from line-transect data is severely limited under currently used protocols. The goal of this project was to produce bias-adjusted size-demography estimates for gopher tortoise populations and develop a simulation-based model that quantifies the probability that an estimated size distribution of tortoises reflects a declining population. Outcomes of this study will better inform managers making decisions about management and conservation practices throughout the gopher tortoise's native range.

Implementing a Wildlife Incident Management System (WIMS) Database to Address the Human Dimensions of Gopher Tortoise Conservation

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Public perceptions and attitudes toward wildlife, as well as policies and management decisions implemented by wildlife agencies, play an important role in the long-term success of conservation initiatives. Integration of the human dimensions perspective into wildlife management strategies is therefore key to achieving sustainable conservation solutions. A potentially challenging aspect of human dimensions of wildlife management (HDW), however, is the acquisition, storage, and analysis of data that is needed to understand public values. Here we present FWC Gopher Tortoise Program's newly developed cloud-based wildlife incident management system (WIMS) database to demonstrate how wildlife agencies can track communications with the public and collect useful data. We also show how public call data analyses can inform customer service response protocols, outreach efforts, and policies. Lastly, we discuss how wildlife agency call data can be incorporated into wildlife value orientation research and facilitate the

development of targeted communication strategies that successfully effect positive change in public attitudes and behavior.

Minimum Density Estimates of Terrestrial Snakes in the Munson Sandhills Adjoining Apalachicola National Forest, Florida

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Knowledge of the density (number/area) of a species in time and space is paramount to its conservation and management. Because of many seemingly intractable aspects of the biology of snakes, density estimates are available for only a few dozen species worldwide. Prior to development of a solar field on the Tallahassee International Airport, we enclosed 131.6 ha of the Munson Sandhills adjoining Apalachicola National Forest (ANF) in Florida with a partially buried (20 cm) 0.9-m tall silt fence. Over a 74-day period in June–August 2019, we first scoped and excavated 144 burrows, and then intensively monitored the site during land clearing to remove and relocate all detected reptiles from this xeric oak-dominated site into the ANF, including the threatened gopher tortoise (*Gopherus polyphemus*) and Florida pinesnake (*Pituophis melanoleucus mugitus*). In 977 person-hr of fieldwork, we relocated 20 tortoises and had 71 observations of 10 species of terrestrial snakes, of which 55 individuals were relocated, 7 escaped capture, and 9 were found dead from construction-related activities. The snake sample was strongly biased towards species and individuals > 50 cm in total body length. We detected most snakes (N = 66) during biomonitoring (11 called in by contractors) and only 5 during tortoise-relocation activities. We found 52% of the snakes in the first 20 days prior to most construction and 42% of the snakes were located within 5 m of the silt fence. Including only known-fate snakes (relocated or dead), minimum density estimates were highest for the eastern coachwhip, *Coluber f. flagellum*, (0.167/ha) and the Florida pinesnake (0.068/ha); at least one large individual of both species scaled the silt fence to enter ANF. Increasing the duration of pre-construction monitoring and employing box traps along the interior perimeter of the silt fence would improve the relocation success of snakes.

Some Like it Hot: The Thermal Activity of Translocated and Resident Gopher Tortoises (*Gopherus polyphemus*) in Georgia

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The thermal ecology of gopher tortoises (*Gopherus polyphemus*) has been relatively well-studied; however, we still have a limited understanding of variability among and within populations and how that may vary throughout and among years. This topic is timely as we become increasingly aware of global climate changes and how those changes are affecting ectothermic animals and their habitats. *Gopherus polyphemus* provides a uniquely interesting model for habitats in the southeastern United States due to their dependence on burrows that broaden the thermal range within which they can elect to be active on the surface or underground. Here, we present results from on-going research that was initiated in 2015 in Wayne County in southeastern Georgia. Our research includes animals that were translocated from Charlton County, Georgia (~90 km) and *G. polyphemus* that were resident to the Wildlife Management Area. All individuals were equipped with GPS tracking devices that store data on-board, VHF transmitters, and iButton® temperature loggers. We used the resulting carapacial temperatures in combination with data from tracking and game cameras to quantify the ranges of when tortoises are active seasonally throughout the year and whether that varies among individuals and years relative to air temperature. Additionally, we present on hypothesized differences among resident and translocated tortoises and the degree to which thermal profiles change over time since release (translocation). Finally, we investigate for differences among sex nested within resident and translocated treatment groups. These temperature patterns are foundational elements of natural history that drive phenology and behaviors in wildlife. Such results have application to increase our understanding of how wildlife health and disease infection influence activity patterns. Additionally, being knowledgeable about thermal preferences can contribute guidance on how we can reduce the disturbance of translocated animals and manage resident habitats to best accommodate availability of optimal thermal conditions.

No Habitat Left Behind: Future Challenges Associated with Relocation of Gopher Tortoises in Florida

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The Florida Fish and Wildlife Conservation Commission's (FWC) gopher tortoise permitting guidelines are among the most complete and effective regulatory frameworks for protecting a state threatened species. However, because the state (admirably) does not permit take of individual gopher tortoises or their burrows, the success of this permitting system depends on the availability of recipient sites that can accept relocated tortoises. Because these regulations limit stocking densities to prevent overcrowding of tortoises, the "best" recipient sites are those that have suitable gopher tortoise habitat but very low gopher tortoise densities. This creates a conservation gap wherein high-quality habitat with robust gopher tortoise populations have limited financial incentives for private landowners to protect these areas. Furthermore, as Florida's population grows and suitable recipient site space disappears, Florida faces an additional dilemma on where to relocate displaced tortoises. Here, we present an overview of the challenges associated with incentives for private landowners to establish gopher tortoise recipient sites on their property. We discuss recently proposed changes in FWC gopher tortoise recipient site monitoring guidelines to collect higher quality population and habitat data, the effectiveness of these proposed changes from both a biological and an economical point of view with respect to the goals of the FWC gopher tortoise management plan, and the results of a previous pilot study to explore a payment for ecosystem services (PES) model to protect higher density tortoise populations. Finally, we discuss some potential solutions to address these upcoming challenges and close with an appeal for a more active dialogue on this topic.

Bridging the Gaps to Save the Burrows: The Power of Proactive Conservation and Local South Florida Findings

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Throughout the past four years, we have been able to utilize citizen scientists, land managers, researchers and non-profit community organizations to protect Gopher Tortoises across South Florida. We have connected various local stakeholders to create a web of community support allowing for and changing the dialogue around gopher

tortoise conservation and management techniques. As a park naturalist for Broward County Parks and Recreation and a doctoral student of Nova Southeastern University my unique position has allowed me to create bridges between local universities and governmental land managers as well as offer opportunities for citizen science both locally and abroad. A large portion of remaining gopher tortoise habitat within South Florida is owned by city and county park departments and lacks the data critical for determining effective management techniques for both the habitat and the species. With the help of local researchers and land managers, we have been able to create a non-profit working group which provides the foundation for proactive community driven conservation. This foundation has allowed us to determine the status of local Gopher Tortoise populations and change the way we manage and conserve the species in South Florida.

Recipients of the 2018 Donna J. Heinrich Environmental Education Grant: A New Gopher Tortoise Exhibit

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In appreciation of receiving the Gopher Tortoise Council Grant this past October 2018, members of the Flint RiverQuarium staff will be presenting the work they have accomplished in the building of the new outdoor Gopher Tortoise exhibit. This new exhibit simulates the natural habitat and allows visitors the opportunity to learn about the needs of, threats to and key role Gopher Tortoises play in the Longleaf Pine Ecosystem. Visitors are also able to learn about the local flora and fauna of southwest Georgia when visiting this new exhibit, as it is located in our outdoor education area. With this new installation, we are hoping to continue addressing the need for conservation education across all audiences within the southwest Georgia community. We plan to have a Power Point presentation with photos of the progress of the exhibit, both the installation as well as the community partners involved.

The Influence of Prescribed Fire on Site Selection in Snakes in the Longleaf Pine Ecosystem

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Prescribed fire is an essential tool for the restoration and maintenance of the longleaf pine (*Pinus palustris*) ecosystem. This type of management benefits many endemic snake species that are associated with open canopy pine forests and rich herbaceous ground cover but few studies have examined the role that fire history has on site selection by snakes. Therefore, our objectives were to quantify the time it takes a snake to occupy a site after fire and identify the fire frequency (fire return interval) for sites used by five snake species in a mature longleaf pine forest managed with prescribed fire. We examined data collected from previous radio-telemetry studies conducted over a nine year period (2003-2012). We used ArcGIS to intersect a composite overlay of annual burn layers from 1994-2012 and snake radio-telemetry locations. Results indicated that 98.2% of locations (n = 158) selected by the eastern coachwhip (*Coluber flagellum*), 81.2% of locations (n = 329) selected by the eastern diamondback (*Crotalus adamanteus*), 90.3% of locations (n = 987) selected by the Florida pine snake (*Pituophis melanoleucus mugitis*), and 91.7% of locations (n =1,175) selected by the eastern kingsnake (*Lampropeltis getula*) were sites where time since burn was less than two years. The gray rat snake (*Pantherophis spiloides*) selected 53.8% of locations where time since burn was less than two years and 23.5% of locations at sites that had not been burned in 10 years (n = 439). Longleaf pine specialists (eastern diamondback and Florida pine snake) selected sites with low burn return intervals (fires every $\leq$ 2.5 years) significantly ($F_{7, 15} = 7.1$, $p < 0.001$) more often than sites with high burn return intervals (fires every $\geq$ 3.3 years). Habitat generalists (eastern coachwhip and eastern kingsnake) selected sites that were burned every 2.5 years significantly ($F_{7, 16} = 3.5$, $p = 0.02$) over all other burn return intervals. The hardwood specialist (gray rat snake) selected sites that were not burned significantly ($F_{7, 1} = 1526.53$, $p = 0.02$) more often than sites burned every 5 years.

Effects of Fire Management on Gopher Tortoise Population Dynamics Depend on Habitat Context

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Long-term datasets are required for understanding the response of long-lived organisms (like gopher tortoises, *Gopherus polyphemus*) to management actions, such as prescribed burns. Gopher tortoises respond positively to burns in their habitats, in that burrow density is positively associated with fire frequency, but previous studies have been conducted over short time frames. Our objective was to estimate the effects of prescribed burning on gopher tortoise population dynamics over decadal time frames using a capture-mark-recapture (CMR) dataset from Fort Stewart Army Reserve located in southeastern Georgia. Tortoise populations occur throughout the base, but this study focused on three sites comprising a ~1,000 hectare area on the western portion of the base. Adult tortoises were captured in summer almost every year from 1994-2019, with ~500 unique adults captured during that time. In addition, since the early 1990s, managers at Fort Stewart have collected careful spatial records of prescribed burns. We used a Bayesian hierarchical CMR model (open population Jolly-Seber model) to estimate the effects of time-since-fire on survival, recruitment, and population size. Abundance was highly variable across all sites, but no long-term trends were detectable. In one site, abundance was negatively affected by time-since-fire, an effect which is likely attributable to increases in emigration and mortality as the frequency of prescribed burns decreases. In the other two sites, there were no effects of prescribed burning frequency on population vital rates, with the differences between sites likely attributable to differences in habitat quality. The site that responded to burns had almost twice the tree cover as the sites that did not respond, indicating that tortoise populations residing in poorer quality habitat (greater tree cover) are more likely to benefit from prescribed fires. Our results demonstrate that gopher tortoise population responses to prescribed burning are complex and context dependent.

Stepping Outside the Burrow and into the Expressway: Road Governance and the Conflict between Residential Properties and Conservation Easement Lands

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Using the case of the Osceola Parkway Extension in Orange and Osceola Counties, we examine how the legal geographies of expressway development and property rights claims intersect with gopher tortoise (*Gopherus polyphemus*) conservation efforts in

Central Florida. Proposed and existing road infrastructure projects, such as the proposed Osceola Parkway Extension, continue to fragment gopher tortoise habitat in Florida. The Central Florida Expressway Authority rationalizes the road as a necessity, justifying appropriation of land for the parkway extension's development. Thus, determining the route of the Osceola Parkway Extension has become the focus of road governance. The majority of the proposed road alignments for the extension transect Split Oak Forest and Wildlife Management Area, threatening the security of both the gopher tortoise population and gopher tortoise mitigation property within the forest. However, while the Central Florida Expressway Authority has jurisdiction over the governance of the road, it does not own the land needed to build it. This creates a relation between road governance and competing property rights, which then poses the question: what property rights must be ceded for right-of-way acquisition? Competing property rights holders have become enmeshed in the road governance process, as environmentalists seeking to protect conservation easements conflict with residential property owners. Thus, the mobilization of competing property rights claims structure the dialogue around road infrastructure encroachment onto conservation lands. How the competing values of suburban family homes and conservation easements, and the human and animal lives they support, are balanced will ultimately shape the road's alignment. This suggests that legal and political conservation strategies need to be understood in dialogue with the governing rationalities of expressway and suburban development that continue to constitute enduring threats to the gopher tortoise and their local environments.

The Effectiveness of Long-Distance Translocation of Eastern Diamondback Rattlesnakes (*Crotalus adamanteus*)

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Eastern diamondback rattlesnakes (*Crotalus adamanteus*) have a limited ability to adapt to habitat loss and fragmentation due to the species' slow life history and limited dispersal ability. Translocations have the potential to help mitigate the effects of habitat loss on a species with life history constraints that limit the species' ability to respond to landscape change. In July 2018, we translocated twelve adult eastern diamondback rattlesnakes from Parris Island to a wildlife management area. We radio located the rattlesnakes approximately three times weekly during the active season and once per week during the inactive season for one year following translocation. We created 95% minimum convex polygons for each individual and used a paired t-test to compare pre-

and post-translocation home ranges. Post-translocation home ranges (42.1 ± 33.4 ha) were larger than the pre-translocation home ranges (14.6 ± 10.3 ha) (paired t-test, t_{11} = 2.25, p = 0.0459). We suspect that large post-translocation home ranges reflect an increase in long-distance and erratic movements when a snake is introduced to a novel environment, as well as the difference in coastal and inland woodland habitats. In order for translocations to be a viable conservation strategy for eastern diamondback rattlesnakes, more research is needed to determine the effects of larger home ranges on the long-term viability of translocated populations.

Effects of Habitat and Weather on Nightly Movements of Gopher Frogs (*Lithobates capito*) during the Nonbreeding Season

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The fine-scale movement behaviors of pond-breeding amphibians during the nonbreeding season are not well-studied. As a commensal of gopher tortoises (*Gopherus polyphemus*), post-metamorphic gopher frogs (*Lithobates capito*) inhabit xeric, fire-maintained habitats and exhibit central place foraging from a daily burrow refuge. We investigated the relative importance of habitat type and weather on nightly movements of gopher frogs at Archbold Biological Station in south-central Florida. Between April 4 and June 20, 2019, we captured 85 frogs at burrows in sandhill and an adjacent old field, including recently burned and unburned areas within each habitat. Captured frogs were measured, marked, dipped in fluorescent powder, and released between 2000 and 2300 hr. We traced their powder trails the following morning to 1) identify whether individuals left their burrows during the night, and 2) measure the maximum displacement distance of individuals that moved. Frogs left their burrows more frequently in the field habitat (z = -2.284, p = 0.022). The relationship between probability of moving and temperature differed between habitats (z = 2.207, p = 0.027). For frogs that left the burrow (n = 64), maximum displacement distance did not differ between habitats or burn treatment (range 0.25–7.0 m). There was, however, a marginally significant interaction between habitat type and burn status (t = 1.797, p = 0.078), with frogs in sandhill moving farther in the unburned treatment and frogs in field habitat moving farther in the recently burned treatment. Gopher frogs moved significantly greater distances on nights with higher ambient temperatures (R^2 = 0.096, p = 0.013). Relative humidity was only important in the old field, where frogs moved shorter distances as relative humidity increased (R^2 = 0.261, p < 0.001). Movement differences among habitat types were likely due to drastically different vegetation structure providing differing microclimates, prey availability, or predator exposure.

Update on the Gopher Tortoise Species Status Assessment (SSA)

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The Gopher Tortoise Core team will be giving an update on the Species Status Assessment (SSA) for the gopher tortoise. Description of the process, information being gathered and used in the analysis, and schedule for the SSA and decision will be presented. In addition, the team will be presenting a summary of an expert elicitation meeting that is being held before the Gopher Tortoise Council Annual Meeting.

Evidence for Fine-Scale Genetic Structuring of a Florida Mouse (*Podomys floridanus*) Population in a Heterogeneous Upland Landscape

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The Florida mouse (*Podomys floridanus*) is endemic to Florida's xeric sandhill and scrub habitats. Due to the widespread loss of these habitats, *Podomys* is currently considered "Near Threatened" by the IUCN Red List and is part of the Florida Fish and Wildlife Conservation Commission's imperiled species management plan. Future management efforts for the species requires an understanding how both natural and anthropogenic fragmentation of *Podomys* habitat shapes connectivity of populations. The Ordway-Swisher Biological Station (OSBS) is a 9500+ acre research facility located approximately 20 miles east of Gainesville in North Central Florida. It consists of 11 natural plant communities, including multiple large swathes of sandhill separated by areas of mesic and hydric habitat. Using 21 microsatellite markers, we assessed whether two spatially adjacent groups of *Podomys* (N_1=73 and N_2=141) at OSBS separated by a combination of non-xeric areas exhibited genetic structure reflecting isolation. Analyses consisted of multiple individual-based approaches, including Principal Components Analysis (PCA), Bayesian clustering using STRUCTURE, and MEMGENE, a tool capable of detecting weak genetic signals within populations. The first two components of the PCA accounts for 4.7% of the genetic variation and a bi-plot of these two components shows a slight but distinct differentiation of the two regions. Similarly, STRUCTURE results show differentiation between the two groups. Finally, the MEMGENE results show small (R^2=0.013) but significant support for the presence of genetic structure. Unexpectedly, the first MEMGENE component variable accounting for 26.1% of this variation shows a different pattern of structure than predicted, while the second MEMGENE component variable (19.9% of variation) shows the expected pattern.

Combined, these results show evidence of weak genetic structure driven by fine-scale habitat heterogeneity, but raises questions about other potential confounding factors that could be influencing genetic structure in this population of *Podomys*.

Vertebrate Use of Pine Stump Holes in the Longleaf Pine Ecosystem

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Some evidence suggests that pine stump holes may be important habitat features for vertebrates in the longleaf pine (*Pinus palustris*) ecosystem. Despite being documented as refugia for several species of concern including the Black pine snake (*Pituophis melanoleucus lodingi*) and the eastern diamondback rattlesnake (*Crotalus adamanteus*), longleaf stumps are still harvested for their rosin. To further investigate vertebrate use of these habitat features, we surveyed 35 stump holes with trail cameras from September 2018 – May 2019. Each stump hole was paired with a nearby gopher tortoise (*Gopherus polyphemus*) burrow that was also surveyed with trail cameras to serve as a reference for a high value vertebrate refugium. We documented 49 different vertebrate species using stump holes as either refugia or foraging sites. Vertebrate occupancy and species composition varied between tortoise burrows and stump holes.

***J. Larry Landers Student Research Award recipient**

A Method for Estimating Gopher Tortoise Densities at Spatial Scales Relevant for Habitat Studies

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A key focus of gopher tortoise conservation is maintaining and/or restoring enough suitable habitat to support large and resilient tortoise populations. To this end much effort has gone into restoring habitat and surveying known populations to estimate current population abundances using line-transect-distance-sampling (LTDS). While

LTDS surveys allow for efficient estimation of abundance at the spatial scale of an entire conservation area (10-1000+ ha), these surveys have limited utility for studying how gopher tortoise densities vary in response to habitat management at fine spatial scales as individual transect lines typically cross multiple habitat types. To better study relationships between habitat conditions and gopher tortoise densities we developed a methodology for estimating densities at the scale of a typical forest stand (1-10 ha) within which management actions are commonly conducted. We used a modified LTDS survey combined with field measurements of detection covariates to allow a pooled estimation of detection functions across multiple individual forest stands. We conducted estimation using a Bayesian hierarchical model which allowed incorporation of auxiliary information on burrow activity and occupancy when available. We used a simulated dataset to test for model bias and sensitivity to spatial variability in burrow distributions and detection covariates. Lastly, we implemented the design to estimate gopher tortoise density on 296 forest stands located on private and public lands in Alabama, Florida, and Georgia. In contrast to most prior habitat studies, this methodology accounts for variation in detectability among habitat types and will allow for unbiased estimates of habitat-density relationships.

Demographic Consequences of Habitat Alteration and Inbreeding for a Gopher Tortoise Population in Southern Florida

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The long-term viability of gopher tortoise (*Gopherus polyphemus*) populations is jeopardized by increased urbanization and habitat degradation owing to fire suppression. Our study aims to clarify the demographic consequences of suboptimal habitat management for a semi-isolated population of gopher tortoises in south-central Florida. We examined differences in demographic parameters among fire-suppressed sandhill, restored sandhill, and former sandhill (i.e., ruderal) habitats at Archbold Biological Station. Using program MARK, we estimated population size and sex-specific and habitat-specific survivorship based on 6 years of mark-recapture data. We also

determined individual growth trajectories and clutch sizes and tested for effects of inbreeding on clutch viability and hatchling traits. Tortoises in the open, ruderal habitat ("Hill Garden") existed at much higher density (7.8/ha) than in adjacent restored (1.4/ha) or fire-suppressed (0.4/ha) sandhill. Despite this dramatically higher density, both adult survivorship and body size were significantly higher in Hill Garden. Although there were no significant differences among habitats in body condition, growth rate, or asymptotic body size, larger female body sizes in Hill Garden resulted in slightly larger mean clutch sizes (9.6 ± 2.5 SD versus 7.9 ± 1.9 eggs in sandhill). High parental relatedness resulted in smaller offspring and was correlated with reduced hatching success, suggesting this relatively small population (~113 adult tortoises) may be experiencing some negative effects of inbreeding depression. Our demographic data suggest that anthropogenic, grass-dominated land-cover types may be important components of the habitat mosaic currently available to this declining species.

Apparent Establishment of a Novel Social Network Following Translocation of Multiple Source Populations of the Gopher Tortoise (*Gopherus polyphemus*)

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The gopher tortoise is a colonial vertebrate that exhibits a social network characterized by the presence of social cliques. This clique structure is maintained by both males and females as individuals of the same clique readily interact while actively avoiding interactions with individuals outside the clique. Cliques were first reported in a naturally occurring population in old growth longleaf pine (*Pinus palustris*) in southern Georgia. Initially, it was assumed that this well-developed social structure may remain stable for many years. Recently, we hypothesized that aggregating multiple source populations of gopher tortoises following translocation would result in multiple social networks developing in a relatively short time period. We also predicted that observed social cliques would be comprised of individuals from the same source population. To assess effects of translocation on social networks, we studied gopher tortoises recently translocated in Florida and tracked 41 adults, representing 7 source populations from 5 counties. Radio telemetry was used to track activity following translocation as social interactions in gopher tortoises can be studied by assessing patterns of burrow usage. Passive behavior is associated with burrow sharing between same-sex individuals, although rare between females. Aggressive behavior (burrow chases) also occurs between same-sex individuals but also may indicate mate-choice when occurring between individuals of opposite sex. Data were analyzed using UCINET® software to determine the structure of the social network and the number of social cliques present. We found one social network containing 8 cliques, 7 of which (87.5%) comprised individuals from multiple source populations. Our preliminary work suggests that gopher tortoises 1) are

able to establish cliques within a very short time following translocation and 2) readily interact with individuals from previously unrelated sites.

***J. Larry Landers Student Research Award recipient**

G**opher Tortoise (*Gopherus polyphemus*) Behaviors Observed at the Naples Preserve, Collier County, Florida**

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Behaviors in gopher tortoises (*Gopherus polyphemus*) are influenced by location and by population density. Located in southwest Florida on U.S. 41, the 9.5-acre Naples Preserve is near the crest of a sandy coastal ridge which supports upland communities of oak scrub and pine flatwoods. The property is surrounded by urban development. At the beginning of 2008, there were 1.1 juvenile tortoises living on this site. In April of that year, a chain link fence was installed to prevent tortoises from leaving the property and 3.7 adult gopher tortoises were relocated to the Naples Preserve from a development site in Collier County. The relocated tortoises started nesting in 2009 and the population began to soar for two reasons: 1) predators had not yet found this site, so all hatchlings were surviving and 2) people were finding tortoises at other locations and releasing them at this site. Population growth started to come under control in 2013 when gray fox and raccoons moved onto the property. As of September 2019, there are more than 120 gopher tortoises occupying about 8.5 acres of the Naples Preserve. Since 2009, volunteers and staff have been observing and recording tortoise behaviors. The oral presentation includes videos and photos showing some of these observations, such as: 1) behavior at a female's burrow; 2) a male's interaction with an empty female's shell; 3) non-plant food choices; 4) behavior during flooding.

POSTER ABSTRACTS

The Reptiles and Amphibians of Ichauway: A Spotlight on the Herpetofauna of the Longleaf Pine Ecosystem

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The biologically diverse longleaf pine (*Pinus palustris*) ecosystem once dominated the landscape across the Southeastern Coastal Plain from southern Virginia to eastern Texas. Currently, it is one of the most endangered ecosystems in North America with < 4% remaining, primarily due to conversion to agriculture and industrial pine plantations, urbanization, and fire suppression. Longleaf pine occurs across a broad range of physiographic conditions. The Jones Center at Ichauway, located on the Dougherty Plain in southwestern Georgia, includes 8,700 ha of second-growth longleaf pine woodlands. Our longleaf pine woodlands range from mesic pine savanna to sandhill with diverse native ground cover. The site also includes more than 100 seasonally inundated wetlands of three different vegetation types (grassy marshes, cypress-gum swamps, and cypress savannas) and >45 km of streams. Ichauway has > 1,100 native plant species and 378 wildlife species, including 31 reptiles and 54 amphibians. Ichauway supports regionally important populations of several imperiled longleaf pine specialists, like the gopher tortoise (*Gopherus polyphemus*), eastern diamondback rattlesnake (*Crotalus adamanteus*), Florida pine snake (*Pituophis melanoleucus mugitus*), southern hognose snake (*Heterodon simus*), and Florida gopher frog (*Lithobates capito*).

Evaluating Current and Potential Habitats for the Endangered Gopher Frog by Assessing Wetland Environments and Land Cover Trends in Conecuh National Forest

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The gopher frog (*Lithobates capito*) is an endangered species facing extinction within the next century due to loss and alteration of its habitat. With limited active gopher frog habitats in Alabama, it is crucial to maintain these areas. The Gopher Frog Working

Group (GFWG) works to ensure the protection and rehabilitation of gopher frog habitats to protect the survival of the species. The NASA DEVELOP Conecuh National Forest Ecological Forecasting team partnered with the Alabama Department of Conservation and Natural Resources, the United States Forest Service's Conecuh National Forest, and the Mississippi State University College of Forest Resources, which are all part of the GFWG, to identify potential habitats for the gopher frog in Conecuh National Forest. As the environment fluctuates over time, present and probable breeding wetlands are threatened. The team identified the environmental concerns endangering the breeding habitats utilizing Landsat 5 Thematic Mapper (TM), Landsat 8 Operational Land Imager (OLI), the Shuttle Radar Topography Mission (SRTM), and Sentinel-1 C-band Synthetic Aperture Radar (C-SAR) satellite imagery. The team produced a series of map products to evaluate the status of the current breeding region as well as forecast the future suitability of the habitat. These products enabled the GFWG to determine where to create new breeding habitats in the Conecuh National Forest.

An Evaluation of Hatching Success Rates of *Gopherus polyphemus* at the FAUP

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Gopherus polyphemus is a keystone species and it has a conservation status of threatened. The gopher tortoise population at the Florida Atlantic University Preserve (FAUP) has failed to produce viable nests according to surveys conducted on 2013, and 2016. My project aims to determine whether FAUP gopher tortoise population have a year-round reproductive season and if they are reproducing yearly, as suggested by its reproductive behaviors that have been caught on camera. In this study we probed all the burrows within the home range of 5 radio transmitted sexually active female tortoises. Once a nest was found we placed cameras facing towards the nest to monitor the nest for predators and hatchling emergence. With this data we will be able to determine why we are not seeing any hatchling tortoises on the preserve. In this study, for the summer season, we have found 2 nests with one containing 11 eggs and the other containing 21 eggs. Our average clutch sizes are larger than what's reported in the literature. There have also been sightings on the camera of coyotes circling the burrow, containing the nest of 21 eggs, and we have also sighted iguanas entering and exiting the other burrow, containing 11 eggs.

Growth Rates of Hatchling and Juvenile Gopher Tortoises (*Gopherus polyphemus*) at Naples Preserve, Collier County, Florida

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Growth rates of gopher tortoises are influenced by factors including climate and habitat. We analyzed data collected on a sub population of gopher tortoises that inhabit the 9.5 acre Naples Preserve located in Collier County Florida. Weight, length and width of 74 individual gopher tortoises were measured on animals encountered between 2009-2019. We analyzed the data for trends among size classes, sex, and the habitat where the tortoises were captured. We found that female gopher tortoises living in the grassy meadow portion of Naples Preserve grew significantly faster than those in either the oak scrub or pine flatwoods. Females grow faster when compared to males especially between approximately 3-4 years estimated age. These results were equally evident whether straight carapace length, weight or width was the parameter measured. Additional findings will be shared. The dataset collected by Becky Speer (Naples Preserve FWC Permit #:LSSC 16 00022A) is rich with additional information that can help us better understand gopher tortoise life history made possible with continued sampling of the same individuals along a temporal scale.

Can Gopher Tortoise Nesting Behavior Compensate for the Effects of Climate Change?

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Climate change could have diverse and strong effects on the fecundity of gopher tortoises (*Gopherus polyphemus*). For this long-lived species, adaptive evolution may be too slow to keep pace with climate change and alternative mechanisms, such as behavioral plasticity, may be necessary for populations to persist. We used a common garden experiment with translocated tortoises at Nokuse Plantation in the panhandle of Florida to assess whether plasticity of several nesting behaviors (i.e. nest temperature, depth, and orientation) and components of fecundity (i.e., clutch size, egg size, hatching success) could compensate for changes in environmental conditions. If tortoises exhibit plasticity by matching nesting behavior to local conditions, we predict that distance from natal site has no effect on nesting behaviors and fecundity. We compared nest characteristics

among translocated females (from across the state of Florida) and examined how distance from natal origin affected aspects of fecundity. Our results will not only help us to understand the resilience of gopher tortoises to impending environmental changes, but will also inform managers on best practices for translocations in terms of acceptable translocation distance from natal site.

A Call Recognizer for Oak Toads (*Anaxyrus quercicus*)

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Oak toads (*Anaxyrus quercicus*) have declined throughout the Southeastern United States due to a combination of habitat loss and urbanization. Historically oak toads have been abundant Longleaf pine ecosystems, but in recent times populations have been in decline. Due to their biphasic life cycle oak toads require ephemeral ponds and upland habitat that are intact, which is becoming increasingly rare. Using audio data from 2015 to present, we used Raven sound software to develop an automated call recognizer with a goal of identifying ponds where breeding occurs. This information will be beneficial in understanding areas which support reproductive populations and allow land managers to make informed conservation decisions.

Post-translocation Population Demographic Estimates of a Translocated Southern Fox Squirrel Population

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Southern fox squirrels (*Sciurus niger niger,* SFS) are habitat specialists associated with pine savannas and woodlands. Fire exclusion has led to the loss of SFS habitat as pine savannas and woodlands succeeded into closed-canopy mixed forest. Translocations have been effectively used to mitigate population declines of various subspecies of fox squirrel

populations. Post-translocation population demographic parameters, such as survival and recruitment are required to assess the success of the procedure. Between January 2016 and June 2017, sixty-two SFS were translocated from five donor sites on to the Marine Corp Recruit Depot Parris Island, South Carolina (MCRDPI). Prior to the study, the MCRDPI had no SFS population, but is within the historic range of the species and stable populations are supported on neighboring sea islands. Live-trapping and radio-telemetry data collected, between January 2016 through August 2019, were used to estimate survival and recruitment of the translocated population. During post-translocation sampling, a total of thirty-two individuals were recaptured, twenty of which being individuals born on the island. Twenty-two individuals were males and ten being females, of which thirteen males and seven females were island-born individuals. Using the best fit Pradel survival and recruitment model, we see that apparent recruitment and survival rate were 0.90±0.26 and 0.50±0.06, respectively. More data are needed but based on our current available data and their life history we can conclude that the translocation was a success.

Surveying *Gopherus berlandieri* GREEN Wildlife Center

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The Lower Rio Grande Valley in South Texas is home to the densest population of the Texas Tortoise (*Gopherus berlandieri).* The increase in urban development within this region has been, *and continues to be,* a severe threat to the status of this population. GREEN's conservation goals for protecting *G. berlandieri* will be to conduct population surveys on select private lands and undeveloped territories within the region. When a robust population is identified, we will begin a radio telemetry study to document daily movements and activities. We aim to: 1) determine the number of burrows; 2) identify the closest water and food sources; 3) distinguish gender determinations in relation to the territories the genders are found in; and update species ratios found within habitat ranges. This data will lead to Phase 2, which is the development of spatial positioning and translocation protocols. Based on the Phase 1 data results, programs can be designed to develop a threshold for translocated tortoises from threatened urban areas to rural and more native remote private lands. Medically screened and cleared of transmittable diseases, determining the correct number of territorial males to females, securing food sources, determining proper soil conditions for burrows, a controlled translocated should be a successful conservation measure. It can also be determined if the tortoises can be added to native areas already inhabited. We will quarterly assess the success of translocations by monitoring population migration and movements, updating spatial

positioning data, adding data to the health status and reproductive activity. Site data will be assessed to develop future translocations of *Gopherus berlandieri*.

Behavioral Preference of the Male Chin Gland Secretion in Social Gopher Tortoises (*Gopherus polyphemus*)

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Gopher tortoises are a social species in the southeast U.S. and are threatened throughout their range by habitat fragmentation and decline. One consequence of habitat loss is reduced mating opportunities when unable to locate conspecifics. Here, we study chemo-sensation by which tortoises gain information through chin secretions. To assess recognition of male chin secretions, we conducted two paired-choice experiments, one with a negative odorant control (NC; distilled water) and one with a positive odorant control (PC; acetone) vs. male chin secretions. Behaviors were defined *a priori*, and their durations were quantified towards treatments. Each sex spent significantly more time with chin secretions during the PC study (p= 0.001). Each sex also spent more total time in sniffing chin swabs in both studies (PC study: p=0.0003; NC study: p=0.001). A principal components analysis of behavioral durations from the PC study identified one significant component, including sniffing, head bobbing, biting, and eating near a swab. Component loadings from the PC study exhibited a significant treatment effect of behaviors performed towards chin secretions (p=0.0003). Our studies provide the first behavioral bioassay of chin secretions from male gopher tortoises. This supports the hypothesis that chin secretions could be social cues used to identify conspecifics.

Gopher Tortoise Habitat Improvement

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Prior research has established that the gopher tortoise is a keystone species because of their environmental impact on their habitat. Gopher tortoise are a threatened species and are known to regulate the composition of their environment because of their ability to modify their surroundings. They create burrows that provide shelter and protection to other coexisting species in the habitat. This study focuses on habitat improvement for the growing population of the gopher tortoises that reside in the USFSM Gopher Tortoise Conservation. This site has 54 burrows (active, inactive and abandoned) and the gopher tortoises in the conservation area need a sustainable food supply to avoid exceeding

carrying capacity of the site. There is a significant invasion of a native Florida vine, *Cassytha filiformis,* at the site. This parasitic vine is extremely fast growing and damages desirable forage plant species for the tortoises. To improve the habitat quality for the tortoises the parasitic vine sites were monitored and a selective removal process is being used to manage the vine's presence at the site and assessments are being made for replacement plantings.

Comparison of Gopher Tortoise and Nine-banded Armadillo Commensal Fauna

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Burrows excavated by the gopher tortoise (*Gopherus polyphemus*) are utilized by hundreds of species. For this reason, the gopher tortoise is considered an ecosystem engineer as well as a keystone species. However, throughout its range in the southeastern United States, the gopher tortoise is now syntopic with another species that excavates burrows: the nine-banded armadillo (*Dasypus novemcinctus*). While many studies have investigated gopher tortoise commensals, relatively few studies have examined armadillo commensals, and no study to date that we are aware of has compared and contrasted burrow commensals in areas where the armadillo and gopher tortoise co-occur. The goal of the present study is to compare and contrast burrow commensals via the deployment of 20 motion activated game cameras placed at burrow entrances (10 armadillo & 10 gopher tortoise burrows) within a mixed-pine hardwood stand at the Lake Louise Field station in Lowndes County, Georgia. Camera deployment was initiated in August 2019 and trapping will occur over a one to two-year period. During preliminary data collection we observed five-lined skink (*Eumeces fasciatus*), mouse species, and Carolina wren (*Thryothorus ludovicianus*) entering both gopher tortoise and armadillo burrows at nearly every camera trapped burrow. In addition, we have observed a bobcat (*Lynx rufus*) investigating entrances of both burrow types. This research will be valuable in that it could be used to determine if the introduced nine-banded armadillo can function as a potential surrogate keystone species in areas where gopher tortoise populations have been reduced.

Gopher Tortoise on St. Vincent Island National Wildlife Refuge

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Little is known about gopher tortoise using coastal habitat, particularly on barrier islands. A range-wide genetic study investigating population structure of gopher tortoise in the southeastern US included samples from only three coastal sites in the entire region; one in Southwest Florida and two from Florida's east coast. Recent work suggests insular tortoise populations may require separate management considerations from mainland populations including decisions about translocation of tortoise for population recovery purposes. Although tortoise have been reported using barrier islands throughout the northern Gulf of Mexico, no samples were included from those areas and few studies have been conducted in that region. Here we will present preliminary data on tortoise use of St. Vincent National Wildlife Refuge. Located along the northern Gulf of Mexico coast in Franklin and Gulf Counties, Florida, the Refuge is comprised of two islands and two mainland holdings totaling nearly 12,500 acres. Gopher tortoise have been documented on St. Vincent Island since at least the 1970s however no formal surveys have yet to be conducted. In 1979, surveys resulted in documentation of 8 burrows, 4 of which were inactive and 4 were abandoned. No tortoise were located. During subsequent surveys in spring 1993, 32 burrows were documented, two of which were active. From 2010-2012, additional informal surveys were conducted in areas previously identified as containing tortoise activity, and an increase in active tortoise burrows documented. Because of this historic data and the need for additional information on tortoise using coastal habitats, we are partnering with the Refuge to initiate formal line-transect surveys beginning in November 2019.

Non-invasive Methods for Sexing Hatchling Gopher Tortoises (*Gopherus polyphemus*)

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Population sex ratios influence mating behavior, reproductive success, and population growth, and therefore sex ratio estimates are important for population modeling. For species with environmental sex determination, accurate methods to estimate sex ratios are

essential for determining how global change will affect population stability. For species of conservation concern, methods to determine individual sex are useful in the development of breeding and head-starting programs. For *Gopherus* tortoises, a group of chelonians with several species of conservation concern, we lack non-invasive methods to determine hatchling sex. Instead, hatchlings must be kept in captivity for months until they are sufficiently mature to perform laparoscopic surgery. Here, we investigate non-invasive methods in the gopher tortoise (*Gopherus polyphemus*), and report the degree to which hatchling sexes can be determined using four approaches: gross morphological measurements, geometric morphometrics of carapace and plastron, baseline testosterone levels, and temporarily elevated testosterone levels following treatment with follicle stimulating hormone. Morphological methods could not separate males and females, and baseline plasma testosterone levels were only partially informative. However, treatment with follicle stimulating hormone significantly increased circulating testosterone, particularly in males. Testosterone level following FSH treatment could be used to correctly identify sex in 23 out of 24 hatchings (six to nine months of age). The ability to sex young tortoises without technically challenging laparoscopic surgery will be useful in ongoing and future conservation efforts for *Gopherus* tortoises and other threatened chelonians.

Persistence and Spatial Ecology of *Gopherus polyphemus* throughout Federally Protected and Unprotected Lands in Southwest Alabama

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The gopher tortoise (*Gopherus polyphemus*) is an ecosystem engineer and a promoter of biodiversity in the xeric pine forests of the southeastern Coastal Plain. In the last century, there has been an 80% decline of gopher tortoise populations throughout the southeastern United States. In southwestern Alabama, the gopher tortoise is federally listed as "threatened" west of the Mobile-Baldwin County line (since 1987), but has remained unlisted east of this line and is protected only by state agencies. Thus, the border of Mobile and Baldwin counties represents a transition between federally protected (Mobile County) and unprotected (Baldwin County) gopher tortoise habitat. From 1991-92 (initial surveys), 164 locations of suitable gopher tortoise habitat were identified and surveyed across Mobile and Baldwin counties. In 2018, 146 of the initial sites were surveyed again. Although our recent surveys found a 21-25% increase in the proportion of active burrows in both counties, our results show a substantial overall decline in total burrow abundance compared to the initial surveys in 1991-92 [Baldwin: 122 (initial), 108 (2018), Mobile: 390 (initial), 300 (2018)]. In addition, gopher tortoise burrows persist at 58.5% of initial sites in Mobile County and only 31.2% of initial sites in Baldwin County. The simultaneous increase in the proportion of active burrows and declines in total burrow abundance seems to indicate that tortoise populations are being concentrated in

remnant areas of suitable habitat. Going forward, we are using ArcGIS and the information gathered from these surveys to identify all remaining suitable habitat in southwest Alabama.

Investigating Multiple Factors that Influence the Distribution of Vertebrate Species Associated with Gopher Tortoise Burrows at Five Study Sites in South Florida

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Gopherus polyphemus, commonly known as the gopher tortoise, is a chelonian keystone species that is endemic to the southeastern United States. Gopher tortoises create networks of underground burrows that are home to an additional 350 species, where approximately sixty of those species are vertebrates. The associations between these vertebrate species and the gopher tortoises are unclear, and although some of the vertebrate species could potentially be commensal species that utilize the burrow in the presence of the gopher tortoise, without harming them, more information is needed to determine their interactions. In this study, camera trapping was used at five different study sites in south Florida to investigate the different factors such as, plant community and seasonality that affect the vertebrate species that are present. The cameras were set at Quiet Waters Park, Deerfield Island Park, Florida Atlantic University Preserve, Pondhawk Natural Area, and Zoo Miami. A list of vertebrates present and the types of interactions observed will also be recorded for each site. I expect species composition to vary between sites and be affected by the plant community, soil composition, and seasonality. I also expect that most species will not have a negative impact on gopher tortoises and therefore, these will not defend their burrows or show territorial behavior. These data will be used to aid in the development of an improved habitat management plan for gopher tortoises as they are a threatened species in the state of Florida.

Movement Patterns of Gopher Tortoises at Eglin Air Force Base, Florida: Preliminary Results and an Assessment of GPS Transmitter Performance on a Burrowing Reptile

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Gopher Tortoises (*Gopherus polyphemus*) on Eglin Air Force Base (Eglin) in the Florida panhandle inhabit both forested longleaf pine (*Pinus palustris*) sandhill and expansive non-forested military testing and training areas (test ranges). Due to the potential significance of Eglin as tortoise habitat, it is important to understand how tortoises use this landscape to access resources such as burrows, conspecifics, and food, particularly in novel habitats such as test ranges. To assess the efficacy of remote-downloading GPS technology on burrowing animals and movement patterns of tortoises inhabiting both forested sites and test ranges on Eglin, we deployed GPS transmitters (Lotek pinpoint Litetrack Turkey Tag) on nine adult tortoises during the summer of 2018. We were initially uncertain whether transmitters would be able to reliably acquire locations from tortoises within burrows, if failed attempts to communicate with satellites when in the burrow would reduce battery life, or if we would be able to obtain data downloads remotely. Therefore, we tested equipment to identify and troubleshoot potential issues and to collect detailed spatial data that would not have been possible using VHF transmitters. We successfully tracked tortoises for up to five months depending on battery efficiency (range 1-5 months) and documented short-term and long distance movements (average maximum distance travelled per tortoise = 277.5 m, range = 37.0 – 559.0 m). Seven of the nine tortoises used two burrows and the two other tortoises used three or four burrows over the tracking period (with no apparent relation between number of burrow changes and length of tracking period). We believe GPS technology has the potential to provide fine-scale detail on movements and habitat use for animals such as Gopher Tortoises, which spend the majority of their time in and around their burrows. Future efforts should concentrate on estimating precision of aboveground GPS locations.

Refugia Selection of the Eastern Diamondback Rattlesnake (*Crotalus adamanteus*) in Southwest Georgia

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Across much of its range, the Eastern Diamondback Rattlesnake (*Crotalus adamanteus*) requires underground refugia during the winter months. Although use of gopher tortoise (*Gopherus polyphemus*) burrows as a refugia by these snakes has been well documented, other refugia including stump holes may be important as well. We tracked 14 Eastern Diamondback Rattlesnakes over the winter from October 2018 – February 2019 and identified the refugia they used. We then investigated the influence of availability and habitat characteristics on refugia selection.

Prevalence of *Cryptosporidium serpentis* at the Florida Eastern Indigo Snake Repatriation Site

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Cryptosporidium serpentis (hereafter, "Crypto") is a highly contagious protozoan that effects the gastrointestinal pathway of snakes. The primary clinical sign is food regurgitation, and mortality is frequent due to complications from emaciation. There is no known cure for this pathogen. Crypto is primarily known from captive collections of snakes. However, little is known about the prevalence of this disease in naturally occurring snake populations. The only ongoing snake repatriation in Florida is for the Federally threatened eastern indigo snake (*Drymarchon couperi*), for which snakes are being bred and reared at Central Florida Zoo's Orianne Center for Indigo Conservation (OCIC). In 2015, OCIC first detected Crypto at their facility and followed all proper quarantine procedures to reduce transmission potential. Because eastern indigo snakes may harbor Crypto while appearing asymptomatic all repatriation animals are tested multiple times before release to assure they are not carriers of Crypto to wild populations. To make more informed management decisions, we need to measure the prevalence of Crypto among wild snakes at the repatriation site, The Nature Conservancy's Apalachicola Bluffs and Ravines Preserve in Bristol, Florida. Therefore, the Florida Fish and Wildlife Conservation Commission and partners initiated a study to capture native

species of wild snakes and test them for Crypto by cloacal swabbing. Field work is currently underway for this project and laboratory results from up to 120 snakes are expected to be analyzed in 2020. The outcomes of this project will add to the scarce knowledge of naturally occurring Crypto and inform future eastern indigo snake repatriation management.

Endoparasite Load in Gopher Tortoise (*Gopherus polyphemus*) Scat from Various Locations in Southwest Florida

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Gopherus polyphemus is a keystone species found throughout Florida. Their habitat has decreased due to intense urban development. It is possible that this loss of habitat may have a negative effect on the health of tortoise populations. Parasites may be more prevalent among tortoises with constricted habitat or other differences. Therefore the intestinal parasite load of gopher tortoises from nine different collection sites in Southwest Florida was examined between May of 2018 to May of 2019. These sites included animals from semi-urban areas (Cape Coral, Lee County), coastal scrub (Barefoot Beach Preserve, Collier County), pinewood and flatwood scrub (Naples Preserve, Collier County, FL, overgrown pine (FGCU) and old pasture in Hernando County. We also sampled captive animals from two locations (Naples Zoo and Everglades Wonder Garden). Fecal flotations were performed on collected samples. Oxyurid, strongylid, and ascarid eggs were identified and counted in over 300 individual tortoises. Our findings show that endoparasites are prevalent across individuals in all habitats studied and are not associated with any obvious physical health problems. Our findings did not reveal any significant difference in parasite loads from among the different sites.