Gopher Tortoise Council 2021 Abstracts

**denotes presenter*

Seed Consumption by Gopher Tortoises at the Southern Limit of their Range

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Seed dispersal is a fundamental ecological process that regulates plant community dynamics. While many mechanisms of seed dispersal exist, seed dispersal by animal ingestion (endozoochory) has drawn the attention of ecologists for decades. Only recently has seed dispersal by turtles and tortoises (chelonochory) been thoroughly examined, with an increasing amount of attention geared towards this mutualism. Gopher tortoises (*Gopherus polyphemus*) are found throughout the southeastern United States, with their southernmost populations occurring in southwest Miami-Dade County, on the Miami Rock Ridge. These tortoise populations are situated in the globally imperiled and florally diverse pine rockland ecosystem, of which <2% of its original extent remains outside of Everglades National Park. In this study, we assessed the role of gopher tortoises as potential seed dispersers by analyzing the seed composition of their diet in the pine rockland habitat surrounding Zoo Miami. We collected scat samples from wild gopher tortoises and identified the species and number of seeds consumed. In total, we extracted 2,484 seeds from 53 samples from at least 10 individual tortoises. Of the 2,484 seeds, we distinguished 33 morphospecies and identified 23 to the species taxonomic level. The 14 most abundant seed species constituted 90% of all seeds ingested by the tortoises. While three of the 14 most abundant seeds were from nonnative plants, none were among the most disruptive (FLEPPC Category I) invasive species. Tortoises mainly consumed seeds of herbaceous ground cover and fibrous grasses, but surprisingly also ingested multiple pineland croton (*Croton linearis*) seeds. Pineland croton is the only known host plant for two federally endangered butterflies which primarily reside in Long Pine Key, Everglades National Park. The large quantity of seeds and wide variety of species in tortoise scats suggest that this species may be serving as a seed disperser for pine rockland plant species.

Regular Oral Presentation

What we have learned over 10 years of research on gopher tortoises in southeast Florida

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Gopher tortoise populations in southeast Florida have recently become the focus of the FFWCC management plan for the species, because populations have not been well documented, nor has species distribution been accurately described. Studies suggest that the biology, ecology, behavior, and reproduction of these populations differ from populations in their northern range. Gopher tortoises in southeast Florida, reproduce all year round, lay nests with a greater number of eggs, and may be genetically distinct. We conducted studies on gopher tortoise biology at eight sites in southeast Florida, namely Palm Beach, Indian River and Martin counties. The first study documented the age structure and distribution of a population of gopher tortoises at the Florida Atlantic University Preserve in the Boca Raton campus (Scholl et. al 2012), while a second investigated the vegetation requirements for the existence of gopher tortoise burrows at the same location (Lauck et. al. 2013). A third study identified the intestinal parasites of adult gopher tortoises at five sites across three counties (Huffman et. al 2018). A fourth documented the existence of a novel species of Hepatozoon spp. within the red blood cells of gopher tortoises Cooney et. al 2019). Present studies involved recording year-round telemetry data on tortoises to document their home range and gain insight into their reproductive strategies, surveying burrow for nests, identifying the vertebrate species associated with gopher tortoise burrows, investigating the interactions between gopher tortoises and the invasive green iguanas, and examining the genetic composition of gopher tortoise populations across three counties. This presentation will provide brief results for all current studies in progress and discuss the needs for future studies.
Regular Oral Presentation

Bridging the Gaps to Save the Burrows: A Framework for Proactive Conservation

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Throughout the past four years, we have been able to utilize community science, land managers, researchers, and non-profit community organizations to help further protect Gopher Tortoises across South Florida. Connecting various local stakeholders helped us create a web of community support allowing for and changing the dialogue around gopher tortoise conservation and management techniques. 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 working group, the Southeast Florida Gopher Tortoise Alliance in partnership with a larger non-profit, the South Florida Conservation Network which provides the foundation for proactive community driven conservation. This foundation has allowed us to begin to determine the status of local Gopher Tortoise populations and change the way we manage and conserve the species in South Florida. Our speed presentation aims to introduce you to our working group and help you envision how you can utilize a similar framework to assist in your local conservation efforts.
Speed Oral Presentation

Continuous Monitoring of Gopher Tortoise Burrows Using Time-Lapse Imaging and Machine Learning

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Camera trap time-lapse recordings can collect vast amounts of data on wildlife in their natural habitat. Transforming these data into information useful to ecologists is a major challenge. Machine learning techniques show promise for becoming important tools to meet this challenge in a cost-effective way. Over the past year, we recorded 5-second interval time-lapse video of twelve active gopher tortoise burrows at Boyd Hill Nature Preserve in St. Petersburg, Florida, generating more than 100 Terabytes of data in the process. Herein, we describe a suite of open-source software tools we developed to manage the collection and analysis of these data, and present preliminary results on tortoise activity levels at this study site. The tools incorporate a convolutional neural network trained to detect gopher tortoises and to generate a draft video segmentation marking when tortoises are present. These tools allow a single human grader to review and refine the draft segmentations for a week's worth of time-lapse recordings (11.5 hours of video if played back at standard speed) in under 3 hours. This research demonstrates that the tools developed can facilitate future studies across research groups to assess key population features as well as to remotely monitor wildlife populations efficiently.
Regular Oral Presentation

A Look Behind the Curtain: A Review of Florida's Listing Process

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Regulatory processes are an important component of imperiled species recovery. State- and federal listing statuses provide protections and conservation benefits to these species, and recovery strategies and implementation benefit from stakeholder involvement. Oftentimes, the processes that guide listing determinations are time consuming, and the steps to complete a listing action may not be apparent to stakeholders. In 2019, the Florida Fish and Wildlife Conservation Commission (FWC) received a request to evaluate the striped newt (*Notophthalmus perstriatus*), a species that occurs throughout the gopher tortoise's (*Gopherus*

polyphemus) Florida range, for state-listing as Threatened. To complete this request, the FWC initiated the state listing process, which included convening a Biological Review Group to review the species' status against rigorous and well vetted criteria developed by the International Union for the Conservation of Nature. The FWC developed a peer-reviewed Striped Newt Biological Status Report that recommended the striped newt receive protections as a Threatened species due to meeting multiple criteria, including population size reduction and geographic range. To complete the listing process, FWC staff are required to draft a Species Action Plan and Species Conservation Measures and Permitting Guidelines that will guide recovery and permitting for the striped newt. These documents will undergo a public comment period and Commission approval prior to the species receiving their state-listing status. This poster presentation provides a review of FWC's listing process, and how to be involved in the public comment process. For more information on the process, please contact Salamander@MyFWC.com.
Poster Presentation

Sightings, Submissions, and Citizen Scientists: Using the FWC Gopher Tortoise Sightings web application to understand tortoise distribution across Florida

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Community involvement in conservation is imperative to its success. New technologies have increased opportunities for conservation agencies and the community to work collaboratively through citizen science. Citizen science promotes awareness of conservation challenges, builds community stewardship, and generates substantial amounts of data across broad geographies in a short timeframe. One way the Florida Fish and Wildlife Conservation Commission (FWC) engages with the community is by encouraging Floridians to report wildlife observations for select species, including the gopher tortoise (*Gopherus polyphemus*). The FWC has maintained a smartphone application since 2014 for public submission of gopher tortoise observations. In September 2020, this app was replaced with the Gopher Tortoise Sightings web application. This new platform allows users to report more detailed information on the location of tortoises, their burrows, or notify the FWC of sick, injured, or dead tortoises. Data collected by citizen scientists provides the FWC with a better understanding of tortoise distribution across Florida. For example, submissions help fill data gaps, including improving our knowledge of tortoises on private and residential lands. One year following the launch of this application, we have found a dramatic increase in citizen involvement with gopher tortoise sightings and data collection. We will present on how community involvement has increased over time and provide preliminary results comparing occurrence submissions between public and private lands. These findings further illustrate the importance of data collection by citizen scientists through the Gopher Tortoise Sightings web application as a valuable mechanism to understand tortoise distribution across both private and public lands in Florida.
Poster Presentation

Reproductive integration of gopher tortoises in a translocated population with multiple source populations

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Translocation is an important management tool that can mitigate the effects of habitat loss for imperiled species. The success of translocation projects that receive individuals from multiple sites hinges on the integration of individuals from different genetic, environmental and social backgrounds into a single reproductive population. Here we test for reproductive integration in a population of adult gopher tortoises (*Gopherus polyphemus*) translocated from multiple source populations to Nokuse Plantation in the Florida panhandle. In 2016 and 2017, 203 adult tortoises from counties throughout northern and peninsular Florida were released at Wolf Creek pen. We assessed parentage of 51 clutches sampled in three consecutive years (2018-2020) using microsatellite genotypes of adults and hatchlings. We identified 23 female and 13 male parents from 16 and 9 source counties, respectively, spanning >350km of latitude. Most (12/17) of the unique reproductive pairs with known source locations consisted of individuals from different counties, suggesting a lack of reproductive barriers between source populations. Four pairs consisted of tortoises from the same source site, suggesting a possible preference for familiar individuals: resampling of mates from the observed reproductive adults indicates this is unlikely the result of chance (p=0.04). The average geographic distance between pair source counties for individuals from different sites was not significantly lower than that expected from random mating, suggesting no regional or population level effects on reproduction beyond site. The abundance of successful clutches resulting from inter-county matings indicates that females readily reproduce with males from distant populations in an environment distant from both parents' natal populations. We also observed substantial reproductive skew among males and high mate fidelity between years, consistent with patterns observed in other gopher tortoise populations, both natural and translocated. We conclude that the diversity of source sites is not a barrier to mating and reproduction in this translocated population.
Regular Oral Presentation

Investigating vertebrate relationships of the south Florida gopher tortoise: a study of vertebrate species within scrub, pine rockland, coastal hammock and grassland habitats
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Gopherus polyphemus is a keystone species that is endemic to the southeastern United States. They create networks of underground burrows that are home to an additional 350 species, where approximately 60 are vertebrates. Vertebrates have been shown in previous literature to differ between habitat types, but limited information is known about vertebrate associates in our region of southeast Florida. This study was designed to develop a list of species of vertebrates

associated with gopher tortoise burrows at different sites, compare lists between habitats, and document behavioral interactions to determine which species could be potential commensals. Camera data was collected from 2019-2021 at four different locations, in three counties in southeast Florida. We placed seven cameras at Deerfield Island Park in Broward County, Florida, seven cameras at Zoo Miami in Miami-Dade County, Florida, seven cameras at Pondhawk Natural Area and fourteen cameras at Florida Atlantic University in Palm Beach County, Florida. We utilized the images or photographs to create a species inventory list for each site and also investigated if the presence of a vertebrate group elicited a territorial response from the gopher tortoise. We compared our results with camera data that was collected at additional sites in Palm Beach County from 2016-2018 by a previous FAU researcher, Jessica Huffman. The camera data was filtered, sorted, and analyzed using the R statistical software. Statistical analysis showed variation in vertebrate presence by habitat type. Overall, few territorial reactions from the gopher tortoise were observed in the presence of other vertebrates. This study acts as a starting point to increase our understanding of local populations. We hope to be able to continue this study and use the data to fill the gap in knowledge on southeast Florida tortoise populations and use it to help develop better species management plans within our local communities.
Regular Oral Presentation

Seasonal Space Use and Inter-Annual Site Fidelity of Female Gopher Tortoises (Gopherus polyphemus)

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Understanding the strength of site fidelity exhibited by Gopher Tortoises (*Gopherus polyphemus*) at different spatial and temporal scales is important for understanding their susceptibility to anthropogenic landscape change. Although prior studies have examined seasonal patterns of space use by adult G. polyphemus, little is known about long-term site fidelity or the effects of body size, tortoise density, and habitat changes on burrow-use dynamics. We analyzed 6 years of telemetry data (2015-2021) for 37 female tortoises at Archbold Biological Station (Highlands Co., FL) to determine 1) whether females show strong fidelity to seasonal activity areas within their annual home range across multiple years; and 2) how body size affects strength of fidelity. Over the 6 years of the study, we recorded 74 instances of females foraging or away from their burrows and used these observations (mean maximum distance from burrow 49.5 m) to define Seasonal Activity Areas (SAA). Using ArcGIS, we created 49-m buffers around all burrows used by a female, then merged and dissolved the buffer polygons used within each season (Nesting, Summer, and Winter) and repeated this for all 6 years. We then used the Pairwise Intersect tool to calculate successive percent overlap of SAAs from one year to the next, as well as pairwise overlap between non-consecutive years. Tortoises exhibited high site fidelity to SAA across successive years and the mean degree of overlap was similar for every season (70%-71%). As expected, overlap between non-consecutive years was much lower, with a maximum mean overlap of 45% during nesting season. In all seasons, larger females showed significantly higher degrees of successive

overlap, though body size alone was a weak predictor (R^2 = 0.05-0.16, $p \leq 0.02$). Ongoing analyses are exploring the role of weather and habitat type on observed patterns of space use in this well-studied population.
Regular Oral Presentation

An Evaluation of *Cryptosporidium serpentis* in Free-Ranging Snakes to Inform the Recovery of an Imperiled Serpent, the Eastern Indigo Snake

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Cryptosporidium serpentis is a single-celled protozoan that parasitizes the stomachs of infected hosts, and severe clinical infections are progressively debilitating and can lead to mortality. In 2016, *C. serpentis* was discovered at the Orianne Center for Indigo Conservation's (OCIC) captive rearing facility, which breeds eastern indigo snakes (*Drymarchon couperi*) for reintroduction sites in Alabama and Florida. All animals that tested positive for *C. serpentis* were removed from the captive breeding program and housed in a separate quarantine room and are regularly screened for the parasite. Little is known about the natural occurrence of *C. serpentis*. Therefore, understanding prevalence of this protozoan in wild populations is critical to make informed adaptive management decisions about future reintroduction strategies. If *C. serpentis* is not prevalent within wild snake populations, the presence of the parasite in OCIC snakes will reduce the potential output of snakes for reintroductions. To evaluate the natural occurrence of *C. serpentis* we sampled free-ranging snakes from the Alabama site (n = 51), Florida site (n = 56), a non-reintroduction site in Georgia (n = 48), and eastern indigo snakes (n = 64) and other snake species (n = 8) opportunistically captured throughout the eastern indigo snakes' range for *C. serpentis*. All snakes at the three focal sites tested negative, but a single incidentally captured indigo snake from South Florida tested positive. Our results suggest that *C. serpentis* positive snakes should not be included in reintroduction efforts; however, additional *C. serpentis* surveillance efforts may inform future reintroduction strategies. Additionally, maintaining a high level of biosecurity in captive breeding programs and wildlife translocation studies is important to minimizing the spread of diseases.
Speed Talk Presentation

Seasonal and Habitat-specific Growth Rates of Juvenile Gopher Tortoises in South-central Florida

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Although variation in juvenile growth rates affects age at sexual maturity and other important aspects of demography in Gopher Tortoises (*Gopherus polyphemus*), no studies have directly compared growth patterns of juveniles between habitats in the southern portion of the species' range. In March 2021, we captured, measured, and radio-tagged 14 juveniles in sandhill and 13 juveniles in ruderal habitats at Archbold Biological Station. Tagged juveniles were tracked twice weekly and remeasured in June and September to assess growth rates in the late dry season and early wet season. We measured frequency of occurrence of grasses, legumes, and other plants within 14 m of each juvenile burrow. We also quantified cover of herbaceous vegetation, shrubs, trees, and bare ground using drone-acquired, high-resolution images. Juveniles exhibited contrasting patterns of seasonal growth depending on habitat. In ruderal habitat, carapace length (CL) increased by an average of 0.14% per day ± 0.04% (SD) during the dry season, but growth rate declined slightly during the wet season (0.11% per day ± 0.03%). In contrast, juveniles in sandhill grew very slowly during the dry season (0.05% per day ± 0.02%) and faster during the wet season (0.08% per day ± 0.04%). We attribute this significant season*habitat interaction (Wilks' $\lambda = 0.531$, $F_{1,13} = 11.469$, $p = 0.005$) to earlier availability of forage, particularly non-native bahiagrass (*Paspalum notatum*), in ruderal habitat. Preliminary multiple regression models of wet-season growth identified percent bahiagrass and initial CL as significant predictors of juvenile growth rate. Larger juveniles grew proportionally less than smaller juveniles, perhaps because our sample included several 5-year-olds that are becoming subadults. Analyses and juvenile tracking are ongoing to better understand the demographic consequences of accelerated growth. An outstanding question is whether pastures and ruderal areas can support the juvenile life stage, or whether these are ecological traps due to poor survival.
Regular Oral Presentation

Status, Distribution, and Habitat Associations of Gopher Tortoises in Southeast Florida
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Gopher tortoise populations are declining throughout their range, despite legal protections range wide. Remnant populations of tortoises in the western portion of their range have received strict legal protections and extensive research, yet similarly depauperate populations in extreme southeast Florida have received very little research attention and far fewer regulatory provisions. Here we conduct the first formal review of gopher tortoise populations in southeast Florida (Palm Beach, Broward, and Miami-Dade Counties), an area that is on the forefront of anthropogenic stressors such as urbanization, habitat loss, and climate change. We conducted burrow surveys at key sites in each county and measured burrow dimensions to estimate age structure. We supplemented these formal surveys with community science databases (Florida Fish and Wildlife tortoise reporting website and the Global Biodiversity Information Facility), a survey to land managers, and management plans from sites harboring tortoises. For populations with existing burrow data, we conducted a spatial analysis to evaluate landscape-level habitat features associated with tortoise burrows (elevation, soil type, land use/land cover). We found dozens of likely gopher tortoise populations including 21 ground-verified populations with most in Palm Beach County (11 of 21). Our habitat analysis revealed a distinct preference for well-drained soils and elevated scrub habitat. Most of our populations were in small, protected areas (average of 43 ha, median of 18 ha). Of the five sites for which we had burrow size information, four showed bimodal size structures suggesting low survival of subadult tortoises. This data synthesis should be foundational for the development of evidence-based conservation planning for populations of the species at the forefront of impacts from urbanization and climate change. We draw direct and explicit contrasts between regulatory and conservation attention towards depleted tortoise populations in the westernmost and southernmost parts of their range, and highlight conservation and research needs for tortoise populations in extreme southeast Florida.
Regular Oral Presentation

Cognition for conservation: How understanding tortoise cognition can help their conservation

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The gopher tortoise is an environmental keystone species under serious threat of extinction from rapid urban expansion. To date, efforts to conserve these tortoises have mainly followed the traditional routes of conservation; understanding their ecosystem, habitat needs, and what behaviors they may, or may not, perform. Current approaches do not take into account crucial factors which determine how animals find, access and return to resources - the cognitive processes underlying their behaviour, something which is likely to be particularly important when animals are translocated. Tortoises have traditionally been considered to be “sluggish and unintelligent creatures” (Yerkes 1901, p 520). However, recent research has revealed an impressive suite of cognitive abilities in this group. This talk will give an overview of what we know about cognition in tortoises and consider how these abilities can be harnessed to improve conservation outcomes.

Regular Oral Presentation