Identification of fauna associated with Gopher Tortoise burrows at Florida Atlantic University Preserve and Jonathan Dickinson State Park

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Introduction

The gopher tortoise *(Gopherus polyphemus)* is endemic to the southeastern United States, and threatened throughout its distribution from extreme eastern Louisiana, to southern South Carolina and Florida[1,2]. The gopher tortoise is an herbivorous chelonian with a life span of up to 60 years according to Florida Fish and Wildlife. Individuals may become reproductively mature typically around 7 years of age and females egg clutch range from 1-15 eggs in each reproductive season[3] where they are mating and laying eggs. Gopher tortoise are originally said to be mating and courting from the month April-June, and laying eggs from May to June[4] . However, evidence are being shown that due to warmer temperature, areas in Florida such as Jupiter shows mounting evens from February to December, carcasses of hatching from January to December, and all year round courtship[4]. The gopher tortoises excavate burrows that can be up to 4 m deep and 12 m long. Chelonians, are ectothermic and rely on their environment to regulate internal body temperatures. Tortoises of the genus *Gopherus* have been observed using thermoregulatory behaviors such as seeking shade, frothing, rapid breathing, and basking [5]. Tortoises and other species have been observed going outside of the burrows to bask and warm up their bodies along with multiple other ectothermic species such as snakes, frogs, and lizards. When temperatures were too extreme, the tortoises, reptiles, mammals, amphibians, and insects would seek shelter in the shade of the burrows [6]. These burrows provide moderate and stable thermal refuge for a diverse array of animal species during extreme conditions.

The importance of their burrows for approximately 350 commensal species, led scientists to classify the gopher tortoise as a keystone species [3,4] , A keystone species is defined as a particular species that plays a crucial role in how an ecosystem functions (i.e., they have a direct effect on the biodiversity of their ecosystem). When a keystone species is removed, it has a

dramatic effects on the habitat and the inhabitants [7]. Species such as the gopher frog (*Rana capito*) are dependent on the burrow for protection against predators and the sun since it provides a moist environment[8]. Other species such as the Florida mouse (*Podomys floridanus*), six-lined racerunners (*Cnemidophorus sexlineata*), and southern black racers (*Coluber constrictor priapus*) are also frequent user of the burrows and have come to greatly depend on it[8]. In addition to benefitting other fauna, the gopher tortoise brings a large amount of soil and nutrients to the surface. This can cause small scale disturbances within the landscape, allowing for understory vegetation growth to increase as new soils bring increased levels of nutrients to the surface. This freshly dug earth can also bring a variety of nutrients and minerals that would otherwise not be found at the surface [9]. This can influence the food web as insects may feast upon the nutrients, which in turns bring smaller predators, which then brings bigger predators. Even though over 350 animal species have been reported utilizing the burrows of gopher tortoises, continuous resource will allow for a deeper and more detailed understanding of the importance of these interactions[7].

Unfortunately, gopher tortoise populations have been declining due to several anthropogenic factors including harvest for food (people eating the gopher tortoise), habitat destruction and fragmentation, and the consequent isolation of populations[10]. Gopher tortoises require a significant amount of acreage of undeveloped land to sustain a healthy population as stated by Florida Fish and Wildlife. Florida Fish and Wildlife Commission has established that the minimum area for gopher tortoises is of two to four tortoises per acre. More than half of the gopher tortoise habitats are located in private property or corporate lands. Agricultural modifications of natural environment along with the encroachment of roads, buildings, and other structures, all contribute to the habit loss for both animals and plants as they are forced to adapt

and survive [12]. Gopher tortoise ideal habitat is an open field, with lots of low vegetation to feed on. The open field also allows the gopher tortoise to bask in the sun and also to forage around for food to eat[13]. These modifications and impeding urbanizations are fragmenting the habitats needed, creating small "island populations" [10] .This can maximize the distance required for tortoises to move during active season. Habitat fragmentation can cause crowding in areas which makes it harder for the tortoise to survive and maintain a healthy life10,14. Crowding can lead to a greater chance for parasite loads. Which can make it easier to spread diseases that can affect tortoise's rates of survival and reproduction.

Despite their ecological importance, gopher tortoise populations in South Florida have been declining rapidly and very little information is known on the species associated with their burrows. This study aims to document the animal species associated with gopher tortoise burrows at two sites in South Florida: (1) Jonathan Dickinson State Park and the Florida Atlantic University Preserve (FAUP). We hypothesize that there will be more fauna associated with closed field versus open field coverage at both site. The reason why two sites were used is because FAUP is a poorly managed fragmented scrub habitat with no fire management while JDSP is a well maintain habitat with 16 different type of habitat and has regular schedule fire management. The objective of this study are to: (1) Identify fauna associated with burrows in two differing sites. (2) Compare the number of faunal species between species between burrows in vegetation types (Closed field and open field) in one site.

Materials and Methods

Study Sites

We will be comparing the fauna associated with gopher tortoise burrows between two sites: Florida Atlantic University Preserve (FAUP) and Jonathan Dickinson State Park (JDSP). FAUP is a 90 acre preserve while JDSP is a state park of about 11,500 acres. FAUP is a poorly managed fragmented scrub habitat mixed with grassy areas, pines and oaks. While there is no fire maintenance, there are mechanical and herbicidal treatments. JDSP is a well maintained site with 16 distinct natural communities (mesic hammock, mesic flatwoods, sandhill, scrub, scrubby flatwoods, depression marsh, dome swamp, floodplain swamp, hydric hammock, strand swamp, wet flatwoods, wet prairie, sandhill upland lake, flatwoods lake, blackwater stream, mangrove swamp). JDSP also has 2-3 year cycle of prescribed burns .

Research Strategy

Forty Moultri M-880i Mini Game Cameras will be used while being mounted on a stand and buried about seven inches into the ground. Twenty cameras will be placed at random burrows at Florida Atlantic University Preserve. Ten of the 20 cameras will be randomly assigned in open field while the other 10 will be placed in closed field. Open field will be restricted to open grassland and sand dunes. Closed field will be restricted to dense vegetation of scrub and oaks trees. The other 20 cameras will be placed at Jonathan Dickinson State Park and will also be assigned to 20 random burrows in closed field. Burrows will be randomized by utilizing =rand() on excel.

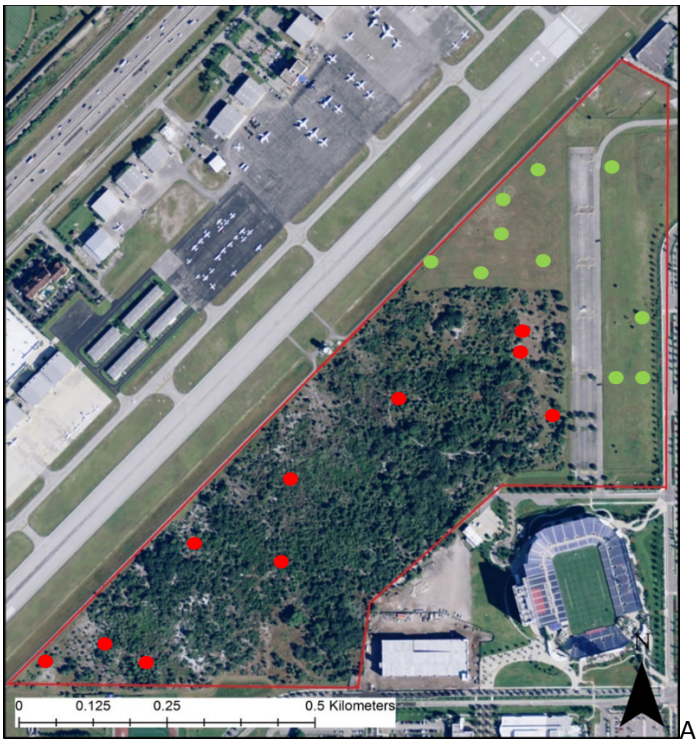

Figure 1. Location of 20 cameras in the preserve at Florida Atlantic University. Red spots represent cameras placed on burrows within closed field. Green spots represent cameras placed in burrows in opened field.

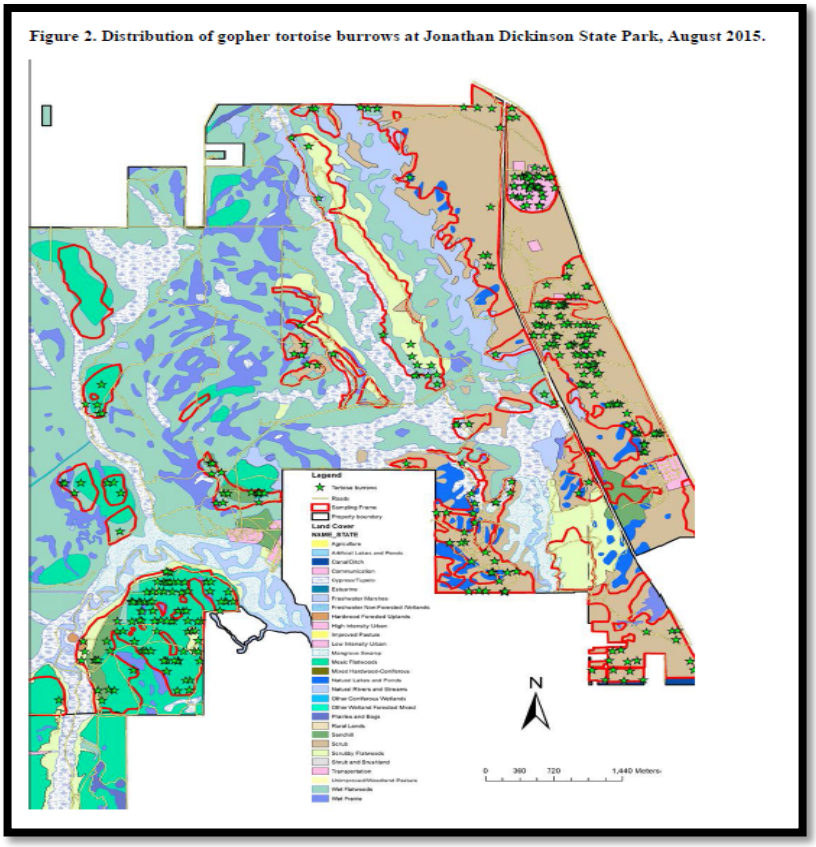

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Figure 2: Distribution of gopher tortoise burrows at Jonathan Dickinson State Park, August 2015 (obtained from JDSP Report). Green stars on map are burrows found by JDSP Rangers

Cameras will be set up to high sensitivity. Cameras will automatically turn on once motion is detected, an image will be taken in 3 trigger shots with a 5 seconds delay between shots. The cameras have a no-glow LED, which allows the camera to function at night and stay hidden from fauna. Cameras will be left at the site for one year capturing footage through all four seasons. Battery life depends on how active the burrow is and whether there are any plants surrounding it which can trigger the motion detection sensors. Therefore, we/or I will be checking the cameras biweekly in order to ensure cameras are functioning properly. SD cards will be downloaded onto a portable laptop, cleared, and reinserted back into the cameras. Based on cameras previous studies, batteries have been shown to last anywhere between two weeks to a

month and a half. Cameras will be used for detecting number of each species since it is difficult to determine abundance of individuals from camera studies (ref)..

Preliminary Results

We found a total of seven different mammalian species, fourteen different avian species, five different reptilian species, and two different amphibian species associated with burrows of gopher tortoises at FAUP during the period of December 2015 through June 2016. For JDSP, we found four mammalian species, one avian specie, one reptilian specie, and one amphibian species (Tables 1 and 2).

Table 1: List of vertebrate species associated with gopher tortoise burrows at FAU Preserve at the Boca Raton campus in Florida.

Types	Species	Grassland (10 cameras)	Scrub (10 cameras)
Mammalia			
	Black Rat (*Rattus rattus*)	x	x
	Eastern cottontail (*Sylvilagus floridanus*)	x	x
	Marsh rabbit (*Sylvilagus palustris*)	x	x
	Opossum (*Didelphis virginiana*)	x	x
	Feral cats		x
	Raccoon (*Procyon lotor*)		x
	Coyote (*Canis latrans*)	x	x
	Squirrel (*Sciurus carlinensis*)		x
Aves			
	Burowing owl (*Athene cunicularia*)	x	
	Great horned owl (*Bubo virginianus*)	x	
	Loggerhead shrike (*Lanius ludovicianus*)	x	
	Mocking bird (*Mimus polyglottos*)		x
	Brown thrasher (*Toxostoma rufum*)		x
	White Ibis (*Eudocimus albus*)	x	
	Northern cardinal (*Cardinalis cardinalis*)		x
	Grey catbird (*Dumetella carolinensis*)		x
	Blue jay (*Cyanocitta cristata*)		x
	Palm Warbler (*Setophaga palmarum*)	x	x
	Great blue heron (*Ardea herodias*)	x	x
	Boat-tailed grackle (*Quiscalus major*)	x	
	Fish crow (*Corvus ossifragus*)	x	
	Cattle Egret (*Bubulcus ibis)*	x	
Reptilia			
	Coachwhip (*Masticophis flagellum*)	x	x
	Green Iguana (*Iguana iguana*)	x	x
	Five-lined Skink (*Plestiodon fasciatus*)		x
	Black Racer (*Coluber constrictor priapus*)	x	x
	Gopher Tortoise (*Gopherus polyphmus*)	x	x
Amphibia			
	Oak Toad (*Anaxyrus quercicus*)		x
	Gopher frog (*Rana capito*)	x	x

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Table 2: : List of vertebrate species associated with gopher tortoise burrows at FAU Preserve at the Boca Raton campus in Florida.

Types	Species
Mammalia	
	Eastern cottontail (*Sylvilagus floridanus*)
	Eastern spotted skunk (*Spilogale putorius*)
	Bobcat (*Lynx rufus*)
	Marsh rabbit (*Sylvilagus palustris*)
Aves	
	Unidentified Bird
Reptilia	
	Gopher Tortoise (*Gopherus polyphmus*)
Amphibia	
	Unidentified Frog

2

Mammalian species associated with gopher tortoise burrows were more numerous in the closed field when compared to the open field area at FAUP (Table 1)

Avian species associated with gopher tortoise burrows were less numerous in the close field when compared to the open field area (stats) (Table 2)

We found only one specie more in the closed field versus the open field for both of reptilian and amphibian species associated with gopher tortoise burrows

A comparison between JDSP and FAUP, indicates that we have found more species at the FAUP scrub than JDSP scrub in all for classes (mammalia, aves, reptilia, and amphibia) (Figure 3).

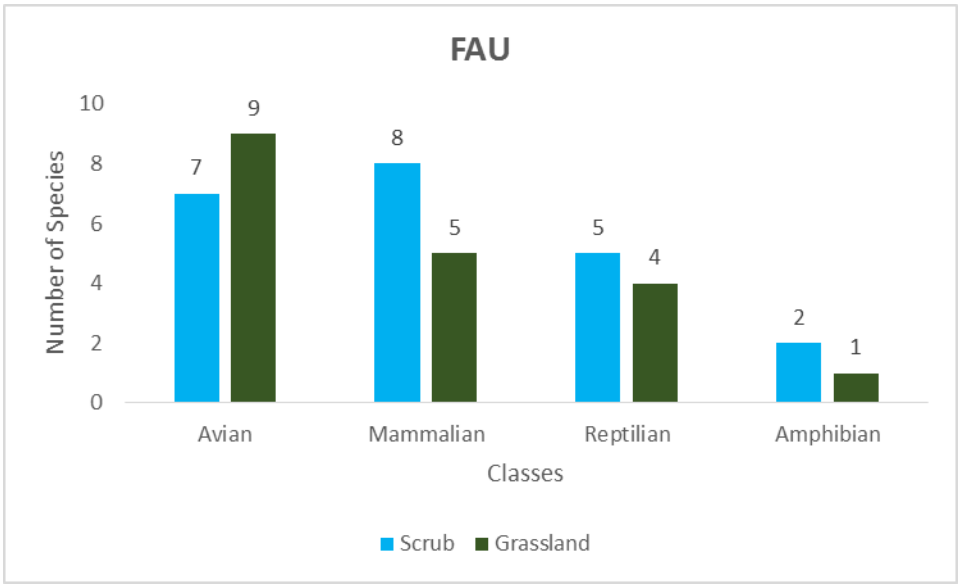

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Figure 3: Comparison of the number of faunal species associated with gopher tortoise burrows between the two vegetation types found at the FAUP.

For JDSP, we anticipate to see more species associated with the gopher tortoise burrow since JDSP has a regular fire management schedule and is a larger, well maintained area. We anticipate some new species that we have not seen at FAUP such as turkeys, bobcat, alligators, deer's, shorebird, and rattlesnake which JDSP park rangers have personally observed. We also anticipate that JDSP will have more animal species associated with the gopher tortoise burrow when compare to FAUP. Definite conclusion cannot be drawn due to the short time frame of camera at JDSP. FAU is more fragmented and smaller allowing less room for fauna to move around. JDSP is so large compared to FAU and has more habitats which allows more for fauna to roam around in (Figure 4).

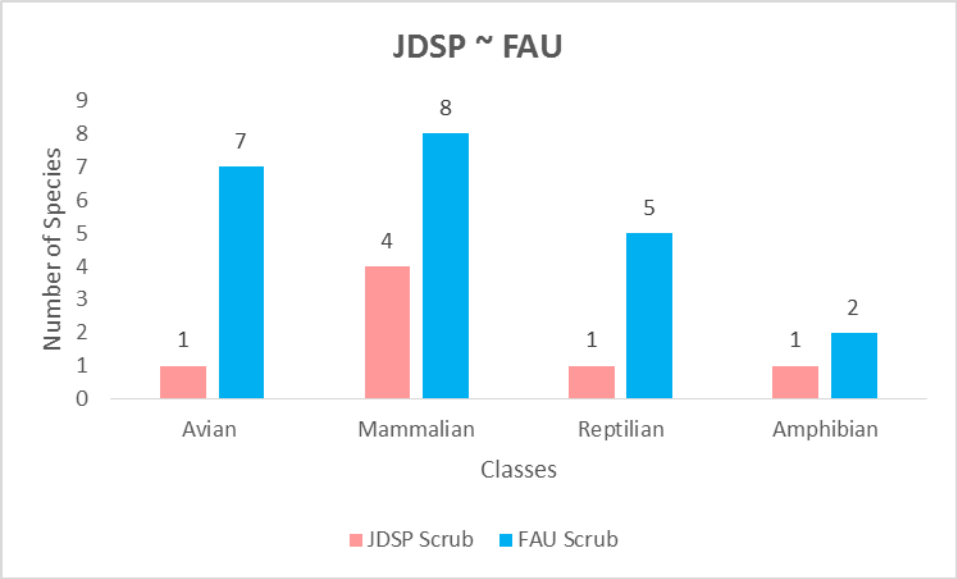

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Figure 4: Comparison of the number of faunal species associated with gopher tortoise burrows between FAUP and JDSP scrub habitat.

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