5-2021

Vertebrates at the University of Southern Mississippi: A Wildlife Survey of the Bear Point Bayou and Surrounding Gulf Park Campus

Hannah McDuffie

Vertebrates at the University of Southern Mississippi: A Wildlife Survey of the Bear Point Bayou and Surrounding Gulf Park Campus

by

Hannah McDuffie

A Thesis
Submitted to the Honors College of
The University of Southern Mississippi
in Partial Fulfillment
of Honors Requirements

April 2021

Approved by:

Robert Turnbull, M.S., Thesis Advisor,
School of Biological, Environmental and Earth Sciences

Jake Schaefer, Ph.D., Director,
School of Biological, Environmental and Earth Sciences

Ellen Weinauer, Ph.D., Dean
Honors College

Abstract

This project originated through interest in pursuing a field-based research project involving vertebrates. After conducting literature reviews, it was found that the Bear Point Bayou running through the University of Southern Mississippi Gulf Park Campus has never been thoroughly surveyed for species richness (Mohrman et al. 2016). Four sites on the Gulf Park Campus were chosen and vertebrate species were documented and identified through observations, camera trapping, and vocalization recordings. These data, along with species previously recorded on campus, were combined, and compared to data from the Gulf Coast Phenology Trail of which the Gulf Park Campus was recently added as a partner site. A total of 82 vertebrate species were catalogued on this campus with species richness being greatest at the Bear Point Bayou observation site. Recommendations for future GCPT involvement as well as the promotion of field-based studies for students on the Gulf Park Campus with emphasis on those majoring in the Biological Sciences are proposed.

Keywords: Vertebrates, Species Richness, Wildlife Survey, Gulf Coast Phenology Trail, Biodiversity, Field Work

Acknowledgment

The author wishes to thank her advisor, Mr. Robert Turnbull, for his support and guidance throughout this project. His continued dedication and encouragement during all steps of the research process helped to make this thesis possible.

Table of Contents

List of Figures

List of Abbreviations

GCPT	Gulf Coast Phenology Trail
IACUC	Institutional Animal Care and Use Committee
USM	The University of Southern Mississippi

Chapter I: Introduction

Species richness is defined by the number of species present in a specified area (Dickman 1987). This information is utilized to monitor factors such as biodiversity and population trends in a given community and is a standard for conservation initiatives (Theis et al. 2008). Conservation and management planning require species richness as well as abundance to be taken into consideration as a baseline for calculations of biomass as well as ecosystem productivity (Theis et al. 2008). Biodiversity is also an indicator of overall ecosystem health and is used in development planning to reduce impacts such as habitat "fragmentation, streamflow modification and invasive species introductions" due to human interaction (Gemfeldt et al. 2008; Alred et al. 2021).

Calculating species richness can typically begin with observations and observational study methods are often preferred in wildlife research as the environments and behaviors of the studied wildlife are minimally impacted. Furthermore, the utilization of trail cameras, or camera trapping, has become increasingly popular in surveying wildlife for factors such as species richness due to their low cost and ease of use (Newey et al. 2015). This method is desirable since it does not require the physical capture of wildlife and necessitates little disruption to their environment (Newey et al. 2015). In addition, camera traps are also effective in that they can be left unattended for extended periods of time, thus limiting the cost of manpower and increasing the efficiency of data collection (Silveira et al. 2003). Initially these cameras did not record sounds, limiting their data collection capabilities to only pictures and videos, but today many models include the ability to record sound and can even be accessed in real time through cellular networks. The limited presence of observers through the use of trail cameras is also

beneficial for collecting data on species that may be unlikely to be present near humans (Long et al. 2008). The ability to capture pictures of focal species allows for individual animals to be identified and tracked based on unique markings (Carbone et al. 2006). However, trail cameras can generate large amounts of unusable footage (motion detectors can be set off by wind blowing tree branches) and can lead to device issues such as limited memory storage and low quality of images, leading to difficulties in identifying species (Newey et al. 2015).

The promotion of hands-on experiences, specifically field work, for biological science undergraduates is a vital extension of continued learning outside of a classroom environment. In an article titled "Saving field biology skills from extinction", Warren stated that the decline in field biology skills has hit a crisis point (Warren 2015). Undergraduate students are not receiving as much hands-on experience in their curriculum often because of factors such as time, resources, and risk management (Fleischner et al. 2017). However, field-based work provides crucial skills for students regarding "behavior, ecology, evolution, systematics, and conservation science" of wildlife (Fleischner et al. 2017). The USM Gulf Park Campus supports a unique environment and ecosystems that can be used to enrich the undergraduate curriculum through wildlife field research, giving students important hands-on experience in skills such as handling wildlife and performing population estimates to use after graduating (McCleery et al. 2005).

The University of Southern Mississippi (USM) Gulf Park Campus sits on 52 acres and is located in the Lower Gulf Coastal Plain. This region supports a variety of

ecosystems including temperate forests as well as wetlands (Goebel et al. 2001). This campus was recently added as an active site on the Gulf Coast Phenology Trail in 2019. This trail was established in 2016 and runs from Pascagoula to New Orleans and is vital for tracking the relationship between plant and animal life cycles in reference to the changing climate (Bishop et al. 2020). Data collected on this trail include both observational plant and animal inventories; activity curves; and weather data, such as average temperature and total precipitation for the partner sites (Bishop et al. 2020). Observations along this trail are often made by citizen scientists trained in Nature's Notebook procedures (Bishop et al. 2020). Currently, the data for this trail at the USM Long Beach site is being collected by two observers, neither of which is a student or faculty member at USM. This provides ample opportunity for student involvement, hands on learning, and potential research. Even though this Phenology Trail collects information on both animal and plant species, for the purpose of this study, only animal focal species will be compared.

The overall purpose of this project was to create a baseline catalog of the vertebrate species that inhabit the Bear Point Bayou and surrounding USM Gulf Park Campus. Given that a project of this nature has never been performed on this campus, the implications are vast. The data collected from this research project, as discussed previously, can be used to contribute to the existing data of the Gulf Coast Phenology Trail in order to aid in increasing their understanding of the relationships between migratory focal species that are present on the USM Gulf Park campus. This information can also be used to supplement courses such as BSC 201/201L General Zoology, BSC 407/407L Vertebrate Biology, and BSC 455/455L Animal Behavior as well as be

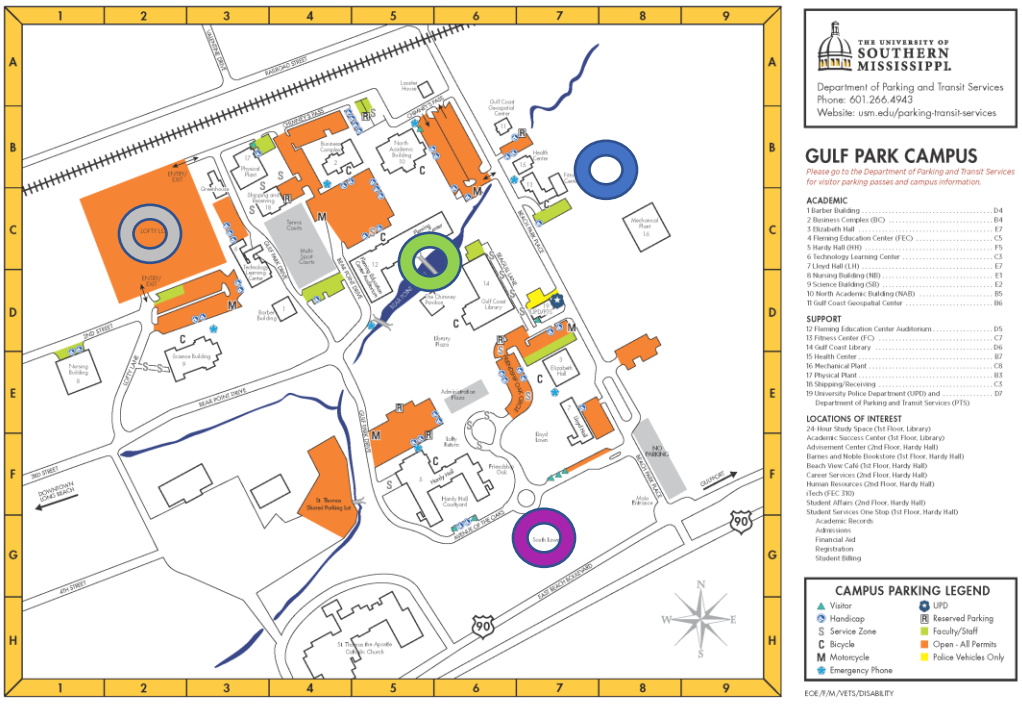
included in discussions for future changes to the Biological Sciences programming on the Gulf Park Campus under the proposed Gulf Coast Reorganization Plan.

Chapter II: Materials and Methods

Study Sites

This study was conducted between September 2020 and March 2021. Four sites were selected on the University of Southern Mississippi Gulf Park campus to survey. These sites include a mixed hardwood/pine forested area behind the Gulf Park Fitness Center, Bear Point Bayou, and two relatively open fields, the South Lawn and Lofty Lot. These sites are referred to as Site One, Two, Three and Four respectively. Selected sites were chosen for their location, ecological diversity, ease of observation, as well as for high local wildlife traffic as indicated by clearly established trails.

Figure 1: Map of USM Gulf Park Campus Observation Sites Indicated by Colored Circles



Reprinted from University of Southern Mississippi Parking and Transit Services Campus Maps. Observation Sites indicated by colored circles. Site One: Wooded Area behind Fitness Center (Blue). Site Two: Bear Point Bayou (Green). Site Three: South Lawn (Purple). Site Four: Lofty Lot (Gray).

Trail Camera

A Bushnell “trail sentry” trail camera with motion detection was positioned at Site One along a clearing with a path already established by the movement of wildlife. Only one trail camera was utilized during this study due to monetary constraints. Site One was selected for the trail camera placement to avoid motion detection triggers other than wildlife, such as students or cars, that would have set it off had it been placed in any of the other three sites. This camera was secured by a tree using a customized piece of wood and nails so that the camera hung approximately 2 feet off the ground, maximizing the ability of the camera’s motion detection to go off in the presence of wildlife while minimizing the impact of its presence on the surrounding environment. This camera was checked every 24-48 hours and was repositioned as needed. Information regarding which species were observed was recorded.

Observations

Two times a week, each site was monitored by the researcher for approximately 30 minutes for wildlife activity. Equal effort was made to record observations between Sites Two through Four during the early morning, afternoon, and evening times in order to observe both crepuscular and diurnal wildlife. Observations were also conducted after rainfall for vertebrates, such as amphibians, that are more active during that time. Photographs were taken with a Google Pixel 3 phone camera when possible.

Recordings of bird vocalizations were also collected using the Google Pixel 3 phone to identify birds that were not seen but heard. These vocalization recordings were compared with the Audubon Bird Guide app to identify species based on their calls.

Information for correctly identifying the observed animals was obtained through the knowledge acquired from the BSC 407/407L Vertebrate Biology course at USM and through advisor aid.

Data were also collected on animals previously observed through advisor documentation on campus, but that were not observed during this study. This includes videos and pictures taken by the advisor on the USM Gulf Park Campus during all parts of the year. Information regarding which species were observed at which site was also recorded. Data were compared to focal species catalogued during all months of the year by the Gulf Coast Phenology Trail as outlined by the Gulf Coast Phenology Trail 2019 Annual Report.

Chapter III: Results

Sixty different species were either directly or indirectly observed (heard) on campus during this study and are presented in Figures 2 through Figure 6. The study included 10 mammal, 35 bird, 8 non-avian reptile, 5 amphibian, and 2 fish species with an additional 22 previously identified vertebrates not seen in this study as indicated by (*). Figure 7 presents a breakdown of the vertebrates documented by site and their phylogenetic groups and Figure 8 shows the focal species of the Gulf Coast Phenology trail that were observed. Of the 15 GCPT focal species, 12 species were recorded as being present on the USM Gulf Park Campus.

Figure 2: Birds Documented on USM Gulf Park Campus

Common Name	Scientific Name
American Crow	*Corvus brachyrhynchos*
American Kestrel	*Falco sparverius*
American Robin	*Turdus migratorius*
Bald Eagle	*Haliaeetus leucocephalus*
Belted Kingfisher	*Megaceryle alcyon*
Black Vulture*	*Coragyps atratus*
Blue Jay	*Cyanocitta cristata*
Brown Pelican*	*Pelecanus occidentalis*
Brown Thrasher	*Toxostoma rufum*
Brown-headed Cowbird	*Molothrus ater*
Carolina Chickadee	*Poecile carolinensis*
Carolina Wren	*Thryothorus ludovicianus*
Chimney Swift*	*Chaetura pelagica*
Common Yellowthroat	*Geothlypis trichas*
Cooper’s Hawk	*Accipiter cooperii*
Dark-Eyed Junco*	*Junco hyemalis*
Eastern Bluebird	*Sialia sialis*
Eurasian Collared-Dove	*Streptopelia decaocto*
European Starling	*Sturnus vulgaris*
Field Sparrow	*Spizella pusilla*
Great Blue Heron	*Ardea Herodias*

Figure 2 (continued)

Great Egret	*Ardea alba*
Green Heron	*Butorides virescens*
House Sparrow	*Passer domesticus*
Indigo Bunting	*Passerina cyanea*
Killdeer	*Charadrius vociferus*
Laughing Gull	*Leucophaeus atricilla*
Least Tern*	*Sternula antillarum*
Loggerhead Shrike	*Lanius ludovicianus*
Mourning Dove	*Zenaida macroura*
Northern Cardinal	*Cardinalis cardinalis*
Northern Mockingbird	*Mimus polyglottos*
Osprey	*Pandion haliaetus*
Pine Warbler	*Setophaga pinus*
Purple Gallinule*	*Porphyrio martinicus*
Purple Martin	*Progne subis*
Red-Bellied Woodpecker	*Melanerpes carolinus*
Red-Tailed Hawk*	*Buteo jamaicensis*
Red-Winged Blackbird	*Agelaius phoeniceus*
Rooster	*Gallus gallus domesticus*
Ruby-Throated Hummingbird*	*Archilochus colubris*
Rufous Sided Towhee*	*Pipilo erythrophthalmus*
Sanderling*	*Calidris alba*
Tufted Titmouse	*Baeolophus bicolor*
Turkey Vulture*	*Cathartes aura*
White-Winged Dove*	*Zenaida asiatica*
Yellow-Billed Cuckoo*	*Coccyzus americanus*
Yellow-Rumped Warbler	*Setophaga coronate*
Total	48

Species indicated by (*) were not observed during this study but were documented as being previously seen on campus.

Figure 3: Mammals Documented on USM Gulf Park Campus

Common Name	Scientific Name
Bobcat	*Lynx rufus*
Coyote	*Canis latrans*
Domestic Cat	*Felis catus*
Domestic Dog	*Canis lupus familiaris*
Eastern Cottontail	*Sylvilagus floridanus*

Figure 3 (continued)

Eastern Gray Squirrel	*Sciurus carolinensis*
House Mouse	*Mus musculus*
Nine-Banded Armadillo	*Dasypus novemcinctus*
Raccoon	*Procyon lotor*
Red Fox	*Vulpes vulpes*
Virginia Opossum	*Didelphis virginiana*
Total	11

Species indicated by (*) were not observed during this study but were documented as being previously seen on campus.

Figure 4: Amphibians Documented on USM Gulf Park Campus

Common Name	Scientific Name
American Bullfrog	*Rana catesbeiana*
American Toad	*Bufo americanus*
Cope's Gray Treefrog*	*Dryophytes chrysoscelis*
Eastern Spadefoot Toad*	*Scaphiopus holbrookii*
Gray Treefrog	*Hyla versicolor*
Green Treefrog	*Hyla cinerea*
Gulf Coast Toad	*Incilius valliceps*
Total	7

Species indicated by (*) were not observed during this study but were documented as being previously seen on campus.

Figure 5: Reptiles Documented on USM Gulf Park Campus

Common Name	Scientific Name
American Alligator*	*Alligator mississippiensis*
Brown Anole	*Anolis sagrei*
Common Snapping Turtle	*Chelydra serpentina*
Copperhead*	*Agkistrodon contortrix*
Eastern Box Turtle	*Terrapene carolina carolina*
Green Anole	*Anolis carolinensis*
Gulf Coast Box Turtle*	*Terrapene carolina major*
Mediterranean House Gecko*	*Hemidactylus turcicus*
Red Eared Slider	*Trachemys scripta elegans*
Southern Five-Line Skink	*Plestiodon inexpectatus*

Figure 5 (continued)

Spiny Softshell Turtle	*Apalone spinifera*
Water Moccasin*	*Agkistrodon piscivorus*
Yellow-Bellied Slider	*Trachemys scripta scripta*
Total	13

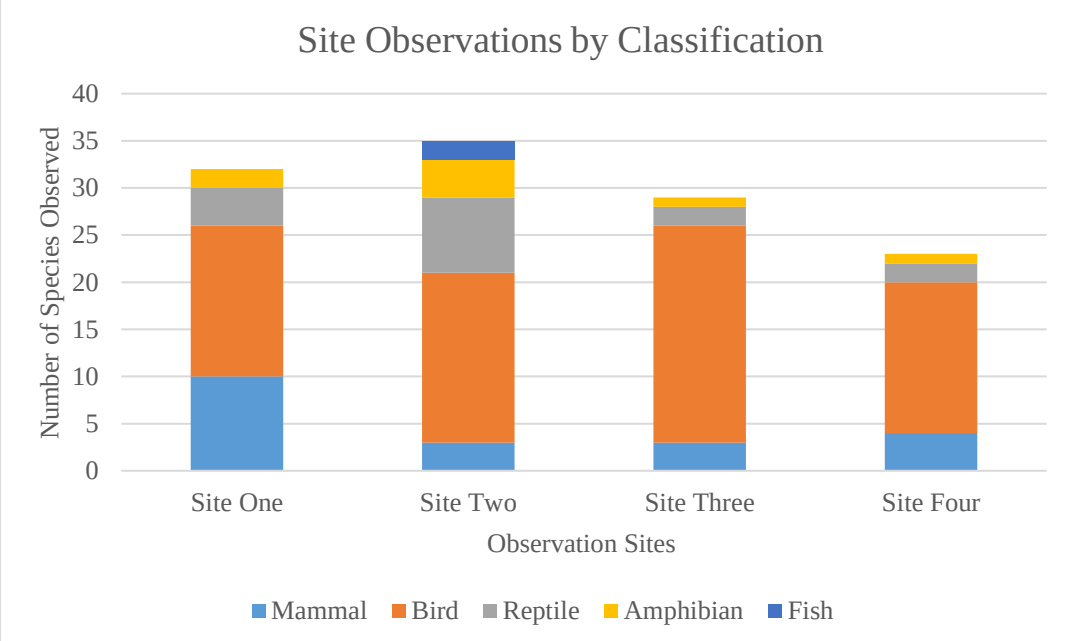
Species indicated by (*) were not observed during this study but were documented as being previously seen on campus.

Figure 6: Fish Documented on USM Gulf Park Campus

Common Name	Scientific Name
Black Bullhead Catfish*	*Ameiurus melas*
Blue Gill	*Lepomis macrochirus*
Spotted Bass	*Micropterus punctulatus*
Total	3

Species indicated by (*) were not observed during this study but were documented as being previously seen on campus.

Figure 7: Sites at Which Vertebrates Were Observed with Classifications



Species richness was highest at Site Two with the lowest richness reported at Site Four. The observations of birds predominated each site.

Figure 8: Focal Species of Gulf Coast Phenology Trail Observed on USM Gulf Park Campus

GCPT Focal Species	Observed During Study
American Robin	Yes
Bald Eagle	Yes
Blue Jay	Yes
Carolina Wren	Yes
Chimney Swift	No*
Eastern Bluebird	Yes
Hooded Warbler	No
Northern Mockingbird	Yes
Northern Parulla	No
Osprey	Yes
Purple Martin	Yes
Ruby-throated Hummingbird	No*
Sandhill Crane	No
Tufted Titmouse	Yes
Yellow Rumped Warbler	Yes

Observations indicated by (*) were not observed during this study but were documented as being previously seen on campus.

Figure 9: Images Captured by Trail Camera at Site One

9.1 Imagine of a Virginia Opossum, *Didelphis virginiana.*

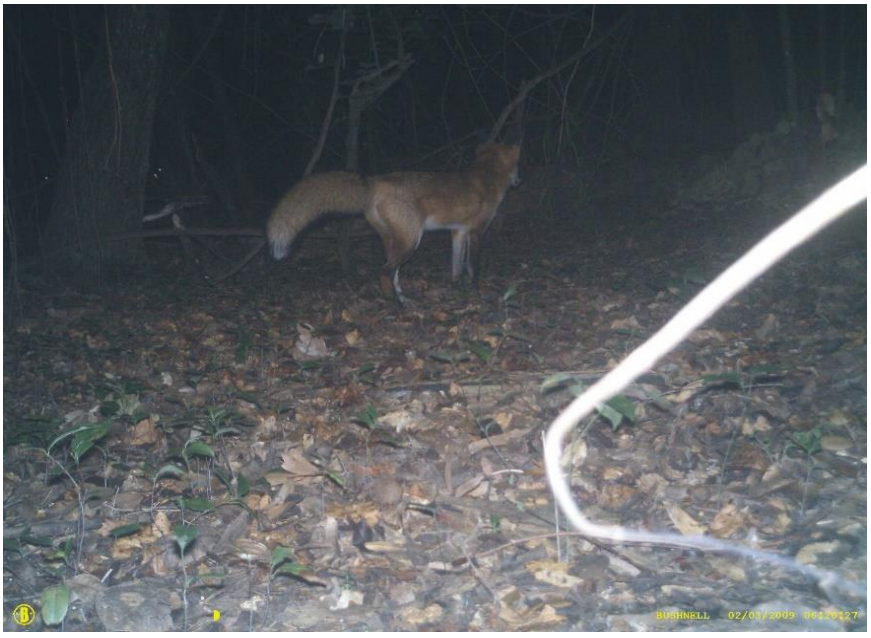
9.2 Imagines of a Coyote, *Canis latrans.*

9.3 Image of an Eastern Cottontail, *Sylvilagus floridanus.*

9.4 Image of an Eastern Gray Squirrel, *Sciurus carolinensis.*

9.5 Images of a Nine-banded Armadillo, *Dasypus novemcinctus.*

9.6 Image of a Blue Jay, *Cyanocitta cristata.*



9.7 Image of a Red Fox, *Vulpes vulpes.*

9.8 Images of Domesticated Cats, *Felis catus.*

9.9 Images of Bobcats, *Lynx rufus.*

9.10 Image of a Raccoon, *Procyon lotor*

Chapter IV: Discussion

During this study, 60 different species were observed at the selected observation sites. Thirty-two of these species were observed at Site One through the use of the trail camera. Although not seen in this study, 22 additional species have been documented as being present on the USM Gulf Park Campus, bringing the total species recorded to 82. The number of reptile and amphibian species identified were expectedly low. It is recommended that future studies include observations in the months of April to August when these groups are more active.

The greatest species richness was observed at Site Two near the Bear Point Bayou with a total of 34 species identified, accounting for approximately 57% of the observed species. This result was expected as this Site includes a body of water in which many different groups can inhabit and exploit. Relatively high species richness was observed at Site One with 32 species identified which could be attributed to the greatest level of survey effort implemented at this site through the use of the trail camera rather than manual observations as many of the more elusive wildlife species would have avoided human presence. The least number of species were observed at Sites Three and Four with 29 species and 24 species identified, respectively. Given the open environment of both the South Lawn (Site Three) and Lofty Lot (Site Four), it was difficult to photograph many of the birds in these areas. Enhanced visual equipment for documentation would be needed for future studies in these areas.

Issues with the trail camera methodology could have altered the totals for Site One. These issues included the camera shutting off prematurely, it being knocked off the

board that was securing it in place as well as batteries running out during an observational period. There were also instances where the motion detection was triggered by something other than the movement of an animal, resulting in many images that were not useful. Unfortunately, as well, the time stamp on the trail camera was not accurate, so the exact date and time of some of the observations were unknown. This method was, however, beneficial in capturing images of some of the more evasive wildlife, such as the two bobcats and red fox. Recordings were also utilized at this site to identify birds based on their call with many of the birds being identified both by their calls and by direct observation.

Of the noted 15 focal species researched by the Gulf Coast Phenology Trail, ten of those were directly observed during this study on the USM Gulf Park Campus, with an additional two as being documented on campus through previous observations. Therefore, 80% of the GCPT focal species have been identified on the campus thus far. According to the 2019 Gulf Coast Phenology Trail Report, the USM Gulf Park campus has only been recorded for their plant inventory by two observers not affiliated with the University (Bishop et al. 2020). This makes the USM Gulf Park Campus an excellent location to increase both student and student organization involvement in collecting these animal inventory data for future reports. In addition, having a more in-depth participation with the Gulf Coast Phenology Trail by students would create opportunities for both field-work and future research projects.

A more comprehensive catalog of species richness could also be obtained through IACUC approval in which trapping, and handling of wildlife would be permitted. This

would be especially useful in areas of the Bear Point Bayou that are not easily observable from the surface. Two American eels were documented as being present in the Bear Point Bayou in the Coastal Streams and Habitat Initiative of 2016 but were not observed or previously documented on the USM Gulf Park Campus (Mohrman et al. 2016). Therefore, continued research is recommended to build upon the foundation of species richness on the USM Gulf Park Campus demonstrated by this project. This could better the profile of various departments on the Gulf Park campus to improve recruitment and offer more field-based studies for student learning through supplementation of various BSC courses. Further research could also work to increase the understanding of Gulf Coast wildlife and their migratory patterns in response to climate change in partnership with the Gulf Coast Phenology Trail. This study can even be expanded to have implications for invertebrates as well as plant species.

Appendix

Figure 10: Vertebrates Observed During Study

Common Name	Scientific Name	Classification
American Bullfrog	*Rana catesbeiana*	Amphibian
American Crow	*Corvus brachyrhynchos*	Bird
American Kestrel	*Falco sparverius*	Bird
American Robin	*Turdus migratorius*	Bird
American Toad	*Bufo americanus*	Amphibian
Bald Eagle	*Haliaeetus leucocephalus*	Bird
Belted Kingfisher	*Megaceryle alcyon*	Bird
Blue Gill	*Lepomis macrochirus*	Fish
Blue Jay	*Cyanocitta cristata*	Bird
Bobcat	*Lynx rufus*	Mammal
Brown Anole	*Anolis sagrei*	Reptile
Brown Thrasher	*Toxostoma rufum*	Bird
Brown-headed Cowbird	*Molothrus ater*	Bird
Carolina Chickadee	*Poecile carolinensis*	Bird
Carolina Wren	*Thryothorus ludovicianus*	Bird
Common Snapping Turtle	*Chelydra serpentina*	Reptile
Common Yellowthroat	*Geothlypis trichas*	Bird
Cooper's Hawk	*Accipiter cooperii*	Bird
Coyote	*Canis latrans*	Mammal
Domestic Cat	*Felis catus*	Mammal
Domestic Dog	*Canis lupus familiaris*	Mammal
Eastern Bluebird	*Sialia sialis*	Bird
Eastern Box Turtle	*Terrapene carolina carolina*	Reptile
Eastern Cottontail	*Sylvilagus floridanus*	Mammal
Eastern Gray Squirrel	*Sciurus carolinensis*	Mammal
Eurasian Collared-Dove	*Streptopelia decaocto*	Bird
European Starling	*Sturnus vulgaris*	Bird
Field Sparrow	*Spizella pusilla*	Bird
Gray Treefrog	*Hyla versicolor*	Amphibian
Great Blue Heron	*Ardea Herodias*	Bird
Great Egret	*Ardea alba*	Bird
Green Anole	*Anolis carolinensis*	Reptile
Green Heron	*Butorides virescens*	Bird
Green Treefrog	*Hyla cinerea*	Amphibian
Gulf Coast Toad	*Incilius valliceps*	Amphibian
House Sparrow	*Passer domesticus*	Bird
Indigo Bunting	*Passerina cyanea*	Bird
Killdeer	*Charadrius vociferus*	Bird

Figure 10 (continued)

Laughing Gull	*Leucophaeus atricilla*	Bird
Loggerhead Shrike	*Lanius ludovicianus*	Bird
Mourning Dove	*Zenaida macroura*	Bird
Nine-Banded Armadillo	*Dasypus novemcinctus*	Mammal
Northern Cardinal	*Cardinalis cardinalis*	Bird
Northern Mockingbird	*Mimus polyglottos*	Bird
Osprey	*Pandion haliaetus*	Bird
Pine Warbler	*Setophaga pinus*	Bird
Purple Martin	*Progne subis*	Bird
Raccoon	*Procyon lotor*	Mammal
Red-Bellied Woodpecker	*Melanerpes carolinus*	Bird
Red Eared Slider	*Trachemys scripta elegans*	Reptile
Red Fox	*Vulpes vulpes*	Mammal
Red-Winged Blackbird	*Agelaius phoeniceus*	Bird
Rooster	*Gallus gallus domesticus*	Bird
Southern Five-Line Skink	*Plestiodon inexpectatus*	Reptile
Spiny Softshell Turtle	*Apalone spinifera*	Reptile
Spotted Bass	*Micropterus punctulatus*	Fish
Tufted Titmouse	*Baeolophus bicolor*	Bird
Virginia Opossum	*Didelphis virginiana*	Mammal
Yellow-Bellied Slider	*Trachemys scripta scripta*	Reptile
Yellow-Rumped Warbler	*Setophaga coronata*	Bird

Figure 11: Previously Documented Vertebrates on USM Gulf Park Campus

Common Name	Scientific Name	Classification
American Alligator	*Alligator mississippiensis*	Reptile
Black Bullhead Catfish	*Ameiurus melas*	Fish
Black Vulture	*Coragyps atratus*	Bird
Brown Pelican	*Pelecanus occidentalis*	Bird
Chimney Swift	*Chaetura pelagica*	Bird
Cope's Gray Treefrog	*Dryophytes chrysoscelis*	Amphibian
Copperhead	*Agkistrodon contortrix*	Reptile
Dark-Eyed Junco	*Junco hyemalis*	Bird
Eastern Spadefoot Toad	*Scaphiopus holbrookii*	Amphibian
Gulf Coast Box Turtle	*Terrapene carolina major*	Reptile
House Mouse	*Mus musculus*	Mammal
Least Tern	*Sternula antillarum*	Bird
Mediterranean House Gecko	*Hemidactylus turcicus*	Reptile
Purple Gallinule	*Porphyrio martinicus*	Bird
Red-Tailed Hawk	*Buteo jamaicensis*	Bird

Figure 11 (continued)

Ruby-Throated Hummingbird	*Archilochus colubris*	Bird
Rufous Sided Towhee	*Pipilo erythrophthalmus*	Bird
Sanderling	*Calidris alba*	Bird
Turkey Vulture	*Cathartes aura*	Bird
Water Moccasin	*Agkistrodon piscivorus*	Reptile
White-Winged Dove	*Zenaida asiatica*	Bird
Yellow-Billed Cuckoo	*Coccyzus americanus*	Bird

Figure 12: Sites at Which Vertebrates Were Observed

Common Name	Site One	Site Two	Site Three	Site Four	Total Sites
American Bullfrog		X			1
American Crow	X			X	2
American Kestrel			X	X	2
American Robin		X	X	X	3
American Toad		X			1
Bald Eagle				X	1
Belted Kingfisher		X	X		2
Blue Gill		X			1
Blue Jay			X	X	2
Bobcat	X				1
Brown Anole	X	X	X	X	4
Brown Thrasher		X	X		2
Brown-headed Cowbird	X			X	1
Carolina Chickadee	X	X			2
Carolina Wren		X	X		2
Common Snapping Turtle		X			1
Common Yellowthroat	X		X		2
Cooper’s Hawk				X	1
Coyote	X				1
Domestic Cat	X		X	X	3
Domestic Dog	X	X	X	X	4
Eastern Bluebird	X		X	X	3
Eastern Box Turtle	X	X			2
Eastern Cottontail	X			X	2
Eastern Gray Squirrel	X	X	X	X	4
Eurasian Collared-Dove		X	X		2
European Starling		X	X		2
Field sparrow		X	X	X	3
Gray Treefrog	X	X			2
Great Blue Heron		X			1

Figure 12 (continued)

Great Egret		X			1
Green Anole	X	X	X	X	4
Green Heron		X			1
Green Treefrog	X		X		2
Gulf Coast Toad		X		X	2
House Sparrow	X		X		2
Indigo Bunting			X	X	2
Killdeer			X		1
Laughing Gull		X	X	X	3
Loggerhead Shrike	X			X	2
Mourning Dove	X	X	X		3
Nine-Banded Armadillo	X				1
Northern Cardinal	X	X	X	X	4
Northern Mockingbird	X	X	X		3
Osprey			X	X	2
Pine Warbler	X		X		2
Purple Martin	X	X			2
Raccoon	X				1
Red-Bellied Woodpecker	X		X		2
Red Eared Slider		X			1
Red Fox	X				1
Red-Winged Blackbird		X	X	X	3
Rooster	X				1
Southern Five-Line Skink	X	X			2
Spiny Softshell Turtle		X			1
Spotted Bass		X			1
Tufted Titmouse	X		X	X	3
Virginia Opossum	X	X			2
Yellow-Bellied Slider		X			1
Yellow-Rumped Warbler	X			X	2
Total Species Present	32	34	29	24	

References

Allred S, Stedman R, Heady L, Strong K. 2021. Incorporating biodiversity in municipal land-use planning: An assessment of technical assistance, policy capacity, and conservation outcomes in New York's Hudson Valley. Land Use Policy. 104. https://doi.org/10.1016/j.landusepol.2021.105344

Bishop G, Wilder S, Posthumus E. 2020. Gulf Coast Phenology Trail 2019 Annual Report.

Carbone C, Christie S, Conforti K, Coulson T, Franklin N, Ginsberg JR, Griffiths M, Holden J, Kawanishi K, Kinnaird M, and others. 2006. The use of photographic rates to estimate densities of tigers and other cryptic mammals. Anim Conserv. 4(1): 75-79. https://doi.org/10.1017/S1367943001001081.

Dickman C. 1987. Habitat fragmentation and vertebrate species richness in an urban environment. J Appl Ecol. *24*(2): 337-351. doi:10.2307/2403879.

Fleischner TL, Espinoza RE, Gerrish GA, Greene HW, Kimmerer RW, Lacey EA, Pace S, Parrish JK, Swain HM, Trombulak SC et al. 2017. Teaching biology in the field: Importance, challenges, and solutions. BioSci. 67(6): 558-567.

Gamfeldt L, Hillebrand H, Jonsson PR. 2008. Multiple functions increase the importance of biodiversity for overall ecosystem functioning. Ecol. 89(5): 1223-1231. https://doi.org/10.1890/06-2091.1

Goebel PC, Palik BJ, Kirkman K, Drew MB. 2001. Forest ecosystems of a Lower Gulf CoastalPlain landscape: multifactor classification and analysis. J Torrey Bot Soc. 128(1): 47-57.

Long, R.A., P. MacKay, J.C. Ray, and W.J. Zielinski. 2008. Noninvasive survey methods for carnivores, vol. 1. Washington: Island Press.

McCleery RA, Lopez RR, Harveson LA, Silvy NJ, Slack RD. 2005. Integrating on campus wildlife research projects into the wildlife curriculum. Wildlife Soc B. 33(3): 802-809.

Mohrman T, Murphy M, Kyle AS, Bay L. 2016. Coastal streams and habitat initiative: A conservation action plan for nine Mississippi coastal streams. 59-68.

Newey S, Davidson P, Nazir S, Fairhurst G, Verdicchio F, Irvine R.J.,Wal R. 2015. Limitations of recreational camera traps for wildlife management and conservation research: A practitioner's perspective. Ambio. 44: 624-635. https://doi.org/10.1007/s13280-015 0713-1.

Silveira, L., A.T.A. Jácomo, and J.A.F. Diniz-Filho. 2003. Camera trap, line transect census and track surveys: A comparative evaluation. Biol Conserv. 114: 351–355. doi:10.1016/S0006-3207(03)00063-6.

Thoisy B, Brosse S, & Dubois MA. 2008. Assessment of large-vertebrate species richness and relative abundance in Neotropical forest using line-transect censuses: What is the minimal effort required?. Biodivers Conserv 17: 2627–2644. https://doi.org/10.1007/s10531-008-9337-0

Warren J., 2015. Saving field biology skills from extinction. Times Higher Education. (23 May 2016; www.timeshighereducation.com/comment/opinion/save-field biology-skills-from extinction-risk/2018721.article).