ANNUAL REPORT JANUARY - DECEMBER 2020

DEDICATION

The 2020 Annual Report is Dedicated to:

Unit Staff

This year we dedicate our annual report to our Unit Staff, Ben Kahler and Lisa Burnett. By all accounts, 2020 was a crazy year. By the end of March 2020, UF and USGS personnel were sent to work from home because of covid-19, where we all learned how to navigate virtual meetings via Zoom and Teams, new rules and restrictions on travel and research, safety protocols and "essential services." Those with school-aged children had to navigate this new way of work/life with kids at home and virtual school. Despite this new "normal," Ben and Lisa managed to keep the Florida Unit going. Within the background of a global pandemic, the Florida Unit added a new Assistant Unit Leader, Conor McGowan, and interviewed for a fourth unit scientist in Fisheries; the job was offered to Andrew Carlson by the end of the year. Ben and Lisa assisted our staff, students, and faculty (old and new) in ensuring that their activities conformed to both University and Federal guidance and helped with the onboarding of our new scientists. Finally, 2020 ended with the Florida Unit moving out of the building we had occupied for 20 years to a building across campus – all right before and during the winter holidays. Ben and Lisa took on the lion's share of packing up ~ 40 years of paperwork and other items (including the legacy of two retired Unit scientists) and unpacking and setting up in the new building. Ben and Lisa are integral parts of the Florida Unit team, and each has a special affinity for the Unit. Ben's previous position with USFWS gives him a deeper knowledge and understanding of the type of work that we do and adds immeasurable value to his administrative skills. For Lisa, the Unit is an extension of family; her daughter Amanda was a Student Assistant at the Coop during all four years of undergraduate study and sold her on our culture. Good staff are the key to any successful venture, and as the Florida Coop Unit weathers the current changes and faces new challenges, our scientists and students are proud and grateful for Ben and Lisa's support.

Lisa Burnett (Administrative Assistant)
and Ben Kahler (Research Administrator)
Photo by Abby Powell

RESEARCH STATEMENT

The mission of the Florida Cooperative Fish and Wildlife Research Unit is to conduct detailed investigation of wetlands and their component fish and wildlife resources, emphasizing the linkages with both aquatic and terrestrial ecosystems, and will emphasize the interaction of biological populations with features of their habitat, both natural and those impacted by human activities.

Clockwise from top left. Zebra longwing, the state butterfly (photo by Ben Kahler). A juvenile green turtle swimming through the shallow seagrass beds near Crystal River, FL (photo by Rick Herren). Screen shot of a video capture of a Florida scrub-jay feeding nestlings (photo by Alexis Cardas). Willet along the Atlantic Coast (photo by Abby Powell).

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FLORIDA COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT INTRODUCTION

The Florida Cooperative Fish and Wildlife Research Unit was established in 1979 as one of the first combined units. The purpose of the Florida Unit is to provide for active cooperation in the advancement, organization, and conduct of scholarly research and training in the field of fish and wildlife sciences, principally through graduate education and research at the University of Florida. The Florida Unit has the mission to study wetland ecosystems within the state. Florida is a low relief, sub-tropical peninsula that is ecologically fragile. Though abundant, Florida's water resources are under increasing pressure from a burgeoning human population. Domestic, recreational, and development needs threaten Florida's water/wetland resources. In following its program directive, the Florida Unit has developed a research program that addresses management issues with approaches spanning species to ecosystem perspectives. Specifically, this Unit conducts detailed investigations of aquatic-terrestrial ecosystem interfaces and their component fish and wildlife resources.

Between 1979 and 2021, over 325 projects totaling more than $60 million were funded through the Unit. These projects covered a wide variety of fish, wildlife, and ecosystem subjects and have involved over 50 line, affiliate, and adjunct faculty members as principal and co-principal investigators. Unit staff have their own research projects, which accounted for about 1/3 of the total effort. Projects associated with the Unit have resulted in over 430 publications, 125 technical reports, 108 theses and dissertations, and 238 presentations. Cooperation has been the Florida Unit's strength. As a Cooperative Research Unit of the U.S. Geological Survey, it serves as a bridge among the principal cooperators, such as the University of Florida, the Florida Fish and Wildlife Conservation Commission (FFWCC), the U.S. Geological Survey (USGS), the U.S. Fish and Wildlife Service (FWS) and the community of state and federal conservation agencies and non-governmental organizations. Evidence of this role is the Unit's funding which has included contributions from FFWCC, 12 BRD research labs and centers, 12 offices within the USFWS Southeast Region, the University of Florida, U.S. Army Corps of Engineers, U.S. Navy, U.S. Department of Agriculture, U.S. Air Force, U.S. National Park Service, Environmental Protection Agency, St. Johns River Water Management District, South Florida Water Management District, U.S. AID, World Wildlife Fund, The Nature Conservancy, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, BRD, Florida Wildlife Federation, National Audubon Society, Florida Alligator Farmers' Association, American Alligator Farmers' Association, Florida Fur Trappers' Association, and other private contributions. Many Unit projects involve multiple investigators from several agencies. This cooperative interaction stimulates continuing involvement of funding sources, provides for student contacts with potential employers and agency perspectives, and directs transfer and application of research results.

UNIT COORDINATING COMMITTEE

Scott Angle Vice President for Agriculture and Natural Resources, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida.

Thomas Eason Assistant Executive Director, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida.

Barry Grand Supervisor, Cooperative Research Units, U.S. Geological Survey, Auburn, Alabama.

Jonathan Gassett Southeastern Field Representative, Wildlife Management Institute, Georgetown, Kentucky.

David Viker Regional Refuge Chief, U.S. Fish and Wildlife Service Southeast Region, Atlanta, Georgia.

BIOGRAPHICAL PROFILES OF UNIT SCIENTISTS

Abby Powell – Unit Leader, Courtesy Professor, Department of Wildlife Ecology and Conservation and College of Natural Resources and the Environment at the University of Florida. Dr. Powell is an avian ecologist, with research interests in population and movement ecology of birds, including but not limited to endangered and threatened species. Her work is directly related to conservation and management issues and includes breeding and overwintering biology and habitat use, as well as migration ecology.

Raymond R. Carthy – Assistant Unit Leader, Courtesy Assistant Professor, Department of Wildlife Ecology and Conservation and College of Natural Resources and the Environment at the University of Florida. Dr. Carthy's research centers on the ecology of endangered species, including reproductive ecology and physiology of coastal and wetland herpetofauna, with a current focus on marine and freshwater turtles. He is also involved in research on threatened upland species, conservation management-oriented studies, and the Program Director/Wildlife Lead for the UF Unmanned Aircraft Systems Research Program.

Conor McGowan – Assistant Unit Leader, Courtesy Associate Professor, Department of Wildlife Ecology and Conservation and College of Natural Resources and the Environment at the University of Florida. Dr. McGowan's research and teaching interests are in decision support science (especially endangered species decision making), population dynamics, predictive modeling of species status, harvest decision modeling, and quantitative methods for population assessment.

Andrew Carlson – Assistant Unit Leader, Courtesy Assistant Professor, Fisheries and Aquatic Sciences at the University of Florida. Dr. Carlson explores fisheries as ecosystems, human systems, and coupled human-natural systems. From sport fish to imperiled species, his lab studies fishes and their habitats to develop strategies for sustaining fish production and biodiversity, particularly amid stressors such as land-use change, species invasion, and groundwater withdrawal. He also studies other aquatic organisms, human systems, and coupled human-natural systems to design aquatic resource management approaches that incorporate perspectives of diverse user groups.

COOPERATIVE UNIT PERSONNEL

Ben Kahler – Research Administrator, Florida Cooperative Fish and Wildlife Research Unit, Department of Wildlife Ecology and Conservation, University of Florida. Responsible for administrative details of annual research program including research work orders, contracts and grants within University, fiscal reports, budgets, travel, purchasing, payables, vehicles (State/Federal), website, and other related functions.

Lisa Burnett – Administrative Support Assistant, Florida Cooperative Fish and Wildlife Research Unit, Department of Wildlife Ecology and Conservation, University of Florida. She is primarily responsible for purchasing card and travel processes in the University financial system, and the tracking and recording spent funds on all grants and state funds. She also handles federal vehicles and helps with general office procedures.

New Unit quarters at 2295 Mowry Road, University of Florida. Photo by Ray Carthy and Andrew Ortega using a UAS (drone).

COOPERATORS

University of Florida
Robert Ahrens
Mendy Allen
Micheal S. Allen
Christine Angelini
Alan B. Bolten
Rena Borkhataria
Cameron Carter
Bon A. Dewitt
Catherine Eastman
Robert Fletcher
Peter Ifju
Steven Johnson
Frank Mazzotti
Robert McCleery
Debbie Miller
Holly Ober
Madan Oli
Todd Osborne
Marcus Lashley
Bill Pine
Christina Romagosa
Katie Sieving
J. Perran Ross
Taylor Stein
Hannah Vander Zanden
Benjamin Wilkinson
Blair Witherington

Florida Fish and Wildlife Conservation Commission
Tyler Beck
Janell Brush
Robin Boughton
Matt Chopp
Andrew Cox
Jason Dotson
Michelina Dziadzio
Sarah Funck
Ryan Hamm
Tomo Hirama
Alyssa Jordan
Catherine Kennedy
Gil McRae
Karl Miller
Bradley O'Hanlon
Raya Pruner
Erin Ragheb
Amy Schwarzer
David Steen
Eric Suarez
Robin Trindell
Chris Wynn

U.S. Geological Survey
Gretchen Anderson
Nick Aumen
Michael Cherkiss
Andrea Currylow
Austin Fitzgerald
Brian Folt
Fred Johnson
Jillian Josimovich
Kristen Hart
Margaret Lamont
James Lyons
Julien Martin
Clinton Moore
Melia Nafus
Katherine O'Donnell
Robert Reed
Charlotte Robinson
Ken Rice
David Smith
Anna Tucker
Amy Yackel-Adams

U.S. Fish and Wildlife Service
Nathan Allan
Sean Blomquist
Laura Brandt
Billy Brooks
Kathleen Burchett
Lew Coggins
Victor Doig
Victoria Garcia
Rebekah Gibble
Jeff Gleason
Andrew Gude
Marla Hamilton
Dave Hewitt
Kate Healy
Chuck Hunter
Todd Jones-Farrand
Kevin Kalasz
Adam Kaeser
Patty Kelly
Joyce Kleen
Lourdes Mena
Joyce Palmer
Erin Rivenbark
Sandra Sneckenberger
John Sweka
Paul Tritaik
Randy Wilson
Larry Woodward

National Park Service
Tylan Dean
Bryan Falk
Jennifer Ketterlin
Donna Shaver

U.S. Army Corps of Engineers
Andy LoShiavo
Melissa Nasuti
Jenna May

National Oceanic and Atmospheric Administration
Joe Aufmuth
Nick Farmer

Conservancy of Southwest Florida
Ian Bartoszek

Florida Coastal Conservancy
Jessica Swindall

Florida Department of Environmental Protection
Keith Morin
Donald Forgione

Florida State University
Mariana Fuentes

South Florida Management District
LeRoy Rodgers
Zach Welch

St. Johns Water Management District
Dianne Hall

City of West Palm Beach
David Witmer
Melissa Tolbert

City of Gainesville
Geoff Parks
Linda Demetropoulos
Sally Wazny

Alabama Department of Conservation and Natural Resources
Roger Clay

Delaware State University
Dewayne Fox

University of Georgia
Bryan Nuse

University of North Carolina, Chapel Hill
Ken Lohmann

Texas A&M University
Michael Marshall

RESEARCH PERSONNEL

(Names in red are supervised by Powell, Carthy, and/or McGowan)

Post-Doctoral Associates:

Brian Folt, Ph.D.
Advisor: Conor McGowan
Research: Gopher tortoise range-wide population viability modeling

Caroline Poli, Ph.D.
Advisor: Robert Fletcher
Research: Spatial ecology and population biology of snail kites

Ellen Robertson, Ph.D.
Advisor: Robert Fletcher
Research: Snail kite monitoring of population demographics; exploring senescence and other aspects of survival

Paul Taillie, Ph.D.
Advisor: Robert McCleery
Research: Affects of global change on priority wildlife species and biodiversity

Dustin Welbourne, Ph.D.
Advisor: Christina Romagosa
Research: Python prey and Everglades food web networks

Krystan Wilkinson, Ph.D.
Advisor: Bill Pine
Research: Informing Gulf Sturgeon population status and trends

Graduate Students:

Trenton Aguilar
Degree: Ph.D., Fisheries and Aquatic Sciences
Graduation Date: May 2023
Research: Human impacts on endangered sea turtles along the Florida coast
Advisor: Raymond Carthy

Carson Arends
Degree: M.S., Department of Biology
Graduation Date: August 2021
Research: Habitat partitioning of sea turtle species at a temperate foraging ground
Advisor: Hannah Vander Zanden

Nichole Bishop
Degree: Ph.D., Interdisciplinary Ecology
Graduation Date: May 2021
Research: Nutritional ecology of sea turtles
Advisor: Raymond Carthy

Alexis Cardas
Degree: M.S., Wildlife Ecology & Conservation
Graduation Date: May 2021
Research: Impacts of translocation on a cooperatively breeding bird in the Ocala National Forest
Advisor: Abby Powell

Daniel Catizone
Degree: M.S., School of Natural Resources and the Environment
Graduation Date: May 2021
Research: Ecology of diamondback terrapins
Advisor: Christina Romagosa

Keara Clancy
Degree: M.S., Wildlife Ecology and Conservation
Graduation Date: Aug 2022
Research: Tegu live and camera trap assessments
Advisor: Christina Romagosa

Natalie Claunch
Degree: Ph.D., School of Natural Resources and the Environment
Graduation Date: August 2021
Research: Invasive reptile physiology and management
Advisor: Christina Romagosa

Scott Eastman
Degree: M.S., School of Natural Resources and the Environment
Graduation Date: August 2020
Research: Effects of climate change and coastal management on the reproductive success of marine turtles
Advisor: Raymond Carthy

Alfredo Gonzalez
Degree: M.S., Wildlife Ecology and Conservation
Graduation Date:
Research: Ecology of the endangered Snail Kite
Advisor: Robert Fletcher

Chris Gulick
Degree: Ph.D., Wildlife Ecology and Conservation
Graduation Date: May 2024
Research: Survival and movement of colonial waterbirds in Mobile Bay
Advisor: Abby Powell

Madison Harman
Degree: M.S., Wildlife Ecology and Conservation
Graduation Date: December 2022
Research: Invasive reptile diet, parasites, and life history
Advisor: Christina Romagosa

Kodiak Hengstebeck
Degree: Ph.D., School of Natural Resources and the Environment
Graduation Date: December 2023
Research: Evolutionary and ecological Impacts of snake invasions
Advisor: Christina Romagosa

Richard Herren
Degree: Ph.D., Wildlife Ecology and Conservation
Graduation Date: May 2020
Research: Composition, distribution and ecology of Nature Coast sea turtle assemblage
Advisor: Raymond Carthy

Brian Jeffrey
Degree: Ph.D., Wildlife Ecology and Conservation
Graduation Date: May 2023
Research: Impacts of climate on Snail Kite demography
Advisor: Rob Fletcher

Philipp Maleko
Degree: M.S., School of Natural Resources and the Environment
Graduation Date: May 2021
Research: Breeding Biology of Nordmann's Greenshank and Common Redshank in Eastern Russia
Advisor: Abby Powell

Stephen Parker
Degree: Ph.D., School of Forest Resources and Conservation
Graduation Date: May 2024
Research: Informing Gulf Sturgeon population status and trends
Advisor: Bill Pine

Arianna Paul
Degree: M.S., Wildlife Ecology and Conservation
Graduation Date: May 2021
Research: Evaluating apple snail and Snail Kite habitat management strategies
Advisor: Christina Romagosa

Caroline Poli
Degree: Ph.D., School of Natural Resources and the Environment
Graduation Date: August 2020
Research: Spatial ecology and population biology of snail kites
Advisor: Robert Fletcher

Katrina Rossos
Degree: M.S., Wildlife Ecology and Conservation
Graduation Date: May 2021
Research: Natural resources communication (non-thesis)
Advisors: Raymond Carthy

Diego Juarez Sanchez
Degree: Ph.D., Wildlife Ecology and Conservation
Graduation Date: December 2022
Research: Python prey species composition sampling
Advisor: Christina Romagosa

Rachel Smith
Degree: Ph.D., School of Natural Resources and the Environment
Graduation Date: August 2023
Research: Effectiveness and feasibility of sensory-based bycatch reduction technology to reduce sea turtle entanglement in Florida trap pot fisheries
Advisors: Raymond Carthy

Molly Tuma
Degree: M.S., Wildlife Ecology and Conservation
Graduation Date: May 2020
Research: Survival, site fidelity, and movement of shorebirds in the Southeastern U.S
Advisor: Abby Powell

Natalia Teryda
Degree: Ph.D., School of Natural Resources and Environment
Graduation Date: August 2022
Research: Sea turtle population distribution and abundance
Advisor: Raymond Carthy

Bradley Udell
Degree: Ph.D., Wildlife Ecology and Conservation
Graduation Date: August 2020.
Research: Monitoring, predicting, and analyzing invasive species management decisions
Advisor: Christina Romagosa

Josh Vine
Degree: Ph.D., School of Natural Resources and the Environment
Graduation Date: May 2024
Research: Informing Gulf Sturgeon population status and trends
Advisor: Bill Pine

Ke Zhang
Degree: Ph.D., Wildlife Ecology and Conservation
Graduation Date: May 2024
Research: Survival and movement of colonial waterbirds in Mobile Bay
Advisor: Abby Powell

ACRONYMS

CRU	Cooperative Research Units, U. S. Geological Survey
ESA	Endangered Species Act
IFAS	Institute of Food and Agricultural Sciences, University of Florida
FFWCC	Florida Fish and Wildlife Conservation Commission
FWRI	Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission
LRMS	Land Remote Sensing Program
NCBS	Nature Coast Biological Station, University of Florida
NERR	National Estuarine Research Reserve
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NSF	National Science Foundation
NWR	National Wildlife Refuge
PES	Priority Ecosystems Science
RWO	Research Work Order
SESC	Systems Engineering Services Corporation
SFWMD	South Florida Water Management District
SFRC	School of Forestry Resources and Conservation
SNRE	School of Natural Resources and Environment, University of Florida
UF	University of Florida
UAS	Unmanned Aircraft Systems
USACOE	United States of America Army Corps of Engineers
USFWS	U. S. Fish and Wildlife Service
USGS	U. S. Geological Survey
WCS	Wildlife Conservation Society
WEC	Department of Wildlife Ecology and Conservation, University of Florida
WMI	Wildlife Management Institute

CURRENT RESEARCH PROJECTS

Florida scrub-jay with Alexis Cardas in Ocala National Forest. Photo by Alexis Cardas.

Impacts of translocation on a cooperatively breeding bird in the Ocala National Forest

Investigators: Abby Powell, Karl E. Miller
Student: Alexis Cardas, M.S., WEC
Duration: August 2017 – May 2021
Funding Agency: FFWCC
In-Kind Support: FFWCC, FWRI

Translocation has been considered as a conservation tool to increase the population numbers of Florida scrub-jays, especially in areas that have been recently restored, and where isolated populations reside and are unlikely to increase naturally through dispersal. The majority of research has focused on the success at recipient sites, not the impacts associated with the donor population. Ocala National Forest is home to the largest remaining population of Florida scrub-jays and serves as the donor site for translocations. As the goal of any translocation is to impact the species population positively, it is imperative that the costs to the donor population are minimized. We focused on potential impacts on the donor population by monitoring nest success and productivity to determine whether the removal of helpers from family groups of Florida scrub-jays is a valid option for future translocations. We removed a subset of helpers from family groups for translocation January-July of 2018 and 2019. We monitored three categories of family groups: no helpers (n = 59), helpers (n = 34), and helpers removed (n = 10). We recorded nest success, mass of nestlings at age day 11, and time spent provisioning (recorded by nest cameras). We found no significant difference in nestling mass between groups (no helpers and helpers present). The best-supported model in predicting daily survival rates included the additive effects of linear date within breeding season and year. We found little support for group size (helper, no helper) as a predictor of daily survival rate. Our results suggest that the presence of non-breeding helpers has less of an effect on nestling mass, productivity, and nest success than the factors associated with time and that removing helpers is a viable option for future translocations of Florida scrub-jays. In addition to concurrent research at the recipient sites, this will be an important first step towards initiating a statewide translocation protocol for Florida scrub-jays.

Molly Tuma conducting a shorebird survey in the Panhandle. Photo by Laura Garey.

Survival, site fidelity, and movement of two migratory shorebirds in the Southeastern U.S.

Investigator: Abby Powell
Student: Molly Tuma, M.S., WEC
Duration: September 2017 – May 2020
Funding Agency: FFWCC and USFWS
In-Kind Support: Audubon Florida, FWCC, New Jersey Audubon Society

Populations of shorebirds are declining worldwide. The Southeastern US supports populations of as many as 39 migratory shorebird species, many of which remain in the region through the winter. However, limited research has been conducted in the region, leaving questions

regarding population demographics and threats to shorebird populations in the Southeast. Research into shorebird demography in the Southeast will inform proper management strategies for species migrating through and wintering in the region. The objectives of this study were to determine the survival, site fidelity, and movement patterns of two imperiled shorebird species that winter in the Southeast: the piping plover (*Charadrius melodus*) and the rufa subspecies of the red knot (*Calidris cantus rufa*).

We used two long-term datasets of band encounter data collected by biologists and citizen scientists to estimate survival and site fidelity for piping plovers in the Panhandle region of Florida and site fidelity and movement patterns for red knots across the Southeast. For piping plovers, we found an average annual site fidelity was 0.95, and our top survival model showed a lower survival of 0.58 (SE = 0.07, 95% CI = 0.44, 0.70) in a year with a harmful algal bloom (HAB) and 0.70 (SE=0.04, 95% CI= 0.60, 0.78) in all other years. Most plovers that encountered the HAB did not become apparent mortalities until the following spring migration, and we hypothesize that the toxin had a carry-over effect on survival, lowering body condition and becoming fatal during the stress of the northward migration. For red knots, we found an average annual site fidelity of 0.75, and we identified a common movement strategy during the nonbreeding season of birds moving between high-use sites in South Carolina, Georgia, and Florida. We also found evidence of birds moving between the Atlantic coast and Texas. The Southeastern US is an important region for nonbreeding shorebirds. Our results identify possible threats to shorebird populations in the region and show that the coastal Southeast is used by shorebirds as a complex of use sites throughout the nonbreeding season. These results will inform future management decisions for shorebirds in the Southeast.

Ke Zhang holding a tagged tricolored heron (left) and Chris Gulick holding a tagged white ibis (right). Photos by Philipp Maleko

Colonial nesting wading bird tracking and habitat use assessment

Investigator: Abby Powell
Students: Ke Zhang and Chris Gulick, Ph.D. WEC
Duration: September 2019 – December 2024
Funding Agency: USGS (RWO 307)
In-Kind Support: USFWS, Alabama Department of Conservation and Natural Resources

Additional information is needed to address information gaps for the metapopulation of several species of colonial wading birds breeding along the Alabama coast in the northern Gulf of Mexico. Specifically, there is interest in the contributions of individual nesting colonies to the metapopulation of Ardeids (herons, egrets, and ibis), daily and seasonal movements, and habitat use (i.e., foraging sites v. roosting/loafing sites v. nesting sites) to guide restoration of their populations within the coastal areas of Alabama. To enhance future restoration planning for key colonial nesting wading bird species along the Alabama coast that were injured by the Deepwater Horizon oil spill, we need to understand the extent to which declines in colonial nesting wading bird populations result from habitat limitation versus other potential population-limiting factors. Overall research objectives include determining daily and seasonal movements, home range size, and habitat use by several species of colonial-nesting wading birds (tricolored herons, little blue herons, and white ibis) in Mobile Bay, Mississippi Sound, Portersville Bay, and Perdido Bay, Alabama.

We conducted the first year of fieldwork at colonies in Mobile Bay and Portersville Bay from 25 May to 6 July 2020. We captured and tagged 26

tricolored herons and 33 white ibises, with 37 transmitters deployed on captured birds. We measured morphological characteristics of each captured bird and collected blood, feather, feces, and arthropod parasites for further analysis. Preliminary analyses indicate that after fledging, juveniles of both species disperse along the Gulf Coast. Most juveniles moved west into Mississippi and Louisiana, although some ibises moved east into Florida. Birds rarely dispersed inland, and many settled in wetlands near human-altered landscapes. Based on transmitted location data, at least 14 tagged birds are speculated to still be alive in February 2021. Agencies will use this study to develop conservation plans and preserve critical habitats to maintain wading bird populations in this region.

Red Knots and Dunlin in flight in Delaware Bay, May 2018. Photo by Molly Tuma.

Movements and overwinter survival of juvenile red knots (*Calidris canutus rufa*) in Southeastern US: Information needs for recovery planning

Investigators: Abby Powell, Jim Lyons (USGS Patuxent), Kevin Kalasz (USFWS)
Student: TBD
Duration: August 2020 – December 2024
Funding Agency: USGS (RWO 309)
In-Kind Support: USFWS

Research and conservation on red knots over the past twenty years has focused on adult birds using only a few sites, primarily in the mid-Atlantic region. However, by focusing on just one stage in their annual cycle, there is a chance that factors that are driving Red Knot populations are being missed. For example, we currently do not fully know the distribution of juvenile red knots or have estimates of their first-year survival. We need to better understand the juvenile life stage to ensure that conservation actions to recover the species are appropriately directed to the areas that have the most significant impact on population growth. We aim to identify the main area(s) in the Southeast US and Caribbean where juvenile red knots occur during their first two years of life, determine how long they survive and whether they recruit into the adult population.

We will be using multiple tracking methods that have long been used successfully to study adult red knots, including the use of coded leg flags (following the Pan-American Shorebird Protocol) and nanotags. In addition, we are proposing to use newly developed solar GPS transmitters which are now light enough for red knots, combined with a recently developed harness attachment. Location and movement data from the above three tracking methods will be imported into ArcGIS for processing of movement patterns, relation to specific sites and habitats, and evaluation of known observed threats and sources of disturbance. Population parameters will be estimated following standard methods appropriate to data type and quantity. Once we better understand the distribution of juvenile red knots, the areas they prefer, and the threats and stressors they are under, we will be able to develop management and protection measures that, when implemented, should increase recruitment into the adult population and increase the population overall. This project could provide the critical information needed to lead the species to recovery.

Philipp Maleko standing on a hummock of the Schaste Bay inland bog, scanning the surrounding landscape for signs of nesting Nordmann's Greenshank. Photo by Konstantin Maslovsky.

Filling knowledge gaps for two declining East Asian shorebirds: Nordmann's greenshank and common redshank

Investigator: Abby Powell
Student: Philipp Maleko, M.S., SNRE
Duration: January 2019 – May 2021
Funding Agency: N/A
In-Kind Support: SNRE, WCS, WEC, Russian Academy of Sciences, East Asian-Australasian Flyway Partnership

Migratory shorebird populations in the East Asian-Australasian Flyway (EAAF) are rapidly declining. Impeding conservation efforts is the inaccessibility to relevant information due to language barriers and insufficient knowledge of factors impacting breeding populations in Eastern Russia. To help address the inaccessibility issue, I collated information from > 300 publications (many in Russian) and constructed a Nordmann's greenshank (*Tringa guttifer*) species account for the Cornell Lab of Ornithology's Birds of the World (BOW) online platform. Key outcomes include descriptions of conservation issues, delineation of habitat requirements, and an outline of priorities for future research. The account also included unpublished findings from ongoing field efforts (for example, the discovery of a ground nest). As Nordmann's greenshanks are a flagship and umbrella species, informing their ecology may help conservation organizations address issues for all EAAF shorebirds.

To expand knowledge on factors impacting breeding bird populations in Eastern Russia, we conducted a breeding ecology study on common redshank (*T. totanus*) in Schaste Bay, Eastern Russia. Common redshank is an indicator species for saltmarshes and coastal meadows; thus, highlighting their conservation issues can help protect those ecosystems and other wetland-nesting shorebirds. Although field efforts were disrupted due to the Covid-19 pandemic in 2020, collaborators in Russia were still able to complete a successful field season. Throughout 2019 and 2020, we found 35 nests and remotely mapped different habitat features throughout the study site. Analyses showed nest presence was disassociated from ponds but associated with meadow habitats. Further analyses revealed that all-terrain vehicle tracks were associated with the same habitat variables as nests, suggesting a possible ecological trap for breeding birds. These results can help inform the potential designation of Schaste Bay as a regional Nature Park, a protected area designation that would allow sustainable recreation and subsistence but legally preclude excessive anthropogenic disturbance.

Juvenile green turtle. Photo by T. Aguilar.

Green turtles and vessel interactions: size class specific response ranges, interaction-likelihood modeling, and predictive population modeling.

Investigator: Raymond Carthy and Mike Allen
Student: Trenton Aguilar, Ph.D., Fisheries and Aquatic Sciences
Duration: August 2018 – August 2022
Funding Agency: NSF, University of Florida Graduate School, McKnight Doctoral Fellowship
In-Kind Support: FAS

Vessel strikes have become a greater threat as an increasing number of sea turtles around the world, and especially in Florida, are stranded (injured or killed) due to strikes by recreational or commercial vessels. For effective management strategies to be established, threats to sea turtles must be thoroughly understood. To more fully understand and thus mitigate this threat, we must study how vessel strikes with turtles occur, what may predict areas of high vessel and turtle interaction, and how growing turtle and human populations may affect this relationship in the future. I will observe how green turtles (*Chelonia mydas)* react to oncoming vessels at varying speeds by conducting observational boat surveys to measure turtle response and flight initiation distance from the vessel and comparing behaviors of turtles of different size classes. I will then create an interaction likelihood model by creating and overlaying habitat selection models for green turtles and recreational boaters in Florida coastal waters to show where these two groups are most likely to interact. Finally, I will develop a population growth model to predict how, with growing human and green turtle populations in Florida, green turtles may be affected by increasing interactions with vessels.

Daytime nesting close to waterline due to beach narrowing. Photo by S. Eastman.

Geospatial assessment of coastal armoring impacts on sea turtles in Ponte Vedra Beach, Florida

Investigator: Raymond Carthy
Student: Scott Eastman, M.S., SNRE
Duration: September 2017 – 2020

Funding Agency: Florida Department of Environmental Protection, Guana Tolomato Matanzas NERR

Florida's sandy beaches are critical nesting habitat for multiple sea turtle species, all of which are federally listed as either endangered or threatened. The cumulative effects of sea level rise, human population growth, the resulting coastal development, and the current paradigm of coastal management adaptative strategies, are all impacting the natural dynamics of our coastal beach dune processes and these rare coastal habitats. Understanding how these factors are affecting these areas and the species that reside in these habitats is critical for adaptive management practices, increased coastal resilience, and greater habitat and species protection. This study provides greater insight into the short-term variability and long-term trends in sea turtle nesting, reproductive success, and the spatial patterns of these trends on both an undeveloped beach and adjacent more heavily impacted beaches. Ponte Vedra Beach serves as a unique setting to specifically elucidate the impacts of coastal armoring on nesting sea turtles. The beaches of the Guana Tolomato Matanzas NERR are 6.8 km of undeveloped natural beaches with minimal disturbance, while a stretch of coastline to the south of the Reserve consists of extensive hardened shoreline (~5km), with constructed seawalls. Additionally, this area has an extensive dataset on nesting sea turtles. Data has been collected on nesting turtles in this area for past 29 years, spatial data (GPS) has been collected for the past 14 years, and through a collaboration with the University of Georgia, genetics data has been collected the past 4 years. Our hypothesis was that due to the development and hardened shorelines we would see a decrease in nesting numbers and reproductive success on the developed beach. Herein, we found that nesting density and nesting success was similar on both the undeveloped and developed beach, but reproductive success was reduced at the developed site, suggesting that this developed beach may be functioning as an ecological trap. Spatial patterns in nesting supported this claim that areas with increased armoring had a decrease in nesting and reproductive success. Gaining a better understanding of the spatiotemporal trends

in sea turtle nesting and reproduction in these increasingly rare undeveloped pocket beaches provides a unique opportunity to compare these trends to help discern critical factors influencing sea turtle nesting behaviors on more urbanized tracts within their range.

D. mawii hatchling in fecal collection diaper. Photo by N. Bishop.

A nutritional ecology study of *Dermatemys mawii*, a critically endangered species of freshwater turtle endemic to Central America

Investigator: Raymond Carthy
Student: Nichole Bishop, Ph.D., SNRE
Duration: December 2014 – May 2021
Funding Agency: USGS (285)
In-Kind Support: Belize Foundation for Research and Environmental Education

Dermatemys mawii is a critically endangered fresh-water turtle endemic to Central America. Captive breeding programs have been identified as an important component of conservation efforts for *D. mawii*, but relatively little is known about their biology and ecology. Diet is a primary means by which an organism interacts with its environment and is essential in understanding an organism's ecology. We are using a nutritional ecology framework to examine *D. mawii's* wild diet, digestive physiology, and microbial endosymbionts to elucidate their dietary adaptations and subsequent implications for captive and wild management. Study objectives are to (1) describe the natural diet composition of *D. mawii* given sex, age, and habitat type, (2) describe and compare age-specific differences in the digestive performance of *D. mawii*, and (3) characterize and compare the gut microflora of *D. mawii* hatchlings, juveniles, and adults. We used a dataset from specimens that identified and quantified stomach contents of 67 *D. mawii* of various age/size, sex, and habitats. The only differences in diet were due to habitat type (rivers vs. lagoons) and a large portion of the diet was dependent on wind-fall vegetation. We conducted feeding trials with yearling *D. mawii* to assess digestive performance. Finally, we collected fecal samples from all age groups of *D. mawii.* We will isolate and identify microbial communities using high-throughput sequencing analysis of 16S rRNA variable regions. Our preliminary results indicate that *D. mawii* are herbivorous as hatchlings and throughout their lives but may have differences in digestive efficiency based on size/age. Therefore, we anticipate that the relationships between digestion, retention time, food quality, and the gut microbiome will be unique for *D. mawii* given they are the only herbivorous fresh-water turtle known that does not undergo an ontogenetic dietary shift. Knowledge gained from our research will address long-term conservation goals by contributing to our understanding of the biology and ecology of *D. mawii* and by informing husbandry practices for captive breeding management in assurance colonies and head-starting programs.

Release of juvenile green turtle after tagging, measuring, and tissue sampling. Photo by R. Herren.

Green turtle spatial distribution, demographics, and movements in the Northeastern Gulf of Mexico

Investigators: Raymond Carthy
Student: Rick Herren, Ph.D., WEC
Duration: September 2016 – Present
Funding Agency: NCBS, Sea Turtle Conservancy
In-Kind Support: Sea Turtle Conservancy

Historical, anecdotal and published accounts suggest that the northwest coast of Florida's peninsula is an important developmental foraging ground for sea turtles. The purpose of this study is to elucidate the spatial distribution and abundance of juvenile green turtles in the Big Bend, describe their demographics, and understand their seasonal movements at three separate foraging areas.

Region-wide vessel surveys were completed in fall 2019. We surveyed 172 transects perpendicular to the coast that averaged 7.3 km in length and covered approximately 1,200 km of seagrass habitat. This data is being included in an abundance model to correct for detectability. The region-wide surveys have led to the direct identification of important sea turtle "hotspots."

To date, 114 green turtles have been captured at hotspots ranging in size from 27.8 cm to 78.7 cm straight carapace length (SCL). The percentage of green turtles with the tumor disease fibropapillomatosis was 56%. Blood or tissue samples were taken from 106 turtles for mtDNA analysis, and plasma samples were taken from 72 turtles for sex determination analysis. We attached 13 Argos satellite transmitters and 10 GPS transmitters to juvenile green turtles in fall 2019 and fall 2020. Many of the turtles are still transmitting data, so a final analysis of overwintering range and interactions between movements, water temperature, and depth is expected to be completed in summer 2021. The comparison between resins was completed, and a publication is currently in prep.

This study will lead to a better understanding of the distribution of sea turtles in this region over space and time. The results are important long-term measures given concerns over vessel strikes, harmful algal blooms, climate change and the global loss of seagrass beds. They can also be valuable decision-making tools for establishing marine protected areas, understanding human impacts and generating new questions for further research. The results from this study may be particularly useful for detecting the effects of climate change because the region lies near the boundary between a temperate and subtropical climate that is likely to shift northward in the future.

Great egret at Cedar Key. Photo by Katrina Rossos.

Natural resources communication

Investigators: Raymond Carthy
Student: Katrina Rossos, M.S., WEC
Duration: 2019 – 2021
Funding Agency: WEC
In-Kind Support: WEC

The reach and impact of scientific research can be enhanced through effective science communication. Ecological research is only as effective as it is understood, and while scientists successfully communicate research with colleagues, many fall short when it comes to informing the public in an accurate, clear manner. A science communicator must understand fundamentals, methodologies, results, and impacts of scientific research to communicate it to the public. Likewise, a science communicator must know how to explain the complexities of the research into a parboiled synopsis that is easy for a lay person to grasp. By learning the concepts behind ecological work, I strive to become a better science communicator, discussing the values of the natural world to the public and the implications of ecological research in a way that general audiences can comprehend. A lot of ecological research informs policy regarding wildlife, fisheries, and natural resource

management, state and federally protected areas, species protections, and restrictions on anthropogenic effects such as pollution, habitat fragmentation, and deforestation. In turn, how the general public views wildlife management and conservation and research can shape that policy, making accurate science communication so vital.

Over the past year, I expanded my writing experience by contributing to federal agencies. I learned how to research and write a management plan for the USFWS. I wrote a Visitor Management Plan for a parcel of land within the Cedar Keys NWR, working with the deputy manager of the refuge to meet all their needs. The plan included a pollinator and bird monitoring and management proposal and a trail system and observation decks, environmental education plan, and new boat launch. Also in 2020, I joined the National Association of Science Writers and wrote an article for them on a recently discovered, exceptionally rare, migration pattern of the long-legged buzzard. I am currently investigating the socio-ecological dynamics of Assateague Island's wild horse population and working on observing and communicating field-work methodologies and techniques to better understand how scientists collect and review data.

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Green fishing light used on nets and lines as a Bycatch Reduction Technology (BRT). Photo by J. Senko.

Approaches to understanding and mitigating sea turtle bycatch in Florida trap fisheries

Investigator: Raymond Carthy
Student: Rachel Smith, Ph.D., SNRE
Duration: September 2019 – 2023
Funding Agency: The Walt Disney Company
In-Kind Support: Inwater Research Group, Arizona State University, FFWCC

Incidental bycatch in fisheries is considered to be the most widespread and urgent threat to sea turtle populations. Still, bycatch rates have been difficult to estimate, given the diversity of fisheries, gear types, spatial and temporal variation in fishing effort, and uncertainty resulting from large data gaps. Specialized attention towards a particular derivative of bycatch, entanglement, is warranted. In a recent survey of sea turtle experts, 84% indicated that entanglement in fishing gear could be causing population-level impacts. One such example is the commercial spiny lobster fishery in Florida and its associated entanglement interactions with sea turtles.

Loggerhead sea turtles (*Caretta caretta*), green turtles (*Chelonia mydas*), and leatherback turtles (*Dermochelys coriacea*) migrate to Florida annually to nest. As such, reproductive females spend several months each summer in nearshore waters, overlapping with the distribution of commercial spiny lobster and recreational blue crab and stone crab pot traps. All sea turtle species except for the Australian flatback have become entangled in trap pot gear in Florida, and the threat these fisheries pose is likely underreported.

There are 4 specific objectives of this study: 1) Create a threat assessment characterizing the threat that lobster trap entanglement poses to sea turtle populations using a mixed-methods approach of biological data and traditional ecological knowledge (TEK); 2) Interview key informants and survey the entire commercial lobster fleet to understand barriers and incentives for adoptability of sensory-based bycatch reduction technology (BRT) in the fishery, 3) Conduct experiments to study the behavioral response of spiny lobster to the presence of BRT 4) Conduct experiments to study the behavioral response of loggerhead and green sea turtles to the presence of BRT.

View of a leatherback surfacing nearby the research boat in Santa Teresita, Samborombon Bay, Argentina. Image taken with UAS Mavic 2 Pro while conducting a survey. Photo by N. Teryda.

Identifying strategies for conservation of the marine turtles in Argentina and Uruguay, South America.

Investigator: Raymond Carthy
Student: Natalia S. Teryda, Ph.D., SNRE
Duration August 2018 – August 2023
Funding Agency: WEC, SNRE

Leatherback and green sea turtle populations have decreased exponentially across the world, leading to their current global protected status. One of the main reasons for their decline is interactions with fisheries and habitat degradation. Due to their complex life cycle, research and further conservation efforts have relied on technological advances to gain an understanding of their population and vulnerabilities in foraging areas like Argentina and Uruguay. Better understanding of habitat use and population densities, as well as their interaction with fisheries, is essential for the conservation of these species. My research aims to develop and consolidate a holistic approach to the analysis and conservation of marine turtles and their coastal habitats and test the use and efficacy of UASs. Efforts will be directed to the investigation of two endangered species with the application of new technologies, the reinforcement of regional conservation and management networks, and integration of these components with community capacity building.

During March 2020 I conducted the second part of a pilot study to develop and test survey methodologies. I tested the methodology adapted after the first field trial of aerial surveys in Argentina. I evaluated the efficiency and detection capability of UAS as a surveying method in the water for live animals. I was able to complete 17 survey sectors, recording 75 turtles and 10 *Fransiscana* dolphins (endemic endangered species). The pilot study enabled me to test the proposed methodology and develop alternative ones for specific environmental (i.e., wind speed) and surveying parameters (i.e., flight pattern, height and speed). Currently, I am working on analyzing the data and incorporating it to a spatial model. With these protocols tested, I will implement the methodology in a Marine Protected Area in Uruguay and apply it to a different habitat and species. As the COVID-19 pandemic restricted travel, my plan to travel to Uruguay was moved from Nov – 2020 to Nov – 2021. This project will advance traditional surveying techniques by applying new technologies and will provide comprehensive and much-needed information for successful sea turtle conservation.

Species Status Assessment prioritization and science needs

Investigator(s): Conor McGowan
Post-Doc: Ashley Goode
Duration: July 2020 – July 2023
Funding Agency: USFWS/USGS (RWO 314)
In-Kind Support: Personnel provided by USFWS

The USFWS has a significant workload for conducting species status assessments (SSAs) to support listing, reclassification, and recovery planning decisions under the Endangered Species Act (ESA). There are hundreds of pending decisions that require a science-based assessment of the species status before making ESA decisions.

We will work with the service to devise an objectives hierarchy and tradeoffs analysis to develop a prioritization system for identifying which SSAs tasks require the most attention or effort, and when to do them. We will develop an objectives hierarchy, identify measurable attributes and design a multi-criteria decision analysis value function to rank the >300 SSA projects in the Southeast Region.

We sought and hired a postdoc in 2020 to fill the position and initiated meetings with management

partners. We are taking a standard PROACT structured decision-making approach to solve this problem and are guiding the USFWS through the decision analysis steps. As a result of this work, the USFWS redesigned their 5- and 10-year work plans for scheduling SSA work.

Modeling tools for Species Status Assessments

Investigator(s): Conor McGowan
Post-Doc: Ashley Goode
Duration: July 2020 – July 2022
Funding Agency: USFWS/USGS (RWO 315)
In-Kind Support: Personnel provided by USFWS

The USFWS has a significant workload for conducting species status assessments (SSAs) to support listing, reclassification, and recovery planning decisions under the ESA. In many cases, they lack the expertise or the tools to conduct the necessary scientific analyses, and they need support in developing generalizable and transferrable tools to facilitate SSA analyses.

We will work with the service to devise modeling tools that support SSA completion and work with the service specifically on two SSAs, the Texas spot-tailed earless lizard and the round-tailed chub. We will develop methods to analyze species status with sparse data, focusing on the utility of occupancy modeling and expert elicitation methods. We sought and hired a postdoc in 2020 to fill the position, and we initiated meetings with the management partners. The tools we develop should be applicable to a variety of future SSAs with sparse data.

Eastern black rails in a coastal marsh. Photo by Christy Hand.

Puerto Rican boa/eastern black rail Species Status Assessments

Investigator: Conor McGowan
Duration: July 2020 – October 2022
Funding Agency: USFWS/USGS (RWO 317)
In-Kind Support: Personnel provided by USFWS

Assessing the status of a species and predicting its future trajectory is a vital part of classification decisions under the ESA. For example, the Puerto Rican boa, an island endemic, was scheduled to undergo a 5-year review and potential reclassification for listing. The eastern black rail (added in a later modification) was proposed for listing. Even though the decision at hand was different, the information needs of the decision makers were similar: a status assessment of the current population and predictions of future trajectories. For each species, we worked with the USFWS to devise data analyses and conduct expert elicitation workshops to inform modeling. These analyses and modeling exercises directly informed the classification decisions (i.e., does the species need protection under the ESA).

The objectives of this research were to develop a PVA model to predict future abundance, population growth, and extinction risk for each species and conduct sensitivity analyses to assess the importance of uncertain parameter effects on decision making. We worked with the USFWS, state agencies, and researchers to design the analysis and projection models. For black rail, we completed dynamic occupancy analyses in the UnMarked package and designed a future status simulation model in R. We also completed the boa modeling in R, and we designed a Shiny App to facilitate manager interactions with the model. We presented results at recommendation team meetings for the rail in 2019 and for the boa in August 2020.

Our model for Puerto Rican boa predicted that the population is likely stable or increasing despite expected further urbanization. Our modeling for black rails predicted steep declines for black rails in the coming decades unless significant conservation management was enacted. As a result, of this work, the eastern black rail was listed as Threatened under the ESA and the Puerto Rican boa will potentially be delisted. These

management actions have significant implications for wetland management in the southeastern US and for forest management in Puerto Rico.

Alligator snapping turtle Species Status Assessment

Investigator(s): Conor McGowan
Duration: July 2020 – October 2022
Funding Agency: USFWS/USGS (RWO 318)
In-Kind Support: Personnel provided by USFWS

Assessing the status of a species and predicting its future trajectory is a vital part of classification decisions under the ESA. The alligator snapping turtle is a widespread species that is very difficult to monitor and assess and predicting its future status offers significant challenges. We worked with the USFWS to devise data analyses and conduct expert elicitation workshops to inform modeling. These analyses and modeling exercise directly informed the classification decision. We developed a PVA model for alligator snapping turtle to predict future abundance, population growth, and extinction risk under a variety to different threats and conservation actions and conduct sensitivity analysis to assess the importance of uncertain parameters effects on decision making.

Our modeling predicted steep declines for alligator snapping turtles in the coming decades unless significant conservation management was enacted. Declines were most strongly influenced by threats. As a result, the USFWS is deciding whether to list the species under the ESA. These management actions have significant implications for wetland management in the southeastern US. Much of the work on this project was completed prior to 2020. We worked with the USFWS, state agencies and researchers to design the analysis and projection models. The modeling was completed in R, and we attended and presented our results at the recommendation team meeting in 2019. The decision for this species has not been finalized, and we continue to work with the USFWS on understanding the results.

Gopher tortoise being weighed as part of mark-recapture study. Photo by Francesca Erickson.

Range-wide population viability analysis for the gopher tortoise

Investigator: Conor McGowan
Post-doc: Brian Folt
Duration: July 2020 – June 2021
Funding Agency: USFWS/TAMU AgriLife Research

The Gopher Tortoise (Gopherus polyphemus) is currently listed as Threatened under the Endangered Species Act in the western portion of their range (West of the Mobile Delta) and is currently a candidate for listing in the remainder of the species' range. To complete the decision process and arrive at a defensible decision, the USFWS needs first to complete a species status assessment (SSA), and part of that assessment entails analysis of existing data sets and predictive modeling about population trajectories and future abundance. We will work with the service to devise a population viability model that support SSA completion and work with the service specifically on the gopher tortoise SSA. Our work will focus on developing a spatially implicit population model that incorporates the probable effects of sea-level rise and climate change on population viability. We will estimate future gopher tortoise population growth and extinction probability while testing the sensitivity of predictions to uncertainty in model parameters and inputs.

In 2020, we sought and hired a postdoc to fill the position and initiated meetings with the management partners. The postdoc made quick and significant progress on developing the model

and providing needed decision support to the USFWS. The model simulated populations in R, accounts for population loss due to sea-level rise and urbanization and expected demographic changes due to increasing temperatures. Results, at this time, are preliminary and incomplete. The service will use the results of the work to directly inform the listing decisions for Gopher Tortoise throughout its range. Further, the tools we develop should apply to various future SSAs with climate and temperature correlated demographics. The final decision is pending and is expected in the late summer of 2021.

A nestling Snail Kite that is ready for tagging. Photo by Caroline Poli.

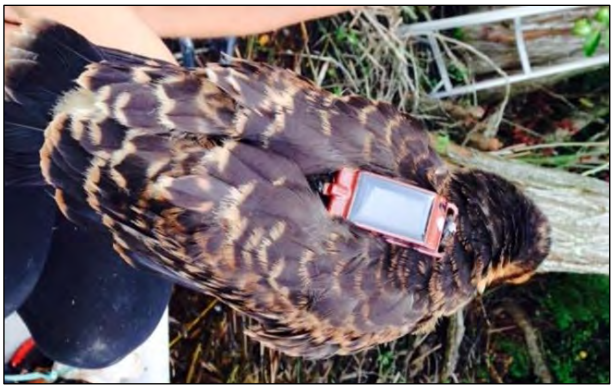
Identifying the role of hydrology and prey for a key bottleneck in the recovery of snail kites in the Greater Everglades

Investigator: Robert Fletcher
Student: Caroline Poli, Ph.D., SNRE
Duration: September 2015 – May 2020
Funding Agency: Greater Everglades Priority Ecosystem Science (RWO 297)

Survival of snail kites during the first year, post-fledging, is important to population growth and therefore recovery of the species; however, monitoring data indicate that 1st year survival varies widely between years. Young snail kites remain near the nest site for the first 30-60 days after fledging and the risk of mortality is highest within 45 days of fledging. Thus, it is likely that variability in 1st year survival is driven by attributes of the natal site such as hydrology and prey availability. Although ongoing monitoring of snail kite demography allows for the estimation of survival at the annual time scale, our capacity to understand and predict survival at shorter timescales is currently limited. Fine-scale (daily, hourly) tracking information that links movement patterns of snail kites with hydrology and prey availability at each occupied site will allow us to develop effective management guidelines to promote 1st year survival of snail kites.

Our objectives are to 1) quantify post-fledgling snail kite movements and 1st survival across the Greater Everglades Ecosystem, 2) link movements and survival to variation in hydrology and measures of prey resources, and 3) develop models that help determine key targets for water management in the Greater Everglades Ecosystem.

In 2016-2020 we deployed GPS tracking devices on snail kites close to fledging age. Tags recorded 12 locations/day for up to 1 year and downloaded data remotely through cellular networks. We estimated movement trajectories and predicted movement behaviors at the nest, during forays, and during emigration using covariates related to snail density (measured through in-situ sampling) and hydrology (extracted from online databases such as EDEN). Data confirm that birds spend the first 30-60 days post-fledging within 1-km of the nest site. Birds that dispersed from the nest site made looping foray flights lasting 1-5 days each, then returned to the original nest site. Hydrology was a driver of movement patters, but snail density as measured was not. Models will be disseminated to agencies and managers to help determine key targets for water management in the Greater Everglades Ecosystem. In particular, identifying potential thresholds in hydrology that can explain changes in movement behaviors.



Nestling snail kite with solar-powered GPS-GSM tag, August 2016. Photo by Alfredo Gonzalez.

Evaluating the movement patterns and survival of juvenile Everglade snail kites (*Rostrahamus sociabilis plumbeus*) at Lake Okeechobee

Investigator: Robert Fletcher
Student: Alfredo Gonzalez, M.S., WEC
Duration: September 2019 – September 2024
Funding Agency: USACOE

Hydrologic alterations, degradation, and loss of wetland habitat are all factors that could have substantial effects on snail kite populations, including the survival of juveniles. Juvenile survival is a key factor for the recovery of the species, and monitoring data show that it is widely variable over time and across wetlands. Because current monitoring of snail kite demography only allows juvenile survival to be estimated yearly, our understanding of this factor and ability to provide effective management guidelines is limited. Fine scale tracking information would allow us to better understand juvenile survival and movement, with the goal of providing information to inform management and promote 1st year survival of snail kites. Our objectives are: 1) to determine causes of mortality in juvenile snail kites, 2) assess whether typical movement behaviors can be defined for a variety of environmental conditions, 3) to identify threats that are most important to juvenile snail kite survival, 4) to provide data on potential population sinks, and 5) to provide specific management recommendations for determining when and where to focus habitat management activities in order to increase population size through reduced mortality of young.

During the 2019-2023 breeding seasons in Lake Okeechobee, solar-powered transmitters and VHF trackers will be deployed on snail kites close to fledging age to understand fine-scale movement and real-time mortality. We will identify behavioral states based on movement data and determine whether key environmental factors can predict changes in movement behavior. We will also estimate monthly juvenile survival, map high mortality areas across the breeding range, and interpret the potential for Lake Okeechobee to act as a population source or sink. Finally, we will determine habitat use by juveniles and the times of year that pose the greatest risk to these individuals. Current work in Lake Okeechobee is ongoing. Data generated from this study will provide information needed to allow for more targeted habitat and hydrologic management aimed at increasing juvenile survival of Snail Kites. Specifically, information on whether movement behavior indicates changes in habitat quality, linking sources of mortality to variation in juvenile survival, and identifying the time windows and locations for more effective management will be of much importance.

Arianna Paul seated on an airboat. Photo by Shelby LeClare.

Evaluating apple snails and snail kite habitat management strategies

Investigator: Robert Fletcher and Christina Romagosa
Student: Arianna Paul, M.S., WEC
Duration: April 2019 – June 2021
Funding Agency: FFWCC

The snail kite (*Rostrhamus sociabilis plumbeus*) is a federally endangered, wetland-dependent raptor

that exhibits an extreme form of dietary specialization, the snail kite feeds almost exclusively on freshwater apple snails (*Pomacea* spp.). The life history strategy and demography of the snail kite is tightly linked to the dynamic environmental conditions that affect the density and availability of apple snails. Recent field observations suggest that apple snails appear to increase following wetland burning and that snail kites seem to aggregate around these recently disturbed areas. Fire management is a common conservation strategy that has known benefits for wetlands and may provide additional benefits for snail kites. Yet, the potential for fire management to enhance populations of apple snails and snail kites remains unknown. The objective of this study is to understand how the management of cattail monocultures affect apple snail populations and apple snail accessibility for snail kites.

We will assess the effects of control burns and herbicide treatments on the abundance of apple snails and relate that to foraging and demographic responses of snail kites.

Herbicide treatment followed by a controlled burn will be conducted by the Florida Fish and Wildlife Conservation Commission (FFWCC) during winter 2019-2020 on the western side of Lake Okeechobee. Snail surveys were/will be done twice pre-treatment (April-June, July-Aug 2019) and three times post-treatment (Oct 2020, March 2021, May 2021) within treatment and control areas. During each survey session, two methods will be used to detect apple snails within each sampling unit: crayfish traps and throw traps. We will also collect data on time-activity budgets of snail kites during each sampling session. We anticipate that the management technique of herbicide paired with fire management will result in the reduction of the cattail monoculture. This reduction should lead to improved habitat quality for apple snails, resulting in an increased abundance, and will also make apple snails more accessible to snail kites.

Josh Vine (left) and Stephen Parker (right) holding Gulf sturgeon. Photos by Stephen Parker and Tyler Coleman.

Informing Gulf Sturgeon population status and trends as a baseline to measure PDARP actions to promote species recovery

Investigator: Bill Pine
Student(s): Josh Vine, Ph.D., WEC; Stephen Parker, Ph.D., SFRC
Duration: August 2019 – 2023
Funding Agency: USFWS/USGS (RWOs 308 and 313)

Gulf sturgeon, *Acipenser oxyrinchus desotoi*, a large anadromous fish species currently listed as "threatened" under the Endangered Species Act, are of conservation concern in the Gulf of Mexico because of their long lifespan and slow population recovery rate. We are working with resource managers to determine Gulf Sturgeon movement patterns and estimate over-winter survival of Age-1 individuals in the Choctawhatchee River. We are also assessing Gulf of Mexico wide status in the species. We are developing tools designed to improve data collection efforts and assist resource managers with evaluating tradeoffs among management actions designed to promote Gulf sturgeon population recovery and to facilitate shared research objectives among collaborators.

In the US Gulf of Mexico, Gulf sturgeon supported a short-lived commercial fishery in the early 20th century. Despite fishery closure since 1985, the stock has not recovered. We are determining the status and basic population demographic variables to help inform decision-making for this species. We are currently using multi-state models to determine differences in mortality rates between eastern and western populations of Gulf sturgeon. We are also using a detailed data simulation

framework linked to multi-state models to inform ongoing and planned monitoring efforts for the species. During 2020 we conducted field sampling to monitor age-1 Gulf sturgeon to estimate over-winter survival in the Choctawhatchee River. We also developed and field-tested our electronic data entry system and compiled all available Gulf Sturgeon monitoring data from the past decade for integration into the Gulf sturgeon database.

Preliminary analyses from multi-state models suggest there may be high mortality rates in the western Gulf. Simulated data reveal we can successfully estimate over-winter survival given high capture probabilities and sample sizes. Five Age-1 Gulf sturgeon were captured in 2020, and their movements are currently being monitored by 15 acoustic receivers in the Choctawhatchee River. The electronic logbook and Gulf sturgeon database were successfully tested in 2020.

Our research seeks to help define future realistic population benchmarks based on Gulf sturgeon population ecology and pair these benchmarks with monitoring programs to measure population response and progress to recovery goals. In this way management actions could operate under a decision analysis framework such that if benchmarks were not met, specific research efforts or alternative management actions could be taken.

A Burmese python emerging from a gopher tortoise burrow. Photo by Kodiak Hengstebeck.

Assessing impacts of invasive pythons on gopher tortoises in Florida

Investigator: Christina Romagosa
Cooperator: Robert Reed
Student: Kodiak Hengstebeck, Ph.D., WEC
Duration: January 2016 – July 2020
Funding Agency: USGS (RWO 296)
In-Kind Support: Conservancy of Southwest Florida and Rookery Bay NERR for staff field time and research equipment

The Burmese python population is expanding from the core population in the southern Everglades. As pythons invade upland habitats, they are documented to use gopher tortoise burrows. As these interactions increase, there will be as-yet-unknown effects on the gopher tortoise and the suite of burrow-commensal vertebrates. The gopher tortoise is a species of special concern in Florida, and pythons could affect their management. Pythons could also potentially use gopher tortoise burrows as winter refugia north of their current range if burrow microclimates in those northern ranges are suitable. The study objectives are: 1) determine rates of gopher tortoise burrow use by Burmese pythons in the occupied range, 2) assess burrow selection by pythons based on burrow and habitat characteristics, and 3) assess burrow microhabitat as a suitable refuge for pythons north of their current range.

We systematically surveyed burrows using a burrow camera. Pythons detected in burrows were captured using a modified tortoise trap. We collected habitat and microhabitat data on burrows north of the current python range to compare to python-occupied burrows in SWFL. Surveys showed that pythons use both gopher tortoise and armadillo burrows, particularly in winter months. Pythons were also found to co-occupy burrows with gopher tortoises, although the potential impacts on tortoises are as-of-yet unknown. Our data suggest that pythons are selecting burrows with smaller entrance widths and burrows located in areas with dense canopy cover. We also found that burrows located north of the current python range can maintain temperatures above the presumed lethal limit for Burmese pythons during winter months. The use of tortoise burrows by pythons could affect the resident gopher tortoises, a species of special concern. If burrow microclimate north of current python range is compatible, then pythons could expand their range and overwinter in tortoise burrows.

Argentine black and white tegu in a trap. Photo by Bradley Udell.

Integrating science and management for optimal prevention and control of aquatic invasive species in the Everglades

Investigator: Christina Romagosa
Student: Bradley Udell, Ph.D., WEC
Duration: September 2015 – December 2020
Funding Agency: USGS (RWO 295)

Invasive plants and animals are a major biological and economic issue facing conservation efforts worldwide, and they are particularly problematic to conservation and restoration efforts in the Florida Everglades. Natural resource managers are tasked with finding cost effective solutions to best monitor and control invasive species when there are limited budgets and significant uncertainties in invasive species distributions and dynamics. Working closely with regulatory agencies, we are developing decision support tools that identify the optimal allocation of resources needed to meet management objectives regarding two invasive species: tegus and melaleuca. More specifically, we are developing dynamic models of population growth and spread and are combining these decision analytic approaches to predict the outcome of potential management actions, and to identify optimal management strategies. The objective of this study is to develop decision analytic support tools for the optimal control of invasive plants and animals by better understanding 1) their abundance and distribution, 2) their population dynamics and spread, and 3) the cost of efficacy of different management strategies.

We are developing methods to estimate and map the abundance of melaleuca old world climbing fern in Loxahatchee National Wildlife Refuge, and Argentine black and white tegu abundance and removal probabilities in the Greater Everglades Ecosystem. Additionally, we are developing models of population growth and spread for each species. Finally, we will combine these models with decision-analytic frameworks to determine the optimal actions to take to best meet management objectives for a limited budget. Abundance maps of melaleuca and old-world climbing fern in Loxahatchee Wildlife Refuge, and of tegus in the Southern Everglades are in development and projected to be finished in the Summer of 2020. The melaleuca dynamics model and tegu dynamics model are also both in development. Both decision frameworks are also projected to be completed by the Fall of 2020. Our decision analytic frameworks will provide managers in the greater everglades ecosystem with information and analytical tools to make more effective decisions in the control of invasive species with limited resources, thus empowering them to reduce and mitigate the biological and ecological damages of invasive species.

Color variation among ornate diamondback terrapins in St. Joseph Bay, FL. Photo by Daniel Catizone.

Ecology of diamondback terrapins in northwest Florida

Investigator: Christina Romagosa
Cooperator: Margaret Lamont
Student: Daniel Catizone, M.S., SNRE
Duration: January 2018 – December 2020
Funding Agency: USGS (RWO 303 and 306)

Diamondback terrapins, comprised of seven subspecies, range from Massachusetts to Texas

and are the only turtle to be found exclusively in coastal salt marshes. Throughout their extensive range, they face a variety of threats from human encroachment, bycatch, and road mortality. To help understand the threats these animals face, we need to first understand their populations, and whether different regions/populations face different threats. There are many gaps in our current knowledge of the 3 subspecies found exclusively in Florida. One region that has not been well studied is Northwestern (NW) Florida, and in order to ensure the populations are healthy, we need to collect demographic data in order to shed light on their status and potential threats they are facing. The primary objective of this study is to collect demographic data on diamondback terrapins in St. Joseph Bay.

We collected habitat variables (e.gs., air temperature, tide, and coastal island make up) and used these variables and occupancy modeling to help predict terrapin presence/absence from a given area. When terrapins are found, we took measurements, biological samples, GPS points at the capture location and marked individuals. Using our marked individuals, we estimated the population in the bay. We collected and tagged 466 individual terrapins comprised of adult males & females, juveniles, and hatchlings. We have estimated the population of SJB to be around 2,414, with a male-biased sex ratio of 8.9:1. We also estimated survival and probability of an individual entering the population. Preliminarily, these individuals show a preference for small coastal islands mostly comprised of spartina and shifts in their habitat use throughout the year.

Moving forward, our work is the beginning of a long-term monitoring project that will produce some of the first data on terrapins from NW Florida region. This data can then be utilized to further protect and understand terrapins in a previously unstudied portion of their range.

CT scan image of UF Florida museum specimen 185239, extreme fecal impaction of Leiocephalus carinatus*. Photo by Edward Stanley.*

Ecology, physiology and control of invasive reptiles in Florida

Investigator: Christina Romagosa
Student(s): Natalie Claunch, Ph.D., SNRE; Madison Harman, M.S., WEC; and Keara Clancy, M.S., WEC
Duration: August 2017 – July 2022
Funding Agency: USGS (RWO 302)
In-Kind Support: UF Graduate School Fellowship

More than 50 species of invasive reptiles have established breeding populations in Florida. Some appear to be increasing in population size and expanding their introduced range(s). The impacts of many of these species are unknown but may not become apparent until eradication or control is no longer economically feasible. In addition, the current demand for reptiles as pets indicates that reptile introductions to Florida are likely to continue. There is little known about how introduced species succeed during introduction and range expansion. Prevention of invasions and early eradication after introduction are the most cost-effective actions for managers. There is a need for improved screening tools that integrate information about an animal's physiological responses to the introduced environment. One objective of this study is to assess physiological metrics that are implicated in invasion success across many established and spreading reptile species.

We found that curly-tailed lizards established in a northern population in Florida had better cold tolerance than those in a southern population established around the same time. We also found that the distribution models based on information from native range only were not informative in predicting the distribution of established populations in Florida. The thermal results indicate that curly-tailed lizards may acclimate or

adapt to local thermal conditions. Information from native range distributions, typically used in invasive species screening tools, does not capture this observed plasticity. Thus, it is important to consider local adaptation and acclimation of species after establishment and integrate plasticity into screening tools.

The skull of a Burmese python from southern Florida. Photo by Kodiak Hengstebeck.

Invasive reptile adaptations and impacts

Investigator: Christina Romagosa
Cooperator: Robert Reed
Student(s): Kodiak Hengstebeck, Ph.D., SNRE; Madison Harman, M.S., WEC
Duration: September 2019 – August 2024
Funding Agency: USGS (RWO 310)

Burmese pythons have established a breeding population in southern Florida and are negatively impacting native wildlife across their range. Pythons in Florida have a broad diet, but the species composition of their prey has changed over time and differs across the landscape. Changes in life history traits of a species can result in plastic or adaptive responses such as morphological or behavioral change. The potential for rapid adaptation by an invasive species is thought to be a driving factor that can affect not only successful establishment but also proliferation. Morphological adaptations, in particular, can improve energy acquisition and aid in a species' establishment potential. Furthermore, morphology, especially of the cranium, is often linked to resource use and can be used to predict shifts in resource availability. Relating morphology to prey use over time and space can thus help predict consequences of invaders on the ecosystem and identify native animals that may be at higher risk.

The objective of this study is to assess plastic or adaptive responses by Burmese pythons to environmental change. Specifically, we will assess morphological plasticity and evaluate aspects of cranial morphology to explore any potential spatial or temporal variation. Researchers have amassed a great deal of data on Burmese pythons in Florida as well as archived specimens over the past 15 years throughout the introduced range. We will use landmark-based geometric morphometrics to evaluate the morphological plasticity of python head shape over time and space.

Relating head morphology to prey use over time and space will improve researcher's ability to predict consequences of invasive pythons on other species of concern. Additionally, it will identify native animals that may be at higher risk of python depredation in important natural areas such as Everglades National Park and Big Cypress National Preserve where Burmese pythons are continually impacting native fauna. Understanding the drivers and impacts of rapid morphological change of invasive species to introduced environments may justify intensive rapid response efforts for new species or populations before impact assessment can occur.

Carson Arends behind a loggerhead turtle (left) Loggerhead turtle (right). Photos by Joseph Alday and Dan Catizone.

Habitat partitioning of sea turtle species at a temperate foraging ground

Investigators: Hannah Vander Zanden and Margaret Lamont
Student: Carson Arends, M.S., Department of Biology

Duration: September 2019 – June 2021
Funding Agency: USGS (RWO 312)

All species of sea turtles using US waters are listed as threatened or endangered under the (US) Endangered Species Act of 1973. The northern Gulf of Mexico supports loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*) and green turtles (*Chelonia mydas*), yet few studies have been published on these assemblages. There is clear documentation of habitat overlap among the three species using satellite tracking, but little has been done to study the specific diet and microhabitat shared. The use of stable isotopes to assess trophic levels and partitioning among habitats by sympatric species has been applied in other organisms. However, these techniques have not commonly been used to assess resource partitioning among sea turtle species. This study aims to understand the diet and microhabitat use and overlap by green, Kemp's ridley, and loggerhead sea turtles in St. Joseph Bay, FL to improve management and protection decisions.

The primary objective of this study is to define habitat partitioning among sea turtles through stable isotope analyses of epidermis tissue and potential diet items. Additionally, we will compare diet and habitat use pre- and post-hurricane Michael. In each field season from 2011-2020, we captured and collected data from three species of sea turtles in St. Joseph Bay, FL. All turtles were captured between the months of March and November using a set net, dip net, or by hand. We collected epidermis tissue to be used for stable isotope analysis and conducted a basic workup to measure and tag each turtle. Additionally, we collected habitat and prey samples in 2019 and 2020 that included POM around the perimeter of the bay.

We have analyzed a total of 512 epidermis samples and 216 potential prey items for carbon and nitrogen isotope composition. Data analysis is underway. Managers and future investigators can use these results to assess resource overlap among co-occurring sea turtle species. The results may also be useful in protecting habitat and monitoring preferred prey items as well as understanding any changes that may occur following a natural disaster such as a hurricane.

White-tailed deer taken by trail camera.

Changes in mammal communities across the Greater Everglades Ecosystem

Investigators: Robert McCleery, Kristin Hart, and Paul Taillie
Duration: September 2018 – August 2021
Funding Agency: USGS (RWO 305)
In-Kind Support: Personnel provided by NPS

The invasion of Burmese pythons in South Florida has contributed to a catastrophic decline in native mammals. With no indication that the python invasion has abated, there are several critical information gaps with regards to mammals. For example, it is important to understand how mammal communities continue to change in the face of an expanding python invasive. Specifically, we would need to know 1) are communities that were once unaltered now showing declines and 2) are communities that were previously depauperate now showing signs of resilience.

We replicated and earlier study (Reichart et al. 2017) that quantified variation in mammal community composition across a gradient of python density using a combination of camera trapping and scat surveys. To measure the effects on scavenging and frugivory, we monitored bait stations with remote cameras and quantified consumption and identified the species consuming bait. Mammal species vulnerable to python predation, such as marsh rabbit and white-tailed deer, continued to decline in South Florida. Though previous studies suggest that rodents may be resistant to python predation, our results suggest these species are starting to decline after other preferred prey has been extirpated. Our work helps to reveal the full scope of the implications of invasive pythons for South Florida ecosystems.


Doris Duke Conservation Scholars Program

Investigators: Raymond Carthy, Christina Romagosa, Rena Borkhataria
Students: Meghan Beatty, Ph.D., WEC, Wes Boone, Ph.D., WEC, Julie Walker, Ph.D., SFRC, and Daniel Catizone, M.S.. WEC.
Duration: September 2013 – September 2019
Funding Agency: Doris Duke Conservation Scholars Program Partnership with UF

The annual goals of the Doris Duke Conservation Scholars Program include providing students with a better understanding of the research process, exposing them to a variety of research and field techniques, and helping to develop a deeper understanding of and appreciation for a topic of their interest through independent projects. In the summer of 2020, the sixth and seventh cohorts of scholars had to pivot to online research and internships due to the COVID-19 pandemic. The program adhered to the formula that has made it a standout among the various mentoring programs administered by the Doris Duke Charitable Foundation:

- cohorts of 4-5 undergraduate Scholars at 5 participating Universities
- guidance provided by Faculty and Graduate student mentors
- summer research experiences and development of individual research projects
- Scholars from all 5 Universities attend a Conservation Leadership Week Program at the USFWS National Conservation Training Center (cancelled in 2020 due to pandemic)
- 1- credit conservation/career focused course and bi-weekly meetings
- data analysis and preparation of abstract and poster from individual projects
- Scholars attend and present projects at a professional meeting.
- Scholars participate in 8-week paid internship with agencies

The DDCSP is enjoying continued success, with many Program alumni now enrolled in advanced degree programs or employed in natural resource conservation capacities.

Interns:

Year 1:
Alex Cronin
Nadia Kemal
Jaclyn Selden
Adreenah Wynn
Xue "Jackie" Zhang

Year 2:
Jeanette Brisbane
Megan Ely
Charmaine Pedrozo
Monica Quintiliani
Sharmin Siddiqui

Year 3:
Modeline Celestin
Camille DeJesus
Hannah Innocent
Elizabeth Sherr

Year 4:
Amy Almond
Joelle Carbonell-Bierbaum
Tre'nard Morgan
Marcela Mulholland
Camya Robinson

Year 5:
Keara Clancy
Faith Morgan
Kristina Rodriguez
Desiree Smith

Year 6:
Jacob Hornfeldt
Gabriela Obando
Eric Trotman
Herby Zephir

Year 7:
Jazmyn Broxton
Juliemar Cuevas-Hernandez
Aleidys Lopez Romero
Mariaguadalupe Vilchez

PUBLICATIONS*

Claunch, N.M., E. Stanley, and C.M. Romagosa. 2020. *Leiocephalus carinatus* (northern curly-tailed lizard). Extreme Fecal Impaction. Herpetological Review 51*:* 127.

Folt B., C.P. McGowan, D.A. Steen, M. Hoffman, J. Godwin, and C. Guyer. 2020. Modeling strategies and evaluating success during repatriations of an elusive and endangered species, Animal Conservation 23: 273-285.

Hengstebeck, K.C., and C.M. Romagosa. 2020. A trap for capturing large burrow-dwelling snakes. Herpetological Review 51: 468–471.

Lamont, M.M., D. Johnson, and R.R. Carthy. 2020. The incubation environment of nests deposited by a genetically distinct group of loggerhead sea turtles in Northwest Florida. Global Ecology and Conservation 23: https://doi.org/10.1016/j.gecco.2020.e01070

McGowan, C.P., Lyons J.E., and D.R. Smith. 2020 Adaptive management of horseshoe crab harvest in Delaware Bay: decision implementation and the double-loop process, in M.C. Runge, S.J. Converse, J.E. Lyons, and D.R. Smith. (eds) Case Studies in Decision Analysis for Natural Resources Management, Johns Hopkins University Press.

McGowan, C.P, N.F. Angeli, W.A. Beisler, C. Snyder and others. 2020. Linking monitoring and data analysis to predictions and decisions for the range-wide eastern black rail status assessment. Endangered Species Research 43:209-222. https://doi.org/10.3354/esr01063

Miller, M.A, J.M. Kinsella, R.W. Snow, B.G. Falk, R.N. Reed, S.M. Goetz, F.J. Mazzotti, C. Guyer, and C.M. Romagosa. 2020. Highly competent native snake hosts extend the range of an introduced parasite beyond its invasive Burmese python host. Ecosphere 11 (6): 03153. https://doi.org/10.1002/ecs2.3153

Overduijn, K. S., C. M. Handel, and A. N. Powell. 2020. Does habitat partitioning by sympatric plovers affect nest survival? The Auk 137:1-16. DOI: 10.1093/auk/ukaa018

Prosdocimi, L., **N. Teryda,** G. Navarro, and R. Carthy. 2020. Use of remote sensing tools to predict focal areas for sea turtle conservation in the Southwestern Atlantic. Aquatic Conservation. Aquatic Conservation: Marine and Freshwater Ecosystems 31 (4):1-11. https://doi.org/10.1002/aqc.3478

Sandfoss, M., **N. Claunch**, N. Stacy, C. Romagosa, and H. Lillywhite. 2020. A tale of two islands: evidence for impaired stress response and altered immune functions in an insular pit viper following ecological disturbance. Conservation Physiology 8: coaa031

Sonsthagen, S., C. Haughey, **M. Sexson**, D. Solovyena, M. Petersen, and A. Powell. 2020. Temporal variation in genetic structure within the endangered spectacled eider. Conservation Genetics 21:175-179. https://doi.org/10.1007/s10592-019-01234-9

Thomason, S.M., J.M. Broxton, C.M. Romagosa, and **N.M. Claunch**. 2020. *Leiocephalus carinatus* (northern curly-tailed lizard). Geographic Distribution. Herpetological Review 51: 272

Tucker, A.M., C.P. McGowan, E.S. Mulero Oliveras, N.F. Angeli, and J.P. Zegarra. 2020. A demographic projection model to support conservation decision making for an endangered snake with limited monitoring data. Anim Conserv. https://doi.org/10.1111/acv.12641

Vitale, N., Brush, J. and A. Powell. 2020. Loss of coastal islands along Florida's Big Bend Region: Implications for breeding American oystercatchers. *Estuaries and Coasts*. https://doi.org/10.1007/s12237-020-00811-3.

Wilkinson, B., H.A. Lassiter, A. Abd-Elrahman, R.R. Carthy, P. Ifju, E. Broadbent, and N. Grimes. 2020. Geometric targets for UAS Lidar. Remote Sensing *11*(24), 3019; https://doi.org/10.3390/rs11243019

Student authors denoted in bold. Coop Unit scientists underlined

THESES/DISSERTATIONS

Eastman, S.F. 2020. A comparative study of loggerhead sea turtle (*Caretta caretta*) nesting on undeveloped and developed beaches in Northeast Florida. M.S Thesis. School of Natural Resources and the Environment, University of Florida, Gainesville.

Tuma, M.E. 2020. Survival, site fidelity, and movement of two migratory shorebirds in the southeastern U.S. M.S. Thesis, University of Florida, Gainesville, FL.

Poli, C. 2020. The roles of habitat and individual-based traits for understanding survival and connectivity across landscapes. Ph.D. Dissertation, University of Florida, Gainesville, FL.

Udell, B. 2020. Monitoring, predicting, and analyzing decisions for invasive species management in heterogeneous landscapes. Ph.D. Dissertation, University of Florida, Gainesville, FL.

LIST OF PRESENTATIONS*

Claunch, N.M., L. Schoenle, S. Oakey, C. Downs, L. Martin, R.N. Reed, and C.M. Romagosa. 2020. A curly tale: stress and immunity across nonnative populations of differing ages in *Leiocephalus carinatus*. World Congress of Herpetology, Dunedin, Otago, New Zealand, 10 January 2020.

Erickson F., C.P. McGowan, J.C. Godwin, C.R. Guyer, and D.V. Young. 2020. Monitoring strategies for repatriated eastern indigo snakes in southern Alabama. The Wildlife Society annual meeting. Virtual Conference, October 2020.

Erickson F., C.P. McGowan, J.C. Godwin, C.R. Guyer, and D.V. Young. 2020. Monitoring strategies for repatriated eastern indigo snakes in southern Alabama. South Eastern Partners in Amphibian and Reptile Conservation Meeting, Culman, AL, March 2020.

Folt B., J.M. Goessling, A.M. Tucker, C. Guyer, S.M. Hermann, E. Shelton-Nix, and C.P. McGowan. 2020. Contrasting patterns of demography and population viability among gopher tortoise populations at the species' northern range edge. The Wildlife Society annual meeting. Virtual Conference, October 2020.

Herren, R. 2020. Green turtle demographics and habitat use in Florida. Bloomsburg University. Bloomsburg, PA. August 2020.

Hornfeldt, J., **M. Beatty**, C.M. Romagosa, R. Carthy, R.J. Fletcher Jr., K.E. Miller, and **D. Catizone**. 2020. The effect of habitat management on vegetation-dwelling arthropods in Florida scrub in Ocala National Forest. Ecological Society of America Conference, 2020 Virtual Annual Meeting.

Jensen, M.B., S.K. Willson, and A.N. Powell. 2020. How effective is the Birdsbesafe cat collar at reducing bird kills by domestic cats? North American Ornithological Conference, Virtual Meeting, August 2020.

Lawson A.J., S.M. DeMay, E. Rivenbark, K. Soileau, K. London, J.H. Waddle, L. Yarborough, C. Coppola, and C.P. McGowan. 2020, Accounting for multiple uncertainties to evaluate population viability of the alligator snapping turtle for the Species Status Assessment. The Wildlife Society annual meeting. Virtual Conference, October 2020.

McGowan, C.P. et al. 2020. Eastern black rail dynamic Species Status Assessment using occupancy and patch persistence modeling. North American Ornithological Congress, Virtual Meeting, August 2020.

Maleko, P. 2020. Nordmann's greenshank: a fight against time. Alachua Audubon Society, Gainesville, Florida, 8 October 2020 (Virtual).

Parker S. W., W.E. Pine, and R.N.M. Ahrens. 2020. A range-wide assessment of Gulf Sturgeon stock status and trends. University of Florida School of Forest Resources & Conservation Fisheries and Aquatic Sciences Graduate Student Symposium. Gainesville, Florida.

Parker S. W. and W.E. Pine. 2020. Integrated Gulf Sturgeon database data summary and discussion. Annual Gulf Sturgeon Workshop. Gainesville, Florida.

Parker S. W., J.F. Moore, and W.E. Pine. 2020. Estimating survival and transition probability for Gulf sturgeon using integrated Gulf Sturgeon Database. Annual Gulf Sturgeon Workshop. Gainesville, Florida.

Pronkevich, V.V., **P.N. Maleko**, K. Maslovsky. 2020. Preliminary results from a breeding ecology study on Nordmann's Greenshanks (*Tringa guttifer)* in Schaste Bay, Sea of Okhotsk (Russia). 1st East Asian-Australasian Flyway Shorebird Science Meeting, Seocheon-gun, Republic of Korea, 4 November 2020 (Virtual).

Silver-Gorges, I., J. Becker, R.R. Carthy, S. A. Ceriani, M. Lamb, M.M. Lamont, C. Matechik, J. Mitchell, M. Reynolds, B. Smith, C. Snyder, M. Ware, M.M.P.B. Fuentes. 2020. Maximizing loggerhead turtle (*Caretta caretta*) hatchling production in light of disturbances in Northern Gulf of Mexico. Gulf of Mexico Oil Spill & Ecosystem Science Conference (GoMOSES), Tampa, FL, February 3-6, 2020.

Tillis, S.B., M.A. Miller, J. Josimovich, **N. Claunch**, I. Bartoszek, J. Humphrey, B. Kluever, R.N. Reed, C.M. Romagosa, J.F.X. Wellehan, Jr., and R.J. Ossiboff. 2020. Identification of divergent serpentoviruses in free-ranging invasive pythons in southern Florida, United States. World Congress of Herpetology, Dunedin, Otago, New Zealand, 10 January 2020.

Trotman, E., M. Beatty, C.M. Romagosa, R. Carthy, R.J. Fletcher Jr., K.E. Miller, and **D. Catizone**. 2020. The effects of habitat management on southeastern American kestrel provisioning rate. Ecological Society of America Conference, 2020 Virtual Annual Meeting.

Tucker, A.M., C.P. McGowan, J.E. Lyons, A. Derose Wilson, and N. Clark. 2020, Annual variation in use of a spring stopover site by three migratory shorebirds. North American Ornithological Congress, Virtual Meeting, August 2020.

Tucker A.M., C.P. McGowan, E. Mulero, N.F. Angeli, and J.P. Zegarra. 2020, A demographic projection model to support conservation decision making for an endangered snake with limited monitoring data. The Wildlife Society annual meeting. Virtual Conference, October 2020.

Udell, B., J. Martin, C. Romagosa, H. Waddle, F. Johnson, B. Falk, A. Yackel Adams, S. Funck, J. Ketterlin, E. Suarez, and F. Mazzotti. 2020. Open removal models to estimate superpopulation abundance, availability, and removal probabilities of a large invasive lizard. Ecological Society of America Conference, 2020 Virtual Annual Meeting.

Vine J. R. and W.E. Pine. 2020. Evaluating the use of multi-state models to estimate juvenile Gulf sturgeon survival in the Choctawhatchee bay. Annual Gulf Sturgeon Workshop. Gainesville, Florida.

Zephir, H., **M. Beatty**, C. M. Romagosa, R. Carthy, R. J. Fletcher Jr., K.E. Miller, and D. Catizone. Comparing characteristics of nest boxes and natural nests of southeastern American kestrels. Ecological Society of America Conference, 2020 Virtual Annual Meeting.

Student authors denoted in bold. Coop Unit scientists underlined

HONORS AND AWARDS

Alexis Cardas (M.S. Student) and Molly Tuma (M.S. Student): Outstanding Service to Wildlife Ecology and Conservation (UF).

Natalia Teryda (Ph.D. Student): 2020 SNRE Travel Grant, University of Florida.

Natalie Claunch (Ph.D. Student): 2020 Doris and Earl Lowe and Verna Lowe Scholarship, University of Florida CALS

Natalie Claunch (Ph.D. student): 2020 Sigma Xi Grants in aid of Research: Determining phylogeography of an invasive lizard with rapid range expansion.

Trash collected by Chris Gulick, Philipp Maleko, and Ke Zhang while doing field work around Mobile Bay, Alabama. Photo by Chris Gulick.

COMPLETED PROJECTS

Identifying the role of hydrology and prey for a key bottleneck in the recovery of snail kites in the greater Everglades.
Investigator: Robert Fletcher
Completion Date: April 2020
Funding Agency: USGS (RWO 297)

Demographic, movement, and habitat studies of the endangered snail kite in response to operational plans in water conservation area 3A.
Investigator: Robert Fletcher
Completion Date: June 2020
Funding Agency: USACOE

Integrating science and management for optimal prevention and control of aquatic invasive species in the Everglades.
Investigator: Christina Romagosa
Completion Date: July 2020
Funding Agency: USGS (RWO 295)

Assessing impacts of invasive pythons on gopher tortoises in Florida.
Investigator: Christina Romagosa
Completion Date: July 2020
Funding Agency: USGS (RWO 296)

Ecology of diamondback terrapins in northwest Florida.
Investigator: Christina Romagosa
Completion Date: December 2020
Funding Agency: USGS (RWO 306)

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