ANNUAL REPORT JANUARY - DECEMBER 2019

DEDICATION

Dr. Jack Payne

This year we dedicate our annual report to one of our staunchest advocates – Dr. Jack Payne. Jack got his start as a graduate student at the Utah Cooperative Fish and Wildlife Research Unit (CRU) and never forgot his "Unit" roots. His professional life as a both a professor and administrator included positions at other universities with CRUs including Iowa State University and Penn State University. Jack arrived at University of Florida in 2010 in his position of Senior Vice President for Agriculture and Natural Resources in the Institute of Food and Agricultural Science (IFAS) and has been a tremendous supporter of the Florida Unit ever since.

Because of Jack's Unit roots, we never had to explain who we are to him. He not only enthusiastically attended every one of our annual Cooperator's Meetings, but interacted with our partners, graduate students, and technicians with genuine interest and support. Jack's passion and persistence on behalf of the CRU system has helped every Unit, not just Florida's. Jack took that passion to the All Hands Meeting in 2016 where he delivered a rousing call to action in defense of evidence-based policy and unflinching criticism of those who undervalue science. He championed the CRUs on op-ed pages from Florida all the way to Alaska. He repeatedly flew to Washington, D.C., to make the case for the CRU system to policy makers and agency officials when funding for the CRUs was cut entirely from the budget. He did this because of his affinity for our two-person Unit and convictions about the importance of the national CRU program, all while effectively functioning in his "day job" of managing a $400-million-a-year organization with thousands of employees.

In 2020 the Florida Unit will be adding another Unit scientist (Wildlife) and advertising for one more (Fisheries), bringing us up to a 4-scientist Unit, thanks to Jack's unending support. Jack is retiring in June 2020 and will be spending time fishing, cooking, biking, and enjoying life in Cedar Key. I am sure he will continue to be involved with the Florida Unit in one way or another. Jack has never forgotten that he got his start at a Unit. We'll never forget him either. Thank you, Jack, from all of us and the entire CRU Program.

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.

2019 Photo Contest Winners

Top Left: Danae Mouton, "Baby Blue", Animal Category

Bottom Left: Nichole Bishop, "*Dermatemys jaren*", People Category

Right: Dan Catizone, "Reflection", Landscape Category

TABLE OF CONTENTS

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 2020, over 312 projects totaling more than $58 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 415 publications, 125 technical reports, 104 theses and dissertations, and 216 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

Jack Payne	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.
Steven Williams	President, Wildlife Management Institute, Gardners, Pennsylvania.
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 special interest in species of conservation concern, wetland-associated species, and migratory connectivity.

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. His research centers on ecology of endangered species. His research interests involve reproductive ecology and physiology of coastal and wetland herpetofauna, with current focus on marine and freshwater turtles. He is also involved in research on threatened upland species, conservation management-oriented studies, and is the Program Director/Wildlife Lead for the UF Unmanned Aircraft Systems Research Program (UFUASRP http://uas.ifas.ufl.edu/).

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 of spent funds on all grants and state funds. She also handles federal vehicles and helps with general office procedures.

COOPERATORS

University of Florida

Robert Ahrens
Mendy Allen
Michael S. Allen
Christine Angelini
Alan B. Bolten
Rena Borkhataria
Cameron Carter
Nancy Denslow
Bon A. Dewitt
Catherine Eastman
Tom Frazer
Robert Fletcher
Peter Ifju
Susan Jacobson
Steven Johnson
David Kaplan
Frank Mazzotti
Robert McCleery
Debbie Miller
Martha Monroe
Holly Ober
Madan Oli
Todd Osborne
Elizabeth Pienaar
Bill Pine
Christina Romagosa
Katie Sieving
Scot E. Smith
J. Perran Ross
Taylor Stein
Hannah Vander Zanden
Benjamin Wilkinson
Blair Witherington

National Park Service

Tylan Dean
Bryan Falk
Jennifer Ketterlin
Donna Shaver

Florida Fish and Wildlife Conservation Commission

Tyler Beck
Janell Brush
Robin Boughton
Matt Chopp
Andrew Cox
Carolyn Enloe
Dan Fox
Sarah Funk
Tomo Hirama
Alyssa Jordan
Catherine Kennedy
Karl Miller
Raya Pruner
Erin Ragheb
Amy Schwarzer
Kristen Sommers
Eric Suarez
Robin Trindall
Chris Wynn

U.S. Geological Survey

Nick Aumen
Andrea Currylow
Austin Fitzgerald
Fred Johnson
Jillian Josimovich
Margaret Lamont
James Lyons
Julien Martin
Melia Nafus
Robert Reed
Charlotte Robinson
Ken Rice
Brian Smith
Hardin Waddle
Amy Yackel-Adams

National Park Service

Tylan Dean
Bryan Falk
Jennifer Ketterlin
Donna Shaver

U.S. Fish and Wildlife Service

Laura Brandt
Kathleen Burchett
Victor Doig
Rebekah Gibble
Andrew Gude
Marla Hamilton
Kevin Kalasz
Adam Kaeser
Patty Kelly
Joyce Kleen
Joyce Palmer
Paul Tritaik
Larry Woodward

U.S. Army Corps of Engineers

Andy LoShiavo
Melissa Nasuti
Jenna May

South Florida Management District

LeRoy Rodgers
Zach Welch

Conservancy of Southwest Florida

Ian Bartoszek

Audubon Florida

Marianne Korosy

Florida Coastal Conservancy

Jessica Swindall

RESEARCH PERSONNEL

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

Post-Doctoral Associates:

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

Dustin Welbourne, PhD
Advisor: Christina Romagosa
Research: Python prey and Everglades food web networks

Krystan Wilkinson, PhD
Advisor: Bill Pine
Research: Informing Gulf Sturgeon population status and trends

Graduate Students:

Trenton Aguilar
Degree: PhD, 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: MS, 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: PhD, Interdisciplinary Ecology
Graduation Date: May 2021
Research: Nutritional ecology of sea turtles
Advisor: Raymond Carthy

Alexis Cardas
Degree: MS, Wildlife Ecology & Conservation
Graduation Date: December 2020
Research: Impacts of translocation on a cooperatively breeding bird in the Ocala National Forest
Advisor: Abby Powell

Daniel Catizone
Degree: MS, School of Natural Resources and the Environment
Graduation Date: December 2020
Research: Ecology of diamondback terrapins
Advisor: Christina Romagosa

Natalie Claunch
Degree: PhD, School of Natural Resources and the Environment
Graduation Date: May 2021
Research: Invasive reptile physiology and management
Advisor: Christina Romagosa

Scott Eastman
Degree: MS, School of Natural Resources and the Environment
Graduation Date: August 2020
Research: Evaluating the effects of climate change and coastal management adaption strategies on the reproductive success of marine turtles
Advisor: Raymond Carthy

Alfredo Gonzalez
Degree: MS, Wildlife Ecology and Conservation
Graduation Date: December 2022
Research: Ecology of the endangered Snail Kite
Advisor: Robert Fletcher

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

Kodiak Hengstebeck
Degree: PhD, School of Natural Resources and the Environment
Graduation Date: December 2023
Research: Assessing impacts of invasive pythons on gopher tortoises in Florida; invasive reptile adaptations and impacts
Advisor: Christina Romagosa

Richard Herren
Degree: PhD, 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: PhD, Wildlife Ecology and Conservation
Graduation Date: TBD
Research: Impacts of climate on Snail Kite demography
Advisor: Rob Fletcher

Philipp Maleko
Degree: MS, 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: PhD, School of Forest Resources and Conservation
Graduation Date: May 2024
Research: Informing Gulf Sturgeon population status and trends
Advisor: Bill Pine

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

Caroline Poli
Degree: PhD, 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: MS, Wildlife Ecology and Conservation
Graduation Date: May 2021
Research: Natural resources communication (non-thesis)
Advisors: Raymond Carthy

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

Rachel Smith
Degree: PhD, 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: MS, 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: PhD, School of Natural Resources and Environment
Graduation Date: August 2022
Research: Sea turtle population distribution and abundance
Advisor: Raymond Carthy

Brad Udell
Degree: PhD, Wildlife Ecology and Conservation
Graduation Date: August 2020
Research: Aquatic and invasive species
Advisor: Christina Romagosa

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

Nicholas Vitale
Degree: MS, Wildlife Ecology and Conservation
Graduation Date: May 2019
Research: Productivity of American oystercatchers
Advisor: Abby Powell

Ke Zhang
Degree: PhD, 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
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
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
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

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

Investigators: Abby Powell, Karl E. Miller
Student: Alexis Cardas, MS, WEC
Duration: August 2017 – August 2020
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 small, isolated populations reside and are unlikely to increase naturally through dispersal. The majority of translocation research has focused on the success at recipient sites, while the impacts associated with the donor population have not been monitored. Ocala National Forest is home to the largest remaining population of Florida scrub-jays and is currently the donor site for translocations. As the goal of any translocation is to have a positive impact on the species population, it is imperative that the costs to the donor population are minimized to the greatest extent possible. This study focuses on potential impacts that translocation could place on the donor population through monitoring of nesting success and productivity. Our goal is 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: (1) no helpers (*n* = 59), (2) helpers (*n* = 34), (3) helpers removed (*n* = 10). We recorded nest success, mass of nestlings at age day 11, and time spent provisioning (recorded by nest cameras). Overall, productivity and nestling weights were higher in 2018 than 2019. Our Initial results found no significant difference in nestling mass between group categories (no helpers and helpers present). Nest success and productivity were variable among groups and between years; we continue to analyze these data. This study aims to inform biologists and land managers on the viability of removing helpers from family groups and will assist in the future development of a statewide translocation protocol. If data shows evidence that helpers do not increase productivity or nest success, then future translocations can focus on removing helpers as opposed to entire family groups.

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

Investigator: Abby Powell
Student: Molly Tuma, MS, 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 U.S. 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: 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 U.S. is an important region for nonbreeding shorebirds. Our results identify possible threats to shorebird populations in the region and shows 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.

Colonial nesting wading bird tracking and habitat use assessment

Investigator: Abby Powell
Students: Ke Zhang and Chris Gulick, PhD 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 Ardieds (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. This study may inform and enhance future restoration planning for key colonial nesting wading bird species along the Alabama coast that were injured by the Deepwater Horizon oil spill. The goals of this proposed project are to better understand the extent to which declines in colonial nesting wading bird populations result from habitat limitation versus other potential population-limiting factors and in turn, which restoration approaches and techniques are most appropriate to effectively target and restore wading bird populations. 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, and Perdido Bay, Alabama. We will use satellite telemetry and individually coded color leg bands to track movements of wading birds (adults and juveniles) captured at nesting colonies in and around the study area. We will begin tagging birds in April 2020. Transmitters are solar-powered and expected to last three years, providing multiple years of locations through the birds' annual cycles. The results of this work should lead to a better understanding of factors influencing foraging habitat quantity and quality, identification of important foraging sites, foraging distances from nesting colonies, and how these factors may affect productivity.

Movements and overwinter survival of juvenile red knots in Southeast US: Information needs for recovery planning

Investigators: Abby Powell, Jim Lyons (USGS Patuxent)
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 in order 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 in the study of 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.

Breeding biology of Nordmann's greenshank and common redshank in Eastern Russia

Investigator: Abby Powell
Student: Philipp Maleko, MS, SNRE
Duration: January 2019 – December 2022
Funding Agency: N/A
In-Kind Support: SNRE, WEC, WCS, Russian Academy of Sciences

Several migratory shorebird populations in East Asia are declining at an alarming rate. Although a lot of research has been conducted regarding threats to shorebirds within their migratory and wintering area, very few studies have been conducted on their breeding grounds in Eastern Russia likely due to much of the region being a remote and inaccessible. Schaste Bay is one of a handful of sites relatively accessible to researchers for extended periods and is a known breeding area for the endangered Nordmann's Greenshank (*Tringa guttifer*). The objective of this study is to

quantify factors critical to two breeding East Asian shorebird species: the endangered Nordmann's Greenshank and ubiquitous Common Redshank (*Tringa totanus*). The most optimistic population estimate of the Nordmann's Greenshank population lies between 1000-2000 individuals. Although the Common Redshank population is still considered as Least Concern, recent surveys predict the population is in decline. In 2019, we found 23 Common Redshank nests and documented breeding habitat characteristics. We also found the first Nordmann's Greenshank nest since 1973 and collected quantitative measurements of its nesting habitat within inland larch forests. With another field season in 2020, we expect to better understand the breeding ecology of both species by extrapolating differences in nest-site features within different spatial scales, and within used and unused sites. We also expect to fill in the knowledge gap of life-history traits like breeding phenology, optimal chick rearing habitats, potential predators threatening adults and juveniles, and site fidelity. Better information on breeding ecology can inform conservation planning for both species.

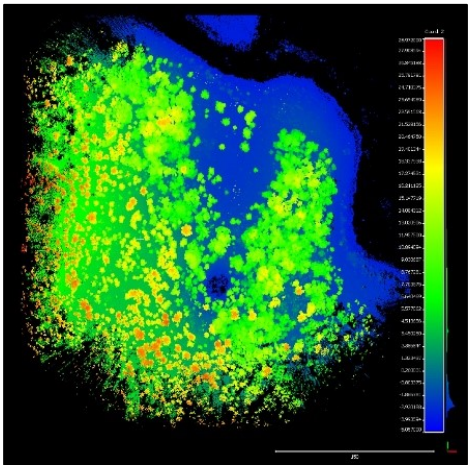
Integration, validation, and fusion of small unmanned aircraft system multimodal sensor data in support of USGS

Investigators: Ray Carthy, Peter Ifju, Ben Wilkinson, Scot Smith and Matthew Burgess
Student: Travis Whitley, PhD, Mechanical and Aerospace Engineering; H. Andrew Lassiter, PhD, Geomatics Department; Chad Tripp and Jeroen Poelstra, Undergraduates, Mechanical and Aerospace Engineering; and Andrew Ortega, Undergraduate, Computer Science and Engineering.

Duration: August 2016 – August 2019
Funding Agency: USGS (RWO 300)
In-Kind Support: WEC

Small unmanned aircraft systems (sUAS) are increasingly popular data collection platforms in natural resources-based scientific studies. Sensor suites for use aboard sUAS can be limited by factors such as size, weight, and cost. Until recently, Light Detection and Ranging (LiDAR) sensors had been unfeasible for sUAS. The University of Florida Unmanned Aircraft Systems Research Program (UFUASRP) was tasked with incorporating a small yet affordable LiDAR sensor to a rotary-wing octocopter sUAS platform. Through technological advances, the generation of high-accuracy terrain maps and other valuable three-dimensional (3D) remotely sensed data products using a LiDAR sensor are now a realistic possibility from sUAS platforms. The combination of high-resolution two-dimensional (2D) imagery collected via existing sUAS sensors with 3D LiDAR-generated point clouds provides a multitude of new opportunities for researchers to create stunning models of target areas suitable for scientific analyses. The objectives of this study included: 1) modifications to an octocopter sUAS platform and payload bay to house and permit unobstructed use of the LiDAR sensor; 2) development of a calibration methodology and correction algorithms to standardize the LiDAR data produced with the new sensor; 3) integration of the sUAS-collected 3D LiDAR data with existing 2D sUAS sensor data (e.g. visual, thermal, hyperspectral, etc.); and 4) creation of a structured workflow for post-processing the data collected by the multimodal sensor suite into user-friendly products for analyses. In the laboratory, the various payload sensor inputs and outputs were determined, schematics of potential sensor configurations within the payload bay were drawn up, and the physical integration (co-mounting) and wiring of the sensors was completed. An innovative 3D ground control target was designed, fabricated, and distributed throughout several experimental flight areas to facilitate high-accuracy calibration of the sUAS LiDAR data. Initial flights with the multimodal payload were utilized for comprehensive data collection and analysis, modifications to sUAS flight operations, and thorough tuning of all sensor suite components. Test flights produced

data suited for rigorous multimodal data fusion methods which were implemented to synthesize the calibrated data products from all sensors, and a post-processing workflow was devised and further refined to produce end-products ready for subsequent analyses. The addition of the 3D LiDAR sensor to the existing sUAS sensor suite is extremely valuable, and further supports the UFUASRP theory that sUAS can be utilized as scientific remote sensing platforms. The ability to create 3D digital point cloud models as framework structures onto which high-resolution 2D imagery collected by existing sUAS sensors can be draped facilitates a host of new natural resource-based sUAS applications. The desire to integrate a LiDAR sensor as a payload component for civilian sUASs has been requested by researchers for over a decade. The UFUASRP has been able to successfully incorporate a LiDAR unit as an available option to their multimodal payload suite. The systematic integration of calibrated LiDAR data capable of generating 3D point clouds from a sUAS is a landmark step in the utility of sUAS as tools for scientific data collection.



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

Investigator: Ray Carthy
Student: Trenton Aguilar, PhD, 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 differing 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.

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

Investigator: Ray Carthy
Student: Nichole Bishop, PhD, 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 in an effort 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.

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

Investigator: Ray Carthy
Student: Scott Eastman, MS, SNRE
Duration: September 2017 – 2020
Funding Agency: Florida Department of Environmental Protection, Guana Tolomato Matanzas National Estuarine Research Reserve

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

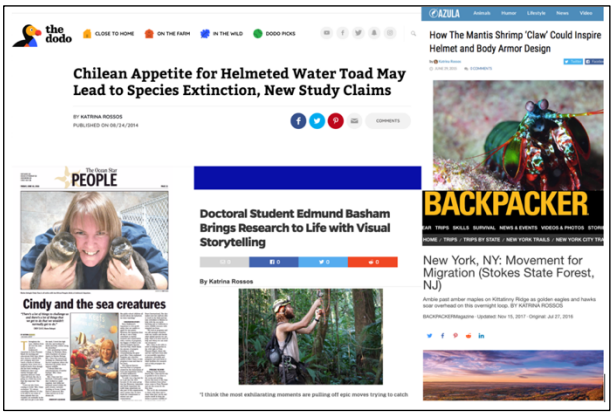
impacting the natural dynamics of our coastal beach dune processes and these rare coastal habitats. Understanding how these factors are affecting these areas and the species that reside in these habitats is critical for adaptive management practices, increased coastal resilience, and greater habitat 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 National Estuarine Research Reserve 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 (~5 km), 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. Gaining a better understanding of the spatiotemporal trends in sea turtle nesting and reproduction in these increasingly rare undeveloped “pocket beaches”, may help managers and scientists discern critical factors influencing turtles nesting on more developed or urbanized tracts within their range.

Green turtle spatial distribution, abundance and habitat models in the Northeastern Gulf of Mexico

Investigators: Ray Carthy
Student: Rick Herren, PhD, WEC
Duration: September 2016 – 2020
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 assess the spatial distribution and abundance of juvenile green turtles in the Big Bend, determine if there are habitat or environmental factors that can predict abundance, describe their demographics, and understand their seasonal movements. 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. We recorded 415 sea turtles on transect and another 126 in transit (i.e. off transect). Green turtles comprised 74% of all sightings, while loggerheads and Kemp’s ridleys comprised 13% and 13%, respectively. Hawksbills comprised less than 1% of the sightings. Most turtles were juveniles, although subadult and adults were also observed. The region-wide surveys have led to the direct identification of important sea turtle "hotspots." Sixteen 1-km2 study sites with varying green turtle abundance and in clear water have been randomly selected from the region-wide surveys to determine the factors driving abundance. Abiotic and biotic factors will be collected at 15 randomly selected stations within each study site during the spring,

summer and fall of 2020. To date, 30 green turtles have been captured at hotspots ranging in size from 27.4 cm to 78.7 cm straight carapace length (SCL). Of the juvenile turtles (< 65 cm SCL), 64% had symptoms of the tumor disease fibropapillomatosis. Samples were taken from 22 turtles for mtDNA and sex determination analysis. We attached six Argos satellite transmitters to juvenile green turtles in fall 2019 and tracked them over the winter at a northern and southern site. This study will lead to a better understanding of the distribution of sea turtles in this region over space and time, and the results are important given concerns over vessel strikes, harmful algal blooms, climate change and the global loss of seagrass beds.



Natural resources communication

Investigators: Ray Carthy
Student: Katrina Rossos, MS, 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. How the general public views wildlife management and conservation can help shape policy, which makes accurate reporting via science journalism and through public information and communications offices so vital.

Effectiveness and feasibility of sensory-based bycatch reduction technology to reduce sea turtle entanglement in Florida trap pot fisheries

Investigator: Ray Carthy
Student: Rachel Smith, PhD, SNRE
Duration: September 2019 – 2023
Funding Agency: Disney Corporation
In-Kind Support: Inwater Research Group, Arizona State University

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 trap pot fishery system in Florida and its

associated entanglement interactions with sea turtles. Florida's nesting beaches receive 90% of the sea turtle nesting activity in the United States. Loggerheads 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 four specific objectives of this study: 1) To supplement existing stranding data, conduct a fisher survey to further characterize the threat that Florida trap pot fisheries pose to sea turtles, 2) Through the fisher survey, assess feasibility and value of using sensory-based bycatch reduction technology (BRT) in Florida's trap pot fisheries, 3) Develop a behavioral ethogram measuring sea turtle response to BRT using turtles in aquaria, and 4) In field trials, use acoustic telemetry and accelerometry to evaluate effectiveness of BRT in reducing sea turtle entanglement in trap pot gear.

Identifying hotspots for conservation of the leatherback turtle (*Dermochelys coriacea*) in the Rio de La Plata Estuary

Investigator: Ray Carthy
Student: Natalia Teryda, PhD, SNRE
Duration August 2018 – August 2023
Funding Agency: SNRE

Leatherback 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 range-wide interactions with fisheries. Due to their complex life cycle, research and further conservation efforts have relied on technology advances to gain fuller understanding of their population and vulnerabilities in areas like the Rio de la Plata Estuary (RLPE) in South America. Better understanding of habitat use and population densities, as well as their interaction with fisheries is essential for the conservation of this species. My research aims to evaluate the abundance and distribution of leatherback turtles in RLPE and assess their susceptibility to fisheries interactions within the area. At the same time, I will test the use of Unmanned Aircraft Systems (UAS) to study sea turtles in this and similar habitats. During Nov-Dec of 2019 I conducted the first part of a pilot study to develop and test survey methodologies. I tested the feasibility of aerial surveys for leatherback turtles with UAS within the RLPE. I conducted and evaluated the efficiency and detection capability of UAS as a surveying method on the beach for stranded animals and in the water for live individuals. I measured oceanographic and weather parameters and food patch availability to establish a baseline of environmental parameters to incorporate in the detection and survey methodology. 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). However, due to the ever-changing weather conditions and intense winds that dominate the study area, surveys were difficult to accomplish. The tested and alternative methodologies are currently being refined, and I will conduct the second part of this pilot study during March 2020. This project will advance traditional surveying techniques by applying new technologies and will provide comprehensive and much needed information for successful sea turtle conservation. It will enhance our understanding of habitat use by endangered leatherback turtles in South America, will provide knowledge for fisheries managers on spatial turtle vulnerability throughout the year, and will provide information on techniques for in-water research that can be used worldwide.

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, PhD, SNRE
Duration: September 2015 - May 2020
Funding Agency: Greater Everglades Priority Ecosystem Science (GEPES) (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 including but not limited to hydrology and prey availability. Although ongoing monitoring of Snail Kite demography allows for estimation of survival at the annual time scale, our capacity to understand and predict survival at shorter timescales is currently limited by the coarse resolution (monthly, yearly) of the data. 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 first-year 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 that were close to fledging age. Tags recorded 12 locations per day for up to 1 year and downloaded data remotely through cellular networks. We plan to estimate movement trajectories using hidden Markov models, and to predict switching of behavioral states using covariates related to snail density (measured through in-situ sampling) and hydrology (extracted from online databases such as EDEN). In 2020 we plan to deploy 3 additional tags and finalize analyses. Preliminary data confirm that birds spend the first 30-60 days post-fledging within 1 kilometer 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. Analysis of movement trajectories in relation to hydrology and prey is ongoing. Models will be disseminated to agencies and managers to help determine key targets for water management in the Greater Everglades Ecosystem. We will emphasize identifying potential thresholds in hydrology and snail metrics that can explain changes in movement behaviors.

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

Investigator: Robert Fletcher
Student: Alfredo Gonzalez, MS, 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 juvenile (1st year) individuals. Juvenile survival is a key factor for

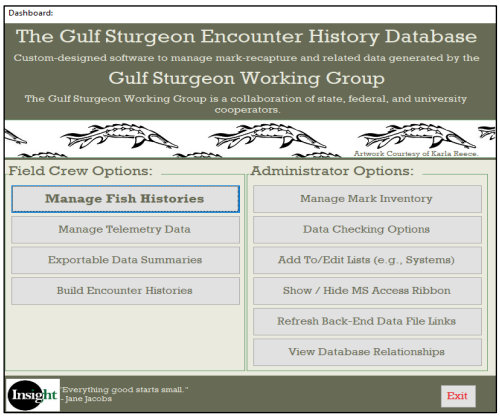
recovery of the species and monitoring data show that juvenile survival is widely variable over time and across wetlands. Because current monitoring of Snail Kite demography only allows juvenile survival to be estimated yearly, our understanding of this factor and ability to provide effective management 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. Assess whether typical movement behaviors can be defined for a variety of environmental conditions, 2) To identify threats that are most important to juvenile snail kite survival, 3) To provide data on potential population sinks, and 4) 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 together on Snail Kites close to fledging age so that we can 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. Using this telemetry and mark-recapture data from our monitoring project, 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, using telemetry data alongside nest location and success data, we will determine habitat use by juveniles and the times of year that pose the greatest risk to these individuals. 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.

Evaluating apple snails and snail kite habitat management strategies

Investigator: Robert Fletcher and Christina Romagosa
Student: Arianna Paul, MS, WEC
Duration: April 2019 – June 2020
Funding Agency: FWWC

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 FFWCC during winter 2019-2020 on the western side of Lake Okeechobee. Snail surveys will be done twice pre-treatment (April-June, July-Aug 2019) and

twice post-treatment (April-June, July-Aug 2020) 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. This study will assess the effectiveness of the herbicide-burn management strategy to increase snail abundance and accessibility. Understanding how different habitat management techniques effect prey, their refugia, and ultimately predator-prey dynamics between the endangered Snail Kite and apple snails will provide valuable information for land managers and policymakers.



Developing a priority fish tagging database to quantitatively assess range wide status and trends

Investigator: Bill Pine
Student(s): Amy Almond, University of FL (BS)
Krystan Wilkinson, Mote Marine Lab (post-doc)
Duration: January 2017 – December 2019
Funding Agency: USFWS Panama City (RWO 304)

Gulf sturgeon *Acipenser oxyrinchus desotoi* a large, anadromous, fish found in the northern Gulf of Mexico, are a species of conservation concern. Recovery of this species is jointly guided by NOAA Fisheries and US Fish and Wildlife Service. Agency staff are developing restoration projects to determine and compare demographic parameters within or between Gulf sturgeon populations before and after different restoration actions. Researchers need access to historic data collected for Gulf sturgeon over the last three decades by various academic and agency cooperators. These data are necessary to help inform long-term trends in Gulf sturgeon demographic parameters such as recruitment and survival as benchmarks from which to measure responses of Gulf sturgeon populations to proposed restoration and management actions designed to promote species recovery. Overall project objectives address a key area of need by updating and revising a Graphical User Interface (GUI) to facilitate entry of data by agency and academic. The existing database currently contains data collected since 1976 with information on more than 55,000 "contacts" with Gulf sturgeon. The existing database identified key gaps in data QA/QC and data compilation that significantly limit the utility of existing Gulf Sturgeon data. This project expands the existing GUI limit data entry errors improving data integrity. Training videos with examples as well as a Beta version of the database are available on the project web page here: https://sites.google.com/view/gulf-sturgeon/home. The project is ongoing, and the results will allow for improved data curation and access leading to more rapid analyses to inform management decisions for Gulf sturgeon.

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, PhD, WEC; Stephen Parker, PhD, SFRC
Duration: August 2019 – 2023
Funding Agency: USGS (RWO 308)

Gulf sturgeon Acipenser oxyrinchus desotoi a large, anadromous, fish found in the northern Gulf of Mexico, are a species of conservation concern. Our research efforts are in support of (1) estimating survival and abundance of juvenile Gulf sturgeon in the Choctawhatchee River and (2) completing a range wide-estimate of Gulf sturgeon status and trends using long-term monitoring data from cooperating agencies, and (3) development of an electronic logbook program for tracking field data and integrating into the Gulf Sturgeon Database to facilitate routine updates of species status. We will begin field efforts for (1) during spring/summer 2020 and implement a test of (3) during at the same time. For (2) we fit multi-state and Cormack-Jolly-Seber capture-recapture models to virtual and field captures of telemetered adult Gulf Sturgeon to develop preliminary estimates of survival by river basin. These results suggest movement between rivers is low, however adult survival was lower for western Gulf of Mexico river basins than those in the east. We are currently integrating additional data into the database to re-assess these results, but the integration between the database and analyses to produce these types of routine estimates of management interest worked well.

Changes in mammal communities across the Greater Everglades Ecosystem

Investigators: Robert McCleery, Kristin Hart, and Paul Taillie
Duration: September 2018 – August 2020
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.

Burmese python use of gopher tortoise burrows in southwestern Florida

Investigator: Christina Romagosa
Cooperator: Robert Reed
Student(s): Kodiak Hengstebeck, PhD, WEC
Duration: January 2016 – July 2020
Funding Agency: USGS (RWO 296)
In-Kind Support: Conservancy of Southwest Florida and Rookery Bay National Estuarine Research Reserve 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 may use gopher tortoise burrows, potentially causing as-yet-unknown effects on gopher tortoises and burrow-commensal vertebrates. Pythons could also potentially use gopher tortoise burrows as winter refugia north of their current range if burrow microclimates in 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, (3) assess burrow microhabitat as a suitable refuge for pythons north of their current range, and (4) develop a burrow trap for capturing Burmese pythons occupying Gopher tortoise burrows. We systematically surveyed burrows using burrow cameras. 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 are 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. If burrow microclimate north of current python range is compatible, then pythons could expand their range and overwinter in tortoise burrows. The modified-for-pythons gopher tortoise trap is a feasible and effective alternative to burrow excavation for removing pythons from burrows. It prevents substantial damage to the burrow, which allows tortoises and other native animals to continue use after trapping. The trap can be used by managers to capture pythons residing in burrows without damaging the structural integrity of the burrow, ensuring that native species can continue to rely on burrows for refuge and protection.

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

Investigator: Christina Romagosa
Student: Bradley Udell, PhD, WEC
Duration: September 2015-December 2020
Funding Agency: USGS (RWO 295)

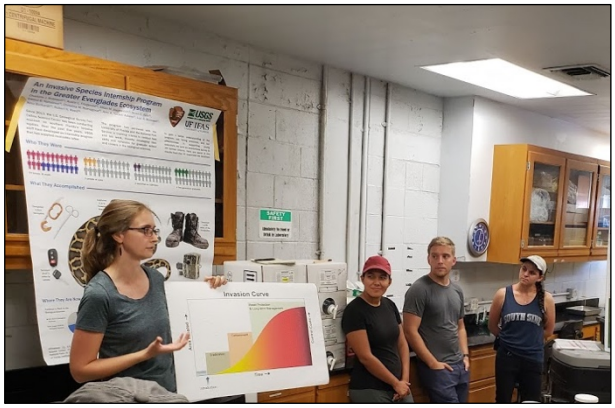
Invasive plants and animals are a major biological and economic issue facing conservation efforts worldwide and are particularly problematic to conservation and restoration efforts in the Florida Everglades. Natural resource managers are tasked with finding cost-effective solutions to best monitor and 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 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 invasive species with limited resources, thus empowering them to reduce and mitigate the biological and ecological damages of invasive species.

Ecology of diamondback terrapins in northwest Florida

Investigator: Christina Romagosa
Cooperator: Margaret Lamont
Student: Daniel Catizone, MS, SNRE
Duration: January 2018 – August 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. The primary objective of this study is to collect demographic data on diamondback terrapins in St. Joseph Bay. The primary objective of this study is to collect demographic data on diamondback terrapins in St. Joseph Bay.



Experiential learning through wildlife research and management of invasive reptiles

Investigator: Christina Romagosa
Student: Natalie Claunch, PhD, SNRE; Diego Juarez, PhD, WEC
Duration: August 2014 – July 2019
Funding Agency: USGS (RWO 292)
2019 Interns: Daniela Alviz, Gretchen Anderson, Shannon Buttimer, Juan Camacho, Kathryn Davison, Kristin Dyer, Meghan Connelly, Madison Harman, Jack Obergfell
In-Kind Support: Graduate Stipend for N. Claunch through UF Graduate School Fellowship; tuition for D Juarez Sanchez by WEC, intern support (Sidney McFarland and Scott Biemiller) by UF College of Agricultural and Life Sciences.

University programs in wildlife ecology and/or management are crucial for the conservation and management of natural resources. Graduates from these programs most often go into academic or natural resource management agency sectors. Students must have a working knowledge of many topics. While some of these topics are taught in the classroom, some are best learned by experiential learning. USGS and UF work with several agencies on invasive reptile research focusing on the biology, ecology, and development of control tools for these species. One such species is the Argentine black and white tegu, an omnivorous species, with various accounts of nest predation of birds, turtles and crocodilians in their native range, as well as turtle and alligator nest predation in Florida. The tegu project meets the need to delineate the current spatial range as well as containing tegus along the eastern boundary of Everglades National Park Our objectives are: a) to provide experiential learning opportunities with invasive reptiles to undergraduate and graduate students; b) provide this experience through the delineation of the tegu's spatial boundaries of the westward invasion front, determine common invasion pathways, and implement an intensive trapping and removal effort; c) identify Burmese python prey items. Interns were recruited to work on a project where tegus are trapped with live capture traps along transects outside Everglades National Park, and a network of cameras serve to identify locations for rapid response efforts within the Park. Python diet contents that were obtained from USGS are identified by D. Juarez Sanchez using a morphological approach. Interns processed more than 1 million camera trap images, and over 1,300 individual prey items from 40 bird, 23 mammal, and two reptile species have been identified from python diet contents. More than 34 interns have worked on the cooperative projects and have gone on to other technician jobs, graduate school, or permanent positions with agencies. As nonnative species introductions increase across the United States, so will the need for wildlife biologists that are trained to address this complex issue. The continued presence of tegus, and their capacity to expand their range, is a concern to ecologically sensitive areas. Everglades National Park will continue trapping efforts in 2020 to prevent incursion of tegus into the park. The python diet results suggest spatial shifts in prey species composition for pythons throughout their range, which supports previous studies showing declining trends for some mammal species throughout the Greater Everglades.

Ecology, physiology and control of invasive reptiles in Florida

Investigator: Christina Romagosa
Student: Natalie Claunch, PhD, SNRE
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. The objective of this study is to assess physiological metrics implicated in invasion success across many established and spreading reptile species. Specifically, we are assessing patterns in stress and immune responses of invasive reptiles to explore whether these blood-sample-derived metrics may be useful early indicators of invasion success. In 2017-2019, blood samples were collected from wild and recently captive Burmese pythons, wild green iguanas, and wild brown tree snakes where these species are proliferating (SW FL, Key Largo, and Guam), and from 11 populations of Northern curly-tailed lizards and 5 populations of Peters' rock agamas, two species which are rapidly expanding their range across Florida. For all, stress hormone (corticosterone) levels were assessed immediately at capture/handling and after 1 hour of acute confinement stress; brown treesnake plasma hormone levels were assessed via radioimmunoassay and enzyme immunoassay to compare differences in interpretation. Population genetic analysis of Northern curly-tailed lizards is planned to elucidate physiological patterns that are not explained by other variables. Differences in immune investment among multiple populations of the same invasive species indicates that not all invaders can be assumed to respond to introduction in the same way and may need to be targeted with different management tools. Dampened hormonal stress responses in very recent lizard invaders shows that these hormonal responses may help elucidate recent versus old but undetected populations; and this difference in hormonal response may indicate that more recent invaders are more vulnerable to management efforts.

Invasive reptile adaptations and impacts

Investigator: Dr. Christina Romagosa
Cooperator: Dr. Robert Reed
Student: Kodiak Hengstebeck, PhD, SNRE
Duration: September 2019 – August 2024
Funding Agency: USGS (RWO 301)
In-Kind Support:

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 responses such as morphological or behavioral change. Whether changes in prey species composition could result in adaptive plasticity in pythons is uncertain. There is a need to evaluate plastic responses by invasive species to environmental change. If plastic responses, such as shifts in morphology, of an invasive

species occur in a short evolutionary timespan, the impact of the invader on natural resources may be dynamic. Furthermore, changes in python morphology could signify shifts in both the density and type of native prey available to pythons in southern Florida. The objective of this study is to assess plastic 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. The information and specimens, along with recent specimens collected from the wild, will be used to document the amount of variation in phenotypic traits. 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 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.

Habitat partitioning of sea turtle species at a temperate foraging ground

Investigators: Hannah Vander Zanden and Margaret Lamont
Student(s): Carson Arends, MS, 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. The northern Gulf of Mexico supports loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*) and green turtles (Chelonia mydas), yet few studies are 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 but has not commonly been used to assess resource partitioning among sea turtle species. We aim to understand the diet and microhabitat use and overlap by green, Kemp's ridley, and loggerhead sea turtles 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 habitat samples (i.e. benthic invertebrates, seagrasses, etc.). Additionally, we will compare diet and habitat use pre- and post-hurricane Michael. Each field season from 2011-2019, we captured and collected data from three species of sea turtles in St. Joseph Bay, FL. All turtles were captured between March and November using a set net, dip net, or by hand. We collected epidermis tissue for stable isotope analysis as well as basic information such as morphological measurements. Additionally, we collected habitat and prey samples in 2019 and will continue to collect turtle tissue and habitat samples in 2020. We have approximately 350 tissue samples and 50 prey samples to date. All samples are currently being prepared for stable isotope analysis and will continue to be analyzed until all necessary samples have been collected in 2020. Managers and future investigators can use this data to understand and improve stable isotope analysis techniques that are used to assess partitioning among 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.

Doris Duke Conservation Scholars Program

Investigators: Ray Carthy, Christina Romagosa, Rena Borkhataria
Student(s): Meghan Beatty, PhD, WEC, Wes Boone, PhD, WEC, Julie Walker, PhD, SFRC, and Daniel Catizone, MS. 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 2019, the sixth cohort of scholars worked with graduate student mentors at Cape San Blas and at the Ocala National Forest. DDCSP cohort number 5 filled their second summer of the Program with a range of productive, instructive, and career-building internships with various agencies. 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
- 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

PUBLICATIONS

Blais, C.B., L.E. Henigan, N.T. Dzikowski, C.M. Romagosa, and **N.M. Claunch.** 2019. *Leiocephalus carinatus armouri* (Northern Curly-tailed Lizard). Diet. Herpetological Review 50:374–375.

Bonneau, M., J. Martin, N. Peyrard, L. Rodgers, C.M. Romagosa, and F.A. Johnson. 2019. Optimal spatial allocation of control effort to manage invasives in the face of imperfect detection and misclassification. Ecological Modeling 392:108–116.

Broxton, J.M., S.M. Thomason, C.M. Romagosa, and **N.M. Claunch**. 2019. *Agama picticauda* (Peters' Rock Agama). Geographic Distribution. Herpetological Review 50:745.

Dzikowski, N.T., C.B. Blais, L.E. Henigan, C.M. Romagosa, and **N.M. Claunch.** 2019. *Agama picticauda* (Peters's Rock Agama). Reproduction. Herpetological Review 50:132.

Evans, D. R., R.R. Carthy and S.A. Ceriani. Migration routes, foraging behavior, and individual fidelity of loggerhead sea turtles (*Caretta caretta*) satellite tracked from a globally important rookery. Marine Biology, 166:134.

Henigan, L.E., C.B. Blais, N.T. Dzikowski, C.M. Romagosa, and **N.M Claunch.** 2019. *Agama picticauda* (Peters' Rock Agama). Cannibalism. Herpetological Review 50:132–3.

Hill, M.K., M.C. Monroe, T.T. Ankersen, R.R. Carthy, T.A. Kay. 2019. Coastal armoring and sea turtles: Beachfront homeowners' opinions and intent. Coastal Management 47:594–610.

Hill, M.K., M.C. Monroe, T.T. Ankersen, R.R. Carthy, and T.A. Kay. 2019. Conservation easements and coastal armoring: protecting sea turtle nesting habitat through property ownership. Ocean and Coastal Management 182:104944.

McGuire, R., R. Suydam, L. Quakenbush, and A.N. Powell. 2019. Population trends of king and common eiders from spring migration counts at Point Barrow, Alaska between 1994 and 2016. Polar Biology 42: 2065–2074.

Powell, A.N., R. Bentzen, and R. Suydam. 2018. Migration trends for king and common eiders and yellow-billed loons past Point Barrow in a rapidly changing environment. Final OCS Study BOEM 2018–059.

Robinson, B. H., L.M. Phillips, and A.N. Powell. 2019. Energy intake rate influences survival rates of black oystercatcher broods. Marine Ornithology 47:277–283.

Sonsthagen, S., C. Haughey, M. Sexson, D. Solovyena, M. Petersen, and A. Powell. 2019. Temporal variation in genetic structure within the endangered spectacled eider. Conservation Genetics 21:175–179.

Swindall, J. E., H.K. Ober, M.M. Lamont and R.R. Carthy. 2019. Informing sea turtle outreach efforts to maximize effectiveness. Wildlife Society Bulletin 43:436–446.

Westfall, A.K., M.A. Miller, C.M. Murray, B.G. Falk, C. Guyer, and C.M. Romagosa. 2019. Host-specific phenotypic variation of a parasite co-introduced with invasive Burmese pythons. PloS One14: p.e0209252.

Student authors denoted in bold; Coop Unit scientists underlined.

THESES/DISSERTATIONS

Farid, R. H. 2019. Demography and population dynamics of the Gunnison's Prairie Dog (*Cynomys Gunnisoni*) in the Southwest United States. Ph.D. Dissertation, University of Florida, Gainesville, FL.

Overduijn, K. S. 2019. Reproductive success of American and Pacific Golden-Plovers (*Pluvialis dominica* and *P. fulva*) in a changing climate. M.S. Thesis, University of Alaska, Fairbanks, AK.

Vitale, N. 2019. Habitat change, predators, and disturbance: Factors influencing productivity of American Oystercatchers (*Haematopus palliatus*) nesting in Florida's Big Bend. M.S. Thesis, University of Florida, Gainesville, FL.

LIST OF PRESENTATIONS

Carthy, R.R., M. Mota, and N. Dejardin. 2019. Effects of engineered beaches on sea turtle incubation and hatching. Workshop presentation, 39th International Sea Turtle Symposium, Charleston, SC.

Carthy, R.R., T., Wibbels, and A. Rees. 2019. 3rd Workshop on the use of UAVs in sea turtle conservation and research. Workshop presentation, 39th International Sea Turtle Symposium, Charleston, SC.

Catizone, D., M. Lamont, C. M. Romagosa, and E. Suarez. 2019. Diamondback terrapin research in the Florida Panhandle. Jacksonville, FL. Feb 8, 2019.

Claunch, N.M. 2019. Reptile Invasions: Your Backyard and Beyond. Invited Speaker, Audubon Western Everglades Annual Meeting. Naples, Florida, Nov 11, 2019.

Claunch, N.M., Schoenle, L., Oakey, S., Downs, C., Martin, L., Romagosa, C.M., and R.N. Reed. 2019. Stress Indices in the infamous island invader, *Boiga irregularis*. Joint Meeting of Ichthyologists and Herpetologists, Snowbird, UT, Jul 24-28, 2019.

Claunch, N.M., Schoenle, L., Oakey, S., Downs, C., Martin, L., Reed, R.N., and C.M. Romagosa. 2019. Stress, Immunity, and Invasion: A case study of multiple populations of two lizards in their introduced range. Joint Meeting of Ichthyologists and Herpetologists, Snowbird, UT, Jul 24-28, 2019.

Claunch, N.M., R.N. Reed, and C.M. Romagosa. 2019. A case for physiological metrics in the management and prevention of reptile invasions. Greater Everglades Ecosystem Restoration Conference, Coral Springs, FL. Apr 22-25, 2019.

Fitzgerald, A. L., C. J. Robinson, J. M. Josimovich, B. G. Falk, E.B. Hanslowe, C.M. Romagosa, A. A. Yackel-Adams, L. R. Bonewell, R.N. Reed, T. Dean. 2019. Invasive species internship program in the Greater Everglades Ecosystem: history, accomplishments, and outreach. Joint Meeting of Ichthyologists and Herpetologists Snowbird, UT. July 24-28, 2019.

Hengstebeck, K.C., C.M. Romagosa, **P. Andreadis, and I.A. Bartoszek**. 2019. Burrow use and selection by invasive Burmese pythons in Florida. Greater Everglades Ecosystem Restoration Conference, Coral Springs, Florida, Apr 2019.

Hengstebeck, K.C., C.M. Romagosa, **P. Andreadis, and I.A. Bartoszek**. 2019. Burmese python use of gopher tortoise burrows in southwestern Florida. Joint Meeting of Herpetology and Ichthyology, Snowbird, UT, Jul 2019.

McFarland, H., A. Will, and A. Powell. 2019. Geolocators and stable isotopes reveal the migratory route and overwintering locations of an arctic-breeding passerine. American Ornithological Society, Anchorage, Alaska.

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. 2019. Highly competent native snake hosts extend the range of an introduced parasite beyond its invasive Burmese python host. Coral Springs, FL. April 22-25, 2019.

Poli, C., R.J. Fletcher, K. Meyer, and P. Darby. 2019. Movement patterns of post-fledging snail kites improve understanding of a key bottleneck in recovery of the species. Greater Everglades Ecosystem Restoration (GEER) Meeting, Apr 24, 2019.

Poli, C., R.J. Fletcher, E. Robertson, **B. Jeffrey**, **and S. Dudek**. 2019. Recent trends in snail kite monitoring, and research to inform habitat management. 7th Biennial FWC - IFAS Research Review, Mar 5, 2019.

Romagosa, C.M. 2019. Diet of the Burmese python in Florida. Everglades Cooperative Invasive Species Management Area Summit July 2019, and Big Cypress National Preserve Research Forum in Oct 2019.

Romagosa, C. M., D. Welbourne, E. Suarez, **D. Juarez Sanchez**, C. Dove, **I. Bartoszek**, B. Falk, and R. N. Reed. 2019. Prey species composition and spatial dietary shifts of the Burmese python in Florida. Greater Everglades Ecosystem Restoration Conference. Coral Springs, FL. 2019.

Tuma, M.E. and A.N. Powell. 2019. Movement patterns of red knots in the Southeastern U.S. and using citizen science data to propose locations for Motus towers in Florida. Southeast Red Knot Working Group meeting, St. Mary's, Georgia, Dec 5, 2019.

Tuma, M.E. and A.N. Powell. 2019. Movement and distribution of red knots (*Calidris canutus*) in the Southeastern US. Western Hemisphere Shorebird Group Meeting, Panama City, Panama, Oct 27, 2019.

Tuma, M.E. & A.N. Powell. 2019. Movement of red knots (*Calidris canutus*) in the Southeastern US. American Ornithological Society meeting, Anchorage, Alaska, Jun 28, 2019.

Tuma, M.E. & A.N. Powell. 2019. Survival and habitat selection of Piping Plovers (Charadrius melodus) in the Florida Panhandle. Florida Chapter of The Wildlife Society meeting, Melbourne, Florida, Apr 11, 2019.

Tuma, M.E. & A.N. Powell. 2019. Survival of an imperiled nonbreeding shorebird in Florida. Poster presented at the annual Fisheries, Wildlife, and Conservation Committee Meeting, Gainesville, Florida, Feb 2, 2019.

Tuma, M.E., R. Pruner, P. Kelly, & A.N. Powell. 2019. Hello, is it me your looking for? Using band resighting data to understand Florida's migratory shorebird populations. University of Florida Suds and Science event, Gainesville, Florida, Apr 3, 2019.

Udell, B., M. Bonneau, J. Martin, F. Johnson, C. Romagosa, B. Stith, L. Rodgers, and R. Gibble. 2019. Decision analysis for the optimal control of invasive plants, Greater Everglades Ecosystem Restoration, Coral Springs, Florida, USA. Apr 23, 2019

Vitale, N., J. Brush, and A. Powell. 2019. Factors limiting reproductive success of American Oystercatchers in Florida's Big Bend region. American Ornithological Society, Anchorage, Alaska, Jun 28, 2019.

Student authors denoted in bold; Coop Unit scientists underlined.

HONORS AND AWARDS

Natalie Claunch (PhD student): 2019 Office of Research Travel Grant - $400, 2019 SNRE Travel Grant - $250.

Kodiak Hengstebeck (PhD student): 2019 African Safari Club Scholarship - $2,500.

Molly E. Tuma (MS Student): 2019 University of Florida Graduate Student Association International Travel Grant - $350, 2019 Western Hemisphere Shorebird Working Group Travel Grant - $350, 2019 American Ornithological Society Travel Grant - $340

Brad Udell (PhD student): 2019 UF Grinter Graduate School Fellowship - $2500.

COMPLETED PROJECTS

Factors influencing productivity of American oystercatchers nesting in the Big Bend
Investigator: Abby Powell
Completion Date: May 2019
Funding Agency: NCBS, USGS (RWO 285)

Experiential learning through wildlife research and management of invasive reptiles
Investigator: Christina Romagosa
Completion Date: July 2019
Funding Agency: USGS (RWO 292)

Integration, validation, and fusion of small unmanned aircraft system multimodal sensor data in support of USGS
Investigators: Ray Carthy, Peter Ifju, Benjamin Wilkinson, Scot Smith and Matthew Burgess
Completion: August 2019
Funding Agency: USGS (RWO 300)

Evaluating effectiveness of outreach and trapping program to remove invasive wildlife in South Florida
Investigator: Frank Mazzotti
Completion Date: December 2019
Funding Agency: USGS (RWO 301)

Developing a priority fish tagging database to quantitatively assess range wide status and trends
Investigator: Bill Pine
Completion Date: December 2019
Funding Agency: USFWS Panama City (RWO 304)

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