ANNUAL REPORT JANUARY - DECEMBER 2018

DEDICATION

For Our 40th Anniversary (1979-2019), the 2018 Annual Report is Dedicated to:

The Florida Unit's Students – Past and Present

As part of our mission, Unit scientists teach graduate level courses, mentor graduate students, and provide continuing education for our cooperators. By combining teaching, research and technical assistance, the Cooperative Fish and Wildlife Research Unit provides students not only with an opportunity to pursue a graduate degree, but also receive unparalleled scientific training and applied work experience. By training the next generation of natural resource scientists, we enable the sound management of the nation's natural resources. Since its inception, the Florida Unit scientists have graduated 68 MS and 41 PhD students. We currently advise five MS and four PhD students:

Current students - Top Row (PhD): Rick Herron, Trenton Aguilar, Natalia Teryda, Nichole Bishop
Bottom row (MS): Scott Eastman, Nick Vitale, Molly Tuma, Alexis Cardas, Philipp Maleko

The Unit houses one Post-doc, eight PhD students, and five MS students working on Unit-associated projects.

To all of our Unitoids– ***the future is yours!***


UF
UNIVERSITY of FLORIDA
The Foundation for The Gator Nation


USGS
science for a changing world


FLORIDA FISH AND WILDLIFE
CONSERVATION COMMISSION


U.S.
FISH & WILDLIFE
SERVICE
DEPARTMENT OF THE INTERIOR


WILDLIFE MANAGEMENT INSTITUTE
WASHINGTON, D.C.

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.

2018 Photo Contest Winner: Sarah Dudek, PhD student, FL CRU - "More Snails Please"

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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 2018, over 306 projects totaling more than $56 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.
Cynthia Dohner	Regional Director, U.S. Fish and Wildlife Service Southeast Region, Atlanta, Georgia.
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

Melody Trapani, B.A.S. – Administrative Services Specialist II, Florida Cooperative Fish and Wildlife Research Unit, Department of Wildlife Ecology and Conservation, University of Florida. Responsible for administrative details of $4.92 M annual research program as well as supervision of staff, student activities, personnel, budgets, research work orders, contracts and grants within University, fiscal reports, travel, purchasing, payables, vehicles (State/Federal), website, and other related functions.

Lisa Burnett – Administrative Support Assistant, Florida Cooperative Fish and Wildlife Research Unit. She is primarily responsible for purchasing card processes within 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
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
Benjamin Wilkinson
Blair Witherington

Florida Fish and Wildlife Conservation Commission

Tyler Beck
Janell Brush
Robin Boughton
Matt Chopp
Andrew Cox
Carolyn Enloe
Dan Fox
Catherine Kennedy
Karl Miller
Raya Pruner
Erin Ragheb
Amy Schwarzer
Robin Trindall
Chris Wynn

U.S. Geological Survey

Nick Aumen
Fred Johnson
Jillian Josimovich
Margaret Lamont
James Lyons
Julien Martin
Robert Reed
Ken Rice
Hardin Waddle
Amy Yackel-Adams

U.S. Fish and Wildlife Service

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

National Park Service

Tylan Dean
Bryan Falk
Jennifer Ketterlin
Donna Shaver

National Oceanic and Atmospheric Administration

Nick Farmer
Joe Heublein
Brian Stacy

U.S. Army Corps of Engineers

Andy LoShiavo
Melissa Nasuti
Jenna May

South Florida Management District

Zach Welch

Conservancy of Southwest Florida

Ian Bartoszek

Audubon Florida

Marianne Korosy

RESEARCH PERSONNEL

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

Post-Doctoral Associates:

Matthew Burgess, PhD
Advisor: Ray Carthy
Graduation Date: August 2018
Research: Integration, validation and fusion of small unmanned aircraft system multimodal data

Dan Gwinn, PhD
Advisor: Mike Allen
Research: Climate change impacts on Florida freshwater fisheries

Nahid Jafari, PhD
Advisor: Christina Romagosa
Research: Integrating Science and Management for Optimal Prevention and Control of Aquatic Invasive Species in the Everglades

Jennifer Seavey, PhD
Advisor: Robert Fletcher and Bill Pine
Research: Climate change, sea-level rise, and biodiversity

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

Research Associates:

Mike Cherkiss, MS
Position: Wildlife Biologist/Crocodile and Python Project Manager
Research: American alligator and crocodile monitoring and assessment program (MAP). IFAS, Fort Lauderdale Research and Education Center

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: Ray Carthy

Nichole Bishop
Degree: PhD, Interdisciplinary Ecology
Graduation Date: December 2019
Research: Nutritional ecology of sea turtles
Advisor: Ray 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

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

Sarah Dudek
Degree: MS, Wildlife Ecology and Conservation
Graduation Date: May 2018
Research: Snail kite ecology
Advisor: Robert Fletcher

Scott Eastman
Degree: MS, School of Natural Resources and the Environment
Graduation Date: May 2016
Research: Evaluating the effects of climate change and coastal management adaption strategies on the reproductive success of marine turtles
Advisor: Ray Carthy

Daniel Evans
Degree: PhD, Wildlife Ecology and Conservation
Graduation Date: December 2019
Research: Elucidation of sea turtle developmental, foraging and reproductive migrations using satellite telemetry
Advisor: Ray Carthy

Kodiak Hengstebeck
Degree: MS, Wildlife Ecology and Conservation
Graduation Date: December 2018
Research: Assessing impacts of invasive pythons on gopher tortoises in Florida
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: Ray Carthy

Tomo Hirama
Degree: PhD, Wildlife Ecology and Conservation
Graduation Date: May 2020
Research: Standardized measurements of loggerhead sea turtle hatching orientation: Quantifying effects of artificial light and light mitigation programs
Advisor: Ray Carthy

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

Jame McCray
Degree: PhD, Wildlife Ecology and Conservation
Graduation Date: August 2018
Research: wildlife legislation and management in Florida: Sea turtles, a test case for creating effective policy
Advisors: Susan Jacobson and Ray Carthy

Caroline Poli
Degree: PhD, School of Natural Resources and the Environment
Graduation Date: August 2019
Research: Spatial ecology and population biology of snail kites
Advisor: Robert Fletcher

Molly Tuma
Degree: MS, Wildlife Ecology and Conservation
Graduation Date: December 2019
Research: Spatial Ecology and Population Biology of Snail Kites
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: Ray Carthy

Brad Udell
Degree: MS, Wildlife Ecology and Conservation
Graduation Date: August 2019
Research: Aquatic and invasive species
Advisor: Christina Romagosa

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

Tyler Ward
Degree: PhD, Mechanical and Aerospace Engineering
Graduation Date: May 2018
Research: UAS Autopilot development
Advisor: Peter Ifju

Travis Whitley
Degree: PhD, Mechanical and Aerospace Engineering
Graduation Date: May 2018
Research: UAS Autopilot development
Advisor: Peter Ifju

Yun Ye
Degree: PhD, School of Forest Resources and Conservation, Geomatics
Graduation Date: May 2018
Research: Computer recognition algorithms for UAS imagery
Advisor: Scot Smith

ACRONYMS

CRU	Cooperative Research Units, U. S. Geological Survey
IFAS	Institute of Food and Agricultural Sciences, University of Florida
FORT	Fort Collins Science Center
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
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
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

Principal Investigators: Abby Powell, Karl E. Miller
Student: Alexis Cardas, MS, WEC
Duration: August 2017 - April 2020
Funding Agency: FFWCC
In-Kind Support: FFWCC

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 intends to focus on the impacts that translocation could place on the donor population through monitoring of nesting success and productivity. Study objectives are to determine whether the removal of helpers from family groups of Florida scrub-jays is a valid option for future translocations. During two field seasons, January-July of 2018 and 2019, a subset of helpers will be removed from groups for translocation. Nests will be monitored within three categories of family groups: (1) no helpers, (2) helpers, (3) helpers removed. Data will be collected on productivity, nest success, weight of nestlings, time spent provisioning, and breeder persistence. Monitoring nests in groups with and without helpers will increase the understanding of how this cooperative breeder benefits from the presence of non-breeding individuals. 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. 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.

Survival, habitat use, and distribution of two federally-listed shorebird species in Florida

Investigator: Abby Powell
Student: Molly Tuma, MS, WEC
Duration: September 2017 - December 2019
Funding Agency: FFWCC and USFWS
In-Kind Support: Florida Audubon

Florida hosts nonbreeding populations of the federally-listed Piping Plover (*Charadrius melodus*) and the rufa Red Knot (*Calidris canutus rufa*); however, there is little information on their ecology in the state. As a result, there are few measures in place to protect their populations from threats, such as human and habitat disturbance. Shorebirds can spend up to 75% of their annual lifecycle on their wintering grounds, and conditions in these areas have carry-over effects that can drive population trends. Understanding the population conditions of Piping Plovers and Red Knots in Florida will help to determine effective management actions in the

state and contribute to range-wide conservation. In this study we estimated survival of Piping Plovers in the Panhandle, habitat use of 8 shorebird species (including Piping Plovers and Red Knots) in the Panhandle, connectivity of nonbreeding sites in Florida for Red Knots and plan to create a state-wide distribution map for Red Knots. Resight data for shorebirds have been collected in the Panhandle since 2013, and Red Knot resight data have been collected across Florida since 2008. We estimated Piping Plover survival from 2013-2017 using a Cormack Jolly-Seber model. We identified what environmental variables drive site selection of shorebirds using a distance-based redundancy analysis. We plan to analyze site use of Red Knots using a connectivity analysis and create distribution maps using species-distribution mapping methods. Piping Plover survival varied across years from 0.56 to 0.74 with a resight rate of 0.95-1. Preliminary analysis indicates that shorebirds could select sites in the Panhandle based on the amount of loafing and feeding habitat and the presence of falcons. Preliminary analysis indicates that Red Knots mainly use the Northeast and West coasts of Florida, with consistent by low exchange of birds between coasts. Florida hosts a wide variety of nonbreeding shorebird species. Without reliable research addressing basic ecological processes in nonbreeding shorebirds in Florida, management actions cannot be effectively implemented in the state.

Factors influencing productivity of American Oystercatchers nesting in the Big Bend

Investigator(s): Abby Powell and Janell Brush
Student: Nick Vitale, MS, WEC
Duration: September 2016 - May 2019
Funding Agency: NCBS, USGS (RWO 291)
In-Kind Support: FFWCC

In Florida's Big Bend region, oystercatcher productivity is poor compared to other locations. The spoil islands at the Cross Florida Greenway State Recreation and Conservation Area provide habitat for one of the largest breeding concentrations of American Oystercatchers in the state. However, each year for largely unknown reasons, most nests fail to successfully fledge chicks. American Oystercatchers are a species of high conservation concern in the U.S. Shorebird Conservation Plan, so there is a strong desire to manage for these birds. In addition, management for this one species will benefit many other coastal species as well. The objective of this study was to determine factors limiting Oystercatcher productivity in the Big Bend both in the form of immediate threats as well as long-term habitat changes. During the 2017 and 2018 oystercatcher-breeding season, we intensively monitored nesting birds using direct observation, remote cameras and telemetry in order to determine reproductive success rates and causes of failure/disturbance. We also analyzed aerial imagery since 1974 to access habitat changes. Over the two years of study, we found that nest site overwash was the leading cause of nest failure, especially in the Cedar Key area. We attributed chick failures largely to predation. However, field observations suggest that limited food availability may be compounding this problem. In addition, we modeled habitat change

across a ~40-year period and found that the limited habitat that is available is eroding away over time, and in some areas may be accelerating in the last two decades. This research will inform us how to better manage and conserve important nesting sites in Florida for oystercatchers and other shorebirds.

Effects of coastal dynamics and climate on loggerhead turtle nests success and management

Investigator: Ray Carthy
Student: Nichole Bishop, PhD, SNRE
Duration: December 2014-December 2018
Funding Agency: USGS (RWO 285)
In-Kind Support: Whitney Laboratory for the Marine Bioscience

St. John's county beaches are popular nesting sites for sea turtles; these same beaches are also popular destinations for people and range in development from dense residential properties to protected, undeveloped reserve. Beach slope is an important factor in sea turtle nesting preference and is a result of multiple factors including erosion and accretion catalyzed by human activities. Although continued monitoring was conducted at all sites, special focus was given to the Archie Carr property just north of Marineland, Florida, given its status as the world's first sea turtle conservation easement. Baseline monitoring is necessary to establish changes to beach morphodynamics given their varied anthropogenic usage, potential impacts from climate change and recent hurricanes (Matthew 2016; Irma 2017). We characterize the Archie Carr beach property in Summer Haven by: 1) monitoring beach slope, 2) measuring sand grain size, and 3) surveying flora. Our methods included: 1) conducting three transects at each beach annually from 2014 to the present (2018) and 2) using the same transects from objective 1, we collected sand samples at the base of the dune, the middle of the dune and the swash zone. Each sample was passed through a sieving column and composition (e.g. shell, plant/organic material, sand, charcoal, etc.) of each fraction was recorded according to the Udden-Wentworth grain-size classification scheme. Three belt transects extended from the vegetation line on the foredune (GPS coordinates were used where dunes were washed away due to hurricanes) to the water line in the estuary. Every 5 m, 1m^2 quadrats were sampled in which plant species and percent coverage for each species were recorded. Summer Haven property has experienced depletion of vegetation from the beach to the estuary as a result of salt water inundation (Hurricane Matthew storm surge followed by Hurricane Irma) and sand deposition. Severe erosion is occurring along the beach and an average of 42% of the beach above the high tide line has been lost since 2014. The Archie Carr property is an active sea turtle nesting beach; however, reduced area (46%) for sea turtle nests as a result of erosion may limit the number of sea turtles able to successfully nest at this beach.

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

Investigator(s): Nichole Bishop & Ray Carthy
Student: Nichole Bishop, SNRE
Duration: December 2014 – December 2019
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 will use a dataset from specimens that identifies and quantifies stomach contents of 67 *D. mawii* of various age/size, sex, and habitats. We will conduct feeding trials with yearling and adult *D. mawii* to determine differences in digestive performance among age classes and collect 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.

The path most travelled: Leatherback and Chelonlid sea turtle migration movements and foraging areas

Investigator: Ray Carthy
Student: Daniel R. Evans, PhD, WEC
Duration: January 2014 - May 2018
Funding Agency: Sea Turtle Conservancy

Foraging in the marine environment is difficult as a result of the patchiness of food, often due to oceanic features. In order to reduce migration energy costs, sea turtle foraging areas need to be predictable and persistent over time. By connecting oceanic features and animal movements, it is possible to identify foraging areas and migration pathways and the associated environmental factors of these areas in the seascape. Research objectives are 1) to identify ocean features that characterize foraging areas in

the Atlantic basin used by post-nesting population on the Caribbean coast of Panama to see if these areas are geographically stable, 2) to model the migration movements of leatherbacks and three Chelonid sea turtle species (green, loggerhead, and hawksbill) from nesting populations in Panama, Florida, Costa Rica and Nevis, and 3) to overlay identified sea turtle foraging areas and migration corridors among the 4 species and with known model (SSSM) was used to determine changes in behavior of leatherback turtles and 3 Cheloniidae species to identify foraging areas, migration pathways, spatial overlap among the 4 species, and the use of MPAs by the tracked turtles. Seven environmental variables were extracted from remote sensing imagery at each sea turtle satellite telemetry location to compare the characteristics of different behaviors and different foraging regions. Results suggest that leatherbacks may not just be bimodal (migration or foraging) in their movement behavior, but that a third intermediate behavior is taking place. This third behavior appears to be different for leatherbacks foraging in the Gulf of Mexico compared to those foraging in the North Atlantic Ocean, with a searching compared to a wandering behavior, respectively. Searching behavior overlapped with restricted area foraging, while the wandering behavior was spatially separate from both migration and restricted area foraging behaviors. Loggerhead turtle residential and core foraging areas were significantly larger than green and hawksbill turtle residential and core foraging areas. Primary core foraging areas environmental characteristic were different among species, mostly a result of each species having different diet regimes. Results from the use of MPAs by sea turtles, the overlap among and within species, and the possible role of nesting departure date in determining foraging region. This project was active last year and was completed in mid-2018. Two manuscripts resulting from the work are in pre-submission review.

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

Investigator: 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 the Northeastern Gulf of Mexico is an important developmental foraging ground for juvenile sea turtles. However, we lack basic knowledge on this juvenile life stage. The Northwest Atlantic green turtle (*Chelonia mydas*) population is listed as threatened in the United States and federal wildlife managers have stressed the need for in-water abundance estimates and more information on the poorly understood juvenile neritic stage. There are five specific goals of this study: (1) conduct region-wide vessel surveys, (2) survey sites with low, medium and high juvenile green turtle abundance and determine the abiotic and biotic factors driving abundance, (3) capture green turtles and determine their size class, health, sex, diet and genetic structure, (4) determine green turtle seasonal movements, and (5) use acoustic telemetry to study green turtle intraspecific behavior. Standardized vessel surveys and captures will be used to describe abundance, size, diet, sex, health and genetic makeup. Water quality and benthic factors will be measured to determine correlations with abundance. A smaller sample of green turtles will be outfitted with satellite and acoustic transmitters to determine their home range and seasonal movements. During recent region-wide surveys, 86 sea turtles were sighted on 270 km of transects in Apalachee Bay, Steinhatchee and Crystal River. The majority

were juvenile green turtles (72%), followed by juvenile Kemp's ridleys (15%), subadult and adult loggerheads (12%) and an unknown species (1%). Estimated density was highest in Crystal River (27.5 km^2; 7.5–100.5 95% CI), however, wide variation at all sites was due to turtle aggregations or 'hotspots'. This study will lead to a better understanding of the distribution of sea turtles in this region over space and time. Monitoring these protected species and their habitat are important long-term measures given concerns over harmful algal blooms, climate change and the global loss of seagrass beds.

Standardized measurements of loggerhead sea turtle hatchling orientation: Quantifying effects of artificial light and light mitigation programs

Investigator(s): Ray Carthy and Blair Witherington
Student: Shigetomo Hirama, PhD, WEC
Duration: 2015 - 2018
Funding Agency: FFWCC, Disney Conservation program
In-Kind Support: Florida Sea Turtle Nesting Survey Permit Holders

Artificial lighting disorients sea turtle hatchlings and reduces their chances of survival. The recovery plan for northwest Atlantic loggerhead sea turtles lists light pollution among the most important mortality factors. Light management as a means of reducing that mortality is under way, but there are no reliable measures for assessing progress and effectively guiding management. The current project provided information on sea turtle hatchling orientation on the Florida beaches along the Gulf of Mexico and Atlantic Ocean. Standardized measurements were used to map the severity of disorientation caused by artificial lighting. The results will directly inform management agencies to reduce artificial lighting so that number of hatchlings that enter the ocean can be increased. Project objectives were to collect data on light intensity and hatchling orientation and to identify the degree of disorientation such that spatial and temporal trends could be assessed. Detail in hatchling orientation measurement provided insights into beach lighting management strategies for reducing disorientation of hatchlings. We measured light intensity on the beach using a photometer at Wabasso Beach, Cocoa Beach, Boca Raton, and Miami Beach. Along with light intensity, we measured two parameters that describe the accuracy of hatchling orientation: angular range and modal divergence from the ocean at 20 beaches throughout Florida. The angular range describes the spread of tracks that hatchlings leave in the sand; it is the absolute value of the difference in bearings between the two most widely separated tracks. Modal divergence from ocean direction shows the divergence of modal direction (most frequent direction that hatchlings traveled) from the ocean direction. Like angular range, a smaller value indicates better accuracy of hatchling orientation. The two parameters proved to be strong quantitative indicators of sea turtle hatchling orientation accuracy and were used to develop a predictive model for disorientation that is available online for stakeholder use, at https://hoiprediction.shinyapps.io/hatchling/. Two publications from this work are currently in preparation. Florida has extensive human development (sources of light pollution) along the coastline and high frequencies of disorientation on the beaches. This work will provide information on the severity of hatchling disorientation to the stakeholders and responsible entities.

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

Investigator: Ray Carthy
Student: Natalia S. 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 interactions with fisheries range-wide. Due to their complex life cycle, research and further conservation efforts have relied on technology improvements 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. I will conduct aerial surveys for leatherback turtles with UAS within the RLPE in different seasons of the year, starting in November 2019. I will test the efficiency and detection capability of UAS as a surveying method and measure oceanographic and weather parameters and food patches availability. Using data from the Argentinean Secretary of Agroindustry fishing fleet database, I will map the fishing fleet's overlap with turtle distribution. 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 of the endangered leatherback turtle 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.

Demographic, movement, and habitat of the endangered snail kite in response to operational plans in Water Conservation Area 3A

Investigator: Robert Fletcher
Student: Sarah Dudek, MS, SNRE
Duration: September 2014 - December 2018
Funding Agency: Army Corps of Engineers

The overarching goals of this monitoring are to provide reliable information on population size and trends, as well as key demographic, habitat, and foraging information of relevance to the recovery of this species. Demographic analyses revealed that snail kite abundance drastically declined between 1999-2008. The period population decline coincided, in part, with drought conditions throughout the southern portion of the kites' range. The objective of this research is to monitor the birds' response to environmental changes focusing on the most critical demographic parameters: survival, reproduction, recruitment, and population growth rate. Snail kites were monitored by performing band-resight surveys in various wetlands. Nests were also monitored, and nestlings were banded with unique bands. A total 624 active nests with known fates were detected. Of those 303 were successful. We banded 789 nestlings and 600 were observed to have fledged. Overall apparent nest success was 49 (± .03) %. Since the snail kite population is critically endangered and because adult fertility plays such an overwhelming role in the population growth rate, it is critical to identify and attempt to limit factors that negatively affect snail kite demography.

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 2019
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 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 2016-2018 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 2019 we plan to deploy additional tags. 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. In particular, we will emphasize identifying potential thresholds in hydrology and snail metrics that can explain changes in movement behaviors.

Foraging ecology and diet of the Florida bonneted bat

Investigator: Holly Ober
Student: Elysia Webb, MS, WEC
Duration: August 2016 - August 2018
Funding Agency: FFWCC; Bat Conservation International

The Florida bonneted bat, *Eumops floridanus*, was listed as a federally endangered species in 2014. These bats are endemic to southern Florida. Virtually nothing was known about the nightly foraging movements or diet composition of these bats before this research began. A better understanding of the foraging habits and diet of this elusive species is required to facilitate

development of strategies for conservation and management of habitat for the species. We investigated the distance bats fly each night while foraging, which land cover types bats prefer to forage in, which insects bats consume, seasonal variation in diet, and geographic variation in diet. We used GPS satellite tags to track foraging paths of bats. We also collected excrement (guano) one night each month for a full year beneath bat roosts to assess seasonal variation in bat diets. Lastly, we collected guano from free-flying bats at the northern and southern extent of the species range to assess geographic variation in diets. We applied GPS units to 37 bats in Babcock-Webb Wildlife Management Area and obtained movement data from 26 of them. On average, females traveled farther distances per night than males, and bats travelled longer distances in December than in April or August. Bats showed a preference for agricultural areas (row crops, pasture, orchards, tree farms). Metabarcoding revealed that these bats specialized on Lepidoptera (moths). Diet breadth was widest in winter, followed by spring, summer, and then fall. Diet breadth was similar between bats at the northern and southern extent of the species range. Our finding that bats which roosted in natural areas foraged in agricultural lands long distances away suggests the species may need landscape mosaics to meet their resource needs. Management strategies should take into account the intersexual and seasonal differences in foraging movements. A high degree of diet overlap among locations suggests similar strategies could be helpful regarding protection or augmentation of prey resources across the species geographic range.

Using models to assess Gulf sturgeon population viability

Investigator(s): Bill Pine and Rob Ahrens
Students: Krystan Wilkinson, PhD
Duration: January 17 - December 2017
Funding Agency: NOAA-Fisheries (RWO 298)
In-Kind Support: SNRE and WEC

Gulf sturgeon, 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-live span and slow population recovery rate. We are working with NOAA and USFWS resource managers to develop two tools to evaluate tradeoffs among management actions designed to promote Gulf sturgeon population recovery. The first was an age-structured population model and the second an individual based population viability model. In the US Gulf of Mexico, Gulf sturgeon *Acipenser oxyrinchus desotoi* supported a short-lived commercial fishery in the early 20th century. Despite fishery closure since 1985, the stock has not recovered. We developed an age-structured population model for Gulf sturgeon to examine population recovery characteristics. We used this model to assess factors that influence population recovery rate and what strategies could be adopted by managers to promote species recovery. We also assessed extinction risk for Gulf sturgeon populations and how changes in frequency of episodic mortality events could influence population viability. Using the Apalachicola River Gulf sturgeon population as a case history, we found that this population is not likely to recover fully to pre-exploitation levels until over 100 years from fishery closure, well exceeding a recovery target date of 2023 specified in the Gulf sturgeon recovery plan. This slow population recovery is a result of a combination of erosion of the adult age-structure when exploitation was high reducing population spawning potential and Gulf sturgeon life-history characteristics. We also found that extinction risk for Gulf sturgeon is low, but as episodic mortality events or total mortality increased, extinction risk also increased. Managers can use our models as tools 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.

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 2017
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 addresses 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. This is an ongoing project. However, 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, but the results will allow for improved data curation and access leading to more rapid analyses to inform management decisions for Gulf sturgeon.

Population ecology of the diamondback terrapin in the Big Bend region of Florida

Investigator(s): Steve Johnson, Mike Allen
Students: Travis Thomas, PhD, WEC
Duration: September 2016 - December 2019
Funding Agency: FFWCC
In-Kind Support: UF/IFAS NCBS

The Diamondback Terrapin is the only turtle species found in the coastal marshes of North America and plays a vital ecological role in the salt marsh ecosystem. However, the Diamondback Terrapin has experienced population declines throughout its range due to loss of habitat and bycatch mortality from drowning in crab traps. Several studies in Florida have documented local populations; however, to date no population estimates are available for the Big Bend Region of Florida. The lack of data available for the Big Bend region is of conservation concern, and information collected could be useful in developing a long-term conservation strategy for this species. The objective of this study is to evaluate occupancy and estimate abundance for the Diamondback Terrapin on coastal islands in the Big Bend region of Florida. In 2018, we used satellite imagery to characterize 24 coastal islands in the Suwannee River Estuary. We surveyed each island multiple times for Diamondback Terrapins. Turtles were hand captured by walking the tidal wrack line. Captured turtles were measured, weighed,

marked, and released. Research is ongoing and turtle surveys will continue in March of 2019. In 2018, turtle surveys produced a total of 3 captures from 3 discrete islands. Our surveys have produced low capture rates compared to studies conducted in the panhandle of Florida, which could result from a lower use of coastal islands in the Big Bend region. In 2019, we plan to continue measuring island habitat variables and conduct more turtle surveys. This study will fill critical data gaps in the Diamondback Terrapin's ecology and distribution within the Big Bend region of Florida.

Changes in mammal communities across the Greater Everglades

Investigator: Robert McCleery
Student(s): Jose Soto and Brian Reichert, Post Docs, WEC
Duration: June 2014-December 2018
Funding Agency: USGS (RWO 288)

Invasive Burmese pythons (*Python molurus bivittatus*) may be causing declines in medium- to large-sized mammals throughout the Greater Everglades Ecosystem (GEE); however, other factors such as urbanization, habitat changes and drastic alteration in water flow may also be influential in structuring mammal communities. The loss of mammals in the Greater Everglades is likely causing drastic losses in the ecological functioning of the system. The cause of decline must be understood as well as what makes some mammals more vulnerable to declines than others so we can focus our conservation efforts on them. We are helping managers identify which mammals are vulnerable to decline from pythons and where these declines are likely to occur. The aim of this study was to gain an understanding of what environmental features and traits of mammals make populations vulnerable to decline from invasive pythons. We used data from trail cameras and scat searches with a hierarchical community model that accounts for undetected species to determine the relative influence of introduced Burmese pythons and environmental features on mammalian species and their different behavioral and morphometric traits. Python density had negative effects on all most species. Despite these negative effects, occurrence of some species increased significantly near urban areas. Additionally, mammals that were large, fecund and/or occupy a number of habitats were more resilient to pressure from increase numbers of pythons. Small, less fecund and specialized mammals appeared to decline with increased presence of pythons. Python-induced changes to mammal communities may be mediated urban, and animals that are fecund generalist. However, specialized endemic mammals are under sever risk from pythons and throughout most of the everglades pythons are likely causing a fundamental restructuring of the food web. These changes are likely to lead to declines in ecosystem function, and creating complex and unpredictable cascading effects.

Burmese python use of gopher tortoise burrows in southwestern Florida

Investigator: Christina Romagosa
Cooperator: Robert Reed
Student(s): Kodiak Hengstebeck, MS, WEC
Duration: January 2016 - December 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 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, (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. Preliminary surveys indicated that pythons are using 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 suggested 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 are capable of maintaining 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.

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)

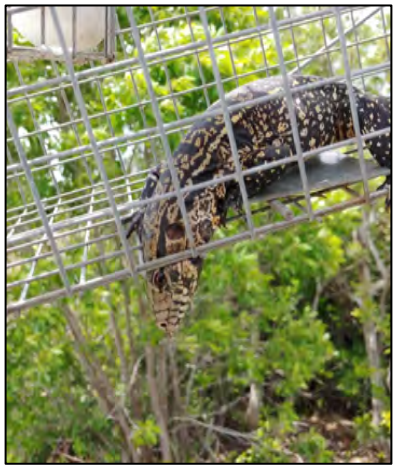
Invasive plants and animals are a major biological and economic issue facing conservation efforts worldwide, and they are particularly problematic to conservation and restoration efforts in the Florida Everglades. Natural resource managers are tasked with finding cost effective solutions to best monitor 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 in Loxahatchee

National Wildlife Refuge, and Argentine black and white tegus 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 in Loxahatchee Wildlife Refuge, and of tegus in the Southern Everglades are in development, and projected to be finished in Fall 2019. The melaleuca dynamics model and tegu dynamics model are also both in development. Prototypes of both decision frameworks are also projected to be completed by the Fall of 2019. Our decision analytic frameworks will provide managers 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 - May 2020
Funding Agency: USGS (RWO 303)

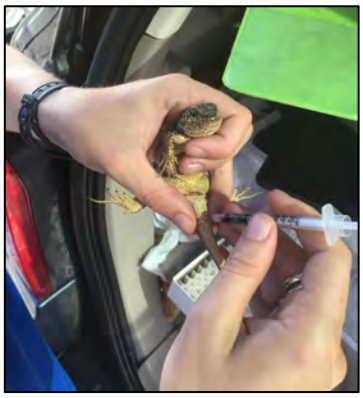
Diamondback terrapins, comprised of seven subspecies, range from Massachusetts to Texas and are the only turtle to be found exclusively in coastal salt marshes. Throughout their extensive range, they face a variety of threats from human encroachment, bycatch, and road mortality. To help understand the 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 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, and a few additional sites throughout northwestern Florida. We have selected sites throughout NW Florida to search for and collect data on terrapins, and our primary study site is in St. Joseph Bay. We will be collecting habitat variables, such as air temperature, water temperature, and coastal island make up. We will then use these variables and occupancy modeling to help predict terrapin presence/absence from a given area. When terrapins are found, we take measurements, biological samples, GPS points at the capture location and sex individuals. To date, we have collected and tagged over 300 individual terrapins comprised of males, females, juveniles, and hatchlings. With successful captures at three of our five proposed sites, we hope to continue this success in the 2019 season at all our sites. Moving forward, our work is the beginning of a long-term monitoring project that will produce some of the first data on terrapins from northwestern Florida.



Experiential learning through wildlife research and management of invasive reptiles

Investigator: Christina Romagosa
Student: Natalie Claunch, PhD, SNRE; Diego Juarez, PhD, WEC
Duration: August 2017-July 2022
Funding Agency: USGS (RWO 302)
2018 Interns: Amanda Bryant, Juan Camacho, Elizabeth Garcia, Arik Hartmann, Elizabeth Scarlett, Mackenzie Stewart, Sarah Cheatham, Frances Cole, Alexander Goerler, Madison Nelson
In-Kind Support: Graduate Stipend for N. Claunch through UF Graduate School Fellowship; UF College of Agricultural and Life Sciences, intern support (Elizabeth Garcia and Madison Nelson).

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. 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. To date, more than 30 interns have worked/are working on the cooperative projects. These interns have gone on to other technician jobs, graduate school, or permanent positions with agencies (USGS, NPS, US Forest Service). In 2018, interns removed the highest number of tegus (319) along the trap lines despite lower trapping effort compared to recent years. Tegus are expanding their range slightly north, and no tegus were observed on the camera network inside Everglades National Park. The continued presence of tegus, and their capacity to expand their range, is of particular concern to ecologically sensitive areas. Everglades National Park will continue trapping efforts in 2019 to prevent incursion of tegus into the park. As nonnative species introductions increase across the United States, so will the need for wildlife ecologists that are trained to address this complex issue.



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. While many studies focus on impacts of introduced species and specific control techniques after a species is established, there is less known about how introduced species succeed during introduction and range expansion. Prevention of invasions as well as 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. The objective of this study is to assess physiological metrics that are implicated in invasion success across many established and spreading reptile species. Specifically, we are assessing patterns in stress and immune responses of invasive reptiles in an effort to explore whether these blood-sample-derived metrics may be useful early indicators of invasion success. In 2017-2018, blood samples were collected from wild Burmese pythons, green iguanas, and brown tree snakes where these species are proliferating (SW FL and Key Largo). In addition, 7 populations of Northern curly-tailed lizards and 4 populations of Peters' rock agamas, two species which are rapidly expanding their range across Florida, were sampled for blood and tissue. Stress hormones were assessed immediately at capture and after 1 hour of acute confinement stress. Immune responses were assessed via bacterial killing ability of the blood plasma. Samples are currently being processed. We plan to collect samples from additional species and native-range populations for comparisons. Preliminary analyses on brown tree snakes indicate that hormonal responses to stress change over the course of an invasion, and that immune responses are correlated to circulating stress hormones. Physiological information gained from blood samples may provide a relatively simple, cost-effective method for prioritizing management efforts. Results of these assays can be obtained quickly from wild animals, then compared to patterns of successful species and populations to bolster current screening tool efforts that facilitate rapid response decisions for eradication and containment.

Doris Duke Scholars Program

Investigator(s): Ray Carthy, Christina Romagosa, Rena Borkhataria
Student(s): Meghan Beatty, PhD, Wes Boone, PhD, Julie Walker, PhD
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. The summer of 2018 saw our fifth cohort of 4 scholars go into the field with 2 new graduate student mentors, at the Whitney Lab and at the Ocala National Forest. DDCSP cohort number 4 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

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: *in press*

Bonneau, M., J. Martin, N. Peyrard, L. Rodgers, C. M. Romagosa, and F. A. Johnson. *In press*. Optimal spatial allocation of control effort to manage invasives in the face of imperfect detection and misclassification. Ecological Modelling 392: 108-11.

Cattau, C. E., R. J. Fletcher, Jr., C. W. Miller, R. T. Kimball, and W. M. Kitchens. 2018. Rapid morphological change of a top predator with the invasion of a novel prey. Nature Ecology and Evolution 2:108-115.

Churchwell, R. T., S. Kendall, S. C. Brown, A. L. Blanchard, T. E. Hollmen, A. N. Powell. 2018. The first hop: Use of Beaufort Sea deltas by hatch-year semipalmated sandpipers. Estuaries and Coasts 41:280-292. https://doi.org/10.1007/s12237-017-0272-8.

Claunch, N. and Crowe-Riddell, J. 2018. *Leiocephalus carinatus* (Northern Curly-tailed Lizard). Extreme Fecal Impaction. Herpetological Review: 118-119.

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: *in press*

Fujisaki, I., M. Lamont and R. R. Carthy. 2018. Temporal shift of loggerhead nest sites in a highly eroding beach in a dynamic barrier island. Ocean and Coastal Management. 155:24–29. https://doi.org/10.1016/j.ocecoaman.2017.12.032Be

Hanslowe, E., C. V. Calafiore, K. N, Sykes, N. Van Ee, B. Falk, A. Yackel, and R. Reed. 2018. *Salvator merianae* (Argentine Tegu). Attempted Predation. Herpetological Review, 48(3), pp.659-660.

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: *in press*.

Herren, R. M., D. A. Bagley, M. J. Bresette, K. G. Holloway-Adkins, D. Clark, and B. E. Witherington. 2018. Sea turtle abundance and demographic measurements in a Marine Protected Area in the Florida Keys, USA. Herpetological Conservation and Biology 13:224–239.

Latty, C. J., T. E. Hollmen, M. R. Petersen, A. N. Powell and R. D. Andrews. 2018. Biochemical and clinical responses of Common Eiders to implanted satellite transmitters. Condor 120: 185-187.

Rees, A. F., L. Avens, K. Ballorain, E. Bevan, A. C. Broderick, R. R. Carthy, M. J. A. Christianen, G. Duclos, M. R. Heithaus, D. W. Johnston, J. C. Mangel, F. Paladino, K. Pendoley, R. D. Reina, N. J. Robinson, R. Ryan, S. T. Sykora-Bodie, D. Tilley, M. R. Varela, E. R. Whitman, P. A. Whittock, T. Wibbels, B. J. Godley. 2018. The potential of unmanned aerial systems for sea turtle research and conservation: a review and future directions. Endangered Species Research 35: 81-100.

Robertson, **E. P.,** R. J. Fletcher, Jr**.,** and J. D. Austin. 2017. The causes of dispersal and the cost of carryover effects for an endangered bird in a dynamic wetland landscape. Journal of Animal Ecology 86:857-865.

Robertson, E. P., R. J. Fletcher, Jr., and J. D. Austin. *In press*. Microsatellite polymorphism in the endangered snail kite reveals a panmictic, low diversity population. Conservation Genetics.

Robinson, B. H., H. A. Coletti, L. M. Phillips and A. N. Powell. 2018. Are prey remains accurate indicators of chick diet? A comparison of diet quantification techniques for Black Oystercatchers. Wader Study (1): 20-32.

Student authors denoted in bold.

THESES/DISSERTATIONS

Boldenow, Megan. 2018. Do wintering conditions drive population trends in semipalmated sandpipers (*Calidris pusilla*)? Evidence from a corticosterone biomarker. M.S. Thesis, University of Alaska Fairbanks, Fairbanks, Alaska.

Dudek, Sarah. 2018. Mapping prey distribution and predator response across the geographic range of a wetland-dependent raptor: an example with the snail kite. M.S. Thesis, University of Florida, Gainesville, Florida.

Evans, Daniel. 2018. The path most traveled: Using satellite telemetry to identify and characterize migration pathways and foraging areas of four species of marine turtles in the north Atlantic and wider Caribbean. Ph.D. Dissertation, University of Florida, Gainesville, Florida.

Hengstebeck, Kodiak. 2018. Burmese python use of gopher tortoise burrows in southwestern Florida. M.S. Thesis, University of Florida, Gainesville, Florida.

Hirama, Shigetomo. 2018. Evaluation of the impact of artificial lighting on sea turtle hatchling orientation. Ph.D. Dissertation, University of Florida, Gainesville, Florida.

McCray, Jame. 2018. Sea turtle friendly lighting in Florida: A multi-level evaluation of policy implementation and effectiveness. Ph.D. Dissertation, University of Florida, Gainesville, Florida.

Webb, Elysia. 2018. Foraging ecology of the Florida Bonneted Bat, *Eumops floridanus*. M.S. Thesis, University of Florida, Gainesville, Florida.

LIST OF PRESENTATIONS

Bishop, N. D. and R. R. Carthy, R.R. 2018. A novel method for assessing color differences in dichotomous groupings: An example with sexual dichromatism in the Central American river turtle (*Dermatemys mawii*). Poster presented at the 16th Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles. Fort Worth, TX, Aug 12-15, 2018.

Bishop, N. D., T. Pop, T. R. Rainwater, J. Marlin, K. A. Bjorndal, and R. R. Carthy. 2017. Is coprophagy an important management consideration for the captive breeding of herbivorous turtles? The effects of adult fecal matter consumption in hatchling *Dermatemys mawii* (Central American River Turtle). Paper presented at the 15th Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles. Charleston, SC.

Bishop, N., R. Hudson, J. Marlin, T. Pop, S. Boylan, R. Atkinson, and R. Carthy. 2016. Estimating age and size at sexual maturity in the critically endangered Central American river turtle, *Dermatemys mawii*. Paper presented at the 14th Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles. New Orleans, LA.

Bishop, N., J. Polisar, P. Eliazar, K. Bjorndal, K., and R. Carthy. 2016. Wild diet of *Dermatemys mawii* assessed by stomach contents analysis. Paper presented at the 2nd Hicatee Research Symposium. Toledo District, Belize.

Bishop, N., T. Pop, J. Marlin, R. Hudson, S. Boylan, J. Polisar, and R. Carthy. 2016. Utilizing growth rates to determine the onset of sexual maturity of *Dermatemys mawii* at the Hicatee Conservation and Research Center at BFREE. Paper presented at the 2nd Annual Hicatee Research Symposium. Toledo District, Belize.

Carthy, R. R., J. R. Brothers, V. Bézy, K. J. Lohmann, and M. M. Lamont. 2018. Ontogeny of orientation responses in developing sea turtle embryos. Presentation at the 38th International Symposium on Sea Turtle Biology and Conservation, Kobe, Japan. Feb. 18-24, 2018

Evans, D. R., R. R. Carthy, and S. A. Ceriani. 2018 - Ten years of satellite tracking loggerheads from the Archie Carr National Wildlife Refuge. Barrier Island Center Meeting, Melbourne Beach, FL, Sept. 2018.

Evans, D. R., R. R. Carthy and C. Ordoñez. Which way do you go: satellite telemetry reveals regionally different foraging behavior of leatherback turtles. Presentation at the 38th International Symposium on Sea Turtle Biology and Conservation, Kobe, Japan. Feb. 18-24, 2018

Hengstebeck, K. C., C. R. Romagosa, P. Andreadis, and I. A. Bartoszek. Trapping large constrictors from underground refugia. Everglades Cooperative Invasive Species Management Area: Everglades Invasive Species Summit, Davie, Florida, July 2018.

Hengstebeck, K. C., C. R. Romagosa, P. Andreadis, and I. A. Bartoszek. Burrow use and selection by invasive Burmese pythons in southwestern Florida. Annual Gopher Tortoise Council Meeting, Lake Placid, Florida, July 2018.

Hengstebeck, K. C. 2018. Outreach Presentation: Invasive pythons in southwest Florida. Audubon of the Western Everglades, Naples, Florida, December 2018.

Hirama, S., M. Wideroff, R. R. Carthy, and B. Witherington. 2018. Measuring the impact of light pollution on hatchling orientation. Presentation at the 38th International Symposium on Sea Turtle Biology and Conservation, Kobe, Japan. Feb. 18-24, 2018.

McCleery, R. A. 2018. The cause and consequences of South Florida's precipitous decline in mammals. University of Missouri, Columbia, MO. *Invited Seminar*.

Robinson, C., M. Mulholland, W. W. Boone IV, C. M. Romagosa, R. R. Carthy, and **N. D. Bishop.** 2018. The effect of microplastic beads on the clearance rate of ctenophores (*Mnemiopsis leidyi).* Poster Presented at the 103rd Ecological Society of America Annual Meeting. New Orleans, Louisiana, Aug. 5-10, 2018.

Pine W. E. and A. Breton. Gulf sturgeon tagging database training workshop. Gulf Sturgeon Working Group Annual Meeting. Pascagoula, Mississippi. April 2018.

Powell, A. N. 2018. Conservation of arctic birds: filling in the missing pieces. Department of Zoology Seminar Series, University of Illinois, Carbondale IL. November 2018. *Invited speaker.*

Soto-Shoender, J., R. A. McCleery, D. C. Gwinn. Life history traits determine resilience of native mammals to an invasive predator, the Burmese Python, in the Greater Everglades Ecosystem. The Wildlife Society Annual Conference, Cleveland, Ohio, 2018.

Tuma, M. E., P. Kelly, R. Pruner, and A. Powell. Why should we care about nonbreeding shorebirds in Florida? Poster presented Florida Chapter of The Wildlife Society Annual Meeting, Crystal River, Florida, 2018.

Udell, B. J., C. M. Romagosa, J. Martin, R. J. Fletcher, F. Johnson, H. Waddle. Poster: Informing and optimizing removal efforts to monitor, control, and contain the Argentine Black and White Tegu. Everglades CISMA Invasive species summit 2018.

Webb, E., H. K. Ober, and E. C. Braun de Torrez. Habitat preference and movement patterns of Florida Bonneted Bats (*Eumops floridanus*). Joint North American Bat Working Group meeting in Roanoke, Virginia, 26-29 March 2018.

Student authors denoted in bold.

HONORS AND AWARDS

Nichole Bishop (PhD student): Turtle Conservation Fund grant fall cycle - $2500, Research Abroad for Doctoral Students - $5000, Honored as “Faces of the Turtle Survival Alliance” by the Turtle Survival Alliance for June 2017 http://www.turtlesurvival.org/blog/1-blog/476-faces-of-the-tsa-vol-5#.WabZHaI8aLU, Honored as “Hicatee Hero” by the Belize Foundation for Research and Environmental Education (September 28, 2017) https://www.facebook.com/BfreeBelize/posts/1669151273126588

Alexis Cardas (MS student): 2018- Jennings Scholarship, University of Florida/IFAS/WEC, $1350; 2018- Florida Wildlife Federation Scholarship, University of Florida/WEC, $1200.

Shigetomo Hirama (PhD student): 2018 - Delores Auzenne Dissertation Award.

Brad Udell (PhD student on RWO 295): 2017 - 18 UF Grinter Graduate School Fellowship ($2500).

Elysia Webb (MS student): Best Student Oral Student Presentation at the Joint North American Bat Working Group Meeting in March 2018.

COMPLETED PROJECTS

Effects of Coastal Dynamics & Climate on Loggerhead Turtle Nest Success & Management
Investigator: Raymond Carthy
Completion Date: October 2018
Funding Agency: USGS RWO 285

Changes in Mammal Communities Across the Greater Everglades Ecosystem
Investigator: Robert McCleery
Completion Date: December 2018
Funding Agency: USGS RWO 288

Using Models to Assess Gulf Sturgeon Population Viability and Screen Management Actions to Inform Policy Decisions
Investigator: William Pine
Completion Date: December 2018
Funding Agency: USGS RWO 298

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