



ANNUAL REPORT JANUARY – DECEMBER 2016

DEDICATION

THE 2016 ANNUAL REPORT IS DEDICATED TO

FRANKLIN PERCIVAL



This year the Florida Cooperative Fish and Wildlife Research Unit dedicated our Annual Report to former Unit Leader Dr. H. Franklin Percival. Franklin came to the Florida Unit in 1981 from Patuxent Wildlife Research Center. He quickly established a broad research agenda that ranged across a variety of taxa and habitats, typified by inclusion of stakeholders at all levels, and with one of the premier alligator research projects in the southeast as a centerpiece.

In 1994, Franklin took on the role of Unit Leader and continued to expand his 'atypical' medicine show throughout Florida- 'atypical' because it actually got results! By combining sound science, a keen feel for important connections, and personal graciousness and generosity, he established many highly productive research and education collaborations. Some of these persist after his formal retirement in 2014: notable examples include the Florida Alligator Research Team (F.A.R.T.), the Population Ecology and Modeling Course Dream Team, and the University of Florida Unmanned Aerial Systems Research Program (U.F.U.A.S.R.P.).

The high regard that the Unit enjoys throughout the state can be linked directly to the scientific and personal integrity that Franklin showed in his support of Unit science, personnel and initiatives. Federal, State, and regional management authorities and natural resources have benefitted from his steadfast leadership through many high-stakes issues. Franklin educated countless wildlife students by his 'Franklin-isms' ("real conservation biology is done from the seat of a tractor", "credit is infinitely divisible", etc.), his *Business of the Business* course, and his *Who Broke the Truck* meetings. He remains connected with Unit issues and personnel and is always available to offer sage opinions (he doesn't give advice). For being a living example of how to put the "Coop" in Coop Unit, Franklin, this one's for you!



COOPERATING AGENCIES

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION

UNIVERSITY OF FLORIDA

U.S. FISH & WILDLIFE SERVICE

U.S. GEOLOGICAL SURVEY

WILDLIFE MANAGEMENT INSTITUTE



RESEARCH MISSION STATEMENT



2016 Photo Contest Winner, Tomo Hirama, PhD student, FL CRU – “Almost There”

The mission of the Florida Cooperative Fish and Wildlife Research Unit is to conduct detailed investigations of wetlands and their component fish and wildlife resources, emphasizing the linkages with both aquatic and terrestrial ecosystems. This charge will include research at a range of levels including populations, community, and ecosystems, and will emphasize the interaction of biological populations with features of their habitat, both natural and those impacted by human activities.

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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 2015, over 300 projects totaling more than \$50 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 400 publications, 125 technical reports, 100 theses and dissertations, and 175 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.
Nick Wiley	Executive Director, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida.
Kevin Whalen	Supervisor, Cooperative Research Units, U.S. Geological Survey, Roundhill, Virginia.
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 and in conservation management oriented studies.

COOPERATIVE UNIT PERSONNEL

M. Gay Hale, BA – 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.

Jen Miller – Fiscal Assistant II, 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 maintains the database and helps with general office procedures.

COOPERATORS

University of Florida

Robert Ahrens	Mendy Allen	Michael S. Allen	Karen A. Bjorndal
Alan B. Bolten	Rena Borkhataria	Cameron Carter	Matthew J. Cohen
Bon A. Dewitt	Catherine Eastman	Robert Fletcher	Tom Frazer
Peter. C. Frederick	Ikuko Fujisaki	Bill Guiliano	Eric Hellgren
Mark Hostetler	Peter G. Ifju	Susan Jacobson	Steven Johnson
Frank Mazzotti	Robert McCleery	Debbie Miller	Martha Monroe
Holly Ober	Madan Oli	Elizabeth Pienaar	William (Bill) Pine
Carrie Reinhart-Adams	Christina Romagosa	J. Perran Ross	Maria Sgambati
Scott E. Smith	Taylor Stein	Benjamin Wilkinson	Blair Witherington (Disney)

Florida Fish and Wildlife Conservation Commission

Britany Bankovich	Tyler Beck	Robin Boughton	Curtis Brown
Janell Brush	William Caton	Matt Chopp	Andrew Cox
Patrick Delaney	Jason Dotson	Harry J. Dutton	Gregg Eason
Kevin Enge	Carolyn Enloe	Anna Farmer	Catherine Kennedy
Tim O'Meara	Erin Ragheb	Scott Sanders	Amy Schwarzer
Zach Welch	Nick Wiley	Allan R. Woodward	

U.S. Geological Survey

Kristen Hart	James Hines	Fred Johnson	Meg Lamont
Julien Martin	James D. Nichols	Bruce Quirk	Kenneth G. Rice
Ken Sulak			

U.S. Fish and Wildlife Service

Daniel Barrant	Laura Brandt	Kathleen Burchett	Victor Doig
Andrew Gude	Layne Hamilton	Stan Howarter	Patty Kelly
Joyce Kleen	Mike Legare	Joyce Palmer	Paul Tritaik
Larry Woodward			

U.S. Army Corps of Engineers

Deberay Carmichael
Gina Ralph

U.S. Air Force

Bruce Hagedorn

South Florida Water Management District

Christa Zweig

Others

Russell Hall

National Park Service

Leonard Pearlstine

RESEARCH PERSONNEL

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

Post-Doctoral Associates:

Mathieu Bonneau, PhD

Supervisors: Ray Carthy and Christina Romagosa
Research: Optimal Management of Migratory Bird Habitat and Harvest; Optimal Control Strategies for Invasive Exotics in South Florida

Dan Gwinn, PhD

Supervisor: Mike Allen
Research: Climate change impacts on Florida freshwater fisheries

Nahid Jafari, PhD

Supervisor: Christina Romagosa
Research: Integrating Science and Management for Optimal Prevention and Control of Aquatic Invasive Species in the Everglades

Jennifer Seavey, PhD

Supervisor: Robert Fletcher and Bill Pine
Research: Climate change, sea-level rise, and biodiversity

Brian E. Reichert, PhD

Supervisor: 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

Brian Jeffrey, MS

Position: Wildlife Biologist/Alligator Project Manager
Research: Endangered snail kites

Graduate Students:

Nichole Bishop

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

Matthew Burgess

Degree: PhD, Wildlife Ecology and Conservation
Graduation Date: May 2017
Research: Collection of Digital Serial Imagery in Support of Aquatic Invasive Species Program and CERP
Advisor: H. Franklin Percival and Ray Carthy

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

Catherine Haase

Degree: PhD, School of Natural Resources and the Environment
Graduation Date: August 2016
Research: Effects of spatial heterogeneity in temperature on habitat use and movement of the Florida Manatee
Advisor: Robert Fletcher

Kodiak Hengstebeck

Degree: MS, Wildlife Ecology and Conservation
Graduation Date: December 2016
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 hatchling orientation: Quantifying effects of artificial light and light mitigation programs
Advisor: Ray Carthy

Jame McCray

Degree: PhD, Wildlife Ecology and Conservation
Graduation Date: August 2017
Research: Wildlife legislation and management in Florida: Sea turtles, a test case for creating effective policy
Advisor: 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

Ellen Robertson

Degree: PhD, Wildlife Ecology and Conservation
Graduation Date: December 2016
Research: Endangered snail kites and interactions with apple snail prey species.
Advisor: Robert Fletcher

Thomas Selby

Degree: MS, Wildlife Ecology and Conservation
Graduation Date: December 2016
Research: Using Passive Acoustic Technology to Understand Juvenile Hawksbill Spatial Ecology.
Advisor: Ikuko Fujisaki

Brian Smith

Degree: MS, Wildlife Ecology and Conservation
Graduation Date: December 2016
Research: Mammal declines and invasive pythons in the Everglades
Advisor: Christina Romagosa

Richard Stanton

Degree: PhD, School of Natural Resources and the Environment
Graduation Date: May 2017
Research: Consequences of Shrub Encroachment for Animal Community Structure and Species Interactions
Advisor: Robert Fletcher

Brad Udell

Degree: MS, Wildlife Ecology and Conservation
Graduation Date: August 2016
Research: Risks of collision between boats and manatees.
Advisor: Robert Fletcher

Nicholas Vitale

Degree: MS, Wildlife Ecology and Conservation
Graduation Date: May 2018
Research: Productivity of American oystercatchers
Advisor: Abby Powell

Tyler Ward

Degree: PhD, Mechanical and Aerospace Engineering
Graduation Date: May 2016
Research: UAS payload construction and data processing of digital imagery
Advisor: Peter Ifju

Travis Whitley

Degree: PhD, Mechanical and Aerospace Engineering
Graduation Date: May 2016
Research: UAS Autopilot development
Advisor: Peter Ifju

Yun Ye

Degree: PhD, School of Forest Resources and Conservation, Geomatics
Graduation Date: May 2016
Research: Computer recognition algorithms for UAS imagery
Advisor: Scot Smith

CURRENT RESEARCH PROJECTS



Productivity of American Oystercatchers

Investigator(s): Abby Powell, Janell Brush
Student(s): Nicholas Vitale, MS, Wildlife Ecology and Conservation
Duration: September 2016-June 2020
Funding Agency: UF Nature Coast Biological Station; USGS (RWO 299)
In-Kind Support: FWCC

Spoil islands created as part of the Cross Florida Barge Canal project support breeding American Oystercatchers. However, annual site productivity is low (average of 0.05 chicks per pair) compared to annual statewide productivity during the same time period (average >0.20 chicks per pair). We need to understand what is limiting breeding productivity for the oystercatcher population breeding along the Nature Coast. Beginning in 2017, we will determine causes of mortality and disturbance (using existing data as well as conducting direct observations and use of remote cameras), and estimate annual productivity (2012-2018) with respect to covariates such as potential sources of disturbance, presence of predators. We will systematically survey breeding sites by boat and on foot. We propose to monitor at up to 20-30 nests at 3-day intervals throughout the 80-day breeding period over two breeding seasons until chicks fledge or the nest/brood fails. We will also use existing data from FWCC to determine nest success for years prior to 2017. Fieldwork will begin in spring 2017; the study design is currently being developed. Determining the effects of disturbance from humans and predators on oystercatcher productivity on the CFG spoil islands will better focus conservation efforts in the area. We will propose management actions to increase annual productivity of oystercatchers nesting on spoil islands in the Cross Florida Greenway State Recreation and Conservation Area.

Optimal Management of Migratory Bird Habitat and Harvest

Investigator(s): Ray Carthy
Student(s): Mathieu Bonneau (post-doc)
Duration: August 2011-Aug 2016
Funding Agency: USGS (RWO 272)
Collaborator: Fred Johnson

Optimal management of wildlife habitats and harvests depends on the ability of a manager to take actions, conditioned on current and anticipated future resource conditions. Optimal solutions to these “sequential-decision problems” can often be calculated, provided there are clearly articulated management objectives, a set of alternative management actions, one or more models of resource dynamics, and a resource-monitoring program. This approach has been applied successfully to the national management of mallard harvests and to the local management of habitat for the threatened Florida scrub jay. In the case of scrub jays, habitat-restoration activities have failed to produce optimal conditions in some areas of Merritt Island NWR. Thus, there is a need develop more effective management strategies. In the case of mallards, the timing of decisions may change. An Environmental Impact Statement described administrative benefits of shortening the timeframe of the regulatory process, such that hunting regulations would be issued each year prior to the availability of annual monitoring data. The potential impacts of this change on the mallard population and on allowable levels of harvest are largely unknown, however. The objectives of this study focused on understanding the implications of resource models and decision timing on optimal management decisions and expected performance. Specifically, this study: (a) modified the existing optimization algorithms to account for potential changes in the models used to inform scrub jay and mallard management; and (b) evaluated the implications of those changes for managers, the resource, and resource users. This study applied Markov decision processes to the optimal management of mallard harvests and the conservation of scrub jay habitat.



Demographic, Movement and Habitat of the Endangered Snail Kite in Response to Operational Plans in Water Conservation Area 3A

Investigator(s): Robert Fletcher

Student(s): Sarah Dudek, MS, School of Natural Resource and Environment

Duration: September 2014-December 2017

Funding Agency: Army Corps of Engineers

Our over-arching goal is to provide reliable information on population size and trends, including 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, with the population approximately halving from 2000 to 2002 and again from 2006 to 2008. Each of these two periods of population decline coincided, in part, with drought conditions throughout the southern portion of the kites' range. By coupling the vital rates measured over this time period with the changes in population size (using a Life Table Response Experiment), it became apparent that the primary demographic factors contributing to this decline were changes in adult fertility (the product of young fledged per adult and juvenile survival). Because demographic parameters are heavily influenced by bird behavior, movement studies constitute the other major aspect of the research. Our objectives are to: 1) evaluate the underlying mechanisms and processes driving population dynamics, and 2) provide reliable estimates of demographic parameters and movement probabilities to upgrade management models to optimize management decisions. Snail kites were monitored by band-resight surveys in various wetlands. Nests were also monitored. Environmental data were recorded at each nest along with nest status. Once the nestlings reached an age of ~24 days, they were marked with unique bands. A total 742 active nests with known fates were detected. Of those 327 were successful. We banded 730 nestlings and 632 were observed to have fledged. Overall apparent nest success was 44 (± 2)%. Since the snail kite population is critically endangered and because adult fertility plays an

overwhelming role in population growth rate, it is critical to identify and attempt to limit factors that negatively affect reproduction and juvenile survival. Long-term monitoring allows us to quantify these vital rates and link them to potential critical variables that may be limiting the population.

Comprehensive Assessment of Spatially-Explicit Demography on Short- and Long-Term Snail Kite Population Growth in the Greater Everglades

Investigator(s): Robert Fletcher, Chris Cattau, Brian Reichert

Student(s): N/A

Duration: March 2015-June 2016

Funding Agency: USGS RWO 294

The snail kite population is spatially structured, and environmental factors and management activities that impact kites often occur on local/regional scales. It is essential to understand spatial variation in vital rates and to determine the relative contribution sites to overall population growth. Although recent research has contributed to our understanding of snail kite population dynamics, there are remaining uncertainties that limit the ability to recover this endangered species. The knowledge gained can be used to help inform research and management decisions by identifying precisely (1) information gaps, (2) ecological processes and life history stages that may be most beneficial for management to target, and (3) which regions contribute most to snail kite population growth. We used stage-structured matrices to investigate population dynamics within each region. This general framework was expanded to incorporate movement dynamics among regions, and the effects of spatial variation in demography rates and movement on overall population. This approach allowed us 1) to estimate both local and range-wide population growth rates, 2) to quantify the effects of particular demographic parameters on population growth, and 3) to estimate the patch value of particular wetland systems. Demographically- and spatially-structured models suggest a growing snail kite population in Florida, with adult survival contributing most to population growth, followed by fertility. We observed similar patterns using a single-state, range-wide model that ignored movement dynamics and spatial heterogeneity in demographic rates. The multistate model also revealed important trends regarding the effects of movement dynamics and regional demography on population growth. Demographic parameters with high sensitivities may represent life history stages functioning as population bottlenecks. The ability to influence population growth by managing for particular aspects of demography is contingent not only on sensitivity values but also the potential for making improvements to particular demographic rates.



Identifying the Role of Hydrology and Prey for a Key Bottleneck in the Recovery of Snail Kites in the Greater Everglades

Investigator(s): Robert Fletcher

Student(s): Caroline Poli, PhD, Interdisciplinary Ecology

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, but monitoring data indicate that it varies among 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 first-year survival is driven by attributes of the natal site, including hydrology and prey availability. 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 first-year survival. Our objectives are to: a) quantify post-fledgling movements and first-year survival across the Greater Everglades Ecosystem; b) link movements and survival to variation in hydrology and measures of prey resources, and c) develop models that help determine key targets for water management in the Greater Everglades Ecosystem. In 2016 we deployed GPS tracking devices on 10 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 2017 and 2018 we plan to deploy 7-25 additional tags per year. Preliminary data confirm that birds spend the first 30-60 days post-fledging within 1 km of the nest site. Birds that dispersed from the nest site made looping foray flights lasting 1-5 days each, then returned to the original nest site.

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. We will emphasize identifying potential thresholds in hydrology and snail metrics that can explain changes in movement behaviors.



Habitat Use and Population Dynamic of Juvenile Green Turtles (*Chelonia mydas*) and Kemp's Ridleys (*Lepidochelys kempii*) Along Florida's Nature Coast

Investigator(s): Ray Carthy

Student(s): Rick Herren, PhD, Wildlife Ecology & Conservation

Duration: September 2016 – June 2020

Funding Agency: UF Nature Coast Biological Station

In-Kind Support: Sea Turtle Conservancy

Florida's Nature Coast is relatively undeveloped and contains the second largest seagrass ecosystem in the Gulf of Mexico. Thousands of acres of shallow seagrass beds and hard-bottom are potential foraging habitats for juvenile green and Kemp's ridleys turtles. Little research has been done in this area since Dr. Archie Carr and colleagues first described the Cedar Key turtle fishery in the 1950s. The goal of this project is to characterize the habitat use and population dynamics of sea turtles foraging in this region. We plan to carry out broad scale vessel and UAV (Unmanned Aerial Vehicle) surveys in nearshore habitats to determine sea turtle occupancy and abundance "hotspots" and coupling those with measurements of environmental and benthic co-factors such as the availability of food and shelter. Our design includes multi-variate occupancy models, which will help us answer questions such as why turtles are present in some areas and not in others even when the habitat might appear to be similar. This research will also help elucidate trends in habitat use over seasons and years. At the same time, we will also be establishing long-term capture-mark-recapture sites to measure demographics, disease rates, diet and sex ratios in

an effort to characterize the population of turtles in these areas. This research is just beginning and will undoubtedly evolve this summer as we ramp up our first season of fieldwork. We are collaborating with a number of entities including the Nature Coast Biological Station, Sea Turtle Conservancy, Inwater Research Group, Florida Department of Environmental Protection Aquatic Preserves, Florida Fish and Wildlife Conservation Commission and Florida State University. Ultimately, the goal is to publish the results in peer-reviewed journals while disseminating the information to organizations managing sea turtle populations in the US and beyond. The included photo is from an Inwater Research Group research trip to St Martins Marsh Aquatic Preserve in 2014.



Habitats and Resources Use by Threatened and Endangered Marine Turtles

Investigator(s): Ikuko Fujisaki
Student(s): Thomas Selby, MS, Wildlife Ecology and Conservation
Duration: February 2015-August 2016
Funding Agency: U.S. Geological Survey (RWO 293)

Critically endangered hawksbill (*Eretmochelys imbricata*) turtles present a unique conservation challenge as they exhibit ontogenetic shifts over long life histories that do not necessarily coincide with existing marine protected area (MPA) boundaries. As juveniles however, hawksbills recruit to shallow coastal rookeries where previous research has shown they have constrained home ranges and high site fidelity, but results are variable. Managers at Buck Island Reef National Monument in the U.S. Virgin Islands recently deployed a passive acoustic receiver array in order to better understand the spatial ecology of juvenile hawksbills found within the monument's boundary. Understanding the variables that affect each receiver's detection range is critical to using this technology and not well understood within a

dynamic coral reef environment. This study aimed to fill in this knowledge gap.

The objective of this study are to (1) understand the variables that affect detection range of in-water acoustic receivers within a coral reef environment and (2) understand the spatial ecology of juvenile hawksbills found within the monument's boundary. Using a generalized linear mixed model, we assessed the association between probability of detecting a range-testing tag and various environmental factors including distance, benthic structure, depth, wind speed, sea-surface temperature, and time of day on the probability of detecting a range-testing tag. This analytical method was also used to examine detection probability of hawksbills acoustically-tracked in Buck Island. Effective detection range was fairly constrained across the array especially in highly rugose benthic structure. Using the detection histories from acoustically tagged juvenile hawksbills, we estimated residency and individual activity spaces within the array and assessed habitat-selection. Activity space areas (km²) were larger than most previously reported home-range estimates. Passive acoustic technology offers a promising method for tracking juvenile hawksbills, but may require numerous receivers to cover areas with highly rugose benthic structure.



Population Ecology of the Diamondback Terrapin in the Big Bend Region of Florida

Investigator(s): Steve Johnson, Mike Allen
Student(s): Travis Thomas, PhD, Wildlife Ecology and Conservation
Duration: September 2016-December 2019
Funding Agency: Florida Fish and Wildlife Conservation Commission
In-Kind Support: Graduate assistantship provided by UF/IFAS Nature Coast Biological Station; tuition waiver provided by Wildlife Ecology and Conservation

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, Diamondback Terrapins have experienced population declines throughout their range due to loss of habitat and bycatch mortality from drowning in crab traps. Furthermore, these are long-lived animals with low reproductive rates, which makes them particularly vulnerable to human-induced mortality sources. Florida is important to this species' conservation, and represents 20% of the Diamondback Terrapin's range. Several studies in Florida have characterized local populations; however, to date no population estimates are available for the Big Bend Region of Florida. In order to effectively manage a species, resource managers need to understand critical aspects of its ecology, especially information on occurrence and population abundance. The lack of data available for the Big Bend region is of conservation concern, and information collected will be useful in developing a long-term conservation strategy for this species. In 2016–2017, GIS satellite imagery will be used to characterize barrier islands in the Big Bend into distinct island types based on variables such as island size, distance to mainland, vegetation, elevation, substrate, and wrack composition. In 2017, we will begin turtle surveys to estimate Diamondback Terrapin population abundance for different island types. Turtles will be hand captured by walking the wrack line. Captured turtles will be measured, weighed, marked, and released. Various open population-models will be used to estimate terrapin abundance. Tissue samples will be collected from terrapins in different localities for future genetic analysis by FWC. All capture points will be marked with GPS and entered into a database.

Preliminary analysis of satellite imagery is ongoing and turtle surveys are scheduled to begin in March 2017. However, early observations reveal that Diamondback Terrapins may congregate in high densities on smaller barrier islands that meet a specific habitat requirement. This study will fill critical data gaps in the Diamondback Terrapin's ecology within the Big Bend region of Florida.



A Nutritional Ecology Study of *Dermatemys mawii*, a Critically Endangered Species of Freshwater Turtle Endemic to Central America

Investigator(s): Nichole Bishop, Karen Bjorndal, & Ray Carthy

Student(s): Nichole Bishop, School of Natural Resources and Environment

Duration: December 2014 – 2018

Funding Agency: USGS

In-Kind Support: Belize Foundation for Research and Environmental Education; Jacksonville Zoo and Gardens

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. I am using a nutritional ecology framework to examine *D. mawii*'s digestive physiology, gut morphology and microbial endosymbiont community in an effort to elucidate their dietary adaptations and subsequent implications for captive and wild management. The objectives are to: 1) describe and quantify the natural diet composition of *D. mawii*; 2) describe and compare age-specific differences in the digestive performance of *D. mawii* between yearlings and adults; 3) describe and compare the gut morphology and allometrics of *D. mawii* among hatchlings, juveniles and adults; and 4) characterize the gut microflora of *D. mawii* hatchlings, juveniles, and adults. The objectives were addressed by: 1) using a dataset from specimens that identifies and quantifies stomach contents of 78 *D. mawii* of various age/size, sex, and habitats; 2) conduct feeding trials with yearlings and adult *D. mawii* to determine differences in digestive performance among age classes; 3) obtain morphometrics by CT scanning previously preserved *D. mawii* specimens; and 4) continue to collect fecal samples from all age groups of *D. mawii*. I will then isolate microbial communities and identify them using

16S rRNA-based pyrosequencing according to the methods in Hong *et al.* (2011). My preliminary results indicate that *D. mawii* are herbivorous throughout their lives. Therefore, I anticipate that the relationships between digestion and retention time, food quality, gut capacity, and rate of intake will be unique among *D. mawii*. Knowledge gained from this study will address the long-term conservation goals by informing husbandry practices and captive breeding protocols for *D. mawii*.



The Path Most Travelled: Leatherback and Cheloniid Sea Turtle Migration Movements and Foraging Areas

Investigator(s): Daniel R Evans

Student(s): Daniel R Evans, PhD, Wildlife Ecology and Conservation

Duration: January 2014-December 2017

Funding Agency: Sea Turtle Conservancy (Private)

Movement between habitats is vital to the survival of marine turtles. Foraging in the marine environment is difficult by patchiness of food, often due to the interaction of oceanic features and currents. Marine turtles are searching for food, pursuing food, or moving to another area that might contain more food. To reduce migration energy costs, sea turtle foraging areas need to be predictable and persistent over time. By connecting oceanic features, currents, geomagnetic fields, and animal movements, it is possible to identify factors influencing feeding areas and migration pathways in the seascape for different species of sea turtles.

Research objectives are 1) to identify ocean features that characterize foraging areas used by female leatherback sea turtles to see if these areas are geographically stable, 2) to model the migration movements of leatherback, green, loggerhead, and hawksbill sea turtles, and 3) to compare identified sea turtle foraging areas and migration pathways to known Marine Protected Areas. Existing leatherback tracking data will be modelled to determine foraging and migration locations. Oceanic features include sea surface

temperature, Chlorophyll-a, salinity, and sea depth. These features will be used to estimate potential prey productivity in identified leatherback foraging areas and assess the stability and persistence of these areas year to year. Preliminary work related to this project involved the deployment of satellite transmitters on 20 post-nesting leatherbacks from the Caribbean coast of Panama, deployment of satellite transmitters on 22 post-nesting green sea turtles from Costa Rica, Mexico, and Nevis, deployment of satellite transmitters on 29 post-nesting loggerhead sea turtles from the central east coast of Florida, and deployment of satellite transmitters on 16 post-nesting hawksbill sea turtles from Nevis and Costa Rica. Data from the transmitters were collected to determine location, movements, swim speed, migration corridors and foraging areas. Space-state models have been run to identify leatherback behavior at each location. The ability to identify new feeding areas, such as the Gulf of Mexico for leatherback sea turtles, identify migration corridors, and determine if these areas are being protected is an important tool in ensuring the survival of sea turtles in the wider Atlantic basin.



Standardized Measurements of Loggerhead Sea Turtle Hatchling Orientation: Quantifying Effects of Artificial Light and Light Mitigation Programs

Investigator(s): Shigetomo Hiram, Robert Hardy, Morgan Young, Ray Carthy, and Blair Witherington

Student(s): Shigetomo Hiram, MS, Wildlife Ecology and Conservation

Duration: 2015-present

Funding Agency: Florida Fish and Wildlife Conservation Commission, 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 provides information on sea turtle hatchling orientation on the Florida beaches along the Gulf of Mexico and Atlantic Ocean. Standardized measurements will be used to map the severity of disorientation caused by artificial lighting. The results will directly inform management agencies to reduce artificial lighting so that the number of hatchlings that enter the ocean can be increased.

Project objectives are to collect data on light intensity and hatchling orientation and to identify the degree of disorientation such that spatial and temporal trends may be assessed. Detail in hatchling orientation measurement would inform beach lighting management strategies for reducing disorientation of hatchlings. We measured light intensity on the beach using a photometer at National Canaveral Seashore (control), Cocoa Beach, Juno Beach, Singer Island, Boca Raton, and Ft Lauderdale. Along with light intensity, we measured two parameters that describe the accuracy of hatchling orientation, angular range and modal divergence from the ocean at 17 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. The modal divergence is the absolute value of the difference in bearings between modal hatchling track direction and ocean direction. Although orientation accuracy widely varies depending on the sites, preliminary analyses indicate that high frequency of hatchling disorientation occur on the beaches of Palm Beach, Broward, and Bay Counties. Florida has extensive human development (source of light pollution) along the coastline and high frequencies of disorientation on the beaches. We can inform the stakeholders and responsible entities of the severity of hatchling disorientation.

large stretches of seawalls being constructed in northeast Florida. The rate and extent of the coastline that is armored, and the effect this is having on the availability of suitable areas for nesting sea turtles is relatively unknown. The current paradigm in coastal management is focused on protection of property through coastal armoring. Roughly 25 percent of Florida's coastal shorelines were recorded as being armored in 1998. These trends in coastal armoring and the effects on sea turtles and their nesting habitats have yet to be fully understood. Our research objectives will take multiple approaches in identifying descriptive and causal inference for the effects of coastal armoring on available sea turtle nesting habitat and reproductive behaviors: a descriptive approach identifying the spatiotemporal trends in the availability of habitat due to coastal armoring, and a comparative model of sea turtle nesting behaviors and reproductive success associated with natural beaches and armored shorelines. To address this issue, we will take two approaches: we will conduct an analysis of the spatiotemporal patterns of coastal armoring in northeast Florida, utilizing remote sensing techniques, historical FDEP permitting records, and high accuracy survey data collected on armoring structures. We will then compare the long-term nesting behaviors, and reproductive success on natural beaches (control) and armored beaches (treatment) within close geographic proximity, with a before and after control and impacted (BACI) design. Currently, digital permitting records of coastal armoring have been acquired from the Florida Department of Environmental Protection and high precision ground truthing and survey efforts are underway. Historical records on sea turtle nesting for both the natural and armored areas have been acquired. The current management responses to rising seas and coastal erosion make understanding coastal armoring effects on the availability of suitable areas for nesting sea turtles and impacts to nesting behaviors critical for adaptive management practices, and can provide critical inputs to compliment a holistic framework for decision-making, ultimately resulting in greater species protection.

The Long-term Spatiotemporal Patterns, Nesting Success and Hatching Success of Marine Turtles on an Undeveloped Beach in Northeast Florida

Investigator(s): Scott Eastman, Todd Osborne, Raymond Carthy

Student(s): Scott Eastman, MS, School of Natural Resources and the Environment

Duration: September 2014-December 2017

Funding Agency: University of Florida, Whitney Laboratory for Marine Bioscience.

In-Kind Support: Personnel provided by the Guana Tolomato Matanzas National Estuarine Research Reserve, Florida Department of Environmental Protection.

Sea level rise, increasing rates of coastal erosion, and the current coastal management response of coastal armoring is resulting in



Effects of Coastal Dynamics and Climate on Loggerhead Turtle Nest Success and Management: An Assessment of Sea Turtle Nesting Beaches in St. John's County Florida

Investigator(s): Raymond Carthy

Student(s): Nichole Bishop, MS, School of Natural Resources and the Environment

Duration: December 2014-December 2018

Funding Agency: US Geological Survey (RWO285)

In-Kind Support: Whitney Laboratory for Marine Bioscience.

St. John's county beaches are popular nesting sites for green turtles (*Chelonia mydas*), loggerheads (*Caretta caretta*) and leatherback turtles (*Dermachelys coriacea*); 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. Baseline monitoring is necessary to establish changes to beach morphodynamics given their varied anthropogenic usage, potential impacts from climate change and most recently, Hurricane Matthew of October 2016. Our objectives are to characterize the Guana Tolomato Matanzas National Estuarine Research Reserve (GTMNERR) beach, Crescent Beach and the Archie Carr beach property in Summer Haven by: 1) monitoring beach slope, 2) measuring sand grain size and 3) surveying flora. To monitor beach slope, students and graduate mentor conducted three transects at each beach annually from June 2014 to the present. Transects were run from the vegetation line at the base of the fore-dune to the low tide line. Elevation was recorded at every meter. For measuring sand grain size, (using the same transects from beach slope,) sand samples were collected at the base of the dune, the middle of the dune and the swash zone. Each sample was collected to a depth of 5cm, dried to constant mass, and passed through a sieving column. The mass 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 and mass percent of each category was calculated. To survey the flora, three belt transects extended from the vegetation line on the foredune to the water line in the estuary. At 5m intervals 1m² quadrats were sampled, and plant species and percent coverage for each species were recorded. For GTMNERR: slope is staying consistent, but beach is eroding. For Crescent Beach: it was highly variable; erosion and accretion and changes in slope occurred throughout the beach. For Summer Haven: erosion and slope increasing, but berms are reduced. We can use the information to assess the impacts of long-term trends, as well as significant events such as Hurricane Matthew.



Foraging Ecology and Diet of the Florida Bonneted Bat

Investigator: Dr. Holly Ober

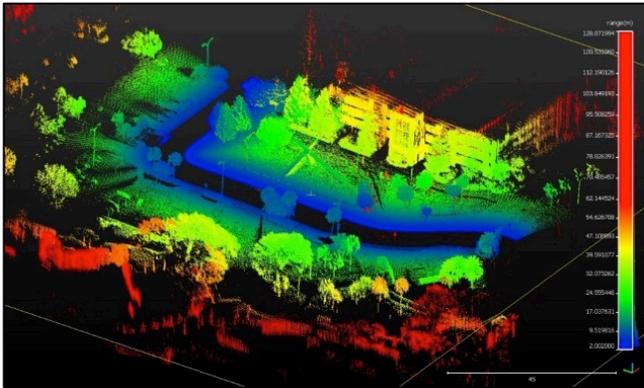
Student: Elysia Webb, MS, Wildlife Ecology and Conservation

Duration: 15 August 2016 – 31 December 2016

Funding Agency: Florida Fish and Wildlife Conservation Commission

The Florida bonneted bat, *Eumops floridanus*, is a federally endangered bat species endemic to southern Florida. Virtually nothing is currently known about its foraging ecology or diet, which hinders the development of management plans and conservation recommendations. A better understanding of the foraging habits and diet of this elusive species is needed to gain greater insight into plausible strategies for facilitating conservation and management of the bats. We will (1) examine foraging habitat selection patterns, and (2) characterize diet. Specific topics to be investigated include the distance bats fly between roosts and foraging areas, the number of foraging trips they make per night, the habitat they prefer to forage in, which insects are consumed, the extent of seasonal variation of diet in a single bat population, and the difference in diet between populations from three distinct regions during a single

season. In addition, we are collecting bat guano and will identify insects within this scat to characterize diet, and elucidate the extent of seasonal and geographic variation in diet. At Babcock-Webb Wildlife Management Area (BWWMA) we applied GPS units to 8 bats in August 2016 and 10 bats in December 2016. We also began monthly collections of guano samples from beneath bat houses at BWWMA in November and December 2016. Understanding which vegetation communities the bats prefer to forage in and the typical distances they travel to forage, will enable development of habitat management strategies. Similarly, knowledge of which insects the bats consume will facilitate development of management strategies that can foster conservation of the species through enhancement or augmentation of preferred insects, or restrictions on pesticide use in areas that foster these insects.



Integration, Validation, and Fusion of Small Unmanned Aircraft System Multimodal Sensor Data in Support of USGS

Investigator(s): Raymond R. Carthy, Peter G. Ifju, Benjamin E. Wilkinson, and Scot E. Smith

Student(s): Travis J. Whitley, Ph.D. Student, Mechanical and Aerospace Engineering; H. Andrew Lassiter, Ph.D. Student, Geomatics Department; Chad S. Tripp, Undergraduate Student, Mechanical and Aerospace Engineering; and Matthew A. Burgess, Ph.D. Candidate, Wildlife Ecology & Conservation

Duration: August 15, 2016 – August 1, 2019

Funding Agency: U.S. Geological Survey RWO#300

In-Kind Support: Temporary loan of a small LiDAR unit by the UF Geomatics Department until the dedicated product purchased by the USGS arrives.

Small unmanned aircraft systems (sUAS) are increasingly popular tools in natural resources-based scientific studies. The University of Florida Unmanned Aircraft Systems Research Program (UFUASRP) has been tasked with integrating a light detection and ranging (LiDAR) sensor to a

rotary-wing sUAS. Using LiDAR technology, the generation of high-accuracy terrain mapping and other valuable three-dimensional (3D) products are possible. Until recently, LiDAR units were too voluminous, heavy, or required excessive power to operate from sUAS. Advances in technology have mitigated most of those limitations.

The objective of this study is to continue research and development of sUAS airframes and sensors, with a particular focus on integrating LiDAR with other multimodal sensor data. Calibration of the sensor suite and creating a post-processing workflow for the LiDAR data are additional objectives. A small LiDAR unit on loan from the UF Geomatics Program has been used to facilitate initial laboratory-based integration and experimentation. The dedicated unit on backorder is manufactured by the same company as the loaned unit, and should have similar input/output conformations; therefore, the timing signals and geoprocessing of raw data observations can be investigated while waiting for the dedicated unit to arrive. Preliminary analyses indicate that the LiDAR unit will provide an extremely valuable tool for creating 3D terrain and surface maps for a host of natural resource-based sUAS applications. Kinematic testing of the loaned unit operating from the back of a truck simulated low-altitude flight of a sUAS that provided data that were fairly remarkable ‘out-of-the-box’ and revealed areas for improvement as well. The desire to integrate LiDAR into civilian sUASs as a sensor option has been a request by end-users for nearly a decade. Technological advancements have overcome the physical restrictions that limited LiDAR applications on sUAS. The systematic integration of LiDAR into the available sensor options for sUAS is a landmark step in the utility of sUAS as tools for scientific data collection.



S1000+™ octocopter sUAS. The various sensor payloads were integrated and calibrated. The airframe was slightly modified to meet the primary mission needs of USGS NUASPO and USDO I researchers. Gimballed payload housings were designed and fabricated for several payload combinations. Collection of directly georeferenced imagery as input into sophisticated imagery post-processing software allowed the generation of three-dimensional imagery products from two-dimensional imagery collected by the sUAS payloads. Through the efforts of the UFUASRP, and partnership with the USGS NUASPO, methodologies for scientific use of sUAS as a tool to augment existing data collection techniques in natural resource-based applications were developed.

To Advance, Test, and Quantify Unmanned Aircraft System Capabilities for the USGS

Investigator(s): Raymond R. Carthy, Peter G. Ifju, Benjamin E. Wilkinson, and Scot E. Smith

Student(s): Matthew A. Burgess, Ph.D. Candidate, Wildlife Ecology & Conservation; Travis J. Whitley, Ph.D. Student, Mechanical & Aerospace Engineering; H. Andrew Lassiter, Ph.D. Student, Geomatics Program; Chad S. Tripp, Undergraduate Student, Mechanical & Aerospace Engineering

Duration: August 1, 2014 – July 31, 2016

Funding Agency: U.S. Geological Survey RWO#290

The USGS National Unmanned Aircraft Systems Project Office (NUASPO), and the University of Florida Unmanned Aircraft Systems Research Program (UFUASRP), have collaborated since 2014 to test and develop new airframes and sensor packages for small unmanned aircraft systems (sUAS). Looking to diversify US Department of the Interior (USDOI) sUAS platforms and sensors, the NUASPO turned to the UFUASRP to provide solutions to meet USGS- and USDOI-scientific objectives. The use of sUAS and their payloads has become a tool for obtaining aerial imagery and other data collection targets for civilian uses. The UFUASRP has been investigating and improving sUAS, payloads, and post-processing methodologies for over 18-years, and is a leader in addressing sUAS applications for natural resource-based questions. The USGS NUASPO presented a collaboration with the UFUASRP that benefited both entities. The primary goals were to obtain an appropriate electric-powered rotary-wing sUAS that the UFUASRP could modify to field various gimballed payload packages containing combinations of cameras and sensors. The integration and calibration of the various sensors was also an objective. Based on the desired sensor payloads selected by the USGS NUASPO, an approximate total mass and volume of the payloads were determined. Extensive review of sUAS platforms available on the consumer market capable of fielding the desired sensor combinations led to the selection of the DJI® Spreading Wings



Low-Altitude Imagery to Assess Vegetation Density, Vegetation Health, and Wildlife Use of the Stormwater Treatment Areas

Investigator(s): Raymond R. Carthy

Student(s): Matthew A. Burgess, Ph.D. Candidate, Wildlife Ecology and Conservation

Duration: August 1, 2014 - September 30, 2016

Funding Agency: South Florida Water Management District; UF#: 118866

In-Kind Support: University of Florida Mechanical and Aerospace Engineering Department professor and Ph.D. graduate student time.

The Stormwater Treatment Areas (STAs) of the Greater Florida Everglades are critical components of excess nutrient removal from water delivered from sources upstream. The removal of phosphorous is of particular concern, and notable differences in phosphorous uptake occur depending on various aquatic vegetation community parameters. Surveys of vegetation within the STAs are needed to assess the influence of vegetation types, species, coverage, density, and condition for both short- and long-term phosphorous removal strategies. While boat-based surveys are necessitated, the University of Florida Unmanned Aircraft Systems Research Program (UFUASRP) developed an external sensor pod (ESP) that mounted to manned aircraft used for

aerial surveys. The ESPs housed high-resolution small unmanned aircraft system (sUAS) optical payloads capable of collecting directly georeferenced imagery suitable for documenting spatial and temporal changes of vegetation in response to experimental treatments.

The objectives of this study were to provide the South Florida Water Management District (SFWMD) with high-resolution vegetation imagery and metadata collection capabilities by building and delivering a pair of ESPs to the SFWMD for aerial surveys, provide support/repair of the equipment, and update items as technology allowed. The UFUASRP built a pair of ESPs specifically designed for working over the STAs. Necessary sensors and payloads were acquired, integrated, and outfitted within the ESPs. The UFUASRP delivered the ESPs, assisted in training staff on use of the equipment, provided basic troubleshooting/repair, and offered suggestions on updates as new technology emerged. The ESPs captured imagery and metadata during flights over the STAs, as well as other active restoration projects within the Greater Florida Everglades. Much was learned about flight path planning, optimizing sensor settings to produce desired imagery, and how to conduct ESP-equipped flights more efficiently. Although sUAS are becoming a highly desired tool for many applications in natural resources, there are areas where sUAS are not permitted to fly, i.e., within a radius of Miami International Airport. Outfitting manned aircraft with ESPs provides a photographic record of detectable targets, supplementing existing manned aerial survey methods.



Monitoring Vegetation Change and Wildlife Use of Active Marsh Improvement Sites

Investigator(s): Raymond R. Carthy

Student(s): Matthew A. Burgess, Ph.D. Candidate, Wildlife Ecology & Conservation

Duration: January 8, 2014 – December 15, 2016

Funding Agency: South Florida Water Management District; UF#: 117049

In-Kind Support: University of Florida Mechanical and Aerospace Engineering Department professor and Ph.D. graduate student time.

Water Conservation Areas (WCA) 2A and 3 in the Greater Florida Everglades are the location of several ongoing Active Marsh Improvement (AMI) projects led by the South Florida Water Management District (SFWMD). As part of these efforts, manned aerial surveys are periodically conducted to assess the efficacy of various treatments. Aerial surveys are needed to obtain perspectives that are unattainable strictly by ground level alone. The University of Florida Unmanned Aircraft Systems Research Program (UFUASRP) developed an external sensor pod (ESP) that mounted to manned aircraft used for aerial surveys. The ESPs housed high-resolution small unmanned aircraft system (sUAS) optical payloads capable of collecting directly georeferenced imagery suitable for the production of detailed imagery products over focal sites. The objectives of this study were to obtain low-altitude, high-resolution imagery and metadata to assess the spatial and temporal efficacy of treatments applied to AMI sites. In addition, the development of methods to improve the efficiency of using ESPs for data collection for natural resource-based questions were also goals. Several multi-day trips to south Florida by the UFUASRP Program Coordinator to field the ESPs on approved SFWMD – Aviation Unit aircraft were conducted. Imagery and metadata from sensors within ESPs were collected over AMI restoration projects, and over the Decompartmentalization Physical Model (DPM) site where fluorescein dye was injected as floodgates were opened to visually trace water flow as part of that project. The ESPs were able to capture imagery and metadata over

AMI projects in WCA 2A and 3, as well as the DPM. Nearly all flights recorded sharp imagery and complete metadata files; therefore, individual images could be georectified and spatial and temporal changes could be noted. Achieving consistent overlap of adjacent imagery to produce complete orthophotomosaics was challenging. The use of ESPs affixed to manned aircraft already tasked with conducting aerial surveys provides another method of data collection for natural resource-based applications. Using ESPs also provides a photographic record of what was detectable during a flight.



technology and identify patterns of python road crossings. The second objective is to understand variability of python resource use (diet and habitat) across the landscape of southern Florida. For this, muscle tissue samples were taken from 425 pythons from across the landscape and we analyzed the samples for carbon and nitrogen stable isotope ratios. We then estimated the size and location of the isotopic niche of pythons from 6 regions of southern Florida. The results for our first objective showed that GPS tags are heavily influenced by habitat factors such as canopy cover, but python movement bouts are captured well by the tags. Preliminary analyses suggest that pythons are most active near 25 °C, and that pythons may be crossing roads more frequently than expected. Results for the second objective showed pythons have an extremely broad isotopic niche, indicating that they can use both terrestrial- and marine-derived food resources and feed across a variety of trophic levels. GPS technology is well-suited to answering specific questions about python movement ecology. Python movements are likely related to specific environmental conditions, and timing removal efforts with these optimal conditions will improve their efficiency. The broad generalism of pythons means that they pose a threat to all native birds and mammals. They are also likely to cause trophic cascades and influence the ecosystem through both predation and competition.

Burmese Pythons in the Greater Everglades: Movement, Habitat Use, Impacts and Control Tools

Investigator(s): Christina Romagosa

Student(s): Brian Smith, MS, Wildlife Ecology and Conservation

Duration: Aug 2014-August 2017

Funding Agency: USGS (RWO 291)

The Burmese python population is expanding outside of the southern Everglades and poses a major threat to native wildlife. This study addresses two issues in python management: (1) understanding fine-scale activity patterns, and (2) understanding diet and habitat-use across the landscape. Previous python tracking studies have yielded broad-scale information, but information on daily activity and fine-scale habitat-use is limited. This information can help optimize removal efforts. Stable isotope analysis adds to current knowledge on python diet and habitat-use of pythons, and how those factors differ temporally and spatially. Our first objective is to refine use of GPS tracking and understand fine-scale activity patterns to optimize removal efforts. For this, we surgically implanted GPS tags into 13 pythons in 2 seasons in Everglades National Park. We used these data to identify strengths and weakness of GPS



Assessing Impact of Invasive Pythons on gopher tortoises in Florida

Investigator(s): Christina Romagosa

Student(s): Kodiak Hengstebeck, MS, Wildlife Ecology and Conservation

Duration: August 2015-December 2017

Funding Agency: USGS (RWO 296)

The Burmese python population is expanding from the core population in the southern Everglades. As pythons invade upland habitats, they are documented to also 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. The study objectives are: (1) determine python occupancy of gopher tortoise burrows in the occupied range, and (2) assess burrow microhabitat as a suitable refuge for pythons north of their current range. In the 2017 field season, we will assess occupancy of tortoise burrows by pythons in SW FL. Pythons in burrows will be captured using a modified tortoise trap. We will also collect microhabitat data on burrows occupied and compare to burrows north of the current python range. Preliminary surveys indicate that pythons are using burrows, particularly in winter months. If burrow microclimate north of current python range is compatible, then pythons could expand their range and overwinter in tortoise burrows



Experiential Learning Through Wildlife research and Management of Invasive Reptiles

Investigator(s): Christina Romagosa

Student(s): Natalie Claunch, PhD, School of Natural Resources & Environment; also supports Diego Juarez, MS, Wildlife Ecology and Conservation

Duration: July 2014 – Aug 2018

Funding Agency: USGS (RWO 292)

In-Kind Support: Graduate Stipend for Claunch through UF Graduate School Fellowship

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, such as natural history, management, ecology, critical thinking, decision-making, effective communication, research design, as well as technological/field techniques. While some of these topics are taught in the classroom, some are best learned by experiential learning. The most effective graduates from wildlife programs are those that can link across concepts and understand how to connect research with management, regardless of whether they are on the research or management side. Florida has more nonnative species than any state, which creates unique needs for wildlife professionals. USGS & UF work with several agencies on invasive reptile research focusing on the biology, ecology, and development of control tools for these species. These projects largely depend on in-the-field work, and provide an opportunity by which interns can participate in research and management on invasive species. The multi-agency approach to these projects educates students on bridging the research-management implementation gap, while giving them field experience necessary to excel in their field. Our objectives are: a) to provide experiential learning opportunities with invasive reptiles to undergraduate and graduate students; b) provide labor through internships to attain research goals for

existing USGS/UF invasive reptile research projects, (Tegu movements and demography, Python diet and Invasive reptile physiology (Claunch PhD project)) and c) increase research collaboration and opportunities between USGS and UF. To date, fifteen 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). As nonnative species introductions increase across the United States, so will the need for wildlife ecologists that are trained to address this complex issue.



Optimal Control of Invasive Exotics in South Florida

Investigator(s): Christina Romagosa

Student(s): Mathieu Bonneau (post-doc); research also included Brian Smith (MS-RWO 291) and Brad Udell (MS at the time research was conducted, now PhD on RWO 295)

Duration: August 2011-Aug 2016

Funding Agency: USGS (RWO 273)

Within the constraints of their budgets, management agencies must routinely make tradeoffs when controlling the spread of invasive species. Temporal tradeoffs must also be considered because decisions made now have future implications. These tradeoffs can be investigated within a decision-theoretic framework, which can identify optimal actions based on management goals and constraints, available budgets, and the demography of the invasive population. A key advantage of a decision-theoretic framework is the ability to make optimal decisions in the face of uncertainty, such as the rate at which an invasive will colonize new areas or the effectiveness of control measures. This approach produces a state-dependent management strategy that prescribes an optimal action for each possible time period and state of the system. This strategy can also be adaptive, as predicted/observed system responses are compared over time. Our objectives were: a) develop a

decision-making framework for controlling invasives that has generic application, b) parameterize that framework using information on invasive species in South Florida, and c) derive an optimal control strategy for those species and evaluate its expected performance relative to control strategies. Research focused on the extension of reaction-diffusion models to account for the effect of control actions on the population growth and spread of pythons and tegus. If an invasive species has a large spatial range, control actions might be applied only on some parcels of land, because of accessibility or limited resources. Selecting locations for control is critical and can significantly impact management efficiency. We extended a classic reaction-diffusion model to incorporate the effect of control both in the diffusion and population growth of the invader. The new reaction-diffusion model accounts for the effect of control, not only on the controlled locations, but on neighboring locations, which are based on the theoretical speed of the invasion front. The generality of the new reaction-diffusion model is potentially suitable for a wide class of management problems and provides a tool for managers to predict the effects of different management strategies. The new model is being used to help support development of optimal control strategies for pythons and tegus in South Florida.



Evaluating Effectiveness of Using an Integrated Outreach and Trapping Program to Remove Invasive Wildlife in South Florida

Investigator(s): Frank J. Mazzotti

Student(s): Jenna Cole, Sarah Cooke

Duration: August 2016-September 2017

Funding Agency: United States Geological Survey (RWO 301)

In-Kind Support: Analytical support provided by U.S. Fish and Wildlife Service

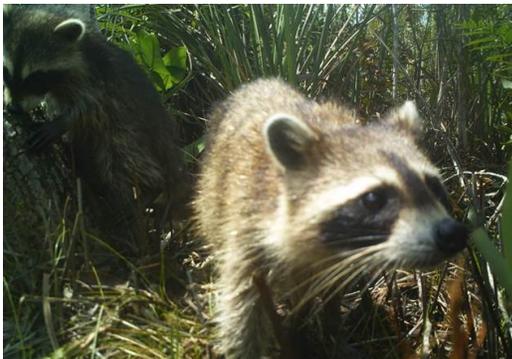
Gold and Argentine black and white tegus (termed tegus) are established in southwestern Miami-Dade County. The core of their distribution is south of Florida City and west of Homestead. Tegus have been captured within Everglades

National Park (ENP), the Southern Glades Wildlife and Environmental Area, Florida Power and Light (FPL) Turkey Point Power Plant (TP) and the FPL mitigation area, and in scattered locations throughout South Dade agricultural area. Camera and live trapping have discovered tegus dispersing in all directions towards the boundaries of ENP, TP, Bird Drive Basin, and Crocodile Lake National Wildlife Refuge (CLNWR). Major gaps in knowledge of tegus include; what is their distribution, abundance, and occupancy in the South Dade agricultural area and how effective is trapping at removing tegus? This knowledge could be applied to develop protocols of where, when, and how to detect and remove tegus as well as how to regionally monitor and evaluate responses of tegus to removal efforts. The objectives of this study are to design and implement a surveillance and removal program to characterize distribution and abundance of tegus in southwestern Miami-Dade County; design, implement and manage a trapping program specifically for gold tegus in southwestern Miami-Dade County; and provide science and outreach support to disseminate results of these activities. Tegu surveillance will include active and passive components such as camera and live trapping, visual surveys, and outreach to landowners, agricultural workers, local herpetologists, and government and utility employees. Camera and live traps will be placed at or near locations where tegus have been sighted or suspected tegu habitat. Visual surveys of these locations will be conducted while traps are being checked. This project has been delayed and in agreement with the funding agency we will begin work in the 2017 season. Results from the surveillance project will be applied to locate traps to remove tegus and to monitor the spread of tegus.

Funding Agency: USGS (RWO 288)

In-Kind Support: NA

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 before they can be addressed by management actions. The aim of this study was to gain an understanding of how mammal communities simultaneously facing invasive predators and intensively human-altered landscapes are influenced by these drivers and their interactions. 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, urbanization, local hydrology, habitat types and interactive effects between pythons and urbanization on mammal species occurrence, site-level species richness, and turnover. Python density had significant negative effects on all species except coyotes. Despite these negative effects, occurrence of some generalist species increased significantly near urban areas. At the community level, pythons had the greatest impact on species richness, while turnover was greatest along the urbanization gradient where communities were increasingly similar as distance to urbanization decreased. Python-induced changes to mammal communities may be mediated near urban development, but elsewhere in the GEE, pythons are likely causing a fundamental restructuring of the food web, declines in ecosystem function, and creating complex and unpredictable cascading effects. These effects will have clear implications for the management of wildlife and ecological function.



Changes in Mammal Communities Across the Greater Everglades

Investigator(s): Robert McCleery

Student(s): Brain Reichert (Post Doc), Wildlife Ecology and Conservation

Duration: June 2014-August 2018



Integrating Science and Management for Optimal Prevention and Control of Aquatic Invasive species in the Everglades

Investigator(s): Christina Romagosa

Student(s): Brad Udell, MS, Wildlife Ecology and Conservation; Mathieu Bonneau, Postdoc; Nahid Jafari, Postdoc; Brian Smith MS also contributed

Duration: August 2015-September 2018

Funding Agency: USGS (RWO 295)

Strategic coordination of invasive species management efforts requires an understanding of the complex tradeoffs associated with the allocation of resources towards monitoring, control and research. These tradeoffs can be investigated formally within the context of a decision-theoretic framework, which can identify optimal actions based on management goals and constraints, available budgets, and the demography of the invasive population. It is critical to integrate science and management into a rigorous and organized framework to make better management decisions. Our project focuses on research that will help make more efficient decisions regarding the control and prevention of invasive species in South Florida. Objectives to develop the decision support tools needed are for 1) optimal control of invasive species and 2) to prevent the establishment of new species by prioritizing non-native species for early detection-rapid response protocols based on the potential risks they pose to native species and habitats. To facilitate these objectives we have been working closely with regulatory agencies, we will develop decision support tools that identify the optimal allocation of resources needed to meet management objectives regarding two invasive species: tegus and melaleuca. The analytical methods developed for these case studies should help address the control of other species (e.g., Brazilian pepper). Building on the outcome of the EDRR Decision Framework Technical Meeting in October 2015, we will develop a screening tool to create an a priority list of species that will elicit immediate response should they be found in the Greater Everglades. Our optimal allocation of resources work is still in

development. The EDRR screening tool will be completed in Spring 2017. Our research will provide a framework for managing agencies to make more efficient decisions regarding the control and prevention of invasive species in South Florida.

Resource Use by the Florida Manatee in the Northern Gulf of Mexico

Investigator(s): Robert Fletcher

Student(s): Katie Haase, PhD, Wildlife Ecology and Conservation

Duration: September 2013-August 2016

Funding Agency: USGS (RWO 274)

Florida manatees range along the Gulf of Mexico coast from Florida to Texas and migrate to peninsular Florida for the winter. They inhabit the northern range of their species distribution, and are therefore frequently exposed to water temperatures below their thermal comfort zone. Manatees thermoregulate by inhabiting natural and artificial warm-water sites, such as thermal outflows from power plants. There is only one artificial warm-water site along the coast of southwestern Florida, so habitat use in this region is not well understood. Understanding the distribution and resource use of manatees in this area will be valuable for managing manatee habitat, particularly in the context of future power plant closures and removal of artificial warm-water sites. The study objectives were: a) Identify specific resources used by manatees, including descriptions of forage and warm water availability in the southwestern coast of Florida; b) Using GPS telemetry, determine the extent of movements and seasonal site fidelity among identifiable manatees in these areas; c) Identify and assess warm water sites that are available for over-wintering manatees. Particular attention will focus on the mechanisms and reliability of these sites; d) Compare habitat usage of the natural warm-water sites to artificial sites in the northern part of Florida. To determine movement responses to temperature, we used animal movement models to classify manatee behavioral states in the Everglades, and related time within each behavior to habitat and environmental covariates. We also developed new types of network analyses to help understand how the proximity of forage resources and thermal refugia explain habitat use. Results suggest that distance between thermal and forage sites, in addition to water temperature, dictate how long manatees spend foraging during stressful water temperatures. Within non-stressful water temperatures, manatees adjust behavior time based on previous behaviors (foraging or warm-water use). Proximity between resource types can highly influence activity time, as we found that the distance between resources highly influences foraging behavior in response to water temperatures. Additionally, manatee use of thermal refugia was highly dependent on

refuge quality; refugia that remained above ambient conditions with little variability were visited more often. These results can be used to identify critical habitats for manatees and how changes in thermal refugia may impact habitat use.



Using Models to Assess Gulf Sturgeon Population Viability

Investigator(s): Bill Pine and Rob Ahrens
Student(s): Merrill Rudd, PhD, University of Washington; Krystan Wilkinson, PhD, University of FL
Duration: August 2016-December 2017
Funding Agency: NOAA-Fisheries (RWO 298)
In-Kind Support: University of Florida SNRE

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 inform management actions designed to promote Gulf sturgeon population recovery. We are designing two population models for use in prioritizing management actions for Gulf sturgeon. The first is a stochastic population viability model (PVA) that allows managers to assess extinction risk for Gulf sturgeon with very small population sizes that have been subjected to frequent high mortality events including oil spills and large hurricanes. The second model is an age-structured population model that is useful for evaluation tradeoffs in management actions directed at different life-history stages. These models for Gulf sturgeon are based on earlier published efforts for similar species. The PVA model is based on an approach described in Pine et al. (2013) based on a series of workshops with USGS and USFWS cooperators. The age-structured model follows a common framework used for many fish populations and was originally developed for commercial fisheries applications. We have completed model development are currently working with USFWS and NOAA colleagues to develop a workshop at the upcoming Gulf

sturgeon working group meeting to present the models and assess a variety of extinction risk and population recovery scenarios as a planning exercise. Gulf sturgeon resource managers are currently developing plans for new management actions such as improved access to spawning grounds, spawning habitat enhancement, or efforts to reduce adult mortality using funds from the Natural Resource Damage Assessment. These models are helping to inform those planning efforts.

Resolving Uncertainty in Natural Mortality and Movement Rates of Gulf Sturgeon using Acoustic Tagging data

Investigator(s): Bill Pine and Rob Ahrens
Student(s): Merrill Rudd, PhD, University of Washington; Krystan Wilkinson, PhD, University of FL
Duration: August 2014-July 2016
Funding Agency: NOAA-Fisheries (RWO 289)
In-Kind Support: University of Florida SNRE

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-life span and slow population recovery rate. We worked with NOAA and USFWS resource managers to estimate mortality rates of Gulf sturgeon to inform management decisions designed to promote Gulf sturgeon population recovery. These efforts are continuing as during our project new data became available that had previously been impounded as part of the Natural Resource Damage Assessment following the Deepwater Horizon oil spill, following a legal settlement in early 2016. We are continuing to compile these data and update the analyses in time for the Gulf sturgeon cooperators meetings in April 2017. Our objective was to estimate site fidelity and mortality of adult Gulf sturgeon. We completed analyses using data available. We fit a multi-state capture-recapture model to data collected as part of a USFWS-NOAA effort to understand spatial distribution of sturgeon movement and mortality patterns. Data available were part of a large telemetry effort designed to track fates of Gulf sturgeon tagged in different river systems across the Gulf of Mexico. Our results are published in a paper with student M. Rudd as lead author. Key findings are high rates of site fidelity based on assumed natal river and also higher mortality rates for adult Gulf sturgeon in western Gulf of Mexico populations than eastern Gulf. Gulf sturgeon resource managers are currently developing plans for new management actions. This work identifies that one hurdle to species recovery may be higher mortality rates in the western Gulf of Mexico populations compared to the eastern Gulf. High site fidelity suggests that spatially explicit management or listing options could be considered for this species.



Doris Duke Scholars Program

Investigator(s): Ray Carthy, Christina Romagosa, Rena Borkhataria

Student(s): Nichole Bishop, Wes Boone, Brian Smith

Duration: September 2013 - September 2019

Funding Agency: Doris Duke Conservation Scholars Program Partnership with University of Florida

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. We believe that we were successful in meeting these goals during the 2016 field season. Students were involved in a variety of research activities that included observational and experimental studies. Individual research projects allowed students to work through all phases of the research process from developing a research question to designing a study to analyzing the data they collected. These individual projects also allowed students to explore a topic in depth, and provided opportunities for students to use a variety of techniques and equipment.

Students had several opportunities throughout the summer that allowed them to meet visiting scientists and work on additional projects that exposed them to novel field techniques. Students at the Whitney Lab volunteered to assist with oyster reef health assessments, in which they collected transect data related to biodiversity. These students also attended a poster session at a conference hosted by Flagler College. This provided them the opportunity to see how scientists communicate the results of their research and interact with a variety of professionals and other students. Connecting with a park ranger with the U.S. National Park Service regarding our road kill surveys has led to further collaboration to identify gopher tortoise road crossings within Fort Matanzas National Monument.

One measure of program effectiveness is a student's ability to communicate the results of their independent research with the scientific community. In previous years, we have had success with students presenting their research as a poster at the Ecological Society of America's (ESA) annual conference: the Summer 2016 cohort have taken pride and ownership of their work as they too look forward to sharing the results of their research at ESA 2017.



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:

Elizabeth Shurr
Modeline Celestin
Camille DeJesus
Hanna Innocent



PUBLICATIONS

Peer-Reviewed Publications

- Cattau, C. E., R. J. Fletcher, Jr., Reichert, B. E., and W. M. Kitchens. 2016. Counteracting effects of a non-native prey on the demography of a native predator culminate in positive population growth. *Ecological Applications* 26: 1952-1968.
- Craig, H.R., S. Kendall, T. Wild, and A. N. Powell. 2015. Dispersal and survival of a polygynandrous passerine. *The Auk: Ornithological Advances* 132:916-925.
- Eastman, S. and G. Appleson. (*accepted*). Sounding the alarm for turtle beaches on an ever-warming planet. In: SWoT Report XII. The State of the World's Sea Turtles.
- Grajal-Puche, A., J. Josimovich, B. Falk, and R. Reed. 2016. *Agkistrodon piscivorus conanti* (Florida cottonmouth) diet. *Herpetological Review* 47: 307.
- Hanslowe, E., B. Falk, M. Collier, J. Josimovich, T. Rahill, and R. Reed. First record of invasive Burmese python oviposition and brooding inside an anthropogenic structure. *Southeastern Naturalist* 15: 103-106.
- Harwood, C. H., R. E. Gill and A. N. Powell. 2016. Nesting ecology of whimbrels in boreal Alaska. *Wader Study* 123(2):99-113.
- Latty, C. J., T. E. Hollmén, M. R. Petersen, A. N. Powell, and R. D. Andrews. 2016. Biochemical and clinical responses of Common Eiders to implanted satellite transmitters. *The Condor: Ecological Applications* 118:489-501.
- Pias, K., R. J. Fletcher, Jr., and W. M. Kitchens. 2016. Implications of novel habitat use by breeding snail kites. *Journal of Fish and Wildlife Management* 7: 449-460
- Reichert, B. E., W. Kendall, R. J. Fletcher, Jr., and W. M. Kitchens. 2016. Spatio-temporal variation in age structure and abundance of the endangered snail kite: pooling across regions masks a declining and aging population. *PLoS One* 11(9):e0162690
- Reichert, B. E., R. J. Fletcher, Jr., C. Cattau, and W. M. Kitchens. 2016. Consistent scaling of population structure across landscapes despite intraspecific variation in movement and connectivity. *Journal of Animal Ecology* 85:1563-1573.
- Selby T. H., Hart K. M., Fujisaki I., Smith B.J., Pollock C.J., Hills-Starr Z., Lundgren I., and M. K. Oli. 2016. Can you hear me now? Range-testing a submerged passive acoustic receiver array in a Caribbean coral reef habitat. *Ecology and Evolution* 6:4823-4835.
- Sexson, M.G., M. R. Petersen, G. A. Breed, and A. N. Powell. 2016. Shifts in the distribution of molting Spectacled Eiders (*Somateria fischeri*) indicate ecosystem change in the Arctic. *The Condor: Ornithological Applications* 118:463-476.
- Wilcox, R. C., and R. J. Fletcher, Jr. 2016. Experimental test of preferences for an invasive prey by an endangered predator: implications for conservation. *PLoS One* 11(11): e0165427
- Zweig, C.L., M.A. Burgess, S. Newman, D.B. Ivanoff, and H.F. Percival. (*in press*). Use of very high-resolution imagery in wildlife population estimation and monitoring.

Technical Publications

- Powell A. N., R. T. Churchwell, K. H. Dunton, J. G. Baguley, A. D. Kamikawa, C. T. E. Kellogg, B. C. Crump, and P. Bucolo. 2016. Sediment Characteristics and Infauna of Deltaic Mudflats Along the Alaskan Beaufort Sea. US Dept. of the Interior, Bureau of Ocean Energy Management, Alaska OCS Region, Anchorage. OCS Study BOEM 2015-045. 77 pp.

Theses/Dissertations

Haase, C. 2016. Effects of the spatial configuration of forage and thermal habitats on the behavior of the Florida manatee. Dissertation, University of Florida. 109 pp.

PRESENTATIONS

- Ahrens, R. N. M., W. E. Pine, and S. K. Bolten 2017. Informing Gulf Sturgeon (*Acipenser oxyrinchus desotoi*) Recovery Goals Based on Historical Population Size and Extant Habitat. NOAA Protected Resources Symposium. Seattle, WA.
- Bishop, N., Hudson, R., Marlin, J., Pop, T., Boylan, S., Atkinson, B., and R. Carthy. 2016. Estimating age and size at sexual maturity in the critically endangered Central American river turtle, *Dermatemys mawii*. 14th Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles. New Orleans, LA.
- Bishop, N., Polisar, J., Eliazar, P., 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., Pop, T., Marlin, J., Hudson, R., Boylan, S., Polisar, J., 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.
- Bonneau, M., F. Johnson, J. Martin, C. M. Romagosa, P. Fackler, B. J. Smith*, B. Udell*, N. Jafari, K. O'Donnell, J. Redwine, T. Pernas, L. Rodgers, B. Zhang, D. DeAngelis. 2016. Optimal control of invasive species in the Greater Everglades. Ecological Society of America Annual Meeting, Fort Lauderdale, FL.
- Brisbane, J., C. Pedrozo, B. J. Smith, C. Romagosa, N. Bishop and R. Carthy. 2016. Environmental factors influencing the detection of frog species in three habitat types of Everglades National Park. Annual Meeting, Ecological Society of America, Fort Lauderdale, FL. (Contributed Poster)
- Carthy, R. R., M. A. Burgess, P.G. Ifju, and T. J. Whitley. 2016. UAS technology for sea turtle research and conservation. The Southeastern Regional Sea Turtle Network Meeting. Mobile, AL.
- Eastman S, T. Osborne, R. Carthy. 2016. Evaluating the Effects of Climate Change and Coastal Management Adaptation Strategies on the Reproductive Success of Marine Turtles. Perspectives in Ecosystem Ecology Research Seminar (PEERS). University of Florida, Gainesville, FL.
- Ely, M, N. Bishop, B.J. Smith, C. Romagosa and R. Carthy. 2016. Monitoring changes in sea turtle nesting beaches in St. Johns County, Florida. Annual Meeting, Ecological Society of America, Fort Lauderdale, FL (Contributed Poster)
- Evans et al. 2016. The Path Less Traveled. Southeast Regional Sea Turtle Conference, Mobile, AL.
- Griffith, B., J. Roach and A. N. Powell. 2016. Identifying Climate Change and Cross-seasonal Research Priorities for Waterfowl. Symposium on Climate Change and Migratory Birds: Connecting Management Challenges to Research Programs. The Wildlife Society, Annual Meeting, Raleigh NC (Invited Oral)
- Haase, C., R. J. Fletcher, and D. Slone. 2016. Landscape complementation for the Florida manatee revealed through bipartite networks. International Association for Landscape Ecology Annual Meeting, Ashville, NC.

- Jafari, N. 2016. Robust Spatial Optimization for the Dynamic Invasive Species Management. CompSust-2016, 4th International Conference on Computational Sustainability, Cornell, NY. .
- Pedrozo, C., J. Brisbane, B. J. Smith, C. Romagosa, N. Bishop and R. Carthy. 2016. Predicting patterns of native snake occurrence along Main Park Road in Everglades National Park, Florida. Annual Meeting, Ecological Society of America, Fort Lauderdale, FL. (Contributed Poster)
- Quintilani, M., N. bishop, B. J. Smith, C. Romagosa and R. Carthy. 2016. Effects of man-made oyster reefs on sediment composition in estuaries. Annual Meeting, Ecological Society of America, Fort Lauderdale, FL. (Contributed Poster)
- Robinson, B. H., L. M. Phillips, and A. N. Powell. 2016. Accelerated energy intake increases survival rates of Black Oystercatcher broods. NPS Centennial Science and Stewardship Symposium, Fairbanks, AK. (Invited Oral)
- Robinson, B. H., L. M. Phillips, and A. N. Powell. 2016. Accelerated energy intake increases survival rates of Black Oystercatcher broods. Alaska Chapter, TWS, Anchorage, AK. (Contributed Oral)
- Selby T. H., Hart K. M., Fujisaki I., Smith B. J., Pollock C. J., Hills-Starr Z., Lundgren I., and M. K. Oli. 2016. Can you hear me now? Range-testing a submerged passive acoustic receiver array in a Caribbean coral reef habitat. Ecological Society of America, Annual Meeting, Fort Lauderdale, FL.
- Shamblin B., M. Dodd, D. Griffin, M. Pate, M. Godfrey, M. Coyne, S. Eastman, R. Boettcher, C. Nairn. 2016. Resolving population dynamics through subpopulation scale genetic capture-recapture of loggerhead turtles. Whitney Laboratory of Marine Bioscience Seminar Series, St Augustine, FL.
- Siddiqui, S., N. Bishop and R. Carthy. 2016. Nutrient Influxes from *Caretta caretta* (loggerhead sea turtle) nesting. Annual Meeting, Ecological Society of America, Fort Lauderdale, FL. (Contributed Poster)
- Smith, B.J., C.M. Romagosa, F.J. Mazzotti, M. Basille, and K.M. Hart. 2016. Does GPS technology help refine our understanding of invasive Burmese python spatial ecology? Ecological Society of America Annual Meeting. Fort Lauderdale, FL.
- Smith, B.J., C.M. Romagosa, F.J. Mazzotti, M. Basille, and K.M. Hart. 2016. Does GPS technology help refine our understanding of invasive Burmese python spatial ecology? Joint Meeting of Ichthyologists and Herpetologists. New Orleans, LA.
- Suarez, E., C. Romagosa, C. Dove, B. Falk and R. Reed. 2016. Prey species composition and dietary shifts of the Burmese python in southern Florida. Joint Meeting of Ichthyologists and Herpetologists, New Orleans, LA; Ecological Society of America Annual Meeting. Fort Lauderdale, FL..
- Suarez, E., C. Romagosa, C. Dove, B. Falk and R. Reed. 2016. Prey species composition of the Burmese python in southern Florida. Ecological Society of America Annual Meeting. Fort Lauderdale, FL.

Invited Seminars

- Carthy, R.R., 2016. Sea turtle conservation research: a view from the Southeastern U.S. Presented to the University of the West Indies- St. Augustine.

COMPLETED PROJECTS

Comprehensive Assessment of Spatially-Explicit Demography on Short- and Long-Term Snail Kite Population Growth in the Greater Everglades

Investigator(s): Robert Fletcher, Chris Cattau, Brian Reichert

Completion Date: June 2016

Funding Agency: USGS RWO 294

Using models to assess Gulf sturgeon population viability

Investigator(s): Bill Pine and Rob Ahrens

Completion Date: July 2016

Funding Agency: NOAA-Fisheries (RWO 289)

To Advance, Test, and Quantify Unmanned Aircraft System Capabilities for the USGS

Investigator(s): Raymond R. Carthy, Peter G. Ifju, Benjamin E. Wilkinson, and Scot E. Smith

Completion Date: July 2016

Funding Agency: U.S. Geological Survey RWO#290

Optimal Management of Migratory Bird Habitat and Harvest

Investigator(s): Ray Carthy

Completion Date: Aug 2016

Funding Agency: USGS (RWO 272)

Collaborator: Fred Johnson

Optimal Control of Invasive Exotics in South Florida

Investigator(s): Christina Romagosa

Completion Date: Aug 2016

Funding Agency: USGS (RWO 273)

Habitats and Resources Use by Threatened and Endangered Marine Turtles

Investigator(s): Ikuko Fujisaki

Completion Date: August 2016

Funding Agency: U.S. Geological Survey (RWO 293)

Resource use by the Florida manatee in the northern Gulf of Mexico

Investigator(s): Robert Fletcher

Completion Date: August 2016

Funding Agency: USGS (RWO 274)

Low-Altitude Imagery to Assess Vegetation Density, Vegetation Health, and Wildlife Use of the Stormwater Treatment Areas

Investigator(s): Raymond R. Carthy

Completion Date: September 2016

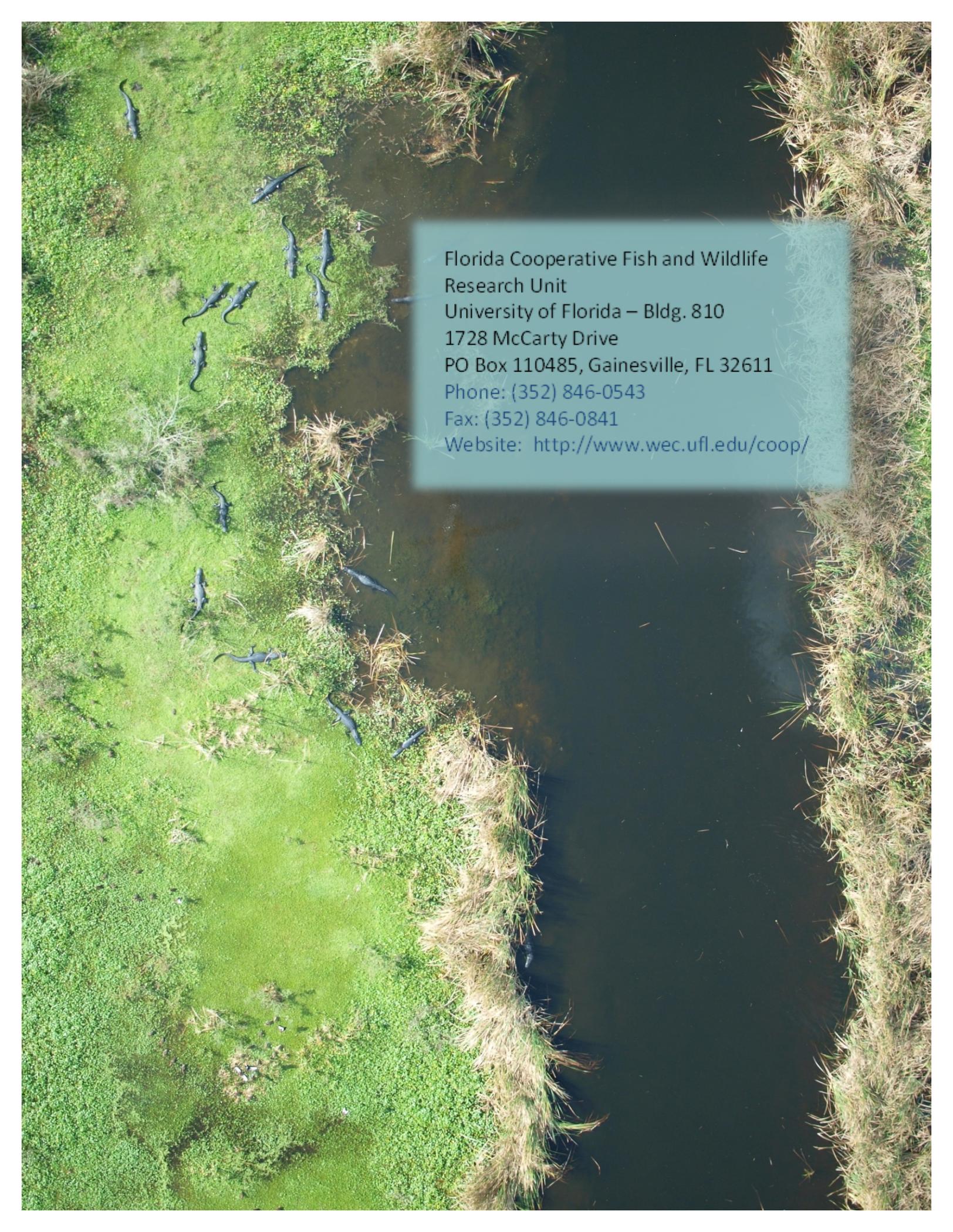
Funding Agency: South Florida Water Management District

Monitoring Vegetation Change and Wildlife Use of Active Marsh Improvement Sites

Investigator(s): Raymond R. Carthy

Completion Date: December 2016

Funding Agency: South Florida Water Management District

An aerial photograph of a swampy area. A dark, narrow body of water runs vertically through the center-right of the frame. The surrounding land is covered in lush green vegetation, including grasses and small shrubs. Numerous alligators are visible, scattered across the land and near the water's edge. Some are basking in the sun, while others are partially submerged. The overall scene depicts a natural habitat for these reptiles.

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