# Annual Report

# 2021

## Florida Cooperative Fish and Wildlife Research Unit


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## COOPERATORS

Florida Fish and Wildlife Conservation Commission

United States Geological Survey

United States Fish and Wildlife Service

University of Florida

Wildlife Management Institute


***Cover Left**: Willet along the Atlantic Coast.* ABBY POWELL; ***Center:** A juvenile green turtle swimming through the shallow seagrass beds near Crystal River, FL.* RICK HERREN; ***Right:** A nestling snail kite that is ready for tagging.* CAROILINE POLI.

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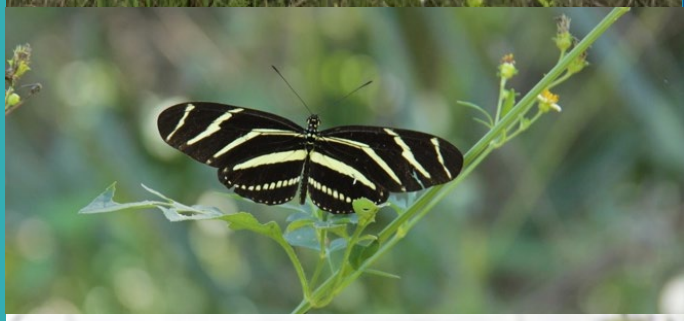
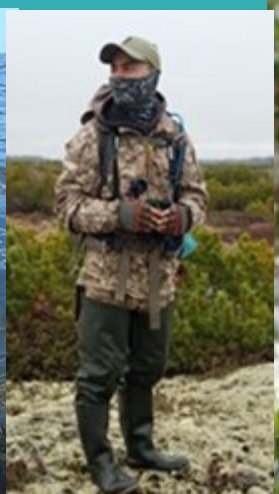




***Clockwise from top right**: UF Master's students Jack Hartfelder and Marina McCampbell tracking cotton rats to examine the influence of python predation in the Everglades.* M. McCAMPBELL; Zebra longwings. BEN KAHLER. *Great egret at Cedar Key, FL.* KATRINA ROSSOSS; *Philipp Maleko standing on a hummock of the Schaste Bay inland bog, scanning the surrounding landscape for signs of nesting Nordmann's Greenshank.* KONANTIN MASLOVSKY; *Release of juvenile green turtle after tagging, measuring, and tissue sampling.* RICK HERREN.

# 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 2022, over 330 projects totaling more than $65 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 450 publications, 130 technical reports, 113 theses and dissertations, and 260 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 (USFWS) and the community of state and federal conservation agencies and nongovernmental 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.

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

# Dedication

The 2021 Florida Cooperative Fish and Wildlife Research Unit Annual Report is dedicated to Dr. Christina Romagosa. Affectionally called "Momagosa" by the students in her lab, Dr. Romagosa had a tumultuous and inspiring 2021. She faced life disruptions with courage and grace and simultaneously assumed new responsibilities and roles with WEC and UF. Momagosa transitioned to a tenure track position in the WEC department, and the program is and feels lucky to have her. She taught graduate and undergraduate courses, welcomed several new graduate students to her lab and was also awarded numerous research and management support grants by the USGS, FFWCC, and others to continue and expand her research program into invasive species, especially reptiles, in Florida. Her practical, management-focused research complements the Unit mission very well and we are pleased that her campus office is in the new Coop building on Mowry Rd. In 2021, Momagosa also served as the co-program leader for the Doris Duke Conservation Scholars Program at UF, making her a campus and national leader in efforts to increase diversity, equity, and inclusion in the field of conservation. She is an excellent colleague and an even better role model for our students, and we are honored to dedicate our annual report to her!

*(Left to right) Dr. Christina Romagosa, Ian Easterling (Conservancy of Southwest Florida), Kodiak Hengstebeck, and Cailin Ervin (Conservancy of Southwest Florida).* NATALIE CLAUNCH

## Mission

The mission of the Florida Cooperative Fish and Wildlife Research Unit is to conduct detailed investigation of aquatic and terrestrial resources and their component fish and wildlife populations. Our research emphasizes the interaction of biota with features of their habitat, both natural and those impacted by human activities, and ranges across state, regional, national, and international scopes.

We have wide-ranging expertise in avian ecology and conservation, endangered species monitoring and assessment, coastal ecosystems, population and ecological modeling, decision analysis, fisheries ecology and management, and coupled human and natural systems. Our research is taxonomically diverse, including but not limited to terrestrial and water birds, terrestrial herpetofauna and marine turtles, and freshwater and marine fishes. Critical components of our mission include applied research, graduate education, and technical assistance in collaboration with the Florida Fish and Wildlife Conservation Commission, U. S. Geological Survey, U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, and many other partners. We are dedicated to training the next generation of natural resource leaders through management-relevant research, working with state, federal, and university cooperators and other stakeholders to address questions pertinent to fish and wildlife conservation in the face of environmental, demographic, and socioeconomic change.

## Diversity, Equity, and Inclusion

Diversity, equity, inclusion, and justice are vital to our mission at the Florida Coop Unit. We are dedicated to building a culture of inclusivity and respect through graduate education, research, and technical assistance. Much like biodiversity imparts ecosystem resilience, we believe that human diversity enhances the resilience of the conservation community, providing pathways to engage with the world and deliver solutions to conservation, and broader societal, challenges. We oppose discrimination, inequality, and racism in all of their forms, seeking to understand and abolish systems of power and privilege in our profession and our world. We believe that diversity is a source of strength, ingenuity, and inspiration. We welcome people from all backgrounds, listen to all voices without judgment, and hold ourselves accountable for building a diverse, equitable, inclusive, and just community.

# UNIT COORDINATING COMMITTEE

| | |
|---|---|
| **Scott Angle** | Vice President for Agriculture and Natural Resources, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida. |
| **Thomas Eason** | Assistant Executive Director, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. |
| **Barry Grand** | Supervisor, Cooperative Research Units, U.S. Geological Survey, Auburn, Alabama. |
| **Jonathan Gassett** | Southeastern Field Representative, Wildlife Management Institute, Georgetown, Kentucky. |
| **David Viker** | Regional Refuge Chief, U.S. Fish and Wildlife Service Southeast Region, Atlanta, Georgia. |

# BIOGRAPHICAL PROFILES OF UNIT SCIENTISTS

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

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

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

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

# COOPERATORS

**Nathan Allan,** *U.S. Fish and Wildlife Service*

**Michael S. Allen,** *University of Florida*

**Gretchen Anderson,** *U.S. Geological Survey*

**Christine Angelini,** *University of Florida*

**Joe Aufmuth,** *University of Florida*

**Nick Aumen,** *U.S. Geological Survey*

**Ian Bartoszek,** *Conservancy of Southwest Florida*

**Tyler Beck,** *Florida Fish and Wildlife Conservation Commission*

**Mo Bennett,** *University of Florida*

**Arthur Bernhardt,** *Florida Fish and Wildlife Conservation Commission*

**Scott Bisping,** *Florida Fish and Wildlife Conservation Commission*

**Karen A. Bjorndal,** *University of Florida*

**Sean Blomquist ,** *U.S. Fish and Wildlife Service*

**Rena Borkhataria,** *University of Florida*

**Robin Boughton,** *Florida Fish and Wildlife Conservation Commission*

**Laura Brandt,** *U.S. Fish and Wildlife Service*

**Anna Braswell,** *University of Florida*

**Billy Brooks,** *U.S. Fish and Wildlife Service*

**Janell Brush,** *Florida Fish and Wildlife Conservation Commission*

**Heather Bulger**, *U.S. Army Corps of Engineers*

**Kathleen Burchett,** *U.S. Fish and Wildlife Service*

**Matt Burgess,** *U.S. Geological Survey*

**Ed Camp,** *University of Florida*

**Cameron Carter,** *University of Florida*

**Michael Cherkiss,** *U.S. Geological Survey*

**Matt Chopp,** *Florida Fish and Wildlife Conservation Commission*

**Chuck Cichra,** *University of Florida*

**Roger Clay,** *Alabama Department of Conservation and Natural Resources*

**Lew Coggins,** *National Oceanic and Atmospheric Administration*

**Andrew Cox,** *Florida Fish and Wildlife Conservation Commission*

**Chelsea Crandall,** *Florida Fish and Wildlife Conservation Commission*

**Andrea Currylow,** *U.S. Geological Survey*

**Wes Daniel,** *U.S. Geological Survey*

**Tylan Dean**, *National Park Service*

**Bon A. Dewitt,** *University of Florida*

**Jason Dotson,** *Florida Fish and Wildlife Conservation Commission*

**Drew Dutterer,** *Florida Fish and Wildlife Conservation Commission*

**Michelina Dziadzio,** *Florida Fish and Wildlife Conservation Commission*

**Ian Easterling**, *Conservancy of Southwest Florida*

**Catherine Eastman,** *University of Florida*

**Cailin Ervin**, *Conservancy of Southwest Florida*

**Bryan Falk,** *National Park Service*

**Nick Farmer,** *National Oceanic and Atmospheric Administration*

**Austin Fitzgerald,** *U.S. Geological Survey*

**Robert Fletcher,** *University of Florida*

**Brian Folt,** *U.S. Geological Survey*

**Bradley Fontaine,** *Florida Fish and Wildlife Conservation Commission*

**Dewayne Fox,** *Delaware State University*

**Karen Frutchey,** *U.S. Fish and Wildlife Service*

**Mariana Fuentes,** *Florida State University*

**Sarah Funck,** *Florida Fish and Wildlife Conservation Commission*

**Victoria Garcia,** *U.S. Fish and Wildlife Service*

**Brian Garrett,** *South Florida Management District*

**Kelly Gestring,** *Florida Fish and Wildlife Conservation Commission*

**Rebekah Gibble,** *U.S. Fish and Wildlife Service*

**Jeff Gleason,** *U.S. Fish and Wildlife Service*

**Heather Goston,** *Florida Department of Environmental Protection*

**Andrew Gude,** *U.S. Fish and Wildlife Service*

**Darby Guyn,** *City of Gainesville*

**Dianne Hall,** *St. Johns Water Management District*

**Marla Hamilton,** *U.S. Fish and Wildlife Service*

**Ryan Hamm,** *Florida Fish and Wildlife Conservation Commission*

**Kristen Hart,** *U.S. Geological Survey*

**Kate Healy,** *U.S. Fish and Wildlife Service*

**Brian Healy,** *National Park Service*

**Eric Hellgren,** *University of Florida*

**Joe Heublein,** *National Oceanic and Atmospheric Administration*

**Dave Hewitt,** *U.S. Fish and Wildlife Service*

**Jeff Hill,** *University of Florida*

**Tomo Hirama,** *Florida Fish and Wildlife Conservation Commission*

**Mark Hoyer,** *University of Florida*

**Vanessa Hull,** *University of Florida*

**Margaret Hunter,** *U.S. Geological Survey*

**Chuck Hunter,** *U.S. Fish and Wildlife Service*

**Reid Hyle,** *Florida Fish and Wildlife Conservation Commission*

**Peter Ifju,** *University of Florida*

**Steven Johnson,** *University of Florida*

**Kevin Johnson,** *Florida Fish and Wildlife Conservation Commission*

**Todd Jones-Farrand,** *U.S. Fish and Wildlife Service*

**Alyssa Jordan,** *Florida Fish and Wildlife Conservation Commission*

**Jillian Josimovich,** *U.S. Geological Survey*

**Adam Kaeser,** *U.S. Fish and Wildlife Service*

**Kevin Kalasz,** *U.S. Fish and Wildlife Service*

**Patty Kelly,** *U.S. Fish and Wildlife Service*

**Catherine Kennedy,** *Florida Fish and Wildlife Conservation Commission*

**Joyce Kleen,** *U.S. Fish and Wildlife Service*

**Trevor Knight,** *Florida Fish and Wildlife Conservation*

*Commission*

**Margaret Lamont,** *U.S. Geological Survey*

**Ted Lange,** *Florida Fish and Wildlife Conservation Commission*

**Marcus Lashley,** *University of Florida*

**Summer Lindelien,** *Florida Fish and Wildlife Conservation Commission*

**Ken Lohmann,** University of North Carolina, Chapel Hill

**Cully W. Lord,** *City of Gainesville*

**Kai Lorenzen,** *University of Florida*

**Andy LoShiavo,** *U.S. Army Corps of Engineers*

**James Lyons, *U.S. Geological Survey***

**Michael Marshall,** Texas A&M University

**Julien Martin,** *U.S. Geological Survey*

**Jenna May,** *U.S. Army Corps of Engineers*

**Frank Mazzotti,** *University of Florida*

**Robert McCleery,** *University of Florida*

**Gil McRae,** *Florida Fish and Wildlife Conservation Commission*

**Lourdes Mena,** *U.S. Fish and Wildlife Service*

**Debbie Miller,** *University of Florida*

**Melissa Miller,** *University of Florida*

**Karl Miller,** *Florida Fish and Wildlife Conservation Commission*

**Barron Moody,** *Florida Fish and Wildlife Conservation Commission*

**Clinton Moore**, *U.S. Geological Survey*

**Keith Morin,** *Florida Department of Environmental Protection*

**Melia Nafus,** *U.S. Geological Survey*

**Eric Nagid,** *Florida Fish and Wildlife Conservation Commission*

**Melissa Nasuti,** *U.S. Army Corps of Engineers*

**Dan Nelson,** *Florida Fish and Wildlife Conservation Commission*

**Bryan Nuse,** *University of Georgia*

**Katherine O'Donnell,** *U.S. Geological Survey*

**Bradley O'Hanlon,** *Florida Fish and Wildlife Conservation Commission*

**Jason O'Connor,** *Florida Fish and Wildlife Conservation Commission*

**Madan Oli,** *University of Florida*

**Todd Osborne,** *University of Florida*

**Joyce Palmer,** *U.S. Fish and Wildlife Service*

**Geoff Parks,** *City of Gainesville*

**Kevin Patton,** *Florida Department of Environmental Protection*

**Ramesh Paudyal,** *Florida Fish and Wildlife Conservation Commission*

**Bill Pine,** *University of Florida*

**Bill Pouder,** *Florida Fish and Wildlife Conservation Commission*

**Gregg Poulakis,** *Florida Fish and Wildlife Conservation Commission*

**Candice Prince,** *University of Florida*

**Raya Pruner,** *Florida Fish and Wildlife Conservation Commission*

**Erin Ragheb,** *Florida Fish and Wildlife Conservation Commission*

**Robert Reed,** *U.S. Geological Survey*

**Lindsey Reisinger,** *University of Florida*

**Ken Rice,** *U.S. Geological Survey*

**Steve Rider,** *Alabama Department of Conservation and Natural Resources*

**Erin Rivenbark,** *U.S. Fish and Wildlife Service*

**Charlotte Robinson**, *U.S. Geological Survey*

**LeRoy Rodgers,** *South Florida Management District*

**Christina Romagosa,** *University of Florida*

**J. Perran Ross,** *University of Florida*

**Amy Schwarzer,** *Florida Fish and Wildlife Conservation Commission*

**Jesse Senko,** *Arizona State University*

**Donna Shaver,** *National Park Service*

**Katie Sieving,** *University of Florida*

**David Smith,** *U.S. Geological Survey*

**Sandra Sneckenberger,** *U.S. Fish and Wildlife Service*

**Kristen Sommers,** *Florida Fish and Wildlife Conservation Commission*

**McKayla Spencer,** *Florida Fish and Wildlife Conservation Commission*

**Channing St. Aubin,** *U.S. Fish and Wildlife Service*

**Courtney Stachowiak,** *Florida Fish and Wildlife Conservation Commission*

**David Steen,** *Florida Fish and Wildlife Conservation Commission*

**Taylor Stein,** *University of Florida*

**Eric Suarez,** *Florida Fish and Wildlife Conservation Commission*

**John Sweka,** *U.S. Fish and Wildlife Service*

**Jessica Swindall,** *Florida Coastal Conservancy*

**Brandon Thompson,** *Florida Fish and Wildlife Conservation Commission*

**Melissa Tolbert,** *City of West Palm Beach*

**Robin Trindell,** *Florida Fish and Wildlife Conservation Commission*

**Nick Trippel,** *Florida Fish and Wildlife Conservation Commission*

**Paul Tritaik**, *U.S. Fish and Wildlife Service*

**Anna Tucker,** *U.S. Geological Survey*

**Quenton Tuckett,** *University of Florida*

**Travis Tuten,** *Florida Fish and Wildlife Conservation Commission*

**Hannah Vander Zanden,** *University of Florida*

**Maureen Walsh,** *U.S. Fish and Wildlife Service*

**Marsha Ward,** *Florida Fish and Wildlife Conservation Commission*

**Zach Welch,** *South Florida Management District*

**Stasey Whichel,** *Florida Fish and Wildlife Conservation Commission*

**Benjamin Wilkinson,** *University of Florida*

**Randy Wilson**, *U.S. Fish and Wildlife Service*

**Sam Wisely,** *University of Florida*

**Blair Witherington,** *Inwater Research Group*

**David Witmer,** *City of West Palm Beach*

**Chris Wynn,** *Florida Fish and Wildlife Conservation Commission*

**Amy Yackel-Adams,** *U.S. Geological Survey*

# RESEARCH PERSONNEL

(Names in green are supervised by Powell, Carlson, Carthy, or McGowan)

## University of Florida Cooperating Faculty

**Robert Fletcher**, *WEC*
**Robert McCleery**, *WEC*
**Bill Pine**, *WEC*
**Christina Romagosa**, *WEC*
**Hannah Vander Zanden**, *Biology*

## Support Staff

**Lisa Burnett**, Administrative Support Assistant
**Ben Kahler**, Research Administrator

## Postdoctoral Research Scholars

**Riley Andrade**
Natalie Claunch
Joshua Cullen
**Brian Folt**
**Ashley Goode**
Caroline Poli
Paul Taillie

## Graduate Students

**Trenton Aguilar**, *Ph.D., Fisheries and Aquatic Sciences*
ADVISOR: Raymond Carthy

**Christopher Anderson**, *Ph.D., Fisheries and Aquatic Sciences*
ADVISOR: Andrew Carlson

**Carson Arends**, *M.S., Biology*
ADVISOR: Hannah Vander Zanden

**Nichole Bishop**, *Ph.D., Interdisciplinary Ecology*
ADVISOR: Raymond Carthy

**Kimberly Bonvechio**, *Ph.D., Fisheries and Aquatic Sciences*
ADVISOR: Andrew Carlson

**Alexis Cardas**, *M.S., Wildlife Ecology and Conservation*
ADVISOR: Abby Powell

**Daniel Catizone**, *M.S., Interdisciplinary Ecology*
ADVISOR: Christina Romagosa

**Keara Clancy**, *M.S., Wildlife Ecology and Conservation*
ADVISOR: Christina Romagosa

**Natalie Claunch**, *Ph.D., Interdisciplinary Ecology*
ADVISOR: Christina Romagosa

**Steven Tyler Coleman**, *Ph.D., Wildlife Ecology and Conservation*
ADVISOR: Andrew Carlson

**Bethany Gaffey**, *M.S., Fisheries and Aquatic Sciences*
ADVISOR: Andrew Carlson

**Alfredo Gonzalez**, *M.S., Wildlife Ecology and Conservation*
ADVISOR: Robert Fletcher

**Kaili Gregory**, *M.S., Wildlife Ecology and Conservation*
ADVISOR: Conor McGowan

**Chris Gulick**, *Ph.D., Wildlife Ecology and Conservation*
ADVISOR: Abby Powell

**Daniel Haro**, *Ph.D., Wildlife Ecology and Conservation*
ADVISOR: Christina Romagosa

**Madison Harman**, *M.S., Wildlife Ecology and Conservation*
ADVISOR: Christina Romagosa

**Kodiak Hengstebeck**, *Ph.D., Interdisciplinary Ecology*
ADVISOR: Christina Romagosa

**Richard Herren**, *Ph.D., Wildlife Ecology and Conservation*
ADVISOR: Raymond Carthy

**Brian Jeffrey**, *Ph.D., Wildlife Ecology and Conservation*
ADVISOR: Rob Fletcher

**Diego Juárez-Sánchez**, *Ph.D., Wildlife Ecology and Conservation*
ADVISOR: Christina Romagosa

**Philipp Maleko**, *M.S., Interdisciplinary Ecology*
ADVISOR: Abby Powell

**Costanza Manes**, *Ph.D., Wildlife Ecology and Conservation*
ADVISOR: Raymond Carthy

**Logan Masterson**, *M.S., Fisheries and Aquatic Sciences*
ADVISOR: Andrew Carlson

**Stephen Parker**, *Ph.D., Fisheries and Aquatic Sciences*
ADVISOR: Bill Pine

**Arianna Paul**, *M.S., Wildlife Ecology and Conservation*
ADVISOR: Christina Romagosa

**Katrina Rossos**, *M.S., Wildlife Ecology and Conservation* ADVISOR: Raymond Carthy

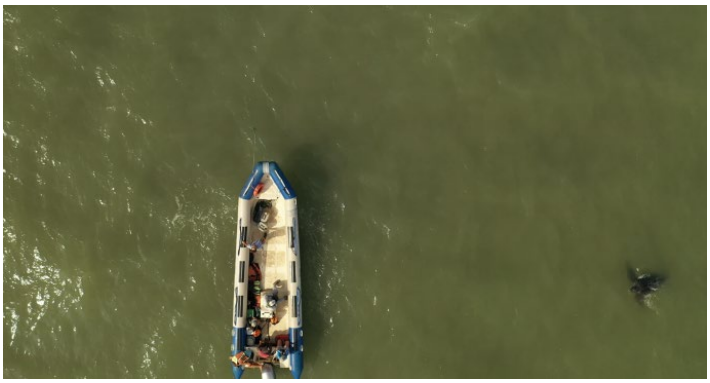
**Jaren Serano**, *M.S., Wildlife Ecology and Conservation* ADVISOR: Raymond Carthy

**Rachel Smith**, *Ph.D., Interdisciplinary Ecology* ADVISOR: Raymond Carthy

**Natalia Teryda**, *Ph.D., Wildlife Ecology and Conservation* ADVISOR: Raymond Carthy

**Josh Vine**, *Ph.D., Wildlife Ecology and Conservation* ADVISOR: Bill Pine

**Ke Zhang**, *Ph.D., Wildlife Ecology and Conservation* ADVISOR: Abby Powell



*View of a leatherback surfacing nearby the research boat in Santa Teresita, Samborombon Bay, Argentina. Image taken with UAS Mavic 2 Pro while conducting a survey.* NATALIA TERYDA

# HONORS AND AWARDS

**3-Minute Thesis Competition Finalist** Awarded to Costanza Manes by the Graduate School Three Minute Thesis Competition Committee. University of Florida. October 20, 2022. Gainesville, Florida.

**Boyd Lyon Sea Turtle Fund Scholarship**. Awarded to Natalia S. Teryda by The Ocean Foundation. April 2021, Washington DC.

**Doris and Earl Lowe and Verna Lowe Scholarship**. Awarded to Natalia S. Teryda by the College of Agricultural and Life Sciences at University of Florida. August 2021, Gainesville, Florida.

**Florida Sea Grant Science Communication Keep Our Oceans Clean Photo Contest**. First Place awarded to Bethany Gaffey. August 17, 2021. Gainesville, Florida.

**Florida Wildlife Federation Scholarship.** Awarded to Madison Harman by the department of Wildlife Ecology and Conservation at University of Florida. 2021. Gainesville, Florida.

**Frederick H. Stoye Award in Herpetology for a Virtual Presentation.** (2021 by Natalie M. Claunch). Joint Meeting of Ichthyologists and Herpetologists. July 21-27, Phoenix, Arizona.

**Jennings Scholarship**. Awarded to Stephen Parker by the Wildlife Ecology and Conservation Department Grants Committee. University of Florida. Gainesville, Florida.

**LS-PAC MODEL Scholar**, Awarded to Trenton Aguilar by the Louis Stokes Center for Promotion of Academic Careers MODELS Center, Louisiana State University, June 2021.

**NSTSTF Scholarship**. Awarded to Costanza Manes by the National Save the Sea Turtle Foundation. University of Florida. August 25, 2021. Fort Lauderdale, Florida.

**Postdoctoral Research Fellowship in Biology FY 2022-2024.** Awarded to Natalie M. Claunch by National Science Foundation.

**Ron Magill Conservation Scholarship**. Awarded to Natalia S. Teryda by the department of Wildlife Ecology and Conservation at University of Florida. April 2021, Gainesville, Florida.

**SEC Emerging Scholar**, Awarded to Trenton Aguilar by the Southeastern Conference Emerging Scholar Program. August 2021.

**Tropical Conservation and Development Working Group Grant.** Awarded to Natalie M. Claunch and others by the Tropical Conservation and Development Program, University of Florida, Gainesville, Florida, 2021.

**University of Florida IFAS blog.** Bethany Gaffey, M.S. student, was the featured graduate student in this serial posting on November 18, 2021. Gainesville, Florida.

# ACRONYMS

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



*Left to right: Aleidys Lopez-Romero (cohort 7) adjusting a wildlife camera during her internship with Sky Island Alliance.* A. LOPEZ-ROMERO; *Maya Encinosa (cohort 8) holds a Florida bonneted bat.* M. ENCINOSA; *Maria Vilchez (cohort 7) conducting fieldwork.* M. VILCHEZ

## Doris Duke Conservation Scholars Program

The Doris Duke Conservation Scholars Program provides students from diverse backgrounds that are usually under-represented in the wildlife field with a better understanding of the research process, exposing them to a variety of research and field techniques, and helping to develop a deeper understanding of and appreciation for a topic of their interest through independent projects. In the summer of 2021, the seventh and eighth cohorts of undergraduate scholars and their mentors continued to respond to the challenges imposed by the ongoing COVID-19 pandemic. Through creative accommodations and hard work by dedicated graduate student mentors, cohort seven was able to participate in ecological projects at various sites in south Florida. Cohort eight engaged in internships ranging from a variety of conservation not-for-profits to research at a zoological park. The program continues to be a standout among the various mentoring programs administered by the Doris Duke Charitable Foundation, and many program alumni are now enrolled in advanced degree programs or employed in natural resource conservation capacities.

**Intern Cohorts:**

| Year 1: | Year 2: | Year 3: | Year 4: |
|---|---|---|---|
| Alex Cronin | Jeanette Brisbane | Modeline Celestin | Amy Almond |
| Nadia Kemal | Megan Ely | Camille DeJesus | Joelle Carbonell-Bierbaum |
| Jaclyn Selden | Charmaine Pedrozo | Hannah Innocent | Tre'nard Morgan |
| Adreenah Wynn | Monica Quintiliani | Elizabeth Sherr | Marcela Mulholland |
| Xue "Jackie" Zhang | Sharmin Siddiqui | | Camya Robinson |

| Year 5: | Year 6: | Year 7: | Year 8: **(2021)** |
|---|---|---|---|
| Keara Clancy | Jacob Hornfeldt | Jazmyn Broxton | Maya Encinosa |
| Faith Morgan | Gabriela Obando | Juliemar Cuevas-Hernandez | Maiya Lester |
| Kristina Rodriguez | Eric Trotman | Aleidys Lopez Romero | Sebastian Summo |
| Desiree Smith | Herby Zephir | Mariaguadalupe Vilchez | Nimsi Trujillo |

INVESTIGATORS Christina Romagosa, Raymond Carthy, and Rena Borkhataria (Doris Duke Charitable Foundation)

MENTORS Marina McCampbell (Ph.D., WEC), Laura Nicholson (M.S., WEC), and Johanna Depenthal (Ph.D., WEC)

DURATION Sep 2013 - Sep 2024

FUNDING Doris Duke Conservation Scholars Program Partnership with University of Florida

# RESEARCH: FISHERIES AND AQUATIC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*Fellsmere Reservoir, Indian River County, FL.* TYLER STEPHEN COLEMAN

*Logan Masterson, M.S. student at the Florida Unit, holds two Largemouth Bass.* L. MASTERSON

## Investigating Grass Carp movement, habitat use, emigration, and natural mortality after stocking in the Harris Chain of Lakes, Florida

Water quality has improved in Florida's Harris Chain of Lakes over the last two decades, creating favorable conditions for expansion of hydrilla, an invasive plant. Herbicide treatments of hydrilla are controversial and expensive, with treatments in the Harris Chain of Lakes accounting for up to 25% of the statewide budget of the FWC Invasive Plant Management section. Given the cost and controversy associated with herbicide application, there is a need to explore alternative control techniques to reduce reliance on chemical treatments. Grass Carp are herbivorous fish that can be efficient, cost-effective consumers of hydrilla, but research on Grass Carp movement and habitat use is needed to identify appropriate stocking rates for the Harris Chain of Lakes. Our objectives are to evaluate stocking mortality and first-year survival of juvenile triploid Grass Carp stocked into lakes Apopka and Yale; assess Grass Carp movement, habitat use, and emigration rates; and investigate mortality and emigration of adult Grass Carp translocated into Lake Apopka. We will use radio telemetry to evaluate Grass Carp movement, habitat use, emigration, and natural mortality. We will use telemetry data to build population models and identify stocking rates that balance the need to reduce herbicide treatment while minimizing consumption of native vegetation by Grass Carp. Our research will provide management-relevant information about the utility of Grass Carp for controlling hydrilla in the Harris Chain of Lakes. Data on Grass Carp movement, habitat use, emigration, and natural mortality will inform population modeling to determine appropriate Grass Carp stocking rates. Hydrilla management is a costly, controversial topic in Florida. Our research on Grass Carp population characteristics and stocking rates will provide important information for integrating herbicide treatments with cost-effective biological control options.

| | |
|---|---|
| INVESTIGATORS | Andrew Carlson |
| STUDENTS | Logan Masterson (M.S., FAS) |
| DURATION | Oct 2021 - Jun 2024 |
| FUNDING | FFWCC |
| IN-KIND SUPPORT | Research assistance provided by FFWCC |


*Josh Vine, Ph.D. student at the Florida Unit, holding a juvenile Gulf Sturgeon* SDTEPHEN PARKER. *Right: Stephen Parker, Ph.D. student at the Florida Unit, holding an adult Gulf sturgeon.* JOSH VINE

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

Gulf Sturgeon, Acipenser oxyrinchus desotoi, a large anadromous fish species currently listed as "threatened" under the Endangered Species Act, are of conservation concern in the Gulf of Mexico because of their long lifespan and slow population recovery rate. We are working with resource managers to determine Gulf Sturgeon movement patterns and estimate over-winter survival of Age-1 individuals in the Choctawhatchee River. We are also assessing Gulf of Mexico wide status in the species. We are developing tools designed to improve data collection efforts and assist resource managers with evaluating tradeoffs among management actions designed to promote Gulf Sturgeon population recovery and to facilitate shared research objectives among collaborators. In the US Gulf of Mexico, Gulf Sturgeon supported a short-lived commercial fishery in the early 20th century. Despite fishery closure since 1985, the stock has not recovered. We are determining the status and basic population demographic variables to help inform decision-making for this species at a range-wide level and assessing fine scale site occupancy and movement patterns at a local (single river) scale. We are currently using multi-state models to determine differences in mortality rates between eastern and western populations of Gulf Sturgeon. We are also using a detailed data simulation framework linked to multi-state models to inform ongoing and planned monitoring efforts for the species. During 2021 we conducted field sampling to monitor age-1 Gulf sturgeon to estimate over-winter survival in the Choctawhatchee River. We also developed and field-tested our electronic data entry system and compiled all available Gulf Sturgeon monitoring data from the past decade for integration into the Gulf Sturgeon database and are rolling that system out for wide-spread use in 2022. Preliminary analyses from multi-state models suggests adult Gulf Sturgeon mortality may be higher in the western Gulf than elsewhere. Simulated data reveal we can successfully estimate over-winter survival given high capture probabilities and sample sizes. We are monitoring the movements of 16 sub-adult and 20 juvenile Gulf Sturgeon using an array of acoustic receivers in the Choctawhatchee River. Our results are preliminary and reflect ongoing research. Our research seeks to help define future realistic population benchmarks based on Gulf Sturgeon population ecology and pair these benchmarks with monitoring programs to measure population response and progress to recovery goals. In this way management actions could operate under a decision analysis framework such that if benchmarks were not met, specific research efforts or alternative management actions could be taken.

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|---|---|
| INVESTIGATORS | Bill Pine |
| STUDENTS | Stephen Parker (Ph.D., FAS), Joshua Vine (Ph.D., WEC) |
| DURATION | Aug 2019 - Aug 2023 |
| FUNDING | USGS/USFWS and NOAA-Fisheries (RWOs 308 and 313) |
| IN-KIND SUPPORT | Research assistance provided by USFWS |

*Bethany Gaffey holding a Gulf Sturgeon.* TYLER COLEMAN

## Cold blood in warming waters: Conserving Gulf Sturgeon using precipitation and groundwater models

Federally threatened Gulf Sturgeon occupy freshwater rivers and coastal marine habitats across the Gulf of Mexico, but relatively little is known about the ecology and population dynamics of juvenile Gulf Sturgeon is some areas of their range. Evaluating survival, abundance, movement, and habitat use of juvenile Gulf Sturgeon will fill critical data gaps and inform conservation efforts while laying a foundation for assessing landscape-level threats to Gulf Sturgeon populations. Our primary objective is to develop thermal habitat models to understand the spatial and temporal distribution of suitable environments for Gulf Sturgeon across their life history (e.g., juvenile, subadult, adult) amid changes in climate and land use in the Choctawhatchee River basin. We will develop thermal habitat models that account for linkages between air temperature, water temperature, precipitation, and groundwater dynamics, unlike many previous thermal habitat modeling frameworks. We will use these models to predict how Gulf Sturgeon thermal habitats in the Choctawhatchee River basin may be affected by climate change and land-use alteration. Our analyses will generate useful information for Gulf Sturgeon conservation, including relationships between Gulf Sturgeon habitat use and air temperature, water temperature, precipitation, groundwater dynamics, and in-stream habitat factors. Preliminary analyses indicate that air and water temperature regimes are spatially and temporally variable across the Choctawhatchee River basin, an important foundation for forthcoming modeling efforts. This project will yield insights about air and water temperatures, precipitation patterns, groundwater dynamics, and other aspects of thermal habitat that will be informative for Gulf Sturgeon conservation amid climate and land-use change.

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| INVESTIGATORS | Andrew Carlson |
| STUDENTS | Bethany Gaffey (M.S., FAS) |
| DURATION | Aug 2021 - Aug 2023 |
| FUNDING | USGS (RWO 308), NRDA Restoration Program |
| IN-KIND SUPPORT | Research assistance provided by USFWS and NOAA |

*Kimberly Bonvechio, Ph.D. student at the Florida Unit, holds an American Eel.* KIMBERLY BONVECHIO.

## Lessons from a long-term fisheries monitoring program: The Florida experience

In 2006, the Florida Fish and Wildlife Conservation Commission implemented a Freshwater Fisheries Long-term Monitoring (LTM) Program to assess temporal trends in freshwater fish population distribution and community structure in 29 lakes and reservoirs across the state. However, the LTM Program has yet to be comprehensively evaluated, and implications of such an evaluation for fisheries management are unknown. Evaluating the LTM Program through consideration of multiple perspectives and tradeoffs (e.g., ecological, statistical, resource availability) will help guide fisheries management decision-making in Florida's freshwater ecosystems. Our objectives are to assess temporal trends in fish population distribution and community structure in 29 Florida lakes and reservoirs since 2006, determine the efficacy of various fish sampling protocols for achieving LTM Program objectives, and develop recommendations for LTM Program delivery and associated fisheries management efforts in Florida. We will evaluate trends in fish population and community metrics within and across lakes over 15 years. We will also identify optimal combinations of sampling gears, locations, and sample sizes for achieving LTM Program objectives and develop recommendations for maximizing the efficiency and continued effectiveness of the program. Our analyses and statistical modeling will yield insights for understanding drivers of fish population distribution and community structure across Florida, as well as potential shifts in these parameters amid natural and anthropogenic changes (e.g., hurricanes, large-scale habitat manipulations). This project will allow fisheries managers to track the success of the LTM Program in achieving its objectives, identify areas for improvement, and showcase the relevance of the program for fisheries management, conservation, and public engagement.

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| INVESTIGATORS | Andrew Carlson |
| STUDENTS | Kimberly Bonvechio (Ph.D., FAS) |
| DURATION | Jul 2021-Jun 2026 |
| FUNDING | FFWCC and USGS (RWO 321) |
| IN-KIND SUPPORT | Research assistance provided by FFWCC |

*Chris Anderson, Ph.D. student at the Florida Unit, holds a Gulf Sturgeon.* CHRIS ANDERSON

## Leveraging habitat suitability modeling to inform management of nonnative fishes in a changing climate

Florida contains more than 200 nonnative fishes that cause major ecological and societal consequences. Florida faces diverse challenges in nonnative fish management—challenges that may be exacerbated by climate change and associated effects on water temperature, a "master variable" affecting the bioenergetics of individual fish and the dynamics of fish populations and communities. As such, there is a need to understand water temperature variability (e.g., daily, seasonal, annual) and the effects of climate change on aquatic thermal regimes to inform nonnative fish management in Florida. Our primary objective is to predict survival, reproduction, recruitment, and dispersal of priority nonnative fishes in Florida over the next 50 years to develop science-driven approaches for managing these species. We will supplement an existing network of 300 water temperature loggers distributed across Florida by deploying 75 additional loggers in key rivers and canals that are not currently monitored. Water temperature monitoring and climate change forecasting will allow us to develop models to predict nonnative fish survival, reproduction, recruitment, and dispersal based on multiple potential climatic scenarios in 2021-2070. Our analysis will yield life-stage-specific information about the thermal habitat suitability of Florida rivers and canals for nonnative fish in 2021-2070. Our research will generate predictive distribution maps, decision support tools, and stakeholder engagement activities to help manage nonnative fishes and inform the public about fisheries conservation. This project will allow fisheries managers to develop robust, spatially explicit programs for preventing the introduction, slowing the spread, eradicating, and controlling nonnative fishes in Florida.

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|---|---|
| INVESTIGATORS | Andrew Carlson |
| STUDENTS | Chris Anderson (Ph.D., FAS) |
| DURATION | Jul 2021 - Jun 2026 |
| FUNDING | FFWCC and USFWS |
| IN-KIND SUPPORT | Research assistance provided by FFWCC |

*Tyler Steven Coleman, Ph.D. student at the Florida Unit, measuring a Florida Largemouth Bass.* T. S. COLEMAN

## Using long-term monitoring data to evaluate Largemouth Bass and Black Crappie population dynamics amid environmental change

Largemouth Bass and Black Crappie are popular sport fishes that are widely distributed across Florida and most of the United States. However, there is limited information about how long-term environmental alterations (e.g., changes in climate, aquatic vegetation coverage, lake trophic status) affect these species and the valuable fisheries they support. This knowledge gap, combined with the ecological and socioeconomic significance of centrarchid fisheries, makes it important to study the effects of environmental alterations on Largemouth Bass and Black Crappie population dynamics (e.g., growth, survival). Such information will fulfill a management need for these high-profile species in Florida. Our primary objective is to evaluate if and how climate change, hydrilla expansion, and cultural oligotrophication have affected Largemouth Bass and Black Crappie population dynamics in lakes across Florida over the last 15 years. We will develop a variety of statistical models to understand historical trends in Largemouth Bass and Black Crappie population dynamics using data from the FWC Freshwater Fisheries Long-term Monitoring Program. We will also conduct a detailed investigation of Fellsmere Reservoir, a system managed by FWC that is renowned for Largemouth Bass abundance and size structure, to understand interactions among Largemouth Bass populations, aquatic habitats, and fisheries stakeholders in this unique, nationally recognized fishery. Our research will yield insights for understanding long-term trends in Largemouth Bass and Black Crappie population dynamics across Florida, and interrelationships among Largemouth Bass populations, habitats, and anglers in Fellsmere Reservoir. Largemouth Bass and Black Crappie are some of Florida's highest-profile freshwater fishes. This project will expand the knowledge base on these species via long-term assessment of population trends and short-term evaluation of a nationally recognized reservoir fishery, yielding management-relevant information for FWC and other partners in fisheries management.

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| INVESTIGATORS | Andrew Carlson |
| STUDENTS | Tyler Steven Coleman, (Ph.D., WEC) |
| DURATION | Aug 2021 - Aug 2023 |
| FUNDING | UF Ph.D. Fellowship, FFWCC |
| IN-KIND SUPPORT | Research assistance provided by FFWCC |

*Clockwise from top left: Andrew Carlson, Bethany Gaffey, Katrina Rossos, and Josh Vine.* TYLER STEVEN COLEMAN

## Abiotic and biotic factors affecting fish occurrence, abundance, and growth in sixty Florida lakes

Studying the effects of abiotic and biotic factors on fish populations is a long-standing tradition in fisheries science. However, there is less information on how fish populations and communities respond to abiotic and biotic factors across broad spatial extents, diverse lake types, and associated gradients in lake surface area, trophic state, and aquatic macrophyte coverage, particularly in Florida. There is a need to evaluate how environmental factors varying across large regions affect fish populations, fish communities, and fisheries management. Addressing these knowledge gaps could reveal useful information for managing fish populations and communities in regions with wide-ranging environmental conditions and predicting how fish populations and communities may respond to environmental changes (e.g., land-use alteration, eutrophication, water diversion). The objective of this study is to investigate fish population and community characteristics in relation to abiotic and biotic factors across wide-ranging conditions of lake surface area, trophic state, and macrophyte abundance in Florida. We will use univariate and multivariate statistical approaches and population models to evaluate relationships between fish population and community metrics and abiotic and biotic factors in Florida lakes. We will integrate these analyses with existing management information to make recommendations for fisheries management now and in the future, in the context of expected environmental changes. Our research will generate data summaries and statistical models to quantify and predict fish occurrence, abundance, growth, and related population/community characteristics in Florida lakes. As environmental changes affect fish populations across Florida and the world, there is a need to understand and predict how fisheries are affected by wide-ranging abiotic and biotic factors in diverse water bodies. Our research will help fill these knowledge gaps and yield practical information for fisheries management in Florida.

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| INVESTIGATORS | Andrew Carlson, Mark Hoyer |
| STUDENTS | TBD |
| DURATION | Oct 2021 - Jun 2026 |
| FUNDING | UF LAKEWATCH program, FFWCC |
| IN-KIND SUPPORT | Research assistance provided by UF LAKEWATCH program, FFWCC |

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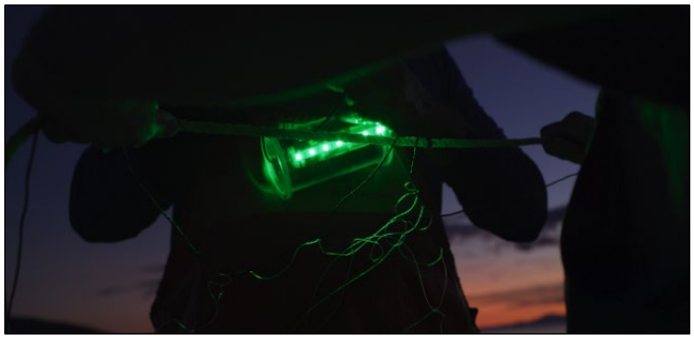

*Green fishing light used on nets and lines as a Bycatch Reduction Technology. J. SENKO*

*Carson Arends with an adult green turtle.* JOSEPH ALDAY

## Habitat partitioning of three sea turtle species at a temperate foraging ground

All species of sea turtles using US waters are listed as threatened or endangered under the (US) Endangered Species Act of 1973. The northern Gulf of Mexico supports loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*) and green turtles (*Chelonia mydas*), yet few studies have been published on these assemblages. There is clear documentation of habitat overlap among the three species using satellite tracking, but little has been done to study the specific diet and microhabitat shared. The use of stable isotopes to assess trophic levels and partitioning among habitats by sympatric species has been applied in other organisms. However, these techniques have not commonly been used to assess resource partitioning among sea turtle species. This study provided information to understand the diet and microhabitat use and overlap by green, Kemp's ridley, and loggerhead sea turtles in St. Joseph Bay, FL to improve management and protection decisions. The primary objective of this study was to define habitat partitioning among sea turtles through stable isotope analyses of epidermis tissue and potential diet items. Additionally, we aimed to compare diet and habitat use pre- and post-hurricane Michael. In each field season from 2011-2020, we captured and collected data from three species of sea turtles in St. Joseph Bay, FL. All turtles were captured between the months of March and November using a set net, dip net, or by hand. We collected epidermis tissue to be used for stable isotope analysis and conducted a basic workup to measure and tag each turtle. Additionally, we collected habitat and prey samples in 2019 and 2020 that included POM around the perimeter of the bay. We analyzed a total of 512 epidermis samples and 216 potential prey items for carbon and nitrogen stable isotope composition ($\delta$13C and $\delta$15N values). We examined the effects of season, turtle size, capture year, and hurricane occurrence (Hurricane Michael in October of 2018) on the $\delta$13C and $\delta$15N values of turtle epidermis for each species. Loggerheads and Kemp's ridleys had the most overlap in isotopic niche space (> 95%), but substantial overlap (> 30%) existed among all three species. All turtle species demonstrated significant changes in $\delta$15N values following the hurricane. Overall, study results indicate that all three sea turtles in St. Joseph Bay have isotopic niche overlap but appear to be partitioning their resources through selection of different prey items. Managers and future investigators can use these results to assess resource overlap among co-occurring sea turtle species. The results may also be useful in protecting habitat and monitoring preferred prey items as well as understanding any changes that may occur following a natural disaster such as a hurricane.

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|---|---|
| INVESTIGATORS | Hannah Vander Zanden and Margaret Lamont (USGS WARC) |
| STUDENTS | Carson Arends (M.S., Biology) |
| DURATION | Sep 2019 - Jun 2021 |
| FUNDING | USGS (RWO 312) |

*Raccoon foraging at experimental scavenging tray design to quantify the loss of ecosystem services associated with the loss of mid-sized mammals from pythons .* ROBERT MCCLEERY

## Understanding Greater Everglades mammal communities adjacent to and within the ARM Loxahatchee National Wildlife Refuge

With no indication that the python invasion has abated, there are a number of critical information gaps with regards to mammals. For example, it is important to understand how mammal communities continue to change in the face of an expanding python invasive. Specifically, we would need to know 1) are communities that were once unaltered now showing declines, changing or adapting, 2) are communities that were previously depauperate now showing signs of resilience and 3) have changing communities alter ecosystems functions. We aimed to quantify how mammal communities have changed over time as pythons have continued to spread and then link these changes to indirect effects on ecosystem function, such as scavenging and frugivory. We replicated and earlier study (Reichart et al. 2017) that quantified variation in mammal community composition across a gradient of python density using a combination of camera trapping and scat surveys. To measure the effects on scavenging and frugivory, we monitored bait stations with remote cameras and quantified consumption and identified the species consuming bait. Mammal species vulnerable to python predation, such as marsh rabbit and white-tailed deer, continued to decline in South Florida. Though previous studies have suggested that rodents may be resistant to python predation, our results suggest these species are starting to decline after other preferred prey has been extirpated. We have also found clear links between the loss of mammals and disease prevalence. Finally, in areas where pythons have reduced or removed midsized mammals, frugivory and scavenging services have been replaced and altered by rodents, bird or reptiles. Our work helps to reveal the full scope of the implications of invasive pythons for South Florida ecosystems.

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| INVESTIGATORS | Robert McCleery, Kristin Hart (USGS), and Paul Taillie |
| POST-DOC | Paul Taillie |
| DURATION | Sep 2018 - Dec 2023 |
| FUNDING | USGS (RWO 305) |
| IN-KIND SUPPORT | SFWMD, FFWCC |

*Adult Dermatemys mawii.* NICOLE BISHOP

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

*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. We examined *D. mawii's* wild diet, digestive physiology, and microbial endosymbionts to elucidate their dietary adaptations. Study objectives were to (1) describe the wild diet of *D. mawii* given sex, age, and habitat type, (2) describe digestive performance of yearlings (3) characterize and compare the gut microflora of hatchlings engaging in coprophagy vs. those that do not, and (4) determine the size and age at the onset of sexual maturity. We used a dataset from wild specimens and collected data from a captive population. Our results indicated (1) a large portion of the wild diet was dependent on wind-fall vegetation; (2) yearlings demonstrated high digestibilities, including cell wall digestion facilitated by gut microflora; (3) there were differences in microbial communities at multiple taxonomic levels between hatchlings engaging in coprophagy vs those that did not; and (4) the size/age at the onset of sexual maturity was 40.0cm SCL / 17 years (females) and 38.0cm SCL / 15 years (males). This is the first study to report growth parameters for *D. mawii* that are important for estimating parameters such as generation time and long-term population growth. The delayed sexual maturity of this species may make it more sensitive to losses of adults in the population. However, the interaction of fast growth rate and high nitrogen digestibility may lead to relatively fast growth rates within the few first years and result in effective "head-start" programs. Hatchlings may also need exposure to adult feces to inoculate them with gut microbes capable of digesting plant cell walls. When releasing captive-bred turtles into the wild, it may be beneficial to choose locations with adequate riparian species that can contribute to wind-fall vegetation which constitutes a large portion of their wild diet.

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| INVESTIGATORS | Nicole Bishop, Raymond Carthy |
| STUDENTS | Nichole Bishop (Ph.D., SNRE) |
| DURATION | Dec 2014 - May 2021 |
| FUNDING | USGS (RWO 285) |
| IN-KIND SUPPORT | Belize Foundation for Research and Environmental Education |


*Rick Herren, PhD Candidate and Project Director, poses with one of the hundreds of juvenile green turtles captured and tagged in the Big Bend since 2019.* EVAN COOPER

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

The purpose of this study is to elucidate the spatial distribution and abundance of juvenile green turtles in the Big Bend, describe their demographics, and understand their seasonal movements at three separate foraging areas. To date, 163 green turtles have been captured at the hotspots we identified in earlier surveys, ranging in size from 27.8 cm to 78.7 cm straight carapace length (SCL). We continued to track the juvenile green turtles that we satellite tagged in the previous years. Many of the turtles were still transmitting data and a final analysis of overwintering range and interactions between movements, water temperature, and depth is close to completion. All but one of the juvenile green turtles that we satellite tagged in 2020 returned to the same place where we first caught them. We believe this is mostly due to the high site fidelity of green turtles. This study will lead to a better understanding of the distribution of sea turtles in this region over space and time. The results are important for long-term consideration, given concerns over vessel strikes, harmful algal blooms, climate change and the global loss of seagrass beds. They can also be valuable decision-making tools for establishing marine protected areas, understanding human impacts, and generating new questions for further research. The findings from this study may be particularly useful for detecting the effects of climate change because the region lies near the boundary between a temperate and subtropical climate that is likely to shift northward in the future.

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| INVESTIGATORS | Raymond Carthy, Rick Herren |
| STUDENTS | Rick Herren (Ph.D., WEC) |
| DURATION | Sep 2016 - Present |
| FUNDING | NCBS, Sea Turtle Conservancy |
| IN-KIND SUPPORT | Sea Turtle Conservancy |

*Juvenile green turtle.* TRENTON AGUILAR

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

Vessel strikes have become a greater threat as an increasing number of sea turtles around the world, and especially in Florida, are stranded (injured or killed) due to strikes by recreational or commercial vessels. For effective management strategies to be established, threats to sea turtles must be thoroughly understood. To more fully understand and thus mitigate this threat, we must study how vessel strikes with turtles occur, what may predict areas of high vessel and turtle interaction, and how growing turtle and human populations may affect this relationship in the future. We will observe how green turtles (Chelonia mydas) react to oncoming vessels at varying speeds, by conducting observational boat surveys to measure turtle response and flight initiation distance from the vessel and comparing behaviors of turtles of differing size classes. We will then create an encounter rate model between green turtles and recreational boaters in Florida coastal waters to show where these two groups are most likely to interact. Finally, we will develop a population growth model to predict how, with growing human and green turtle populations in Florida, green turtles may be affected by increasing interactions with vessels. Observational data from the field is currently being collected through the fall of 2021 and the spring and summer of 2022. The encounter rate model has shown to be useful in predicting areas of high turtle and boater interaction and with future applications towards more localized use where turtle density data is available. The encounter rate model alone could be used for future management planning as more data is collected on both recreational boater registrations locally and around the state of Florida as well as green turtle or other sea turtle species density data becomes available. This model will be able to predict areas of interaction concern and can help management allocate resources to limit potential vessel strikes.

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| INVESTIGATORS | Trenton Aguilar, Raymond Carthy, Mike Allen |
| STUDENTS | Trenton Aguilar (Ph.D., FAS) |
| DURATION | Aug 2018 - Aug 2023 |
| FUNDING | NSF, Florida Education Fund, UF Graduate School, McKnight Doctoral Fellowship, Sea Turtle Conservancy |
| IN-KIND SUPPORT | FAS |

*Natalia Teryda setting up a Phantom 4 Pro V2.0 UAS aircraft to conduct an aerial survey from the beach at Cerro Verde and Islas de La Coronilla Marine Protected Area, nearby La Coronilla town, Department of Rocha, Uruguay.* KARUMBE NGO

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

Leatherback and green sea turtle populations have decreased exponentially across the world, leading to their current global protected status. One of the main reasons for their decline is interactions with fisheries and habitat degradation. Due to their spatially heterogeneous life cycle, research and further conservation efforts have relied on technological advances to gain understanding of their population and vulnerabilities in foraging areas like Argentina and Uruguay. Better understanding of habitat use and population densities, as well as their interaction with fisheries, is essential for the conservation of these species. This research aims to develop and consolidate a holistic approach to the analysis and conservation of marine turtles and their coastal habitats as well as to test the use of UASs. Efforts will be directed to the investigation of two endangered species with the application of new technologies, the reinforcement of regional conservation and management networks, and integration of these components with community capacity building. After conducting a pilot study to develop and test survey methodologies, as well as completing 17 successful leatherback surveys in Rio de La Plata Estuary in December 2020 to January 2021, we will be applying the developed methodology in Uruguay. We will conduct systematic coastal aerial surveys in the Cerro Verde and Islas de La Corinilla Marine Protected Area in department of Rocha, Uruguay (Dec 2021 - Feb 2022 and Mar - May 2022). The goal is to analyze green turtle density and habitat variation during the end of southern spring, summer and beginning of fall. These UAS surveys will implement the previously developed methodology which will be modified as needed based on weather parameters and the coastal system morphology. In Uruguay I will be working with and alongside Karumbe NGO, a Uruguayan sea turtle conservation non-profit and the local Park Rangers. This project will advance traditional surveying techniques by applying new technologies and will provide comprehensive and much needed information for successful sea turtle conservation.

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| INVESTIGATORS | Raymond Carthy |
| STUDENTS | Natalia Teryda (Ph.D., SNRE) |
| DURATION | Aug 2018 - Aug 2023 |
| FUNDING | WEC, SNRE, Ron Magill Conservation Scholarship, Doris and Earl Lowe and Verna Lowe Scholarship, Boyd Lyon Sea Turtle Fund Scholarship, The Ocean Foundation |
| IN-KIND SUPPORT | Karumbe NGO |

*Rachel Smith measuring a spiny lobster.* RACHEL SMITH

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

Incidental bycatch in fisheries is considered the most urgent threat to sea turtle populations. Still, bycatch rates have been difficult to estimate, given the diversity of gear types and uncertainty resulting from large data gaps. Specialized attention is warranted towards a derivative of bycatch, entanglement. Yet, efforts to quantify impacts from entanglement in trap fisheries have been minimal. Five sea turtle species spend time in Florida state waters and experience entanglement in trap gear. However, these interactions are likely underreported. An assessment of the impact that trap fisheries pose to sea turtle populations is imperative, along with empirical research on the efficacy of conservation interventions to reduce sea turtle entanglement in trap fisheries. There are 3 specific objectives of this study: 1) Characterize the threat that trap entanglement poses to sea turtle populations using a mixed-methods approach of biological data and traditional ecological knowledge (TEK); 2) Explore barriers and incentives for adoptability of sensory-based bycatch reduction technology (BRT) in the Florida commercial spiny lobster fishery, and 3) Study the behavioral response of both target species (spiny lobster) and bycatch species (loggerhead and green turtles) to BRT. Corresponding to the objectives above: 1) Conduct a mixed-methods threat analysis, 2) Conduct interviews and surveys of commercial lobstermen in Florida, and 3) Conduct controlled behavioral choice experiments to study animal responses to BRT. Though additional sampling is anticipated, preliminary results from the pilot study of Caribbean spiny lobsters (n = 22) indicate that spiny lobsters do not preferentially select hides based on the presence or absence of green LED lights (sensory-based BRT), indicating that using this conservation intervention in the fishery may not influence target catch rates. Fishery managers will be able to use the results of this study to mitigate sea turtle entanglement rates in Florida trap fisheries. Further, the threat assessment may be used to encourage management strategies in other trap fisheries around the world to reduce interactions with sea turtles.

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| INVESTIGATORS | Raymond R. Carthy |
| STUDENTS | Rachel Smith (Ph.D., SNRE Interdisciplinary Ecology) |
| DURATION | Sep 2019 - May 2023 |
| FUNDING | The Walt Disney Company |
| IN-KIND SUPPORT | FFWCC Fish and FWRI, Disney's Animals, Science, and Environment, New College of Florida |

*CRU alum Katrina Rossos (left) and UF fisheries student Josh Vine (right) hold a captured Gulf sturgeon on the Choctawhatchee River in Florida.* KATRINA ROSSOS

## Natural Resources Communication

Ecological research is only as effective as it is understood, and while scientists successfully communicate research with colleagues, many fall short when it comes to informing the public in an accurate, clear manner. A science communicator must understand fundamentals, methodologies, results, and impacts of scientific research to communicate it to the public. Likewise, a science communicator must know how to explain the complexities of the research into a parboiled synopsis that is easy for a lay person to grasp. By learning ecological concepts, issues, and protocols, I improved my skills as a natural resource writer. Conservation research informs policy regarding wildlife and fisheries management, state and federally protected areas, species protections, and restrictions on anthropogenic effects such as pollution, habitat fragmentation, and deforestation. In turn, how the public views wildlife management and conservation and research can shape that policy, making accurate science communication so vital. Katrina Rossos completed a capstone project to complete her Master of Science degree in 2021. The project involved the creation of publicly facing science communications materials for University of Florida wildlife and fisheries scientists. I interviewed researchers, accompanied them in the field, and assisted in field work (when permitting allowed) on eight projects. The research ranged from population ecology of endangered birds to oyster bed restoration to disease ecology. On each project, I created a technical document and a piece of collateral that relayed the research in layman's terms, such as a news article, press release, or a feature story. The Wildlife Management Institute's "Outdoor News Bulletin" published two of these articles, and my feature story on the management of the Snake Key rookery at Cedar Keys National Wildlife Refuge was published by U.S. Fish and Wildlife Service's "Open Spaces" blog in December 2021.

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| INVESTIGATORS | Katrina Rossos and Raymond Carthy |
| STUDENTS | Katrina Rossos (M.S., WEC) |
| DURATION | 2019 - 2021 |
| FUNDING | WEC |
| IN-KIND SUPPORT | WEC |

*Jaren Serano measures gas efflux at the dune toe of a beach.* RAYMOND CARTHY

## Assessing effects of anthropogenic and climate-induced change on health of coastal ecosystems.

Florida's coastline is constantly reworked by long and short-term climatic cycles. Shifts in the frequency and intensity of those cycles due to global change, in conjunction with anthropogenic alterations, are affecting the resilience of coastal habitats and the species that rely on them. This research is integrating existing approaches with novel techniques to examine the coupling of oceanographic and onshore processes and their effects on sea turtle nest incubation and dune stabilization. Sea turtles nest in a variety of beach environments, and the success of an individual nest is influenced by its location on the beach and the resulting incubation micro-environment. Some of the factors affecting sea turtle nest incubation include moisture, rainfall, sand particle size, temperature, tides, and gas exchange. We are evaluating how beach incubation dynamics and productivity respond to altered gaseous environments. Additionally, we are beginning to examine the role of beach nourishment in shifting offshore/onshore organic matter budgets, and the implications for greenhouse gas emissions. The results of this work will identify how and where habitat suitability issues might arise and inform sound conservation planning measures and better nourishment practices, including mitigation and alternative actions.

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| INVESTIGATORS | Raymond Carthy |
| STUDENTS | Jaren Serano (M.S., WEC) |
| DURATION | Sep 2020 - Dec 2022 |
| FUNDING | USGS (RWO 316) |

*Juvenile green turtle with Fibropapillomatosis (left,* COSTANZA MANES*) and healthy juvenile green turtles (right,* RICK HERRENK*).*

## Integrative assessment of Fibropapillomatosis dynamics in free-roaming green turtles (*Chelonia mydas*) living in the Northeastern Gulf of Mexico

Fibropapillomatosis is a panzootic neoplastic disease of sea turtles. Green turtles (Chelonia mydas) are the most heavily affected species, with prevalence of up to 70% around the world. This debilitating disease forms tumor growths on their bodies, preventing them from seeing, swimming, and feeding properly. Fibropapillomatosis incidence is increasing, and its threat to the conservation of green turtle populations needs to be better understood. Because of the unknown factors in the etiology of this disease, we must look at viral (herpesvirus ChHV5 associated with fibropapillomatosis) and host factors, as well as environmental factors that might exacerbate severity and spread of the disease in wild green turtle populations. We will capture animals in coastal ecosystems areas and investigate patterns between disease severity, viral load, and environmental variables, such as marine pollution levels. We will compare viral load with disease severity, as well as disease severity with seawater levels of PCBs, PAHs, and pesticides. Thus, our proposed project offers a greater understanding of the disease, and findings will be applicable to fibropapillomatosis-afflicted sea turtle populations globally. Our goal is to enhance sea turtle health by improving our understanding of fibropapillomatosis through a highly multifactorial assessment. Initial fieldwork was carried in 2021 and will continue throughout the duration of the project. We currently have data on fibropapillomatosis incidence and body-mapping for the individuals analyzed in the field season. This project will elucidate possible viral and environmental drivers behind the severity and propagation of fibropapillomatosis. Data on viral correlation will inform fibropapillomatosis researchers of findings on viral levels from wild populations. Data on environmental correlations will be utilized to inform coastal managers and policymakers on the best potential changes to be applied to relieve green turtle population from disease burden and aid their recovery and conservation.

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| INVESTIGATORS | Costanza Manes, Raymond Carthy, and Ilaria Capua |
| STUDENTS | Costanza Manes (Ph.D., WEC) |
| DURATION | Jan 2021 - Dec 2024 |
| FUNDING | One Health Center of Excellence, National Save the Sea Turtle Foundation |


*Chris Gulick (left) holding a tagged adult tricolored heron.* KE ZHANG. *Ke Zhang (right) holding a tagged juvenile white ibis.* CHRIS GULICK

## Colonial nesting wading bird tracking and habitat use assessment

Key information is missing from populations of coastal-dwelling wading birds that may have been damaged by the Deepwater Horizon oil spill in the northern Gulf of Mexico. To better conserve these populations, we require an understanding of the movements, connectivity, survival, and health metrics of key coastal wading bird species to guide future restoration efforts for these species. We need to understand the movement capacity of individuals from both populations, and the drivers underlying these movement patterns. Further, we need to understand limitations on the survival and reproduction of each species in coastal areas of the Northern Gulf of Mexico. In so doing, we will better understand the capacity of each population to recover from future environmental degradation. Our objectives are to determine dispersal patterns and seasonal movements of colonial nesting wading birds (white ibises and tricolored herons), as well as the health, and survival of each species in Mobile Portersville bays, Alabama. We conducted the second year of fieldwork at colonies in Mobile Bay and Portersville Bay from 20 May to 7 July 2021. We captured and tagged 37 tricolored herons and 35 white ibises, with 42 transmitters deployed on captured birds. We measured morphological characteristics of each captured bird, and collected blood, feather, feces, and arthropod parasites for further analysis on the sex and fitness of each bird. We tracked their movements in the nonbreeding season of 2020 using Argos transmitters and estimated nonbreeding home ranges for both species. Preliminary analyses indicate that, following the breeding season, white ibises established more home ranges during the nonbreeding season, and exhibited lower philopatry than tricolored herons. Argos data from the winter of 2021 indicates that tricolored herons move greater distances to nonbreeding ranges and show connectivity with populations in Central America. Most white ibises remained in Portersville Bay or moved west to coastal Louisiana, while several individuals moved east into Florida. As of January 2022, 32 tagged birds are still alive, with eight tricolored herons and one white ibis wintering in Central America and the Caribbean. This research will be useful to managers as they develop conservation plans, preserve critical habitats, and assess each species' ability to respond to environmental disasters like catastrophic oil spills.

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| INVESTIGATORS | Abby Powell |
| STUDENTS | Ke Zhang (Ph.D., WEC), Chris Gulick (Ph.D., WEC) |
| DURATION | Sep 2019 - Dec 2024 |
| FUNDING | USGS (RWO 307) |
| IN-KIND SUPPORT | USFWS, Alabama Dept. of Conservation and Natural Resources |


*Banded Red Knot at Fort De Soto County Park, FL.* PETER PLAGE

## Movements and overwinter survival of juvenile Red Knots (*Calidris canutus rufa*) in Southeast US: Information needs for recovery planning

Research and conservation on Red Knots over the past twenty years has focused on adult birds using only a few sites, primarily in the mid-Atlantic region. However, by focusing on just one stage in their annual cycle there is a chance that factors that are driving Red Knot populations are being missed. For example, we currently do not fully know the distribution of juvenile Red Knots or have estimates of their first-year survival. We need to better understand the juvenile life stage in order to ensure that conservation actions to recover the species are appropriately directed to the areas that have the most significant impact on population growth. We aim to identify the main area(s) in the Southeast US and Caribbean where juvenile Red Knots occur during their first two years of life, determine how long they survive and whether they recruit into the adult population. Field work for this study has been delayed for two years due to the covid-19 pandemic. We plan to use multiple tracking methods, including of coded leg flags (following the Pan-American Shorebird Protocol) and nanotags. In addition, we are proposing to use newly developed solar GPS transmitters which are now light enough for Red Knots, combined with a recently developed harness attachment. Location and movement data from the above three tracking methods will be imported into ArcGIS for processing of movement patterns, relation to specific sites and habitats, and evaluation of known observed threats and sources of disturbance. Population parameters will be estimated following standard methods appropriate to data type and quantity. Once we better understand the distribution of juvenile Red Knots, the areas they prefer, and the threats and stressors they are under, we will be able to develop management and protection measures that, when implemented, should increase recruitment into the adult population and increase the population overall. This project could provide the critical information needed to lead the species to recovery.

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| INVESTIGATORS | Abby Powell, Jim Lyons (USGS Patuxent), Kevin Kalasz (USFWS) |
| STUDENTS | TBD |
| DURATION | Aug 2019 - Dec 2023 |
| FUNDING | USGS (RWO 309) |
| IN-KIND SUPPORT | USFWS |

## Population viability analysis and species status assessment for alligator snapping turtle

Assessing the status of a species and predicting its future trajectory is a vital part of classification decisions under the endangered species act. The alligator snapping turtle, *Macrochelys temminckii*, is a widespread species that is very difficult to monitor and assess and predicting its future status offers significant challenges. We worked with the service to devise data analyses and conduct expert elicitation workshops to inform modeling. These analyses and modeling exercise directly informed the classification decision (i.e., does the species need protection under the endangered species act?). We developed a PVA model for alligator snapping turtle to predict future abundance, population growth, and extinction risk under a variety to different threats and conservation actions and conduct sensitivity analysis to assess the importance of uncertain parameters effects on decision making. Much of the work on this project was completed prior to 2020. We worked with USFWS, state agencies and researchers to design the analysis and projection models. The modeling was completed in R. We presented our analysis and model at the recommendation team meeting for the turtle in 2019. The decision for this species has not been finalized and we continue to work with the Service on understanding the results. Our modeling predicted steep declines for alligator snapping turtles in the coming decades unless significant conservation management was enacted. Declines were most strongly influenced by threats. The USFWS decided to list both alligator snapping turtle species as threatened in 2021, in part based on the modeling results we provided. These management actions have significant implications for wet land management in the southeastern US. The USFWS has received new data on AST distributions and genetic delineations, and we are working with the service to determine if the models require revisions.

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| INVESTIGATORS | Conor McGowan |
| Post-Doc | TBD |
| DURATION | Sep 2020 - Oct 2022 |
| FUNDING | USGS/USFWS (RWO 318) |
| IN-KIND SUPPORT | Personnel provided by USFWS |

## Decision analysis for species status assessment science needs prioritization

The US Fish and Wildlife Service has a significant workload for conducting species status assessments to support listing, reclassification, and recovery planning decisions under the Endangered Species Act. There are hundreds of pending decisions that require a science-based assessment of the species status before making ESA decisions. We will work with the service to devise an objectives hierarchy and tradeoffs analysis to develop a prioritization system for identifying which SSAs tasks require the most attention or effort, and when to do them. Develop an objectives hierarchy, identify measurable attributes, and design a multi-criteria decision analysis value function to rank the >300 SSA projects in the Southeast Region. In 2020 we sought and hired a post doc to fill the position and we initiated meetings with the management partners. We are taking a standard PROACT structured decision-making approach to solve this problem and are guiding the Service thought the decision analysis steps. In spring of 2020, we conducted a series of team meetings with to elicit the prioritization objectives from field office supervisors and regional off deputies. We have since worked to devise a value function and a prototype optimization analysis in Solver using MSExcel. Thus far we have a working prototype that is limited by the computational dimensions of MSExcel's solver "addin." We are working to resolve the dimensionality limits to fully analyze the SSA list and working to collect the final data about the species that need SSAs before running a final assessment. As a result, of this work the Service will redesign their 5- and 10-year work plans for scheduling SSA work in the field offices.

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| INVESTIGATORS | Conor McGowan |
| POST-DOC | Ashley Goode |
| DURATION | Jul 2020 - Jul 2023 |
| FUNDING | USGS/USFWS (RWO 314) |
| IN-KIND SUPPORT | Personnel provided by USFWS |

## Modeling tools for species status assessments

The US Fish and Wildlife Service has a significant workload for conducting species status assessments to support listing, reclassification, and recovery planning decisions under the Endangered Species Act. In many cases they lack the expertise or the tools to conduct the necessary scientific analyses and they need support in developing generalizable and transferrable tools to facilitate SSA analyses. We will work with the service to devise modeling tools that support SSA completion and work with the service specifically on two SSAs, the Texas spot-tailed earless lizard and the Round-tailed chub. Develop methods to analyze species status with sparse data, focusing on the utility of occupancy modeling and expert elicitation methods. We completed work on the Roundtail Chub viability assessment in June 2021. We developed a stochastic simulation model to predict stream occupancy in the future based on current occupancy and expert elicited parameters. We have been working with the USFWS Austin and Corpus Christy field offices in Texas to develop analyses to support the spot tailed earless lizard SSA. Dr. Ashley Goode, postdoctoral research associate, designed a sized based life table analysis to use single capture event data to estimate survival and recruitment of the two species. Dr. Goode is using the results to develop a PVA projection model to predict future status. Results are still forthcoming from this project. We have used a species distribution model to estimate current abundance with a population density estimate and have drafted a simulation model for predicting future status. The round tailed chub analyses are complete and the modeling that we did directly inform the pending listing decisions. The service will use the results of the work to directly inform the listing decisions for two lizards in Texas. Further, the tools we develop should be applicable to a variety of future SSAs with sparse data.

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| INVESTIGATORS | Conor McGowan |
| POST-DOC | Ashley Goode |
| DURATION | Jul 2020 - Jul 2022 |
| FUNDING | USGS/USFWS (RWO 315) |
| IN-KIND SUPPORT | Personnel provided by USFWS |

*Eastern black rails in a coastal marsh.* CHRISTY HAND

## Puerto Rican boa/eastern black rail Species Status Assessments

Assessing the status of a species and predicting its future trajectory is a vital part of classification decisions under the endangered species act. The Puerto Rican Boa is an island endemic snake species the was scheduled to undergo a 5-year review and potential reclassification and the eastern black rail (added in a later modification) was proposed for listing. Even though the decision at hand was different, the information needs of the decision makers was similar, status assessment of the current population and predictions of future trajectories. For each species we worked with USFWS to devise data analyses and conduct expert elicitation workshops to inform modeling. These analyses and modeling exercise directly informed the classification decisions (i.e., does the species need protection under the endangered species act?). We developed a PVA model for Puerto Rican Boa to predict future abundance, population growth, and extinction risk for each species and conduct sensitivity analysis to assess the importance of uncertain parameters effects on decision making. Much of the work on this project was completed prior to 2020. We worked with USFWS, state agencies and researchers to design the analysis and projection models. For black rail, dynamic occupancy analyses were completed in the UnMarked package and the future status simulation model was designed in R. The Boa modeling was also completed in R, and we designed a Shiny App to facilitate manager interactions with the model. In 2019 we added and presented at the recommendation team meeting for the Rail to present our analysis and model and in August 2020 we did the same for the PR Boa. Our modeling predicted steep declines for Black rails in the coming decades unless significant conservation management was enacted so the Service decided to list the species as threatened. The Boa decision meeting was held in late 2020 and the resulting decision has not been publicized but our model predictions that the population is likely stable or increasing despite expected further urbanization. As a result, of this work, the Eastern Black Rail was listed as Threatened under the ESA and the PR Boa will potentially be delisted. These management actions have significant implications for wetland management in the Southeastern US and for Forest Management in Puerto Rico. The PR Boa classification decision is still pending currently, and we continue to respond to information requests from the USFWS to support their decision process.

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| INVESTIGATORS | Conor McGowan |
| POST-DOC | Riley Andrade |
| DURATION | July 2020 - Sep 2022 |
| FUNDING | USGS (RWO 317) |

*Gopher tortoise being weighed as part of mark-recapture study.* FRANCESCA ERICKSON

## Range-wide population viability analysis for the gopher tortoise

SSA are an essential part of the classification decision process for threatened and endangered species. The Gopher Tortoise (*Gopherus polyphemus*) is currently listed as Threatened under the Endangered Species Act in the western portion of their range (West of the Mobile Delta) and is currently a candidate for listing in the remainder of the species' range. Likewise, the snail kite is federally protected in Florida and undergoing a 5-year review to potentially reclassify the species (e.g., down list) or revise the recovery plan. To complete these decision processes and arrive at a defensible decision, the USFWS needs first to complete a species status assessment (SSA), and part of that assessment entails analysis of existing data sets and predictive modeling about population trajectories and future abundance. We worked with the service to devise a population viability models that supported SSA completion for the gopher tortoise and Snail Kite SSAs. Our work will focus on developing a spatially implicit population model that incorporates the probable effects of sea-level rise and climate change on population viability. We will estimate future gopher tortoise population growth and extinction probability while testing the sensitivity of predictions to uncertainty in model parameters and inputs. In 2020, we sought and hired a postdoc to fill the position and initiated meetings with the management partners. The postdoc made quick and significant progress on developing the model and providing needed decision support to the USFWS. The model simulated populations in R, accounts for population loss due to sea-level rise and urbanization and expected demographic changes due to increasing temperatures. Results, at this time, are completed and we presented the model and results to the recommendation team meeting in October of 2021. The Snail Kite PVA was completed in January in 2022 and submitted to the FWS for use in their SSA. The tools we develop should apply to various future SSAs with climate and temperature correlated demographics. The final decision is pending and is expected in the late summer of 2021.

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| INVESTIGATORS | Conor McGowan, Robert Fletcher |
| POST-DOCS | Brian Folt, Josh Cullen |
| DURATION | July 2020 - June 2021 |
| FUNDING | USFWS/TAMU AgriLife Research |

## Southwestern and northwestern pond turtle viability analysis to support a species status assessment

Assessing the status of a species and predicting its future trajectory is a vital part of classification decisions under the endangered species act. The western pond turtle is a widespread species that is very difficult to monitor and assess and predicting its future status offers significant challenges. The species was proposed for listing and recently split into two species, based on genetics data. The USFWS needs assessments of current status and predictions of future status to make informed decisions about the species' level of protection. We worked with the USFWS to devise data analyses and conduct expert elicitation workshops to inform modeling. These analyses and modeling exercise directly informed the classification decision (i.e., does the species need protection under the endangered species act?). Our study objectives are to 1) use available data to estimate current status and quantify ecological and environmental relationships for northern and southern western pond turtles, and 2) develop a predictive model to assess future status of the species, estimating resiliency and redundancy in the foreseeable future. We have focused in on using data in an occupancy modeling analysis to estimate current occupancy probability of adults and juveniles separately. We've received data from state agencies and federal partners, begun organizing the data and planning the analysis. Next steps are to design a predictive viability model. We have not yet completed analysis and have no results to present at this time. We have, however, been successful engaging with state agencies federal and working to acquire data for the analyses. The results of this work will directly inform the listing decision for the two species.

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| INVESTIGATORS | Conor McGowan |
| STUDENTS | Kaili Gregory (M.S., WEC) |
| DURATION | Jan 2021 - Dec 2022 |
| FUNDING | USGS/USFWS (RWO 319) |
| IN-KIND SUPPORT | Personnel provided by USFWS |

*Lake Alice, University of Florida, Gainesville.* BEN KAHLER

## Bird conservation classification and assessment for the Southeastern United States

The US Fish and Wildlife Service has a is increasingly concerned with the loss of wild animals, contracting ranges and abundance declines and the SE region of the USFWS sought to develop a process of evaluating the success of conservation actions and make decisions about wildlife conservation prioritization (focusing on birds) going forward. In other words, how can they allocate time, effort and money towards conservation that maximized conservation impact while meeting other agency objectives? We are developing methods for aligning conservation actions to agency objectives to maximize impact of the agency's effort. With the results of this project, the service can evaluate alternative funding allocations within the migratory bird and science applications programs with respect to bird conservation impact and other agency goals. We use decision analysis and group facilitation techniques to link agency actions to agency objectives and develop a framework for prioritizing actions and funding allocations within the program. We conducted a series of virtual structured decision-making workshops to elicit a problem statement, a objectives hierarchy and conceptual systems model. Results are still forthcoming from this project. We developed an objectives hierarchy and a conceptual model of agency operations. Our next steps are to address measurable attributes of the management objectives and link the agency operations model to the objectives hierarchy. The assistant regional director and the deputy assistant regional director will use the prioritization framework to assess budget allocation options each fiscal year. Also, the Migratory Birds office in the southeast will be able to use the results of this work to evaluate proposals and projects annually to choose projects that best address bird conservation priorities.

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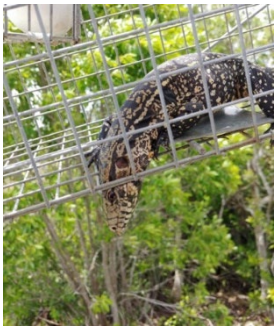
| INVESTIGATORS | Conor McGowan |
| POST-DOC | Riley Andrade |
| DURATION | Apr 2021 - Jul 2022 |
| FUNDING | USGS/USFWS (RWO 320) |
| IN-KIND SUPPORT | Personnel provided by USFWS |

*White ibis with satellite transmitter.* ATLEE HARGIS





*Left: A female panther chameleon (Furcifer pardalis) perched on a branch during the thermal acclimation project.* NATALIE CLAUNCH Middle: Burmese python emerging from a gopher tortoise burrow. KODIAK HENGSTEBECK Right: Argentine black and white tegu in a trap. BRADLEY UDELL

## Ecology, physiology, and control of invasive reptiles in Florida

More than 50 species of invasive reptiles have established breeding populations in Florida. Some appear to be increasing in population size and expanding their introduced range(s). The impacts of many of these species are unknown but may not become apparent until eradication or control is no longer economically feasible. In addition, the current demand for reptiles as pets indicates that reptile introductions to Florida are likely to continue. There is little known about how introduced species succeed during introduction and range expansion. Information about an animal's physiological responses to the introduced environment can be used to predict where they may occur, and how they may spread. A better understanding of invasive reptile life history and movements can inform population growth models and impacts from these species. Our study objectives are (1) assess physiological metrics that are implicated in invasion success across many established and spreading reptile species, specifically whether thermal tolerance and performance is influenced by seasonal change and prior exposure, (2) monitor the presence of tegus within and outside Everglades National Park, and (3) better understand python survival, reproduction, and dispersal. Our interns, grad students, and PI work together on various invasive reptile projects with our USGS-Fort Collins Science Center collaborators.

The primary focus in 2021 was on Burmese pythons, tegus, and panther chameleons. In 2020-2021, we assessed the thermal limits, performance, and preferences of panther chameleons (*Furcifer pardalis*) captured from an established population in central Florida and exposed to seasonal thermal regimes in Gainesville, Florida. Interns radio-tracked juvenile and adult pythons in Big Cypress National Preserve for information on survivorship and movements, and managed tegu-monitoring cameras placed outside and within Everglades National Park. We also performed necropsies and collected diet samples on these species.

Chameleons did not display differences in either critical thermal minimum or gaping temperature across seasons. Mean critical thermal minimum was 9.95°C, and mean gaping temperature was 39.22°C, with a resulting thermal breadth of 29.34°C. While sprint speed performance of chameleons was dependent on body temperature, chameleons did not display differences in sprint speed performance across seasons. Chameleons did not display differences in thermal tolerance associated with season. Mean preferred body temperature of chameleons was 32.8°C. Tegu camera monitoring data are still being sorted and analyzed, and interns (with USGS-FORT collaborators) are actively tracking adult and juvenile pythons. Panther chameleons from the Orange County population did not display seasonal acclimation of thermal tolerance, performance, or preference. It is uncertain whether this lack of acclimation applies to the species as a whole, or whether it is a result of local adaptation to cool winter temperatures within this population. These data will be useful for determining suitable habitat where other incipient populations may exist through mechanistic niche modeling techniques- this is ongoing. Information on tegu presence within Everglades National Park is critical to containment efforts. Information on python survivorship and movements will be used to inform population models. This project will be expanded in 2022 with our USGS collaborators from the Fort Collins Science Center and the Wetland and Aquatic Research Center.

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| INVESTIGATORS | Christina Romagosa |
| STUDENTS | Natalie Claunch (Post-Doc), Diego Juárez-Sánchez (Ph.D., WEC) |
| DURATION | Aug 2017 - Feb 2022 |
| FUNDING | USGS (RWO 302) |
| IN-KIND SUPPORT | UF Graduate School Fellowship (N. Claunch), WEC (D. Juárez-Sánchez) |

*Top left: Jawbone of Least Shrew,* Cryptotis parva floridana. MADISON HARMAN *Top right: Pentastome, likely* Raillietiella orientalis, *from a tegu lung* MADISON HARMAN. *Split page (left): CT scan of UF Museum specimen 185239, extreme fecal impaction of Leiocephalus carinatus.* EDWARD STANLEY

## Assessing impacts of invasive Argentine giant tegus in southern Florida

Argentine giant tegus are thoroughly established in Miami-Dade County. This population has persisted despite trapping efforts by multiple agencies, and it continues to expand farther into Everglades National Park each year. There are now multiple populations of tegus in Florida, including those located in Charlotte County, Hillsborough County, and St. Lucie County. The full extent of consequences from these invasions is not yet known but is suspected to be severe due to the tegus' generalist omnivorous nature. Tegus are known to consume eggs, fruits, and small vertebrates. However, we do not know their specific impacts on various native wildlife species or whether they are dispersing non-native plant seeds. They also vector invasive pentastomid parasites which are detrimental to the health of native snakes. The study objectives are: (1) identify the diet of adult tegus in the Miami-Dade population and describe potential variation between sexes, seasons, and habitat types, (2) compare the diet of the Miami-Dade population with a smaller sample of tegus from the Charlotte county population, (3) provide baseline data on which endo- and ectoparasites are present in tegus from both locations, and (4) conduct a spatial analysis of parasite infection intensity and attempt to identify correlates of high infection risk, such as habitat type. Tegus were trapped intensively by the NPS (Miami-Dade) and FFWCC (Charlotte) from Feb - Oct each year. Tegus were humanely euthanized and necropsied to collect diet contents, parasites, reproductive status, fat weight, and morphological measurements. Gastrointestinal contents were washed, sorted, dried, and identified to the lowest taxonomic level possible. Parasites were identified either morphologically, genetically, or both when possible. Preliminary results show that tegus are consuming a broad variety of taxonomic groups, including mammals, reptiles, amphibians, birds, fish, insects, arachnids, crustaceans, gastropods, fruits, and other plants. They consume both native and non-native wildlife and seeds, indicating they are likely dispersers of invasive plants within their home range. Tegus are also hosts of various parasites, including ticks, pentastomes, nematodes, digeneans, cestodes, and acanthocephalans. Some of these parasites are known invasives, while others have likely been picked up in the tegu's invasive range. Tegus threaten small vertebrates, particularly small mammals and birds that are already under stress from predation by invasive Burmese pythons, *Python bivittatus*. They may also reduce recruitment of long-lived animals like turtles and alligators by preying on their eggs and young. Tegus readily consume gastropods, which have yet to be identified but may include endangered tree snails. Additionally, their role as seed dispersers may be helping to spread invasive plants into the Everglades. Similarly, tegus vectoring parasites can act as amplifying reservoirs of both native and invasive parasites, disrupting local host-parasite dynamics in the ecosystem.

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| INVESTIGATORS | Christina Romagosa |
| STUDENTS | Madison Harman (M.S., WEC) |
| DURATION | Aug 2020 - Dec 2022 |
| FUNDING | USG (RWOs 302 and 322) |
| IN-KIND SUPPORT | FFWCC provided carcasses and data from their trap lines in Charlotte County |

*Tracking a Burmese python in Big Cypress: (left to right) Daniel Haro, Axelle Bethencourt, and Eva Herberg.* AUSTIN FITZGERALD

## Modeling Burmese python abundance using data from removal efforts

Burmese pythons in Florida are costly and difficult to manage due to their cryptic nature and to the difficulty of navigating the Everglades ecosystem. Impacts of management programs are also difficult to evaluate because of the relatively low number of python specimens acquired through management efforts, and because of the inability to release and recapture pythons. This project aims to apply and improve novel modeling methods to infer demographic traits, such as population size, using opportunistically collected python specimens. Traditional population estimation methods such as mark-recapture studies cannot be applied to Burmese python populations in Florida because of logistical constraints. This project aims to make use of counts and genetic data from pythons collected through removal programs to estimate python population abundance through two general methods: one uses repeated sampling to infer a total population size, and the other uses genetic data to model pairs of individuals in ways analogous to traditional mark-recapture methods. Our overall objectives are to investigate the use of novel modeling methods to infer python abundance, and if so to provide realistic abundance estimates so that the impacts of management can be better assessed. Our first goal is to accurately simulate a python population so that we may apply estimation methods and identify the data inputs that most affect our estimate accuracy. Our next step will be to update our model inputs using data collected from pythons in Florida. Our last step will be to apply out modeling methods to a specific region given the appropriate model inputs. We do not currently have any results to report. Our first results will show if/how our estimates are biased given the model inputs. Invasive species management is a multi-million-dollar burden to the United States, and to the Florida government. Without a proper understanding of python abundance, the impacts of costly management programs cannot be known.

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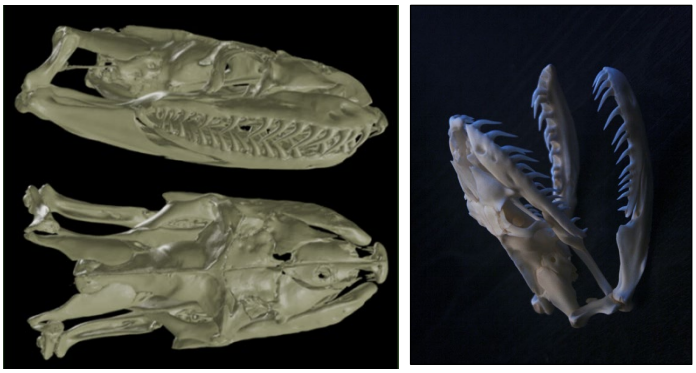
| INVESTIGATORS | Christina Romagosa |
| STUDENTS | Daniel Haro (Ph.D., WEC) |
| DURATION | Aug 2021 - Present |
| FUNDING | USGS (RWO 322) |



*A CT scan (left) and photo (right) of a skull from a Burmese python captured in southern Florida.* KODIAK HENGSETBECK

## Invasive reptile adaptations and impacts

Burmese pythons have established a breeding population in southern Florida and are negatively impacting native wildlife across their range. Pythons in Florida have a broad diet, but the species composition of their prey has changed over time and differs across the landscape. Changes in life history traits of a species can result in plastic or adaptive responses such as morphological or behavioral change. Whether changes in prey species composition could result in phenotypic plasticity or adaptation in pythons is uncertain. There is a need to evaluate plastic or adaptive responses by invasive species to environmental change. Understanding factors that contribute to invasion success is essential for sufficient prevention, mitigation, and management efforts. The potential for rapid adaptation by an invasive species is thought to be a driving factor that can affect not only successful establishment, but also proliferation. Morphological adaptations, in particular, can improve energy acquisition and aid in a species' establishment potential. If these changes in morphology occur in a short evolutionary timespan, the impact of the invader on natural resources may be dynamic. Furthermore, morphology, especially of the skull, is often linked to resource use and can be used to predict shifts in resource availability. Relating morphology to prey use over time and space can thus help predict consequences of invaders on the ecosystem and identify native animals that may be at higher risk. The objective of this study is to assess plastic or adaptive responses by Burmese pythons to environmental change. Specifically, we will assess python skull morphology to explore any potential spatial or temporal variation. Researchers have amassed a great deal of data on Burmese pythons in Florida as well as archived specimens over the past 15 years throughout the introduced range. Data collected from >500 specimens, including both archived specimens and recent specimens collected from the wild, will be used to document the amount of variation in phenotypic traits. All specimens will be analyzed digitally using nano-CT technology. We will use landmark-based geometric morphometrics to evaluate plastic or adaptative variations in python head shape over time and space. Relating head morphology to prey use over time and space will improve researchers' ability to predict consequences of invasive pythons on other species of concern. Additionally, it will identify native animals that may be at higher risk of python depredation in important natural areas such as Everglades National Park and Big Cypress National Preserve where Burmese pythons are continually impacting native fauna. Understanding the drivers and impacts of rapid morphological change of invasive species to introduced environments may justify intensive rapid response efforts for new species or populations before impact assessment can occur.

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| INVESTIGATORS | Christina Romagosa |
| STUDENTS | Kodiak Hengstebeck (Ph.D., SNRE) |
| DURATION | Sep 2019 - Aug 2024 |
| FUNDING | USGS (RWO 310) |
| IN-KIND | WEC |

*Banded snail kite nestling.* BRIAN JEFFERY

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

The over-arching goals of this monitoring are to provide reliable information on population size and trends, as well as key demographic, habitat, and foraging information of relevance to the recovery of this species. Demographic analyses revealed that snail kite abundance drastically declined between 1999-2008. The period population decline coincided, in part, with drought conditions throughout the southern portion of the kites' range and water management changes. The objective of this research is to monitor the birds' response to environmental changes focusing on the most critical demographic parameters: survival, reproduction, recruitment, and population growth rate. Snail kites were monitored by performing band-resight surveys in various wetlands. Nests were also monitored, and nestlings were banded with unique bands. A total 555 active nests with known fates were detected. Of those 206 were successful. We banded 474 nestlings and 361 were observed to have fledged. Overall apparent nest success was 37 (± .02)%. Since the snail kite population is critically endangered and because adult fertility plays such an overwhelming role in the population growth rate, it is critical to identify and attempt to limit factors that negatively affect snail kite demography.

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| INVESTIGATORS | Robert Fletcher |
| STUDENTS | Alfredo Gonzalez (M.S., WEC) |
| DURATION | Sep 2019 - Sep 2024 |
| FUNDING | USACE, FFWCC, SFWMD, St. John's River WMD |
| IN-KIND SUPPORT | USGS |

*Nestling snail kite with solar-powered GPS-GSM tag, August 2016.* CAROLINE POLI

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

Hydrologic alterations, degradation, and loss of wetland habitat are all factors that could have substantial effects on Snail Kite populations, including the survival of juvenile (1st year) individuals. Juvenile survival is a key factor for recovery of the species, but it is much less understood. Fine scale tracking information would allow us to better understand juvenile survival and movement, with the goal of providing information to inform management and promote 1st year survival of Snail Kites. The study objectives are 1) to determine causes of mortality in juvenile snail kites. Assess whether typical movement behaviors can be defined for a variety of environmental conditions, 2) to identify threats that are most important to juvenile snail kite survival, 3) to provide data on potential population sinks, and 4) to provide specific management recommendations for determining when and where to focus habitat management activities in order to increase population size through reduced mortality of young

Deploying solar-powered transmitters and VHF trackers on Snails Kites fledglings so that we can understand both fine-scale movement and real-time mortality and behavioral states of individuals. GPS/VHF transmitters were deployed on 11 fledglings in 2021 between April 15th to June 2nd. Of these individuals, 3 individuals were confirmed dead and 2 additional individuals could not be confirmed but are presumed dead, such that 45% (5 of 11 individuals) were assumed to suffer mortality shortly after fledging from nests. Individuals traveled total distances of 1300.4 ± 184.0 km and traveled as fast as 37.1 km/h. Birds primarily remained within 2.2 ± 1.7 km of the nest site for 43.6 ± 13.6 days after fledging. Regular attendance of the natal site ceased suddenly at approximately 44.5 – 62.3 days post-fledging and birds did not appear to return. Data generated from this study will provide information needed to allow for more targeted habitat and hydrologic management aimed at increasing juvenile survival of Snail Kites.

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|---|---|
| INVESTIGATORS | Robert Fletcher |
| STUDENTS | Alfredo Gonzalez (M.S., WEC) |
| DURATION | Sep 2019 - Sep 2024 |
| FUNDING | USACE |
| IN-KIND SUPPORT | USGS |

*Arianna Paul seated on an airboat.* SHELBY LeCLAIRE

## Evaluating apple snails and snail kite habitat management strategies

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

We will assess the effects of control burns and herbicide treatments on the abundance of apple snails and relate that to foraging and demographic responses of snail kites. Herbicide treatment followed by a controlled burn will be conducted by the Florida Fish and Wildlife Conservation Commission (FFWCC) during winter 2019-2020 on the western side of Lake Okeechobee. Snail surveys will be done twice pre-treatment (April-June, July-Aug 2019) and twice post-treatment (April-June, July-Aug 2020) within treatment and control areas. During each survey session two methods will be used to detect apple snails within each sampling unit: crayfish traps and throw traps. We will also collect data on time activity budgets of snail kites during each sampling session

We anticipate that the management technique of herbicide paired with fire management will result in the reduction of the cattail monoculture. This reduction should lead to improved habitat quality for apple snails, resulting in an increased abundance, and will also make apple snails more accessible to snail kites. This study will assess the effectiveness of the herbicide-burn management strategy to increase snail abundance and accessibility. Understanding how different habitat management techniques effect prey, their refugia, and ultimately predator-prey dynamics between the endangered Snail Kite and apple snails will provide valuable information for land managers and policymakers.

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| INVESTIGATORS | Robert Fletcher and Christina Romagosa |
| STUDENTS | Arianna Paul (M.S., WEC) |
| DURATION | Apr 2019 - Jun 2021 |
| FUNDING | FFWCC |
| IN-KIND SUPPORT | USGS |

BEN KAHLER

# PUBLICATIONS AND PRESENATATIONS*

**Student authors denoted in **bold**. Coop Unit scientists underlined*

## PUBLICATIONS

**Bishop, N.D.**, R. Hudson, J. Marlin, T. Pop, T. Rainwater, S. Boylan, B. Atkinson, and R.R. Carthy. 2021. Using growth rates to estimate the minimum age and size at sexual maturity in a captive population of the critically endangered Central American river turtle Dermatemys mawii. Journal of Zoo and Aquarium Research 9: 150-156. https://doi.org/10.19227/jzar.v9i3.432

Bonvechio, T.F., and **K.I. Bonvechio**. 2021. Proposed standard weight equation and standard length categories for Lake Chubsucker. North American Journal of Fisheries Management 41: 1375-1383. https://doi.org/10.1002/nafm.10655

Borcyk, P., E. Fortner, **N.M. Claunch**, and S.A. Johnson. 2021. Florida's introduced reptiles: green iguana (*Iguana iguana*). UF IFAS Extension Document.

Burkett-Cadena, N.D., E.M. Blosser, A.A. Loggins, M.C. Valente, M.T. Long, L.P. Campbell, L.E. Reeves, I. Bargielowski, and R.A. McCleery. 2021. Invasive Burmese pythons alter host use and virus infection in the vector of a zoonotic virus. Communications Biology 4: 1-11. https://doi.org/10.1038/s42003-021-02347-z

Carlson, A.K., T. Young, M.A. Centeno, S.A. Levin, and D.I. Rubenstein. 2021. Boat to bowl: Resilience through network rewiring of a community-supported fishery amid the COVID-19 pandemic. Environmental Research Letters 16: 034054. https://doi.org/10.1088/1748-9326/abe4f6

Carlson, A.K., D.I. Rubenstein, and S.A. Levin. 2021. Modeling Atlantic herring fisheries as multiscalar human-natural systems. Fisheries Research 236: 105855. https://doi.org/10.1016/j.fishres.2020.105855

**Claunch, N.**, I.A. Bartoszek, S. Tillis, R.J. Ossiboff, J.F.X. Wellehan, N.I. Stacy, S. Oakey, L.A. Schoenle, and C.M. Romagosa. 2022. Physiological effects of capture and short-term captivity in an invasive snake species, the Burmese python (*Python bivittatus*) in Florida. Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology 267: 111162. https://doi.org/10.1016/j.cbpa.2022.111162

**Claunch, N.**, C. Goodman, R. Reed, C.M. Romagosa, and E.N. Taylor. 2021. Invaders from islands: thermal matching, potential, or plasticity? Biological Journal of the Linnean Society 134: 587-603. https://doi.org/10.1093/biolinnean/blab103

**Claunch, N.**, I.T. Moore, H. Waye, L. Schoenle, S.J. Oakey, R.N. Reed, and C.M. Romagosa. 2021. Understanding metrics of stress in the context of invasion history: the case of the brown treesnake (*Boiga irregularis*). Conservation Physiology 9: coab008. https://doi.org/10.1093/conphys/coab008

Fieldsend T., **N. Claunch**, B. Fridie, C. Goodman, **M. Harman**, K. Krysko, C. Raxworthy, C. Romagosa, and T. Collins. 2021. Extreme male color polymorphism supports the introduction of multiple native-range Panther Chameleon (*Furcifer pardalis*) lineages to Florida, USA. Reptiles and Amphibians 28: 257-261. https://doi.org/10.17161/randa.v28i2.15599

Evans, D.R., R.A. Valverde, C. Ordóñez , and R.R. Carthy. 2021. Identification of the Gulf of Mexico as an important high-use habitat for leatherback turtles from Central America. Ecosphere 12(8): e03722. https://doi.org/10.1002/ecs2.3722

Fletcher, R.J., **E.P. Robertson**, **C. Poli**, **S. Dudek**, **A. Gonzalez**, and **B. Jeffery**. 2021. Conflicting nest survival thresholds across a wetland network alter management benchmarks for an endangered bird. Biological Conservation 253: 108893. https://doi.org/10.1016/j.biocon.2020.108893

**Hirama, S.,** B. Witherington, K. Kneifl, A. Sylvia, M. Wideroff, and R.R. Carthy. 2021. Environmental factors predicting the orientation of sea turtle hatchlings on a naturally lighted beach: A baseline for light-management goals. Journal of Experimental Marine Biology and Ecology 541: 151568. https://doi.org/10.1016/j.jembe.2021.151568

Johnson, S.A., C. Reyes, B. Dodge, and **N. Claunch**. 2021. Florida's introduced reptiles: brown anole (*Anolis sagrei*). UF IFAS Extension Document.

Lawson, A.J., B. Folt, A.M. Tucker, F.T. Erickson, and C.P. McGowan. 2021. Decision context is a necessary component of population viability analysis appraisal. Conservation Biology 35(5): 1683-1685. https://doi.org/10.1111/cobi.13818

Lindelien S., A.C. Dutterer, P. Schueller, and **C.C. Anderson**. 2021. Evidence dorsal spine removal is nonlethal and unharmful for Largemouth Bass in Florida. Journal of Fish and Wildlife Management 12(1): 190–196. https://doi.org/10.3996/JFWM-20-033

**Maleko, P. N.**, V. V. Pronkevich, and K. S. Maslovsky. 2021. Nordmann's Greenshank (*Tringa guttifer*), version 2.0. In Birds of the World (S. M. Billerman, P. G. Rodewald, and B. K. Keeney, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.norgre1.02

**Reichert, B.E.**, R.J. Fletcher, and W.M. Kitchens. 2021. The demographic contributions of connectivity versus local dynamics to population growth of an endangered bird. Journal of Animal Ecology 90(3): 574-584. https://doi.org/10.1111/1365-2656.13387

Silver-Georges, I., S.A. Ceriani, M. Ware, M. Lamb, M. Lamont, J. Becker, R.R. Carthy, C, Matechik, J. Mitchell, R. Pruner, M. Reynolds, B. Smith, C. Snyder, and M.M.P.B. Fuentes.

2021. Using systems thinking to inform management of imperiled species: a case study with sea turtles. Biological Conservation 260: 109201. https://doi.org/10.1016/j.biocon.2021.109201

Soto-Shoender, J.R., D.C. Gwinn, A. Sovie, and R.A. McCleery. 2020. Life-history traits moderate the susceptibility of native mammals to an invasive predator. Biological Invasions 22(9): 2671-2684. https://doi.org/10.1007/s10530-020-02278-6

**Taillie, P.J.**, K.M. Hart, A. Sovie, and R.A. McCleery. 2021. Native mammals lack resilience to invasive generalist predator. Biological Conservation 261: 109290. https://doi.org/10.1016/j.biocon.2021.109290

Tucker, A.M., C.P. McGowan, J.E. Lyons, A. Derose-Wilson, and N.A. Clark. 2021. Species-specific demographic and behavioral responses to food availability during migratory stopover. Population Ecology 64(1): 19-34. https://doi.org/10.1002/1438-390X.12094

**Tuma, M.E.** and A.N. Powell. 2021. The southeastern U.S. as a complex of use sites for nonbreeding rufa Red Knots: fifteen years of band-encounter data. Wader Study 128(3): 265-273. https://doi.org/10.18194/ws.00256

**Vitale, N.**, J. Brush, and A.N. Powell. 2021. Loss of coastal islands along Florida's Big Bend Region: Implications for breeding American Oystercatchers. Estuaries and Coasts 44: 1173–1182. https://doi.org/10.1007/s12237-020-00811-3

## THESES AND DISSERTATIONS

Bishop, N. 2021. Nutritional ecology of the critically endangered central American river turtle, *Dermatemys mawii*. Ph.D. Dissertation. University of Florida, Gainesville, FL.

Arends, C. 2021. Variation in resource partitioning of three sea turtle species at a temperate foraging ground. M.S. Thesis. University of Florida, Gainesville, FL.

Catizone, D. 2021. Ecology of the ornate diamondback terrapin (*Malaclemys terrapin macrospilota*) in St. Joseph Bay, FL. M.S. Thesis. University of Florida, Gainesville, FL.

Claunch, N. 2021. Physiological legacies of reptile invasions. Ph.D. Dissertation. University of Florida, Gainesville, FL.

Maleko, P. 2021. Filling knowledge gaps for two declining east Asian-Australasian flyway shorebirds: Nordmann's greenshanks and common redshanks. M.S. Thesis. University of Florida, Gainesville, FL.

## PRESENTATIONS

**Aguilar, T**. 2021. Creating an encounter rate model for green turtles and recreational boaters, FAS Graduate Student Symposium, Gainesville, Florida, 25 February 2021.

**Aguilar, T**. 2021. How can boaters save sea turtles? Three-minute Thesis Competition Finals, Gainesville, Florida, 9 November 2021.

**Cardas, A.,** A. Powell, and K. Miller. 2021. Impacts of translocation on the cooperatively breeding Florida scrub-jay in Ocala National Forest, Friday Findings Webinar, USGS Ecosystems Mission Area.

**Claunch, N.M.** 2021. Physiological effects of capture and captivity in invasive Burmese pythons (*Python bivittatus*) Florida Cooperative Fish and Wildlife Research Unit Cooperators Meeting, Gainesville, FL, April 2021.

**Claunch, N.M.** 2021. Physiological legacies of reptile invasions. School of Natural Resources and Environment Departmental Research Seminar. University of Florida, Gainesville, Florida, April 2021.

**Claunch, N.M**. 2021. Let's talk about stress. Invited Research Seminar. Florida International University, March 2021.

**Claunch, N.M.**, C.M. Goodman, R. Guralnick, and C.M. Romagosa. 2021. Islanders on the mainland: exploring thermal influences on establishment in an invasive lizard. FLMNH Seminar Series, December 2021.

**Claunch, N.M**. 2021. Invasive herpetofauna: a focus on cane toads and Cuban treefrogs. Natural Areas Training Academy: Managing for Diversity across Florida's Unique Landscapes Workshop, December 2021.

**Claunch N.M.**, C.M. Goodman, R. Guralnick, and C.M. Romagosa. 2021. When island lizards colonize the mainland: thermal matching, potential, or plasticity? Joint Meeting of Ichthyologists and Herpetologists, Phoenix, AZ Awarded Frederick H. Stoye Award for Best Virtual Presentation, July 2021.

**Claunch N.M.**, C.M. Goodman, R. Guralnick, R. Reed, and C.M. Romagosa. 2021. Invaders sourced from islands: thermal matching, potential or plasticity? Society of Integrative and Comparative Biology, Virtual Meeting, January 2021.

**Claunch N.M.**, C.M. Goodman, R. Guralnick, and C.M. Romagosa. 2021. Thermal influences on invaders from islands. SNRE Student Research Symposium, April 2021.

**Claunch, N.M.**, L. Schoenle, S. Oakey, C. Downs, L. Martin, R.N. Reed, and C.M. Romagosa. 2021. Glucocorticoid profiles vary with establishment history in invasive lizards. International Society of Wildlife Endocrinologists Virtual Event, August 2021.

**Gulick, C.K.**, **K. Zhang**, and A.N. Powell. 2021. Factors influencing wading bird movement in the nonbreeding season. Oral Presentation. Waterbird Society Annual Meeting (virtual), 10 November 2021.

**Harman, M.**, T. Fieldsend, C. Mothes, T. Collins, M. Miller, and C. Romagosa. 2021. Unexpected impacts: Non-native lizards as vectors of introduced pentastomid parasites in Florida. Joint Meeting of Ichthyologists and Herpetologists, July 2021.

**Maleko P.N.**, V.V. Pronkevich, K S. Maslovsky, J.C. Slaght, A.N. Powell. 2021. The importance of Schaste Bay, Khabarovsk Krai, Russian Far East to Nordmann's Greenshank (*Tringa guttifer*). International Wader Study Group Conference (virtual), 10 October 2021.

**Manes C.** 2021. Assessment of environmental drivers in the prevalence of Fibropapillomatosis in green turtles (Chelonia mydas) populations across Florida, Texas, and Hawaii. Sea Turtle Fibropapillomatosis Research Symposium, St Augustine, Florida, October 2021.

**Manes C**. 2021. Environmental driver and human impacts behind sea turtle cancer. Coastal EcoSystem Dynamics Seminar Series, Gainesville, Florida, 9 September 2021.

**Manes C.** 2021. A mysterious cancer of marine turtles. Florida Cooperative Fish and Wildlife Research Unit Coordinating Committee Lightning Talks, Gainesville, Florida, 6 May 2021.

**Manes C.** 2021. Environmental etiology of green turtle Fibropapillomatosis. University of Florida Emerging Pathogen Institute Research Day, Gainesville, Florida, February 2021.

**Manes C.** 2021. Human impact, sea turtle diseases and One Health. Exotic Animal Club and One Health Student Association, Gainesville, Florida, 16 March 2021.

Moore, J. and W. E. Pine. 2021. N-mixture model performance is poor when sample sites are not chosen at random and site fidelity is occurring. Annual Gulf Sturgeon Workshop. Virtual

**Parker S.W.**, W.E. Pine, and R.N.M. Ahrens. 2021. CJS mortality estimation for adult Gulf Sturgeon. Annual Gulf Sturgeon Workshop. Virtual.

**Vine J.R**. and W.E. Pine. 2021. Initial assessments of juvenile Gulf sturgeon survival in the Choctawhatchee Bay. Annual Gulf Sturgeon Workshop. Virtual

**Zhang, K.**, **C.K. Gulick**, and A.N. Powell. 2021. Habitat use of wading birds during the non-breeding season in the norther Gulf of Mexico. Waterbird Society Annual Meeting (virtual), 11 November 2021.

## COMPLETED PROJECTS

**Habitat partitioning of sea turtle species at a temperate foraging ground.**
Investigator: Hannah Vander Zanden
Completion Date: June 2021
Funding Agency: USGS (RWO 312)

**The effects of cattail removal on apple snail and snail kite in Okeechobee.**
Investigator: Robert Fletcher
Completion Date: June 2021
Funding Agency: FFWCC

**Everglade Snail Kite population and nesting monitoring.**
Investigator: Robert Fletcher
Completion Date: September 2021
Funding Agency: SFWMD

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