Annual Report 2023

Florida Cooperative Fish and Wildlife Research Unit

FLORIDA COOPERATIVE
FISH AND WILDLIFE RESEARCH UNIT

PO Box 110485
2295 Mowry Rd, Bldg. 106
University of Florida
Gainesville, FL 32611-0485

COOPERATORS

Florida Fish and Wildlife Conservation Commission

United States Geological Survey

United States Fish and Wildlife Service

University of Florida

Wildlife Management Institute



Cover: Bar Hammock. CONOR MCGOWAN
Left: Jaiere Harlow and Ray Carthy in MOCC Training. BRENT SIGAFUS USGS
Center: Holding Horseshoe Crabs Sheds. CONOR MCGOWAN
Right: Darcey Doran-Myers Holding Bear Cubs. UNKNOWN

Table of Contents

INTRODUCTION..... 4
- In Dedication 5
- Mission Statement 6
- Diversity, Equity, and Inclusion 6

UNIT COORDINATING COMMITTEE..... 7
- Unit Scientists 7

COOPERATORS..... 8

RESEARCH PERSONNEL..... 10
- UF Cooperating Faculty 10
- Support Staff 10
- Postdoctoral Research Scholars 10
- Graduate Students 10

HONORS AND AWARDS..... 12

ACRONYMS..... 13

Doris Duke Conservation Scholars Program..... 14

RESEARCH: FISHERIES AND AQUATIC..... 15

RESEARCH: WILDLIFE AND HABTATS..... 23

PUBLICATIONS AND PRESENTATIONS..... 31
- Publications 33
- Presentations 33
- Theses And Dissertations 36
- Completed Projects 37

TOP RIGHT: Costanza Manes at MOCC Training. JAZMIN CALDERON-MARQUEZ;
CENTER RIGHT: Darcy Doran-Myers holding bear cub. UNKNOWN.
BOTTOM RIGHT: Happy Catfish. MARION BAKER
BOTTOM: Chris Anderson, Ph.D. student. FWC

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.

New Unit quarters at 2295 Mowry Road, University of Florida. RAYMOND CARTHY and ANDREW ORTEGA using a UAS drone

Between 1979 and 2023, 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.

Tyler Coleman and Andrew Carlson at Graduation.
BETSY RILEY

In Dedication to Tyler Steven Coleman

Students are the lifeblood of the Florida Unit. From the field to the lab, conference room, and lecture hall, students make the Unit mission possible and enrich the lives of everyone in the Unit family. We thank all past, present, and future Unit students for their countless contributions and cherished friendship.

Every now and then, we encounter a student whose achievements are so noteworthy, and whose resilience amid adversity is so remarkable, that they deserve special recognition. We dedicate the 2023 Annual Report to one such student, **Tyler Steven Coleman.**

Tyler arrived at the University of Florida in 2019 with an M.S. degree and a competitive Ph.D. fellowship in hand. He made an immediate impact on campus, catalyzing collaborations with faculty and leveraging his knowledge and experiences to support students and colleagues. Throughout his life, Tyler has risen above challenges. When adversity arose in his initial Ph.D. program, Tyler responded with courage and fortitude. Joining the Unit in 2021, Tyler launched a second Ph.D. project and completed it in two years, a remarkable feat.

Throughout his time as a Unit Ph.D. student, Tyler befriended and supported faculty, staff, and students and won numerous awards, including the Outstanding Graduate Teaching Award in WEC and the Roger Rottman Memorial Scholarship from the Florida Chapter of the American Fisheries Society. Then and now, Tyler's commitment to high-quality science and teaching is matched only by his dedication to improving the lives of those around him. Despite adversity—and indeed because of it—Tyler is a driven, magnanimous person with a clarity of purpose for life and career that is truly inspiring. Tyler's resilience, passion for natural resources, and compassion for people leave a legacy at the Florida Unit and embody the invaluable contributions of all Unit students.

Tyler earned his Ph.D. in December 2023 and is now a postdoctoral scientist studying aquatic ecosystems in Louisiana. We miss Tyler's energy, enthusiasm, and cordiality around the Unit building, but we celebrate his achievements and look forward to his continued contributions to natural resource science, management, and education.

Florida Unit students, staff, and leaders at their spring picnic, 2023. UNKNOWN

MISSION STATEMENT

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.

DIVERSITY, EQUITY, AND INCLUSION

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, 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

Robert Gilbert, Dean for Research, 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*

Brandon Baker, *Georgia Department of Natural Resources*

Benjamin Baiser, *University of Florida*

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*

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*

Devin Donmoyer, *National Park Service*

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*

Deborah Epperson, *U.S. Geological Survey*

Nick Farmer, *National Oceanic and Atmospheric Administration*

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

Jacquelyn Guzy, *U.S. Geological Survey*

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*

Amanda Kissel, *U.S. Geological Survey*

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*

COOPERATORS

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*

Earl Lundy, *Florida Fish and Wildlife Conservation Commission*

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*

Lisa McBride, *U.S. Geological Survey*

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*

Jason O'Connor, Florida Fish and Wildlife Conservation Commission

Katherine O'Donnell, U.S. Geological Survey

Bradley O'Hanlon, *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*

Caroline Poli, *Florida Fish and Wildlife Conservation Commission*

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*

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

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

Ellen Robertson, *U.S. Geological Survey*

LeRoy Rodgers, *South Florida Management District*

J. Perran Ross, *University of Florida*

Mark Sandfoss, *U.S. Geological Survey*

Jesse Senko, *Arizona State University*

Donna Shaver, *National Park Service*

Colin Shea, *Florida Fish and Wildlife Conservation Commission*

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*

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*

Support Staff

Jazmin Calderon, *Administrative Support Assistant*
Jeremy Miller, *Research Administrator*
Cassidy Summerlin, *Research Administrator*

Postdoctoral Research Scholars

Riley Andrade
Natalie Claunch
Joshua Cullen
Luke Evans
Adrian Figueroa
Brian Folt
Ashley Goode
Caroline Poli
Paul Taillie

Ray Carthy and the Unit UTV. ABBY POWELL

Graduate Students

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

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

Marion Baker, MFAS, FAS
ADVISOR: Andrew Carlson

Meghan Beatty, *Ph.D., Wildlife Ecology and Conservation:* ADVISOR: Robert Fletcher

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

Tyler Steven Coleman, *Ph.D., Wildlife Ecology and Conservation* ADVISOR: Andrew Carlson
*Graduated in December 2023

Lara Elmquist, *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

Shelby LeClare, *M.S., SNRE*
ADVISOR: Christina Romagosa

Gabriela Logo, *M.S., Wildlife Ecology and Conservation*
ADVISOR: Christina Romagosa

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

RESEARCH PERSONNEL

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

Graduate Students

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

Chelsea Myles-McBurney, M.S., FAS
ADVISOR: Andrew Carlson

Stephen Parker, Ph.D., WEC
ADVISOR: Bill Pine (Co-advisor: Andrew Carlson)
*Graduated in December 2023

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

Peter Xiong, *M.S., Wildlife Ecology and Conservation*
ADVISOR: Christina Romagosa

Ke Zhang, *Ph.D., Wildlife Ecology and Conservation*

FL Unit Leaders and students at the annual WEC Awards picnic, 2023.
UNKNOWN

Jaiere Harlow at MOCC Training. JAZMIN CALDERON-MARQUEZ

Costanza taking measurements on the field.
RICHARD HERREN

HONORS AND AWARDS

DOI 30-Year Service Award. Raymond R. Carthy. 2023

African Safari Club Conservation Scholarship. Kodiak Hengstebeck. 2023

All Hands Meeting Planning Team Pre-meeting Planning Group Award, Abby Powell. USGS/CRU. 27 January 2023.

Best Oral Presentation Award, Madison Harman in the Conservation category of the Henri Siebert Competition from the Society for the Study of Amphibians and Reptiles (2023 Joint Meeting of Ichthyologists and Herpetologists)

Best Student Speed Talk, Kimberly Bonvechio. Florida Chapter of the American Fisheries Society. 11 May 2023.

Diversity Undergraduate Wildlife Student Award. Mariaguadalupe Vilchez. Florida Chapter of The Wildlife Society. 2023.

Doris and Earl Lowe and Verna Lowe Scholarship, Tyler Steven Coleman, University of Florida, College of Agricultural and Life Sciences. 3 August 2023.

Excellence in Science Award, Kimberly Bonvechio, Ph.D. student. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute. 19 May 2023.

Feature Paper Distinction awarded first chapter of dissertation (Bonvechio et al. 2023) “representing the most advanced research with significant potential for high impact in the field.” Kimberly Bonvechio, 19 April 2023.

First Chapter of Dissertation (Bonvechio et al. 2023) published as a Cover Article in Fishes. Kimberly Bonvechio, Ph.D. student. 17 May 2023.

Honorable Mention - Best Student Paper Award, Chris Gulick, The Waterbird Society. 12 October 2023.

Luby Microgrant, Kyle Miller. University of Florida, Warrington College of Business. 12 January 2023.

Outstanding Service Award, Mariaguadalupe Vilchez, undergraduate researcher, University of Florida, Department of Wildlife Ecology and Conservation. 28 April 2023.

Outstanding Teaching Award, Tyler Steven Coleman, University of Florida, Department of Wildlife Ecology and Conservation. 28 April 2023.

Plenary Planning and Management Group STAR Award, Abby Powell, USGS Cooperative Research Program. 21 March 2023.

President’s Award, Marion Baker, Georgia Chapter of the American Fisheries Society. 15 February 2023

Simberloff Award for Outstanding Presentation, Shelby LeClare, Ecological Society of America. 2023.

Sharon Fitz-Coy Memorial Award, Mariaguadalupe Vilchez, University of Florida, School of Forest, Fisheries, and Geomatics Sciences. 1 April 2023.

Study Abroad Scholarship, Lexie Scott, Undergraduate researcher. University of Florida, College of Agricultural and Life Sciences. 24 February 2023.

Undergraduate Diversity Student Scholarship, Mariaguadalupe Vilchez, Florida Chapter of The Wildlife Society. 23 February 2023.

UF Wildlife Graduate Student Association Travel Grant. Stephen Parker. 2023.

University of Florida Graduate School Grinter Fellowship. Stephen Parker. 2023.

University Scholar (competitive program to fund honors thesis research), Lexie Scott, Undergraduate researcher. University of Florida, College of Agricultural and Life Sciences. 9 March 2023.

University Scholars Program Mentor Award, Madison Harmon. 2023.

Tyler Stephen Coleman, Kaili Gregory, and Costanza Manes received awards from UF WEC in 2023.
ABBY POWELL

ACRONYMS

CRU	Cooperative Research Units, U. S. Geological Survey
ESA	Endangered Species Act
IFAS	Institute of Food and Agricultural Sciences, University of Florida
FAS	Fisheries & Aquatic Sciences, School of Forest Fisheries, & Geomatics Sciences, UF
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

Doris Duke scholars and mentors at the 2023 CCM. (L to R Maria Vilchez, Jesus Rodriguez-Riverol, Christina Romagosa, Spencer Zeitoune, Ray Carthy, and Chris Gulick). UNKNOWN

Doris Duke Conservation Scholars Program

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

MENTORS: Cohort 9: Christopher Gulick (Ph.D. WEC), Jaren-Claude Serano (M.S., WEC), Rebecca McKee (Ph.D., WEC), and Eric Trotman (Ph.D. Zoology); Cohort 10: Lara Elmquist (M.S., WEC), Lameace Hussain (M.S., WEC), and Peter Xiong (M.S., WEC)

DURATION September 2013 - September 2024

FUNDING Doris Duke Conservation Scholars Program Collaborative with University of Florida, USGS

The Doris Duke Conservation Scholars Program (DDCSP) Collaborative is a 2-year undergraduate conservation, diversity, equity, and inclusion field program designed to provide students from underrepresented groups with an experiential introduction to a career in natural resources. The Arizona, Florida, Idaho, and Massachusetts Coop Units are members of the collaborative. The students attend leadership training, work with scientists and graduate students on research projects, and are mentored by current CRU program graduate students and Federal scientists. The Doris Duke Scholars participate in paid summer internships with local, State, Federal, and Tribal agencies, or nongovernmental organizations.

In the summer of 2023, Cohort 9 filled their second summer in the program with a range of career-building internships with various conservation agencies and organizations. Cohort 10 and two new graduate mentors went into the field to work with Snail Kites and Argentine Black and White Tegus. Both cohorts had the opportunity to attend The Wildlife Society's annual conference in November, and Cohort 9 presented posters on their independent projects from their first summer. This year the DDCSP Collaborative was honored to receive The Wildlife Society's 2023 Group Achievement Award. The Group Achievement Award recognizes an organization's outstanding wildlife achievement that is consistent with and/or assists in advancing the objectives of The Wildlife Society.

In 2023, we learned that the Doris Duke Foundation has decided to draw the Doris Duke Conservation Scholars Programs to a close. We know our program has been successful. Five years after completing the program, more than two-thirds of our scholars are pursuing careers in environmental science and conservation. More than 25% of our scholars have completed or are pursuing graduate degrees related to conservation. Our goal is to continue our program as the Conservation Collaborative Scholars Program (https://www.conservation-collaborative.org/) and to launch our next cohort of Conservation Scholars in the summer of 2025.

Intern Cohorts:

Year 1 (2014)	Year 2 (2015)	Year 3 (2016)	Year 4 (2107)	Year 5 (2108)
Alex Cronin	Jeanette Brisbane	Modeline Celestin	Amy Almond	Keara Clancy
Nadia Kemal	Megan Ely	Camille DeJesus	Joelle Carbonell-Bierbaum	Faith Morgan
Jaclyn Selden	Charmaine Pedrozo	Hannah Innocent	Tre'nard Morgan	Kristina Rodriguez
Adreenah Wynn	Monica Quintiliani	Elizabeth Sherr	Marcela Mulholland	Desiree Smith
Xue "Jackie" Zhang	Sharmin Siddiqui		Camya Robinson	

Year 6 (2109)	Year 7 (2020)	Year 8 (2021)	Year 9 (2022)	Year 10 (2023)
Jacob Hornfeldt	Jazmyn Broxton	Maya Encinosa	Otto Alvarez	Pablo Araya
Gabriela Obando	Juliemar Cuevas-Hernandez	Maiya Lester	Jesus Rodriguez-Riverol	Delana Gonzalez
Eric Trotman	Aleidys Lopez Romero	Sebastian Summo	Logan Stratton	Emily Martucci
Herby Zephir	Mariaguadalupe Vilchez	Nimsi Trujillo	Spencer Zeitoune	Felix Roy

Research: Fisheries and Aquatic

Lessons from a long-term fisheries monitoring program: The Florida experience..... 16

Leveraging habitat suitability modeling to inform management of nonnative fishes in a changing climate..... 16

Using long-term monitoring data to evaluate Largemouth Bass and Black Crappie population dynamics amid environmental change..... 16

Investigating Grass Carp movement, habitat use, emigration, and natural mortality after stocking in the Harris Chain of Lakes, Florida..... 17

Ecology and conservation of endangered Smalltooth Sawfish.... 17

Evaluating a habitat suitability index for Bluenose Shiner populations in peninsular and panhandle Florida rivers..... 17

Effects of Spotted Bass on Shoal Bass and Largemouth Bass in the Flint River..... 18

Understanding and conserving gravel-bar fish assemblages in the Escambia River, Florida..... 18

Abiotic and biotic factors affecting fish occurrence, abundance, and growth in sixty Florida lakes..... 18

Informing Gulf Sturgeon population status and trends as a baseline to measure PDARP actions to promote species Recovery..... 19

Integrative assessment of Fibropapillomatosis dynamics in free -roaming green turtles (*Chelonia mydas*) living in the Northeastern Gulf of Mexico..... 20

Identifying strategies for conservation of the marine turtles in Argentina and Uruguay, South America..... 20

Green turtles and vessel interactions: size class specific response ranges, interaction-likelihood modeling, and predictive population modeling..... 20

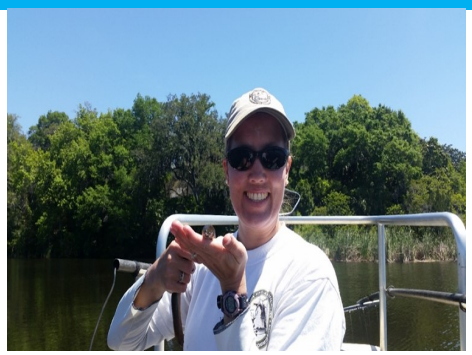
Green turtle spatial distribution, abundance, and habitat models in the northeastern Gulf of Mexico..... 21

Tidally-driven gas exchange: Effects on loggerhead sea turtle (*Caretta caretta*) hatchling emergence..... 21

Sea turtle abundance, demographics and movements in the northeastern Gulf of Mexico..... 22

Approaches to understanding and mitigating sea turtle bycatch in Florida trap fisheries..... 22

Rivers Breathe. MARION BAKER



Kimberly Bonvechio, Ph.D. student. FWC

Lexie Scott, undergraduate researcher. UNKNOWN

Tyler Steven Coleman, Ph.D. student. AUBURN UNIVERSITY

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

In 2006, the Florida Fish and Wildlife Conservation Commission (FWC) 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.

INVESTIGATOR	Andrew Carlson
STUDENT	Kimberly Bonvechio, Ph.D. Fisheries and Aquatic Sciences
DURATION	July 2021-June 2026
FUNDING	FWC and USGS (RWO 321)
IN KIND SUPPORT	FWC

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 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 also experimentally evaluate the effects of Tilapia *Oreochromis* spp. on population dynamics of Largemouth Bass and Bluegill. 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. Experimental work will occur collaboratively with USGS-WARC. 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.

INVESTIGATOR	Andrew Carlson
STUDENTS	Chris Anderson, Ph.D. Fisheries and Aquatic Sciences; Lexie Scott, Undergraduate Honors Thesis
DURATION	July 2021-June 2026
FUNDING	FWC, USFWS, USGS-WARC
IN KIND SUPPORT	FWC, USGS-WARC

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 developed 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 also conducted 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 yielded insights for understanding long-term trends in Largemouth Bass and Black Crappie populations 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 expanded 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.

INVESTIGATOR	Andrew Carlson
STUDENTS	Tyler Steven Coleman, Ph.D., WEC; Mariaguadalupe Vilchez, Undergraduate
DURATION	August 2021–December 2023
FUNDING	UF (Ph.D. Fellowship), FWC
IN KIND SUPPORT	FWC

Logan Masterson, M.S. student. FWC

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.

INVESTIGATOR	Andrew Carlson
STUDENT	Logan Masterson M.S. Fisheries and Aquatic Sciences
DURATION	October 2021–June 2024
FUNDING	FWC
IN KIND SUPPORT	FWC

Andrew Wooley, M.S. student. FWC

Ecology and conservation of endangered Smalltooth Sawfish

The Smalltooth Sawfish is a Federally endangered species that is confined to a small portion of Florida's coast. Despite active research on Smalltooth Sawfish by multiple organizations across Florida, key knowledge gaps remain. More information is needed on Smalltooth Sawfish habitat use and movement in Charlotte Harbor—an area that contains critical habitats for the species across its life history—to inform management and conservation programs. Our objectives are to (1) identify ontogenetic shifts in habitat use of Smalltooth Sawfish in Charlotte Harbor and (2) evaluate residency of juvenile fish by quantifying patterns in habitat use and home range as related to sex, size, and environmental factors. We will use acoustic telemetry and catch data to assess the duration and timing of Smalltooth Sawfish habitat use in Charlotte Harbor, with emphasis on nursery, refuge, and foraging areas and other high-priority locations. We will give special emphasis to characterizing ontogenetic habitat shifts at size classes that have historically been most difficult to monitor (i.e., intermediate-sized fish and the very largest individuals). Our analyses and statistical modeling will yield insights for understanding what habitats are most important for Smalltooth Sawfish across their life history in Charlotte Harbor. We will also characterize when and why shifts in habitat use occur. This project will provide fisheries managers with key information on Smalltooth Sawfish habitat use and movement that will allow them to prioritize habitats and management strategies to promote conservation of this endangered species.

INVESTIGATOR	Andrew Carlson
STUDENT	Andrew Wooley, M.S. Fisheries and Aquatic Sciences
DURATION	July 2022–December 2024
FUNDING	FWC, NOAA
IN KIND SUPPORT	FWC

Kyle Miller, M.S. student. FWC

Evaluating a habitat suitability index for Bluenose Shiner populations in peninsular and panhandle Florida

The Bluenose Shiner is a threatened species in the state of Florida that is vulnerable to water quality degradation and habitat loss. Despite the imperiled status of Bluenose Shiner and imminent conservation threats, the species has received relatively little research attention. Bluenose Shiners have a spatially disjointed range in Florida, with populations concentrated in rivers of the north-central peninsula and western panhandle and no documented populations elsewhere. Researchers recently developed a Habitat Suitability Index (HSI) for Bluenose Shiners based on expert opinion, but the HSI has not been empirically validated. The objectives of this project are to (1) develop range-wide water velocity, water depth, and cover/substrate HSIs for Bluenose Shiners in Florida; (2) provide updated information on the spatial distribution of Bluenose Shiners in Florida; and (3) identify key Bluenose Shiner habitats for protection and rehabilitation. Our research will combine fish sampling in rivers where Bluenose Shiners have been previously documented (e.g., Alexander Springs Creek, Rock Springs Run, portions of the Escambia and Yellow rivers) with GIS analysis and HSI modeling. Our research will provide updated information on Bluenose Shiner distribution in Florida and yield new insights into how environmental conditions influence Bluenose Shiner population demographics. This project will provide aquatic resource managers with important information for conserving Bluenose Shiner populations and their habitats while informing establishment of statutory minimum flows and levels (MFLs) for key water bodies.

INVESTIGATOR	Andrew Carlson
STUDENT	Kyle Miller, M.S. Fisheries and Aquatic Sciences
DURATION	July 2022–December 2024
FUNDING	FWC
IN KIND SUPPORT	FWC

Marion Baker, MFAS student. GEORGIA DNR

Effects of Spotted Bass on Shoal Bass and Largemouth Bass in the Flint River

Shoal Bass are endemic to the Apalachicola–Chattahoochee–Flint (ACF) River basin in Florida, Georgia, and Alabama and support a socioeconomically important fishery. Introduction of nonnative Spotted Bass into the ACF basin is cause for concern due to potential negative interactions with Shoal Bass and Largemouth Bass. The Georgia DNR maintains robust, long-term data on population demographics of Shoal Bass, Largemouth Bass, and Spotted Bass in the Flint River, information that has yet to be comprehensively analyzed. We are forming a tri-state collaboration (Florida, Georgia, Alabama) to assess how Shoal Bass and Largemouth Bass have responded to the introduction of Spotted Bass in the Flint River. We will also evaluate how quickly Spotted Bass have spread throughout the system and identify how environmental conditions influence their establishment and population demographics. We will supplement a long-term database on population demographics of Shoal Bass, Largemouth Bass, and Spotted Bass in the Flint River with contemporary field sampling and statistical modeling. Our analyses will reveal if and how Shoal Bass and Largemouth Bass been affected by the introduction of Spotted Bass in the Flint River. This project will provide new insights for managing native bass species and associated fisheries in the ACF basin.

INVESTIGATOR	Andrew Carlson
STUDENT	Marion Baker, MFAS Fisheries and Aquatic Sciences
DURATION	November 2022–December 2025
FUNDING	Georgia DNR
IN KIND SUPPORT	Georgia DNR

Chelsea Myles-McBurney, M.S. student. UNKNOWN

Understanding and conserving gravel-bar fish assemblages in the Escambia River, Florida

Gravel bars are dynamic riverine habitats important for the life-history processes of aquatic and terrestrial species. Relatively uncommon in the subtropical and temperate rivers of Florida, gravel bars are important, data-limited systems in need of more research in the Sunshine State. There is a need to identify the abiotic and biotic factors that influence gravel-obligate fish species and gravel-bar fish assemblages in Florida rivers. Likewise, there is a need to evaluate how these abiotic and biotic factors, and their effects on gravel-bar fish assemblages, change over space and time. The objectives of this project are to (1) evaluate fish assemblages in gravel bars within the Escambia River, with a special focus on fish Species of Greatest Conservation Need; and (2) assess the degree to which observed changes in gravel-bar fish assemblages are related to time of day, depth, season, and environmental factors. We will integrate FWC fisheries data with a series of univariate and multivariate statistical approaches and population models to evaluate the status of gravel-bar fish assemblages in the Escambia River in the context of environmental change. Our study will produce data summaries and statistical models to quantify and predict how abiotic and biotic factors influence gravel-obligate fish, including Species of Greatest Conservation Need, in the Escambia River. Gravel bars are home to Species of Greatest Conservation Need in Florida, yet they are relatively understudied systems, particularly from a fisheries perspective. Our research will yield novel information about the current and projected future status of gravel-bar fish assemblages in the Escambia River that will aid fish conservation efforts in north Florida and other areas with gravel-bar habitats.

INVESTIGATOR	Andrew Carlson
STUDENT	Chelsea Myles-McBurney, MFAS Fisheries and Aquatic Sciences
DURATION	May 2023–December 2025
FUNDING	FWC
IN KIND SUPPORT	FWC

Clockwise from top left: Andrew Carlson, Bethany Gaffey, Katrina Rossos, 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.

INVESTIGATORS	Andrew Carlson, Mark Hoyer
DURATION	October 2021–June 2026
FUNDING	UF LAKEWATCH program, FWC
IN KIND SUPPORT	UF LAKEWATCH Program, FWC

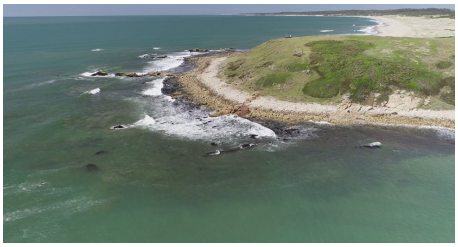
Bethany Gaffey and a Gulf Sturgeon.
TYLER STEVEN COLEMAN

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

A long-term goal of the Gulf Sturgeon Recovery Plan is to establish self-sustaining populations that could allow the delisting of the species. However, population status and trends are uncertain. Additionally, the effects of new and changing threats on population viability is unknown. Despite the differing objectives of previous short-term, small-scale studies, most employed mark-recapture techniques, which can be used as a common analytical framework for analyses. Most studies focused on adult fish, so we collected new juvenile data. We aimed to gain insight into the status and trends of Gulf Sturgeon population dynamics across their range by utilizing all available adult Gulf Sturgeon data within a common analytical framework to estimate population parameters and inform population viability simulations. We also set out to learn more about juvenile occupancy and mortality patterns. We synthesized available Gulf Sturgeon data in a common database and used it to generate capture histories for mark-recapture models to estimate survival, movement, and recruitment. We used these estimates to inform simulations of future population conditions. We also telemetered fish to understand juvenile occupancy and mortality patterns in the Choctawhatchee River. Our analyses suggest that adult Gulf Sturgeon survival is generally high, but lower survival rates in the western Gulf may limit population recovery. Extirpation risk among these populations also differs as lower adult survival rates and initial abundances make these western Gulf populations more susceptible to episodic mortality events. Juvenile analyses support adaptation potential in the context of future environmental conditions as these fish demonstrated avoidance of unfavorable conditions. We evaluated future threat scenarios and determined there is little risk of losing all seven river populations. If there is interest in promoting resilience through maintaining all populations, then actions should be taken to ensure populations are at, or above, the critical levels of abundance and survival identified in this project. Reassessing critical habitat in terms of providing capacity for adaptation is an area of crucial future work.

INVESTIGATOR	Bill Pine
STUDENT	Stephen Parker Ph.D., WEC
DURATION	July 2019–December 2023
FUNDING	NOAA and USFWS (RWO 308)

Costanza Manes preparing environmental monitoring canisters for deployment. EVAN COOPER



Aerial view captured by DJI Pahntom 4 Pro V2 of Cerro Verde, CV-CMPA, Uruguay. NATALIA TERYDA

Adult Loggerhead Turtle. TRENTON AGUILAR

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

Fibropapillomatosis is a neoplastic epizootic of sea turtles. Green turtles (Chelonia mydas) are the most heavily affected species, with prevalence of over 60% in Florida. This debilitating disease forms tumor growths on the turtle 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 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. We will address our objectives by carrying health assessment of green turtle populations in the Northeastern Gulf of Mexico and deploying passive environmental samplers for the measurement of seawater pollutant concentrations. Fieldwork started 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. We deployed passive environmental samplers on August 2023 and retrieved them after 25 days and are currently awaiting the results from the lab. This project will elucidate possible viral and environmental drivers behind the severity and propagation of fibropapillomatosis. Data will be utilized to inform coastal managers and policymakers on the best changes to be applied to relieve green turtle population from disease burden and aid their recovery and conservation.

INVESTIGATORS Raymond R. Carthy, Ilaria Capua

STUDENT Costanza Manes, Ph.D. WEC

DURATION January 2021–January 2025

FUNDING One Health Center of Excellence, National Save the Sea Turtle Foundation

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

Leatherback and green turtle populations have decreased exponentially across the world, leading to their current global protected status. Reasons for their decline include 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. Information on habitat use, population densities, and threats is essential for their conservation. Efforts were directed to investigating two endangered species with new technologies and the reinforcement of regional conservation and management networks. From December 2021 to May 2022, we conducted aerial surveys over the water in the Cerro Verde and Islas de La Coronilla Marine Protected Area (CMPA) in the department of Rocha, Uruguay. We deployed the UAS from the shore, collecting video of the coastal foraging grounds while flying 200m linear transects at an altitude of 35 - 40 m. We conducted 123 missions in four survey areas over 25 field days. Mission duration ranged from 7 to 16 minutes, totaling 20.4 hours of video. Days in the field were limited due to high wind and Beaufort Sea State, with operations only possible at mean wind speeds below 28kph (max gusts of 35kph) and sea state of 3. Depending on the survey area, we counted 0 – 70 turtle sightings, with an outlier of 126 individuals. We will calculate Observations-per-Unit-Effort and estimate Relative Density of green turtles in CMPA accounting for individuals not available to being seen (probability of being visible). Our work indicates that UAS are effective tools for sea turtle monitoring in a region that was previously understudied due to environmental factors like water clarity. Furthermore, we show the potential benefit of using UAS in sub-optimal environmental and oceanographic conditions, providing information and opportunities to study habitat use, distribution and density of the juvenile green turtle in the main feeding area in Uruguay.

INVESTIGATOR Raymond R. Carthy

STUDENT Natalia Teryda, Ph.D. SNRE

DURATION August 2019–May 2025

FUNDING FL Coop Unit, SNRE, KARUMBE

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

Vessel strikes pose a threat to sea turtles globally, with a particular impact in Florida where an increasing number of these endangered animals face injury or fatality due to encounters with recreational or commercial vessels. To enhance our understanding and subsequently mitigate this peril, our research focuses on investigating the dynamics of vessel strikes involving turtles. This involves the examination of how such incidents occur, the prediction of high encounter zones between vessels and turtles, and an exploration of the potential influence of growing turtle and human populations on future mortality concerns. Conducting observational boat surveys, we measured turtle responses and flight initiation distances, comparing behaviors across different size classes of turtles, and determining green turtles of all size classes studied were equally susceptible to vessel strikes. Subsequently, we constructed an encounter rate model depicting the likelihood of interactions between green turtles and recreational boaters in Florida. This model illuminates areas where these two groups may intersect, namely nesting beaches and human population centers. We also developed a population growth model to forecast the impact of growing human and green turtle populations in Florida on the escalating interactions with vessels. Our model illustrates the unsustainability of the current management surrounding vessel strikes on green turtles as interactions between boats and turtles increase alongside the human population growth in the state. The efficacy of the encounter rate model has been demonstrated in predicting zones of heightened turtle and boater interaction, with potential applications tailored to localized contexts where turtle density data is available. Furthermore, our population model elucidates various scenarios of vessel-related mortality and their potential effects on Florida's green turtle populations. As we accumulate more data, particularly on recreational boater registrations locally and across the state of Florida, as well as sea turtle species density, these models will evolve into valuable tools for future management planning.

INVESTIGATORS Raymond Carthy, Mike Allen

STUDENT Trenton Aguilar, Ph.D., FAS

DURATION August 2018–August 2024

FUNDING NSF, Florida Education Fund, UF Graduate School, McKnight Doctoral Fellowship, Sea Turtle Conservancy

IN KIND SUPPORT FAS

Manatee in Crystal River. ELSA HAUBOLD, USFWS

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

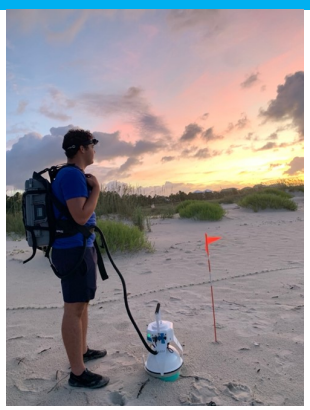
Although efforts are ongoing, there are still many concerns about the future of the Florida manatee population, including conservation management needs for their habitat, and anthropogenic activity impacting their population throughout Florida. Current legislation and research efforts are working to improve conservation efforts for a more secure future for the population. There has been much debate about financial needs and scientific communication when it comes to the ecological issues of the Florida manatee, and there is still room for improvement on local, regional, and national scales for better comprehension of the effects and severities of anthropogenic impacts on both the natural and human subsystem. Although studies have expressed the critical nature of these ecological concerns and potential threats for the future, there has been minimal work acknowledging and incorporating the socioeconomic aspects or the integration of the natural and human subsystems, and how residents within the surrounding communities have been impacted. Very few have addressed how the subspecies population and their habitat needs have affected and can continuously affect the population of the human subsystem, and conversely, how public attitudes and behaviors influence the manatee population and habitat. This project is using the CHANS (Coupled Human and Natural Systems) framework to analyze manatee research and conservation efforts, anthropogenic inputs and impacts, and assess information and management actions/outcomes informed by inputs from professionals and laypersons within the manatee network. We will analyze past and present population work (aerial surveys, genetics, photo-ID, modeling, etc.), habitat work (tracking, general seagrass and targeted seagrass studies), policy/behavioral work (response to boats and people, speed zone policies) and advocacy group inputs to identify synergies/ interconnectivity/similarities and differences. Identifying key instances of telecoupling can place findings into a historical perspective and inform management plans for continued protection and sustainability of the manatee population in Florida.

INVESTIGATOR Raymond R. Carthy

STUDENT Jaiere Harlow, Ph.D., SNRE

DURATION January 2023–December 2027

FUNDING USGS, USFWS (RWO 330)



Doris Duke Conservation Program Scholar Otto Alvarez taking gas efflux measurements at Salinas Beach, Cape San Blas, FL. JAREN-CLAUDE SERANO

Tidally-driven gas exchange: Effects on loggerhead sea turtle (*Caretta caretta*) hatchling emergence

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. The objectives of this study included investigating how gas exchange on beaches fluctuates throughout the tidal cycle on different beach types by using CO-2 efflux as a proxy to quantify this exchange. Findings were compared with the most recent hatchling emergence success data from the beaches observed, to deduce the effects these factors may have on hatchling emergence success over time. The effects of the tidal cycle on gas efflux readings in the study system were examined using an infrared trace gas analyzer. Sand samples from each beach were collected and then processed using a graduated series of U.S standard sieves. Results revealed that higher emergence success occurred at the beach possessing the finer sand particle size and a higher, more stable CO2 efflux. However, due to additional variables involved in incubation and successful emergence, further investigation is required to better comprehend the relationship between emergence success and tidally driven gas exchange. Results from this work can identify habitat suitability issues and inform conservation planning measures and better nourishment practices, including mitigation and alternative actions.

INVESTIGATOR Raymond R. Carthy

STUDENT Jaren-Claude Serano, M.S., WEC

DURATION September 2020–December 2026

FUNDING USGS (RWO 316)

A satellite tagged Kemp's ridley sea turtle swimming over seagrass beds. EVAN COOPER

Sea turtle abundance, demographics and movements in the northeastern Gulf of Mexico

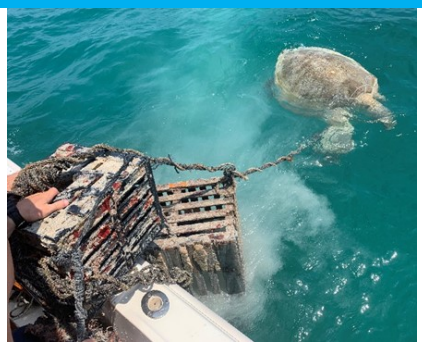
Since their legal protection in 1978, green turtles have increased throughout Florida. Historical accounts suggest the northeastern Gulf of Mexico is an important sea turtle foraging area. However, wildlife managers lack a basic understanding of sea turtles in this region and need more information on juvenile life stages in nearshore waters. This research is part of a collaboration between Sea Turtle Conservancy (STC) and Dr. Carthy at the USGS Florida Cooperative Fish and Wildlife Research Unit. The objective is to understand the abundance, demographics, movements, and threats in Florida's Big Bend and Panhandle. The first three studies within this objective were to: 1) determine spatial distribution and abundance, 2) compare green turtle size, sex ratio, health, and genetic origin at three widely separated study sites, and 3) determine green turtle overwintering movements using satellite telemetry and correlate them with water temperature. Boat-based surveys were used to estimate abundance in the Big Bend using probability of detection models. Turtles were captured to determine their size, sex ratio, health, and genetic origin. Satellite transmitters were attached to 22 juvenile green turtles to determine their behavior and movements during the winter from 2019 to 2021. The surveys indicated that green turtles were by far the most abundant species in the Big Bend with the south region (Citrus and Hernando counties) containing the most turtles. There were significant differences in size, sex ratio, and disease rates between green turtle aggregations. We obtained five to seven months of data from 78% of the tracked turtles, which showed a pattern of migration south and offshore during the winter and then back to their original warm-water foraging site in the spring. The results are being prepared for publication and have led to a better understanding of the sea turtles in this region. Additional research is underway, in collaboration with STC, focusing on Kemp's ridley movements, green turtle health, and green turtle diets.

INVESTIGATOR Raymond R. Carthy

STUDENT Richard M. Herren Ph.D., WEC

DURATION September 2019-December 2025

FUNDING Sea Turtle Conservancy



Loggerhead turtle entangled in trap line. FWC SEA TURTLE STRANDING AND SALVAGE NETWORK

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

Trap/pot fishing is ubiquitous and used in industrial, small-scale, commercial, and recreational fisheries throughout the world. While we know that trap and pot gear is highly selective considering traditional bycatch, much less is known about impacts resulting from marine megafauna entanglement. Specifically, sea turtle entanglement is comparatively understudied in trap fishery systems as opposed to trawl, longline, and gillnet fisheries. Florida is a hotspot for sea turtles, with five of the seven species using inshore waters and beaches for foraging or nesting activities. It is also a hub for commercial/recreational trap fishing with three major trap fisheries occurring in state waters, thus representing an important nexus from which to better understand population impacts of trap fishing on five sea turtle species. This project will implement a social-ecological system (SES) framework that integrates biological data and local ecological knowledge to describe, for the first time, the impact of Florida's trap fisheries on local sea turtle populations, filling an essential gap in knowledge. Spatial and temporal trends, magnitude and scope of impacts, and other observations will be explored using 36 years of sea turtle entanglement reports provided by Florida's Sea Turtle Stranding and Salvage Network. Key stakeholders and commercial fishers will be interviewed and surveyed to gather Local Ecological Knowledge (LEK) on turtle entanglement patterns and impacts, as well as to explore motivations and barriers of adopting various turtle bycatch/entanglement reduction strategies in the fisheries. Stakeholder member-checking will be undertaken to ensure findings accurately represent the thoughts and perspectives of those interviewed for this project. From there, recommendations will be developed to reduce trap gear interactions of sea turtles in Florida, with the hope that these results may be applied in other trap fisheries around the world.

INVESTIGATOR Raymond R. Carthy

STUDENT Rachel Smith Ph.D., SNRE

DURATION September 2019-December 2024

FUNDING The Walt Disney Company

IN KIND SUPPORT FWC, FWRI, New College of Florida, Disney's Animal Kingdom-Science and Environment

Research: Wildlife and Habitats

Movements and overwinter survival of juvenile Red Knots (*Calidris canutus rufa*) in Southeast US: Information needs for recovery planning..... 24

Colonial nesting wading bird tracking and habitat use assessment..... 24

Bird conservation classification and assessment for the Southeastern United States..... 24

Southwestern and Northwestern pond turtle viability analysis to support a species status assessment..... 25

Modeling Tools for Species Status Assessments..... 25

Range-wide population viability analysis for the Gopher Tortoise..... 25

SSA prioritization and science needs..... 26

Science Applications and Migratory Bird program alignment in the Southeast..... 26

Developing and evaluating tools for expert elicitation integration with population viability models..... 26

Habitat Connectivity for Large Mammals in the Greater Everglades..... 27

Evaluating the Movement Patterns and Survival of Juvenile Everglade Snail Kites (*Rostrahamus sociabilis plumbeus*) at Lake Okeechobee..... 27

Demographic, Movement and Habitat of the Endangered Snail Kite in Response to Operational Plans in Water Conservation Area 3A..... 27

Invasive reptile adaptations and impacts..... 28

Understanding Greater Everglades mammal communities adjacent to and within the ARM Loxahatchee National Wildlife Refuge..... 28

Analysis of diet and parasites in Florida's invasive tegus..... 29

Internships and research support for invasive reptiles in Florida 30

Banded Snail Kite nestling. *BRIAN JEFFERY*

Juvenile Red Knot fitted with a nanotag. ABBY POWELL

Doris Duke Scholar, Otto Alvarez, holds a juvenile white ibis fitted with a satellite transmitter. KE ZHANG

Sandhill Cranes. CONOR MCGOWAN

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 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 was delayed for two years due to covid-19, but in February 2022 we captured, banded, and flagged 123 red knots at Fort DeSoto, Florida. We deployed 19 nanotags and three pinpoint ARGOs transmitters on birds identified as second-year age classes. Unfortunately, the GPS transmitters we deployed failed, but one of the birds carrying a transmitter was resighted in South Carolina in May and back in Florida in September. Preliminary data show that a 40-71% of flagged birds that were resighted were seen in coastal South Carolina from March through June 2022 and then resighted in the Tampa Bay area from August through December. The only flagged birds remaining around Tampa Bay in June and July were juveniles. We are planning to capture and tag more birds in spring/summer 2023. 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.

INVESTIGATORS	Abby Powell, Jim Lyons (USGS), Kevin Kalasz (USFWS)
STUDENTS	TBD
DURATION	August 2019 – December 2024
FUNDING	USGS (RWO 309)
IN KIND SUPPORT	USFWS

Colonial nesting wading bird tracking and habitat use assess-

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. To date we have deployed transmitters on 50 white ibis and 49 tricolored herons over three breeding seasons, 2020-2022. 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 indicate 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 December 2023, 14 ibises and 5 tricolored herons were still transmitting data, and we continue to update our analyses of movements and site fidelity. 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.

INVESTIGATOR	Abby Powell
STUDENTS	Ke Zhang, Ph.D., WEC, Chris Gulick, Ph.D., WEC
DURATION	September 2019 – December 2024
FUNDING	USGS (RWO 307)

Bird conservation classification and assessment for the Southeastern United States

The US Fish and Wildlife Service is increasingly concerned with the loss of wild animals, contracting ranges, and abundance declines. 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 developed 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. We used the hierarchy and conceptual models to build an optimization using Solver, a MSExcel tool that seeks optimal allocation of staff time and effort to maximize conservation value. The tool we developed helped the Assistant Regional Director for the SAMB program assess current staffing and how to adjust staff time and effort going forward. It also allows supervisors and managers to look at current achievement and set goals for the future. The Assistant Regional Director and the Deputy Assistant Regional Director will use the prioritization framework to assess staff allocation options. 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.

INVESTIGATOR	Conor McGowan
POST-DOCS	Riley Andrade Ellen Pero
DURATION	April 2021–September 2023
FUNDING	USGS/USFWS (RWO 320)
IN KIND SUPPORT	USFWS

Freshwater Turtle. CONOR MCGOWAN

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. Predicting its future status offers significant challenges. The species was proposed for listing and recently split into two species, based on genetics data. The FWS needs assessments of current status and predictions of future status to make informed decisions about the species' level of protection. 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). Our study objectives are: to use available data to estimate current status and quantify ecological and environmental relationships for Northern and Southern Western Pond Turtles, and to develop a predictive model to assess future status of the species, estimating resiliency and redundancy in the foreseeable future. We developed a stochastic simulation model to predict future abundance and extinction risk. Available count data from recent years surveys were used along with habitat data to estimate starting abundance. We then devised functions to represent future threats and projected the populations into the future. Extinction risk was low for the near term, but for both species extinction probability was >0.50. Drought in the south and the invasive bull frogs were expected to have the largest impacts on viability. The results of Kaili Gregory's thesis work directly informed the decision to list both species as Threatened under the Endangered Species Act.

INVESTIGATOR	Conor McGowan
STUDENT	Kaili Gregory, M.S
DURATION	July 2021 – July 2023
FUNDING	USGS/USFW (RWO 319)
In-Kind Support	USFWS

Elicitation. CONOR MCGOWAN

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 (ESA). In many cases, they lack the expertise or the tools to conduct the necessary scientific analyses and they need support in developing generalizable and transferrable tools to facilitate SSA analyses. We will work with the service to devise modeling tools that support SSA completion and work with the service specifically on two SSAs, the Texas Spot-tailed Earless Lizard and the Roundtail Chub. We developed 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. Dr. Ashley Goode designed a sized-based life table analysis to use single capture event data to estimate survival and recruitment of the two species. Dr. Goode completed a threat linked stochastic viability model for the species, devising several scenarios based on cooperator input. The Chub viability model predicted low viability if the perceived threats continue into the future. We also ran additional scenarios with reduced threat effects to try and match field observations in recent years. The future viability results for the Texas lizard predict low probability of extinction over the next 20 years but increase substantially at 50 years. Viability for the species was highly sensitive to road mortality, road density and urban growth. The Roundtail Chub analyses are complete and the modeling that we did directly informed the decision to not list the species. The service chose not to use our viability model to support the listing decisions for two lizards in Texas. However, the tools we develop should be applicable to a variety of future SSAs with sparse data.

INVESTIGATOR	Conor McGowan
POST-DOC	Ashley Goode
DURATION	July 2020 – July 2022
FUNDING	USGS/USFWS (RWO 315)
IN KIND SUPPORT	USFWS

Gopher Tortoise. CONOR MCGOWAN

Range-wide population viability analysis for the Gopher Tortoise

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 was a candidate for listing in the remainder of the species' range. The Snail Kite is federally threatened 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, the USFWS needed to first 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 devised a population viability model for the tortoise and kite SSAs. Our work focused on developing spatially implicit population models that incorporated probable effects of potential threats on population viability. We predicted population growth and persistence while testing the sensitivity of predictions to uncertainty in model parameters and inputs. Our study objectives are: to develop a PVA models for Gopher Tortoise and Snail Kites to predict future abundance, population growth, and extinction risk under a variety to different scenarios, and to conduct sensitivity analysis to assess the importance of uncertain parameters effects on decision making. We worked with USFWS, FWC and researchers during model development. The model for tortoises accounted for population loss due to sea-level rise and urbanization and expected demographic changes due to increasing temperatures. We presented the model and results to the USFWS in October of 2021. The Snail Kite PVA was completed in January in 2022 and submitted to the FWS for use in their SSA. Models predicted declines for Gopher Tortoises in the coming decades. Declines were most strongly influenced by threats such as warmer dryer climate and habitat loss. Snail Kite population growth was primarily limited by precipitation and changes in hydrology. The USFWS decided that listing the Gopher Tortoise was not warranted and that the Snail Kite would retain its listed status.

INVESTIGATORS	Conor McGowan Robert Fletcher
POST-DOCS	Brian Folt Josh Cullen
DURATION	July 2020–August 2023
FUNDING	USFWS/TAMU AgriLife Research
IN KIND SUPPORT	USFWS

Workshop. CONOR MCGOWAN

SSA prioritization and science needs

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 (ESA). There are hundreds of pending decisions that require a science-based assessment of the species status before making ESA decisions. We will work with the service to devise an objectives hierarchy and tradeoffs analysis to develop a prioritization system for identifying which SSAs tasks require the most attention or effort and when to do them. We developed an objectives hierarchy, identify measurable attributes and design a multi-criteria decision analysis value function to rank the >300 SSA project 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 through the decision analysis steps. In spring of 2020, we conducted a series of team meetings to elicit the prioritization objectives from field office supervisors and regional office deputies. Dr. Goode developed an optimization analysis that schedules SSAs to maximize information quality, minimizes controversy constrained by court-ordered deadlines and staffing capacity. We completed the analytical tool that addresses the project needs. We have tested output sensitivity to value function formulation and competing objective weights. We have also tested and demonstrated that the court-ordered deadlines imposed by lawsuits against the service to force decision deadlines reduces overall value. As a result of this work, the service can and has updated their work plan of SSAs in the coming years. They are also using the data collected to complete the optimization to identify science needs in the future based on pending SSAs and available data.

INVESTIGATOR Conor McGowan

POST-DOC Ashley Goode

DURATION July 2020 – July 2023

FUNDING USGS/USFWS (RWO 314)

IN KIND SUPPORT USFWS

Least Bitterns. CONOR MCGOWAN

Science Applications and Migratory Bird program alignment in the Southeast

The US Fish and Wildlife Service recently merged the Science Applications Program and the Migratory Birds Program in the Southeast region under one assistant regional director. Aligning personnel and efforts towards conservation objectives in this "new" SAMB program will enhance delivery and improve conservation outcomes but requires careful thinking and objective evaluation. We developed 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 staffing strategies and how to best allocate their effort and time toward program objectives.
We use decision analysis and group facilitation techniques to link agency actions to agency objectives and develop a framework for staff FTE allocations within the program. We devised a program objectives hierarchy and identified measurable attributes for each fundamental objective of the program. We also estimated the expected relationship between staff time, effort and measurable attributes to use in an FTE optimization analysis. The tool we developed helped the Assistant Regional Director for the SAMB program assess current staffing and how to adjust staff time and effort going forward. It also allows supervisors and managers to look at current achievement and set goals for the future. The Assistant Regional Director and the Deputy Assistant Regional Director will use the prioritization framework to assess staff allocation options. 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.

INVESTIGATOR Conor McGowan

POST-DOC Ellen Pero

DURATION January 2023 – June 2024

FUNDING USGS/USFW (RWO 328)

In-Kind Support USFWS

Barbed Wire. DARCY DORAN-MYERS

Developing and evaluating tools for expert elicitation integration with population viability models

Assessing the conservation status of at-risk species and predicting species' future trajectories helps to inform listing decisions under the Endangered Species Act. Species status assessments, however, often encounter significant data gaps. Analysts and modelers increasingly turn to expert elicitation to build their models. Questions remain regarding how reliable and accurate these methods are for filling data gaps in these decision settings. Do they represent the best available science and/or are there ways to improve these tools? We are devising methods to experimentally test expert elicitation methods, by comparing concealed data from American Black Bear research to expert elicitation data from panels of black bear experts. We also plan to use simulation modeling to test elicitation biases and explore the potential for AI to serve as an alternative tool for filling data gaps. Our goals are to: 1) develop methods and tools for integrating responses for multiple questions to estimate model parameters, 2) develop and improve tools for simulating populations with expert elicited parameters and 3) develop methods for testing accuracy of expert elicited parameter distribution and model predictions. We are in the early stages of implementing this project. Darcy Doran-Myers is gathering black bear spatial capture recapture data from across the species range to analyze and use in elicitation experiments. She has further been in contact with language model and deep learning AI experts to explore the potential for designing tools to fill endangered species data gaps. The work we complete will either endorse the effectiveness and accuracy of existing elicitation methods, suggest improvements to existing methods, or propose alternative approaches to filling critical data gaps in endangered species status assessments.

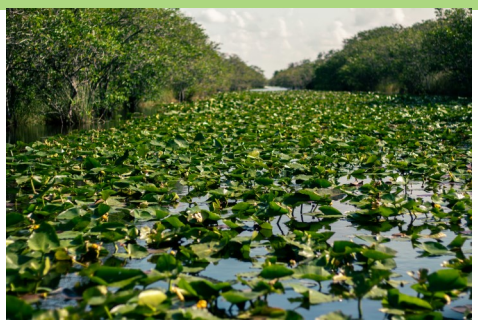
INVESTIGATOR Conor McGowan

STUDENT Darcy Doran-Myers, Ph.D., WEC

DURATION January 2023–September 2025

FUNDING USGS/USFWS (RWO 329)

IN KIND SUPPORT USFWS



Everglades, Florida. ANDY CHENG

Habitat Connectivity for Large Mammals in the Greater Everglades

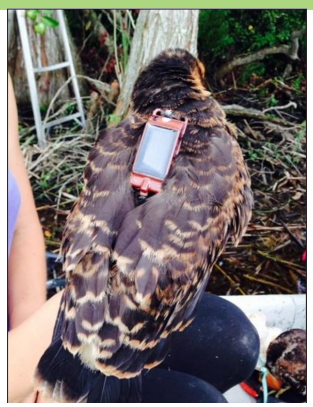
There is a global challenge in designing effective large-scale corridors to provide long-term habitat connectivity for multiple species with varying dispersal capacities. Corridor evaluations are scarce and a standardized approach is lacking. Implementing a standardized approach that accounts for the dispersal limitations of multiple species will offer a more comprehensive framework for assessing corridor effectiveness. This will provide valuable insights to policymakers and planners, guiding redesigns for underperforming corridors. This study aims to introduce a general multi-species approach using the 'spatial absorbing Markov chain' (SAMC) framework that accounts for the dispersal limitations of species to evaluate the effectiveness of the Florida Wildlife Corridor for a mammal community. It illustrates this framework´s utility for corridor evaluation by analyzing how well the corridor captures movement and its ability to enhance dispersal among protected areas. We integrate the SAMC with habitat suitability models and random-walk dispersal kernels to assess movement and dispersal for six mammal species across Florida Managed Areas (FLMAs). Our evaluation of the Florida Wildlife Corridor involved overlapping high movement values with the corridor and comparing settlement probabilities at FLMAs within and outside the corridor. Results indicate that species with limited dispersal capacity show greater overlap between predicted movement and the corridor while highly mobile species tend to move beyond the corridor's extent. However, the corridor's impact on settlement probability within FLMAs increased with dispersal distance, with no evident effect of the corridor for the species with the lowest dispersal capacity. The study emphasizes the limited impact of corridors on species with poor dispersal capacity due to their landscape isolation, highlighting the importance of incorporating dispersal metrics while evaluating corridors. The study advocates for a standardized approach that can be applied across broad scales to evaluate corridors and provide valuable insights for policymakers and planners.

INVESTIGATOR Robert Fletcher

POST-DOC María Eugenia Lezzi, WEC

DURATION July 20203– July 2024

FUNDING USGS (RWO 331)



Nestling snail kite with solar-powered GPS-GSM tag. 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. Our study's 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. Our methods deploy solar-powered transmitters and VHF trackers on Snails Kites fledglings so that we can understand both fine-scale movement, real-time mortality, and behavioral states of individuals. GPS/VHF transmitters were deployed on 30 fledglings from February 13th to June 19th. Of these individuals, 7 individuals were confirmed dead and 8 additional individuals could not be confirmed but are presumed dead, such that 50% (15 of 30 individuals) were assumed to suffer mortality shortly after fledging from nests. Individuals traveled total distances of 858.3 ± 491.9 km and traveled as fast as 88.0 km/h. Birds primarily remained within 1.7 ± 0.9 km of the nest site for 48.0 ± 17.6 days after fledging. Regular attendance of the natal site ceased suddenly at approximately 29.4 — 110.3 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.

INVESTIGATOR Robert Fletcher

STUDENT Meghan Beatty, Ph. D.,WEC

DURATION September 2019– September 2024

FUNDING US Army Corps of Engineers

Snail kite nest in relation to water levels. BRIAN JEFFERY

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

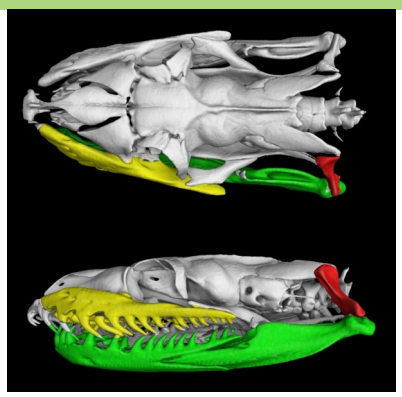
The over-arching goals of this monitoring are to provide reliable information on population size and trends, as well as key demographic, habitat, and foraging information of relevance to the recovery of this species. Demographic analyses revealed that snail kite abundance drastically declined between 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 of 339 active nests with known fates were detected. Of those 145 were successful. We banded 273 nestlings and 251 were observed to have fledged. Overall apparent nest success was 44 (± .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.

INVESTIGATOR Robert Fletcher

STUDENT Lara Elmquist, MS, WEC

DURATION September 2019-September 2024

FUNDING Army Corps of Engineers, South Florida Water Management District, Florida Fish and Wildlife Conservation Commission, St. Johns Water Management District



A CT scan of a skull from a Burmese python captured in southern Florida. Skull features to be assessed for signs of dietary-associated morphological change are highlighted in red (quadrate), yellow (maxilla), and green (mandible).
KODIAK HENGSTEBECK

Invasive reptile adaptations and impacts

Burmese pythons are negatively impacting native wildlife across their range in southern Florida. Pythons in Florida have a broad diet, but the prey species composition 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. Morphological adaptations 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. Relating morphology to prey use over time and space can help predict consequences of invaders on the ecosystem and identify native species at 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. Data collected from >500 python specimens over the last 15 years from across their Florida range 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. We used computed tomography at UF College of Engineering to produce high resolution 3-D digital models of python specimens for detailed morphometric analyses related to this study, and permanently stored these data for future research projects. In 2024, we will also use these methods to assess brown treesnake populations. 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. 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.

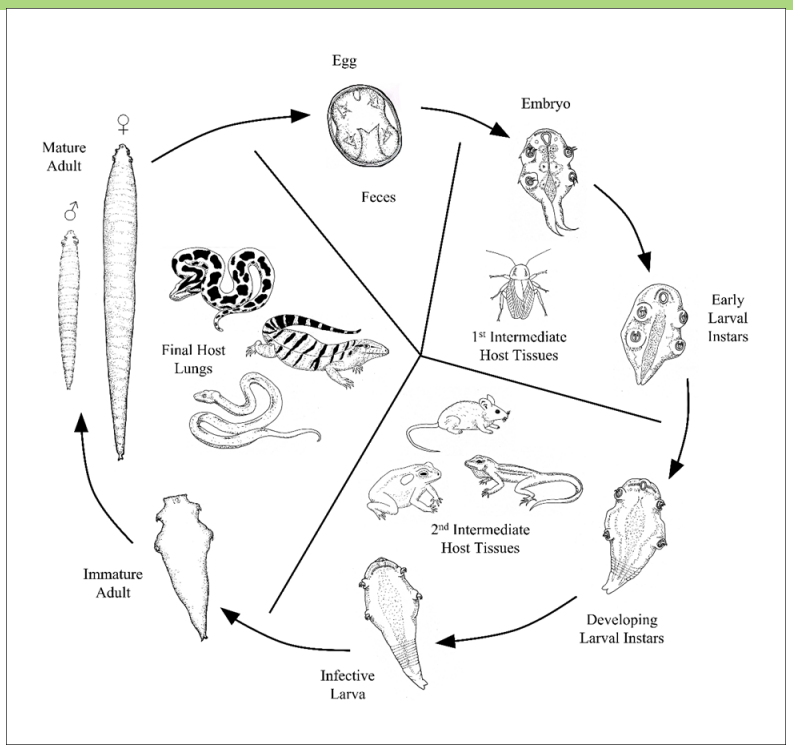
INVESTIGATOR	Christina Romagosa
COOPERATOR	Amy Yackel-Adams
STUDENT	Kodiak Hengstebeck, Ph.D., SNRE
DURATION	September 2019-August 2024
FUNDING	USGS (RWO 310)

Cotton rats and raccoons foraging at giving-up-densities (GUD) patches. Bottom: Decoys presented at GUD patches to assess animal fear response to different predators. UNKNOWN

Understanding Greater Everglades mammal communities adjacent to and within the ARM Loxahatchee

Since its introduction in the 1990s, the invasive Burmese python (*Python molurus bivittatus*) has become a significant threat to Florida's terrestrial vertebrate communities. Despite growing evidence linking pythons to declines in native mammal populations, uncertainties persist regarding the role of behavioral factors in the population declines of native mammals. Notably, prey naivete—the inability of prey species to recognize and respond to cues from novel predators—may play a pivotal role in shaping the vulnerability or resilience of native mammals. Furthermore, our understanding of the broader implications of mammal population declines on ecosystem function remains incomplete. To address these knowledge gaps, we conducted foraging experiments both within and beyond the zone of python invasion. Specifically, we established foraging stations north of the invasion front to assess prey naivete in hispid cotton rats and raccoons, two model mammal species with distinct population responses following the python invasion. To evaluate the potential impacts of python-associated mammal declines on two critical ecosystem functions—scavenging and frugivory—we monitored the efficiency of these processes in areas with and without mesomammals present. Our behavioral experiments revealed evidence of prey naivete in raccoons (a declining species) but not in the hispid cotton rat (a resilient species). Experimental evidence from scavenging and frugivory experiments suggests these processes to be robust to losses in mesomammals. Collectively these findings contribute to a deeper understanding of the python invasion and its diverse effects on species and ecological processes.

INVESTIGATOR	Robert McCleery
STUDENTS	Rebecca McKee, Ph.d., WEC Marina McCampbell, M.S. WEC
DURATION	September 2018-December 2023
FUNDING	USGS (RWO 305)
IN KIND SUPPORT	SFWMD, FWC



Approximate life cycle of invasive pentastome, Raillietiella orientalis, showing transmission between hosts. Illustrated by MADISON HARMAN and ASHELY HAMERSMA

Male pentastome, Raillietiella orientalis. MADISON HARMAN

Analysis of diet and parasites in Florida's invasive tegus

Florida currently has four established populations of invasive Argentine giant tegus, located in Miami-Dade, Hillsborough/Polk, Charlotte, and St. Lucie Counties. As generalist omnivores, tegus represent a threat to many of Florida's native animals. Tegus are also known to vector an invasive pentastomid parasite (Raillietiella orientalis), that was introduced to Florida by Burmese pythons and has spilled over into native snakes. This study aims to (1) document prevalence and infection intensity of pentastomes in Miami-Dade and Charlotte County tegus, and (2) investigate potential influence of habitat, seasonality, tegu size and sex on pentastome infection intensity. We collaborated with the National Park Service, United States Geological Survey, and the Florida Fish and Wildlife Conservation Commission to trap tegus and perform necropsies. We collected pentastomes during necropsies and identified them morphologically. Genetic confirmation of these identifications is under way. We analyzed potential factors influencing pentastome infection intensity using a zero-inflated negative binomial regression. We also spatially analyzed theses data using kernel density estimation and Getid-Ord hot spot analysis.

We collected a total of 504 pentastomes and identified R. orientalis pentastomes in both tegu populations. We also documented at least one other species of Raillietiella that is currently unidentified and awaiting genetic sequencing. Pentastome infection intensity was best predicted by habitat, month, and host sex. Kernel density estimations suggest that pentastome infection intensity was not spatially biased by trapping effort or host density. Local spatial clustering found high pentastome counts in marsh habitats within Miami-Dade County and in mesic flatwoods in Charlotte County. We confirmed that invasive tegus are competent hosts of the invasive pentastome, R. orientalis, and documented substantially higher prevalence in Charlotte county than Miami-Dade. New tegu introductions within or beyond Florida should be assessed for invasive parasites and rapidly removed in order to prevent spread to native snake species.

INVESTIGATOR	Christina Romagosa
COOPERATORS	Andrea Currylow, Amy Yackel Adams, Ben Baiser
STUDENT	Madison Harman, MS, WEC
DURATION	August 2020– August 2024
FUNDING	USGS (RWO 322 and 310)
IN KIND SUPPORT	FFWCC (providing carcasses and data from trap lines in Charlotte County)

Tracking invasive Burmese pythons would not be possible without a large and dedicated intern crew to assist USGS collaborators. This crew is made possible through USGS Research Internship partnership with the University of Florida (via Dr. Christina Romagosa, RWO 322). The 2023 intern biologists and USGS staff pictured above include: [first row, left to right]: Lisa McBride (FORT) and Jose Torres (WARC; both former interns, now USGS Biologists), Adam Nawrocki, Gretchen Anderson (former intern, now FORT USGS Biologist), Carter Haley^, Conor Joye^, Grant McCargar^, Diana Rodas^, Eleanor Lane^, Gabriella Silva^, and Genesis Aponte-Santiago^ (kneeling). [Back row]: Jackie Guzy (WARC PI), Mark Sandfoss (FORT PI, former UF PhD student), and Enrique Ribas. Not pictured are interns Sarah Payne, Derrick Biglin, Amelia Larroque, and John-Kaarli Rentof. Symbols refer to affiliations, (WARC Intern, ^ FORT intern). CHRISTINA ROMAGOSA

Internships and research support for invasive reptiles in Florida

Invasive non-native reptiles threaten southern Florida ecosystems and the native species that inhabit this region. Florida provides an experiential-learning opportunity for interns and students to gain experience and learn about science to inform invasive species management. We have several invasive reptile projects with USGS (FORT and WARC) and partner agencies (NPS, FWC, SFWMD) that focus on their biology, impacts, and control. One such project explores how Scout Snake (radio-tagged pythons) Programs and Python Removal Programs can be used to inform python management and efficacy. Information on life history, demography, and trophic-level impacts of invasive reptiles in Florida is still lacking, and abundance estimates are difficult. This information is critical for population ecology research and to evaluate management efficacy. This work aims to fill information gaps and improve novel modeling methods to infer demographic traits and impacts using radio-tagged pythons, and pythons removed through the FWC and SFWMD python removal programs. Our objectives are to (1) better understand python life history and demography and (2) use this data to investigate the use of novel modeling methods to infer python abundance and trophic impacts. Interns, students, and agency cooperators monitor radio-tagged pythons to collect survival data as well as information on growth, movement, dispersal, and habitat selection. Additional data include diet contents, hormone assays, and reproductive status.

We also use counts of removed pythons and detailed search effort data supplied by the South Florida Water Management District to estimate abundance and detection probability with a robust-design-removal model (led by Ph.D student Daniel Haro). Finally, we took diet data from >1500 pythons and a published pre-invaded food web network to perform ecological network analyses to quantify the python's trophic role in the food web pre- and post- invasion (led by MS student Shelby LeClare, co-advised by Dr. Ben Baiser). Our intern team tracked 30 hatchling and 25 adult pythons in Big Cypress National Preserve, and we are working to estimate the vital rates for these animals. . This work has led to a number of intern-led/authored publications. Blood collected will be analyzed for stress and reproductive hormones by MS student Gabriela Logo. Abundance estimates are still in progress, but preliminary analysis for the robust-design-removal model suggests that search effort has a positive effect on detection probability. We found that pythons function similarly to Largemouth bass, another highly invasive predator that exhibits strong top-down impacts within its aquatic habitats. Pythons primarily affect native mammal populations through top-down predation effects, displacing other top predators within the food web, and altering patterns of carbon flow along the food chain. Invasive species management is a multi-million-dollar burden to the United States and to the Florida government. Without a proper understanding of python demography, abundance, and impacts, the importance and efficacy of costly management programs is not known.

Field, lab, and modeling work associated with these projects would not be possible without our interns and students. Interns and graduate students who have participated in our collaborative research projects have successfully gone on to attend graduate school and/or obtained positions within government agencies. The multi-agency, cross-cutting approach to these projects can help educate young scientists on how to bridge the research-management implementation gap, while giving them the invaluable field, lab, and mathematical experience necessary to excel in their field.

INVESTIGATOR	Christina Romagosa
STUDENTS	Daniel Haro, Ph.D., WEC Gabriela Logo, M.S., WEC Shelby LeClare M.S., SNRE
DURATION	August 2021-August 2026
FUNDING	USGS (RWO 322)
IN-KIND SUPPORT	NPS, housing in Big Cypress

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Flock of Red Knots at Fort DeSoto County Park.
ABBY POWELL

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Zhang, K., C. K. Gulick, Z. S. White, K. Wilson, S. M. Wisely, and A. N. Powell. 2023. Haemosporidian parasites on wading birds captured from breeding colonies in coastal Alabama. Wildlife Disease Association Annual Meeting, Athens, GA, August 2023.

Zhang, Ke, C. K. Gulick, and A. N. Powell. 2023. Infection rates of avian malaria in white ibis and tricolored herons in the southeastern US. Annual Conference of the Waterbirds Society, Fort Lauderdale, FL, October 2023.

Zhang, K., C. K. Gulick, and A. N. Powell. 2023. Haemosporidian parasites in wading birds captured from breeding colonies in coastal Alabama. Florida TWS Meeting, Jacksonville, FL., March 2023.

Zhang, K., C. K. Gulick, Z. S. White, K. Wilson, S. M. Wisely, and A. N. Powell. 2023, Haemosporidian parasites wading birds captured from breeding colonies in coastal Alabama. Annual Meeting, American Ornithological Society, London, Ontario, August 2023.

THESES AND DISSERTATIONS

Tyler Steven Coleman (Ph.D., Fall 2023): Long-term assessment of Florida fisheries amid changing climatic and environmental conditions.

Bethany Gaffey (M.S., Fall 2023): Fisheries in focus: Development of case study videos for online STEM learning.

Stephen W. Parker (Ph.D., Fall 2023): Maximizing Learning Opportunities in Conservation: Gulf Sturgeon Stock Status and Trends. University of Florida, Gainesville, FL.

Jaren-Claude Serano (M.S. 2023): Tidally-driven gas exchange: Effects on loggerhead sea turtle (*Caretta caretta*) hatchling emergence. University of Florida, Gainesville, Fl.

Port St. Joe turtle Patrol Volunteers, Doris Duke conservation scholar: Otto Coleman, WEC MS Student: Jaren-Claude Serano

JAREN-CLAUDE SERANO

Completed Projects

UAS Coastal Surveys for FDACS Hurricane Irma Marine Debris Project. Investigator: Raymond Carthy. Completion Date: July 2023. Funding Agency: NOAA

Endangered Species Act, Recovery Science Support. Investigator: Conor McGowan. Completion Date: August 2023. Funding Agency: FWS

Southwestern and northwestern pond turtle viability analysis to support a species status assessment. Investigator: Conor McGowan. Completion Date: September 2023. Funding Agency: USGS (RWO 319)

Bird conservation classification and assessment for the South-eastern United States. Investigator: Conor McGowan. Completion Date: December 2023. Funding Agency: USUS (RWO 320)

Leatherback entangled in trap buoy.
FWC SEA TURTLE STRANDING AND SALAVAGE NETWORK

Top Left Column: Abby Powell and Andrew Carlson fishing in Tampa Bay. ABBY POWELL

Bottom Left Column: Port St. Joe turtle Patrol Volunteers, Doris Duke conservation scholar: Otto Coleman, WEC MS Student: Jaren-Claude Serano. UNKOWN

Center: Jazmyn Broxton Over the Water Training. JAZMIN CALDERON-MARQUEZ

Top Right Column: Huge Spotted Seatrout. CONOR MCGOWAN

Bottom Right Column: Unit Scientists fishing in Tampa Bay before their All-Hands Meeting in 2023

(L to R Clint Boal, AUL TX; Andrew Carlson ; AUL FL; Anna Chalfoun, AUL MT; Abby Powell, UF FL). UNKNOWN

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