Annual Report
January – December 2015

Meet Our New Unit Leader
Abby Powell

Dr. Abby Powell became the Unit Leader of the Florida Cooperative Fish and Wildlife Research Unit in September 2015. Dr. Powell is an avian ecologist, with special interest in species of conservation concern, wetland-associated species, and migratory connectivity. She moved to Gainesville after 15 years as an Assistant Unit Leader of the Alaska Cooperative Fish and Wildlife Research Unit at the University of Alaska, Fairbanks. While in Alaska, Abby and her numerous graduate students worked on a variety of issues ranging from impacts of environmental change on shorebirds and sea ducks to impacts of expanding populations of gulls and ravens on species of conservation concern. These collaborative studies worked closely with agencies such as US Fish and Wildlife Service, National Park Service, Bureau of Land Management, Bureau of Ocean Energy Management, USGS Alaska Science Center, and NGOs, universities, and private industry.

Prior to moving to Alaska, Abby's work included research on grassland bird communities throughout the Midwest (USGS Northern Prairie Wildlife Research Center) and endangered/threated birds associated with coastal wetlands in southern California (USGS Western Ecological Research Center). Her PhD research (University of Minnesota) focused on techniques to enhance endangered shorebird populations and created the prototype for captive rearing of Great Lakes piping plovers. Abby's M.S. research through the Pacific Estuarine Research Lab (San Diego State University) focused on Belding's Savannah sparrows, an endangered salt marsh endemic.

Abby grew up in New York State. After hitting most regions of the U.S. in her education and research pursuits, she is happy to have landed in Florida. She looks forward to working with graduate students at UF, pursing new and interesting research opportunities, and enjoying time in the sun and on the water. Most of all, she is looking forward to continuing the incredible legacy of research and collaboration established by the scientists and staff of the Florida Cooperative Fish and Wildlife Research Unit.

COOPERATING AGENCIES:

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION
UNIVERSITY OF FLORIDA
U.S. FISH & WILDLIFE SERVICE
U.S. GEOLOGICAL SURVEY
WILDLIFE MANAGEMENT INSTITUTE

RESEARCH MISSION STATEMENT

2015 Photo Contest Winner, Thomas Selby, FL CRU – “Classic Florida”

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

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2015 PROJECT DESCRIPTION

FLORIDA COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT INTRODUCTION

The Florida Cooperative Fish and Wildlife Research Unit was established in 1979 as one of the first combined units. The purpose of the Florida Unit is to provide for active cooperation in the advancement, organization, and conduct of scholarly research and training in the field of fish and wildlife sciences, principally through graduate education and research at the University of Florida. The Florida Unit has the mission to study wetland ecosystems within the state. Florida is a low relief, sub-tropical peninsula that is ecologically fragile. Though abundant, Florida's water resources are under increasing pressure from a burgeoning human population. Domestic, recreational, and development needs threaten Florida's water / wetland resources. In following its program directive, the Florida Unit has developed a research program that addresses management issues with approaches spanning species to ecosystem perspectives. Specifically, this Unit conducts detailed investigations of aquatic-terrestrial ecosystem interfaces and their component fish and wildlife resources.

Between 1979 and 2015, over 300 projects totaling more than $50 million were funded through the Unit. These projects covered a wide variety of fish, wildlife, and ecosystem subjects and have involved over 50 line, affiliate, and adjunct faculty members as principal and co-principal investigators. Unit staff have their own research projects which accounted for about 1/3 of the total effort. Projects associated with the Unit have resulted in over 400 publications, 125 technical reports, 100 theses and dissertations, and 175 presentations. Cooperation has been the Florida Unit's strength. As a Cooperative Research Unit of the U.S. Geological Survey, it serves as a bridge among the principal cooperators, such as the University of Florida, the Florida Fish and Wildlife Conservation Commission (FFWCC), the U.S. Geological Survey (USGS), the U.S. Fish and Wildlife Service (FWS) and the community of state and federal conservation agencies and non-governmental organizations. Evidence of this role is the Unit's funding which has included contributions from FFWCC, 12 BRD research labs and centers, 12 offices within the USFWS Southeast Region, the University of Florida, U.S. Army Corps of Engineers, U.S. Navy, U.S. Department of Agriculture, U.S. Air Force, U.S. National Park Service, Environmental Protection Agency, St. Johns River Water Management District, South Florida Water Management District, U.S. AID, World Wildlife Fund, The Nature Conservancy, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, BRD, Florida Wildlife Federation, National Audubon Society, Florida Alligator Farmers' Association, American Alligator Farmers' Association, Florida Fur Trappers' Association, and other private contributions. Many Unit projects involve multiple investigators from several agencies. This cooperative interaction stimulates continuing involvement of funding sources, provides for student contacts with potential employers and agency perspectives, and directs transfer and application of research results.

UNIT COORDINATING COMMITTEE

Jack Payne- Vice President for Agriculture and Natural Resources, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida.

Nick Wiley- Executive Director, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida.

Kevin Whalen- Supervisor, Cooperative Research Units, U.S. Geological Survey, Roundhill, Virginia.

Cynthia Dohner- Regional Director, U.S. Fish and Wildlife Service Southeast Region, Atlanta, Georgia.

Steven Williams- President, Wildlife Management Institute, Gardners, Pennsylvania.

David Viker- Regional Refuge Chief, U.S. Fish and Wildlife Service Southeast Region, Atlanta, Georgia

BIOGRAPHICAL PROFILES OF UNIT SCIENTISTS

Abby Powell– Unit Leader, Courtesy Professor, Department of Wildlife Ecology and Conservation and College of Natural Resources and the Environment at the University of Florida. Dr. Powell is an avian ecologist, with special interest in species of conservation concern, wetland-associated species, and migratory connectivity.

Raymond R. Carthy – Assistant Unit Leader, Courtesy Assistant Professor, Department of Wildlife Ecology and Conservation and College of Natural Resources and the Environment at the University of Florida. His research centers on ecology of endangered species. His research interests involve reproductive ecology and physiology of coastal and wetland herpetofauna, with current focus on marine and freshwater turtles. He is also involved in research on threatened upland species and in conservation management oriented studies.

COOPERATIVE UNIT PERSONNEL

M. Gay Hale, BA- Administrative Services Specialist II, Florida Cooperative Fish and Wildlife Research Unit, Department of Wildlife Ecology and Conservation, University of Florida. Responsible for administrative details of $3.75M annual research program as well as supervision of staff; student activities, personnel, budgets, research work orders, contracts and grants within University, fiscal reports, travel, purchasing, payables, vehicles (State/Federal), website, and other related functions.

Jen Miller- Fiscal Assistant II, Florida Cooperative Fish and Wildlife Research Unit. She is primarily responsible for purchasing card processes within the University financial system, and the tracking and recording of spent funds on all grants and state funds. She also maintains the database and helps with general office procedures.

COOPERATORS

University of Florida

Amr Abh-Elraham, Robert Ahrens, Michael S. Allen, Karen A. Bjorndal
Alan B. Bolten, Rena Borkhataria, Lyn Branch, Matthew J. Cohen
Robert M. Cubert, Nancy Denslow, Bon A. Dewitt, Catherine Eastman
Robert Fletcher, Peter. C. Frederick, Bill Guiliano, John Hayes
Eric Hellgren, Aaron Higer, Mark Hostetler, Peter G. Ifju
Elliot R. Jacobson, Susan Jacobson, Steven Johnson, Michael Kane
Paul A. Klein, Leda Kobziar, Martha Monroe, Frank Mazzotti
Robert McCleery, Debbie Miller, Madan Oli, Todd Osborne
Elizabeth Pienar, William (Bill) Pine, Carrie Reinhart-Adams, Christina Romagosa
Carlos H. Romero, J. Perran Ross, Maria Sgambati, Coleman Sheehy III
Scott E. Smith, Marilyn G. Spalding, Taylor Stein, Benjamin Wilkinson

Florida Fish and Wildlife Conservation Commission

Joe Benedict, Joan Berish, Arnold Brunell, Janell Brush
Larry Campbell, Cameron Carter, Patrick Delaney, Terry Doonan
Harry J. Dutton, Jim Estes, Rebecca Hayman, Lindsay Hord
Richard Kiltie, Julien Martin, Henry Norris, Tim O'Meara
Stephen W. Rockwood, Scott Sanders, Lawson Snyder, Rio Throm
Zach Welch, Nick Wiley, Blair Witherington, Allan R. Woodward

U.S. Geological Survey

Beverly Arnold, G. Ronnie Best, Jaime A. Collazo, Paul Conrads
Michael Conroy, Donald L. DeAngelis, Robert M. Dorazio, Susan Finger
Kristen Hart, Tara Y. Henrichon, James Hines, Fred Johnson
William L. Kendall, Meg Lamont, Catherine Langtimm, Lynn W. Lefebvre
Cynthia S. Loftin, Elizabeth Martin, Kelly McDonald, Clinton Moore
James D. Nichols, Kenneth G. Rice, Michael Runge, John Sauer
J. Michael Scott, Daniel Slone, Pamela Telis, Kenneth WIliams

U.S. Fish and Wildlife Service

Daniel Barrand, Laura Brandt, Billy Brooks, Pam Darty
Andrew Gude, Stan Howarter, Chuck Hunter, Michael Jennings
John Kasbohm, Mike Legare, Shannon Ludwig, Fred Martin
Lorna Patrick, John Robinetter, Heath Rauschenberger, Sandra Sneckenberger
Paul Souza, Heather Tipton, Paul Tritaik, Russell Webb
Kathy Whaley, Larry Woodward

U.S. Army Corps of Engineers

Kristin A. Farmer, Michael T. Hensch, John K. Kilpatrick, Jon S. Lane
Jon M. Morton, Gina Ralph, Glenn G. Rhett, David J. Robar
Adam N. Tarplee, Damon A. Wolfe, Victor L. Wilhelm

St. Johns Water Management District

Roxanne Conrow, Mike Coveney
Steven Miller, James Peterson

U.S. Air Force

Bruce Hagedorn

U.S. Parks Service

Bob Miller

University of Central Florida

Dean Bagley, Llewellyn M. Erhart
Ross Hinkle, Marshall Tappen
Betsy von Holle, John Weishampel

University of Idaho

Janet Rachlow

Idaho Fish and Game

Pete Zagar

Boise State University

Jennifer Foorbey

Washington State University

Lisa Shipley

University of West Florida

Phillip C. Darby

National Park Service

Leonard Pearlstine

South Florida Water Management District

Christa Zweig

Others

Russell Hall, Tommy C. Hines

Research Personnel 2015
(Names in red are supervised by Powell and/or Carthy)

Post-Doctoral Associates:

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

Chris Cattau, PhD
Supervisor: Rob Fletcher
Research: Comprehensive Assessment of Spatially-Explicit Demography on Short- and Long-Term Snail Kite Population Growth in the Greater Everglades

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

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

Alvina Mehinto, PhD
Supervisor: Nancy Denslow
Research: Genomic Analysis of Peripheral Blood Cells from Sturgeon Exposed to Oil and Oil-Related Chemicals

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

Brian E. Reichert, PhD
Supervisor: Robert Fletcher
Research: Snail kite monitoring of population demographics; exploring senescence and other aspects of survival.

Research Associates:

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

Brian Jeffrey, MS
Position: Wildlife Biologist/Alligator Project Manager
Research: Endangered snail kites

Brail Stephens, MS
Position: Wildlife Biologist/Supervisor
Research: Sea Turtle & Escarpment Monitoring, Loggerhead Nest Content Collection, Marine Debris

Graduate Students:

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

Matthew Burgess
Degree: PhD, Wildlife Ecology and Conservation
Graduation Date: December 2015
Research: Collection of Digital Serial Imagery in Support of Aquatic Invasive Species Program and CERP
Advisor: H. Franklin Percival and Ray Carthy

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

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

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

Nia Haynes
Degree: PhD, Wildlife Ecology and Conservation
Graduation Date: December 2015
Research: Effects of Coastal Dynamics and Climate on Loggerhead Turtle Nest Success and Management
Advisor: Susan Jacobson

Kodiak Hengstebeck
Degree: MS, Wildlife Ecology and Conservation
Graduation Date: December 2016
Research: Assessing impacts of invasive pythons on gopher tortoises in Florida
Advisor: Christina Romagosa

Jame McCray
Degree: PhD, Wildlife Ecology and Conservation
Graduation Date: August 2016
Research: Wildlife legislation and management in Florida: Sea turtles, a test case for creating effective policy
Advisor: Susan Jacobson and Ray Carthy

Jessica Swindell
Degree: M.S., Wildlife Ecology and Conservation
Graduation Date: May 2015
Research: Human Dimensions of Sea Turtle Conservation
Advisor: Ray Carthy and Holly Ober

Caroline Poli
Degree: PhD, School of Natural Resources and the Environment
Graduation Date: August 2019
Research: Spatial Ecology and Population Biology of Snail Kites
Advisor: Robert Fletcher

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

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

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

Adia Sovie
Degree: MS, Wildlife Ecology and Conservation
Graduation Date: August 2015
Research: Translocation of Marsh Rabbits to Everglades National Park
Advisor: Robert McCleery

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

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

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

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

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

Technicians:

Thomas Bacher
Jeffrey Beauchamp
Laura Brandt
Andrew Bro
Michelle Budney
Sarah Burton
James Camp
Rafael Crespo
Elizabeth Dancer
Ryan Deibler
Mathew Denton
Lauren Diaz
Sarah Dudek
Seth Farris
Kirk Gastric
Caitlin Hackett
Emma Hanslowe
Whitney Haskell
Rodney Hunt
Michelle McEachern
Andrew Marx
Ed Metzger
Andre Revell
Charlotte Robinson
Michael Rochford
Adam Rosenblat
David Seay
Danielle Sims
Michiko Squires
Austin Waag
Bradford Westrich
Sara Williams

Doris Duke Interns:

Alex Cronin
Nadia Kemal
Jaclyn Selden
Adreenah Wynn
Xue "Jackie" Zhang

Year 2:
Jeanette Brisbane
Megan Ely
Charmaine Pedrozo
Monica Quintiliani
Sharmin Siddiqui

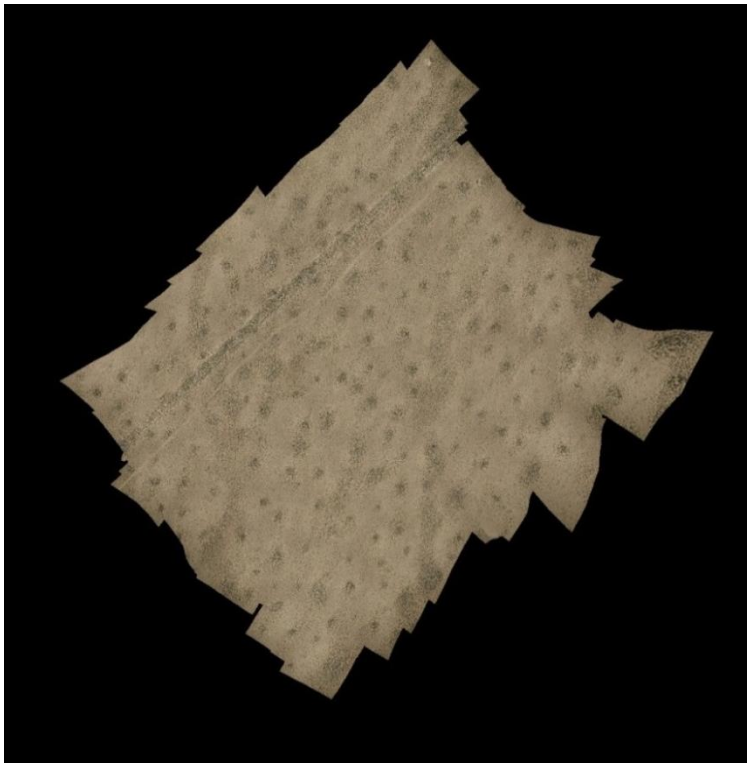
Current Projects

Cooperative Research

Modeling the tradeoffs within Food, Fear & Thermal Scapes to explain habitat use by mammalian herbivores

Principal Investigator: Raymond Carthy
University of Idaho Principal Invstigator: Janet Rachlow
Funding Agency: NSF/University of Idaho
Expected Completion: 12/31/2015 (UF PJ#00108818)
Graduate Students: M. Burgess

The University of Idaho (UI), Boise State University (BSU), and Washington State University (WSU) have been working under a cooperative agreement with financial support from the United States Bureau of Land Management and the National Science Foundation to conduct research aimed at better understanding the habitat and ecology of the endangered pygmy rabbit (*Brachylagus idahoensis*). As part of this research, the group has collaborated with the University of Florida (UF) Unmanned Aircraft Systems Research Program to conduct low-altitude flights over sagebrush-steppe habitats using a small unoccupied aircraft to collect digital imagery to address several goals of the remote sensing portion of the research. One goal is to capture high-resolution digital images that can be used to measure the concealment of rabbits from predators which is provided by the sagebrush species. Another goal is to collect digital aerial photographs that may help indicate the quality of various sagebrush species as food resources for pygmy rabbits. As part of the effort to understand the animal's habitat needs, the work aims to create maps of habitat quality that will be matched with patterns of habitat use by the animals. The first mission took place during June 2013, and a second mission in January 2014. The flights within each mission will be used to compare vegetative concealment and diet quality between summer and winter seasons.



Among the interesting potentials of UAS imagery of endangered pygmy rabbit habitat in Idaho is habitat analysis. Note in this mosaic of a small portion of the Cedar Gulch, ID study area that vegetation density appears to be measurably different on the higher elevations of the naturally occurring mounds and the abandoned railroad bed in the image. The UF SFRC Geomatics program and Idaho collaborators are working toward digital soultuions to measuring extents and differences of sagebrush habitat as well as more precise 3D solutions to image interpretation.

The summer mission conducted in June 2013 at two research study sites in Idaho resulted in a total of nine flights (five in the visible color spectrum, and four in the color-infrared spectrum). The four days of fieldwork yielded a total flight time of six hours and 19 minutes; just over 42 minutes per flight on average. During the nine flights, 8,534 total ≈10 MP .jpg images were captured, occupying 42.5 GB of digital drive space. The imagery collected covered roughly 115 Ha of targeted

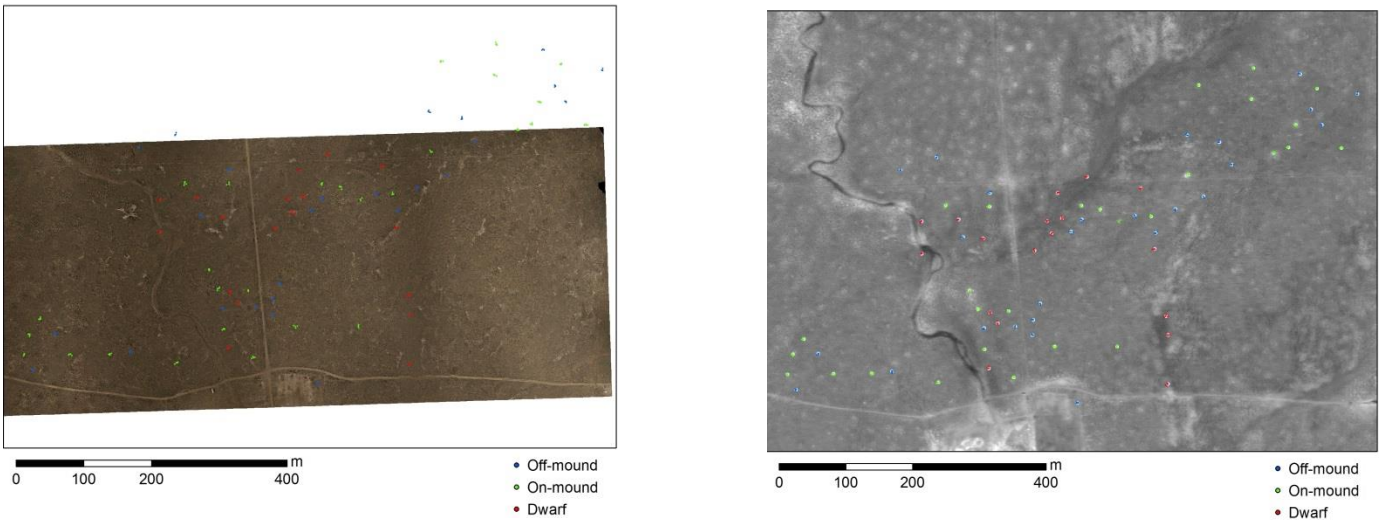
sagebrush-steppe habitat, and had a ground resolution of approximately 2.3-2.5 cm/pixel. The UFUASRP learned a tremendous amount of information about the Nova 2.1 aircraft performance during these flights as this was the first time the aircraft had been flown over an area with ground-level altitudes significantly higher than sea level. Flying at an effective altitude of 10,000 ft (considering actual altitude and record breaking high temperatures) was a challenge and we learned that minimally a longer propeller (17 as opposed to 15 inches) is required for the plane to operate satisfactorily In addition, the auto-land feature of the autopilot had been in use prior to last summer 2013 flights. It was deployed necessarily and successfully on each of the nine landings. The only possibility for landing was a rocky, two-rut road carved through sagebrush. Consistently landing a plane with a nine-foot wingspan on a 12 foot wide runway by remote control would not have been possible.

The UF UAS team was at home in record high temperatures in June in Idaho. In January, Idaho collaborators equipped the Gators with gaiters and taught them the difference between a balaclava and baklava.

The winter mission conducted January 2014 at three sites resulted in 12 flights (all visible color) and additional 11, 379 images covering over 150 Ha of habitat and occupying 56.7 GB of digital hard drive space. Having improved auto-landing and operating at higher altitudes, there were other challenges. Extreme cold and its effects on batteries, other mechanical components, and Floridians were predictable. Idaho collaborators provided some resolutions in advance and the entire team improvised in the field to accommodate a successful mission. The new challenge of flying an additional study area having mountains on 3 sides required many hours of extra programming of the autopilot to accommodate tighter turns to both avoid hitting the mountains and achieve level, straight flight by the time the plane returned over the target area.

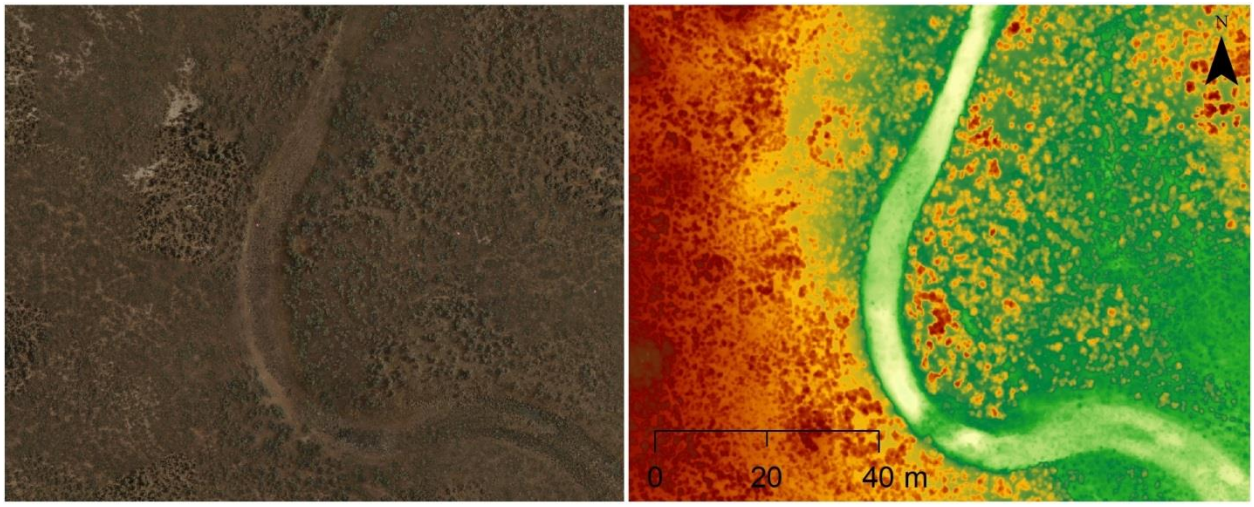
Fortunately, the software for post-processing aerial imagery has recently and dramatically improved. Visible spectrum imagery mosaics were of good quality, and since December 2013, the products are considerably better. As the software and computing power continue to improve over the next few months, the imagery mosaics produced should be even more remarkable. Future analyses of the imagery will include mosaicking the color-infrared spectrum imagery, and superimposing those mosaics on and off the visible-spectrum mosaics. Additionally, three-dimensional digital surface models constructed using two-dimensional imagery by the post-processing software will be utilized for comparisons to ground-based models constructed from terrestrial-based data that were simultaneously collected during the summer 2013 field season. Collaborators from Boise State University, Washington State University, University of Idaho, and UF are all using the data in different manners.

This project reached the end of its contractual date during this reporting period, and a final report was delivered to the collaborators by 31 December 2015. The raw data and imagery collected from this project was delivered to the collaborators, and UFUASRP undertook the development of post-processed imagery products. Further analyses of the datasets by UF and our collaborators is ongoing.

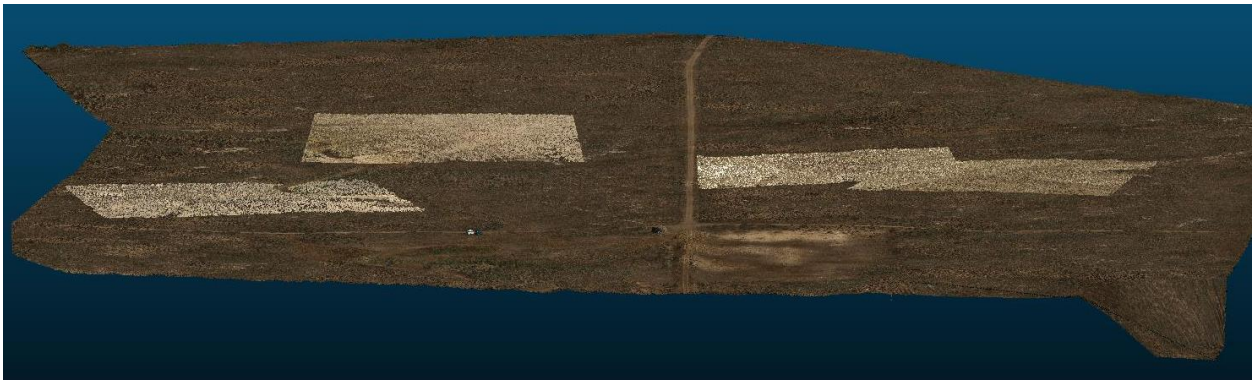


Patches from sample strata over UAV data (2.5cm-resolution, left) and NAIP NDVI (1m-resolution, right).

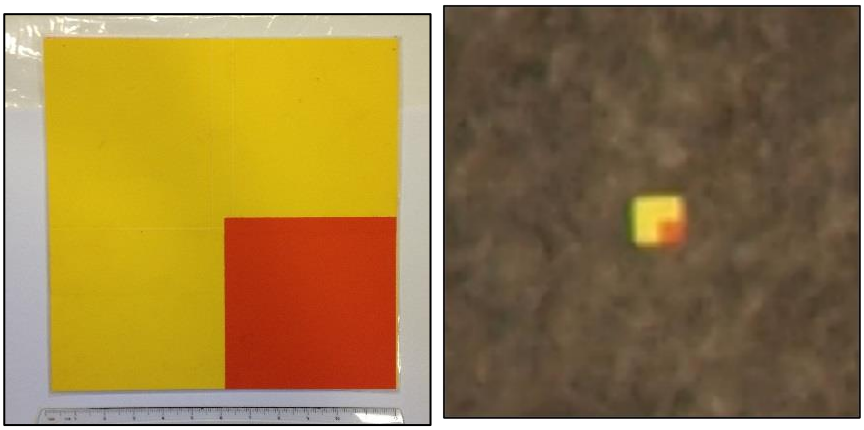
For NAIP: possibility to scale classification of low patches (dark areas) and mounds (bright spots) to areas where we don't have UAV data.



Close-up of UAV imagery (left) and digital surface model (right), showing potential for classification of shrubs for food types and cover. [M.A. Burgess, UF]



Point cloud/digital surface model with TLS scans on top (whiter areas). [J. Lonneker, UI]



Ground control points (coverboards) used to help assess pygmy rabbit concealment by sagebrush, and to aid in post-processing the aerial imagery into mosaics. [M.A. Burgess, UF]

Testing natural resource applications using a small unmanned aircraft system

Principal Investigator: Raymond Carthy
Funding Agency: USGS
Expected Completion: 2/28/15 (RWO#284, UF PJ#00102993)
Graduate Students: M. Burgess

The need for cost-effective monitoring of wildlife populations and habitat is common to natural resource managers in state and federal agencies as well as NGOs. The University of Florida Unmanned Aircraft Systems Research Program (UFUASRP) was the first in the United States (US), and possibly the world, to custom design a small Unmanned Aircraft System (sUAS) explicitly for natural resources assessment and monitoring. After 12 years of development the UFUASRP is currently working with its fifth-generation of sUAS, the Nova 2.1. The Nova 2.1 has significant advantages in portability, ease of use, and mission flexibility when compared to larger Unmanned Aircraft Systems (UAS) and differs from other sUAS in that the latter focus on intelligence, surveillance, and reconnaissance whereas the Nova 2.1 is a precision natural resources surveying tool. Of the remaining hurdles for deployment, the most important is testing applications of the tool with state of art statistical and analytical techniques. In addition, FAA regulations limit the use of UAS in scope and scale as well as user requirements. We investigate practical tools to overcome some of these requirements.

OBJECTIVES

1) Assess the potential advantages and limitations of the UF Nova 2.1 sUAS as a scientific tool to augment and assist in existing natural resource data collection and estimation efforts.

The evolution of the Nova 2.1 was spawned by rapid technological developments such as miniaturization of digital cameras, new frontiers in battery and materials technology, and the rapid development of high capacity memory components. While this has meant many teams are developing UAS worldwide, the UF effort has always been driven by the desire to solve specific ecological questions. Now that the Nova 2.1 is aeronautically and

electronically stable, the next big frontiers are image postprocessing, machine learning, image recognition, novel statistical techniques, and application driven adaptations.

The Nova 2.1 is beginning to be deployed in a variety of real world applications. The repeated overlay capability has already provided a handy, quantitative solution to a long standing problem of estimating turnover in colonial nesting birds. Florida Coop Unit faculty and students have also teamed with the University of Idaho to evaluate fine scale characteristics of pygmy rabbit habitat, and estimate burrow density. In collaboration with Idaho Fish and Game, the UAS will be used to estimate Chinook salmon redd density in relation to habitat characteristics, and to estimate white pelican colony size. Computer scientists and ecologists and the University of Central Florida will be using UAS data to estimate nesting sea turtle population size and to differentiate beach tracks of loggerhead, green and leatherback turtles. CEMML (Colorado State University) is teaming with UF to assess waterbird distribution and abundance at the Patuxent Naval Air Station. The Mote Marine Laboratory in southwest Fl will use UAS data to estimate abundance and size class distributions of assemblages of rays near Sarasota. The USGS Southeast Ecological Science Center and FL Fish and Wildlife Conservation Commission are collaborating to provide novel statistical techniques for estimating abundance from UAS data.

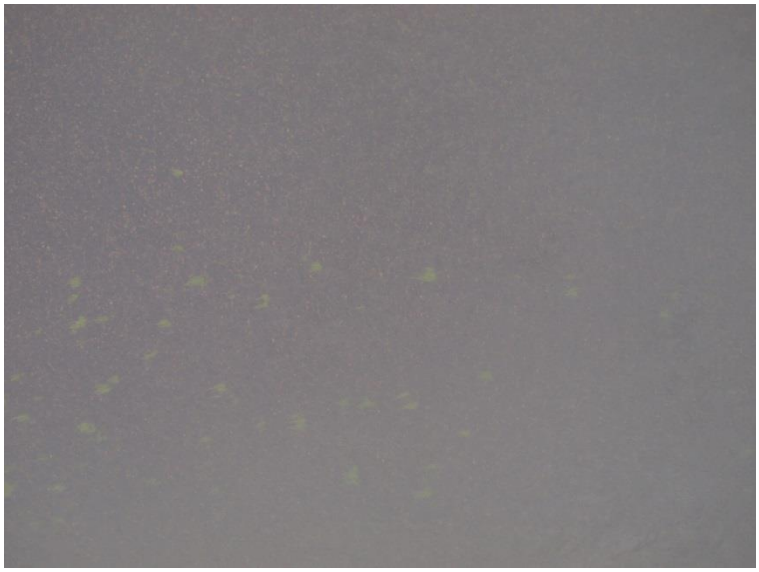
UAS have huge potential as a tool to fill the gap between a biologist on the ground with a pair of binoculars, and satellite imagery. The examples above illustrate that UAS also have the ability to provide wildlife ecologists not just static images, but highly accurate and repeatable GIS products. This opens the door to investigations at a novel and extremely appropriate geographic scale for wildlife, and the ability to produce statistically robust results. When coupled with the ability to fly in remote areas dangerous for manned aircraft, and remove human safety from the picture, UAS could turn out to be as important to ecologists and managers as satellite imagery has been.

2) To test the photogrammetric parameters of the UF Nova 2.1 optical payload deployed on a Cessna© 172-model Skyhawk™.

A limitation of sUAS technology is its range and deployment in situations where sample points or targets of interest are widely separated. Examples are surveys of manatees (Trichechus sp.) at warm-water refugia or salmon (Oncorhynchus sp.) redd surveys in the Snake River, Idaho/Washington. The targets may be separated by scores of miles within a range of their 150 mile or greater extent and must be surveyed within a small temporal window. The sUAS might deliver very appropriate data but logistics obviate their use over such a large extent. The Nova 2.1 payload on a manned aircraft might deliver data that are far superior to ocular estimates of human observers, and also eliminate the need for trained observers in the manned aircraft. The photogrammetric solutions might vary from that of the Nova 2.1 because of the difference in the high-precision of programmed flight plans of the sUAS versus that of a human-piloted aircraft. UF's aeronautical engineers produced drawings and constructed an aluminum box of aircraft standards to contain the Nova 2.1 payload. In 2011-12, we worked with a local FAA Designated Engineering Representative to secure a FAA Supplemental Type Certificate for attaching the box to a Cessna 172M owned by our collaborator, Avian Research And Conservation Institute (ARCI) . Subsequently we have gained approvals for attachments to a Bell 407 helicopter (courtesy of South Florida Water Management District) and a Bell 206 helicopter (courtesy of Hillcrest Aviation, Lewiston, ID, Idaho Power and Light C., Idaho Fish and Game).

The UAS payload has been installed with FAA permissions in a Cessna 172 M (Avian Research and Conservation Institute), a Bell 206 helicopter (Hillcrest Aviation, Inc), and a Bell 407 helicopter (South Florida Water Management District).

All of these attachments proved to be aeronautically and photogrammetrically unobtrusive. There was no interference with flight characteristics of the aircraft. Attachments provided a clear nadir view for the camera, there was no vibration to affect the imagery, and satellite reception was adequate for the GPS. The technique holds great promise especially when used for transects. Our current payload fires too slowly for the greater airspeed of all the aircraft tested plus resolution (10 mp) suffers above 200m for some applications. Our team currently is working on a new payload which promises to have smaller intervals between shutter openings and 18 mp images. More detailed analyses of imagery taken over a great blue heron colony (Cessna 172), salmon redds (Bell 206), Everglades habitat and wading birds (Bell 407) are currently being accomplished. We will have opportunities in 2014 to test all 3 aircraft with the new payload.



Chinook salmon redds in the Snake River, ID are clearly visible in imagery taken from the Bell 407 attachment of the payload box to a cargo basket.

3) To test the efficacy of deploying "day" pilots for the UAS ground crew. Among many FAA regulations for sUAS field deployment is the requirement for three

individuals as a ground crew: a UAS pilot, a ground station operator, and a qualified visual observer to constantly search for potential aircraft incursions. In addition the sUAS pilot must possess at least a current private pilot's license and a Class II Medical clearance. Maintaining manned pilots on payroll is a complication in addition to considerable expense in most situations. We tested our ability to employ a pilot dually trained in flying remote control and manned aircraft on an as-needed daily basis. Our pilot is certified to pilot multi-engine and single engine aircraft and has a commercial pilot's license. Those certifications are far in excess of the requirement. The pilot successfully gained competence in first computer remote control (RC) flight training, small off the shelf RC aircraft, and finally the Nova 2.1. His personal schedule is such that we have been very successful in scheduling his time to match our needs. As long as that requirement exists, we believe that an operational program can definitely benefit from such an arrangement. The pilot familiarity with FAA regulations also has been instrumental in more effectively gaining the Supplemental Type Certificate for the Cessna 172, submitting NOTAMS prior to flights, and submitting COA requests. The FAA has gained increasing confidence in our ability to work within their guidelines. We believe that our pilot's IFR competence as well as the addition of a transponder to our aircraft will enable us to fly in some sites heretofore unavailable to us.

This project has ended and a final technical report is currently being prepared in manuscript form as part of a doctoral dissertation. Within the framework of small unmanned aircraft systems (sUAS) as a tool in addressing questions based in natural resources, the UF Nova 2.1 fixed-wing sUAS, and sUAS in general, have both abilities and limitations as scientific tools to enhance and assist in natural resources data collection. The manuscript will review the efficacy of deploying sUAS "day" pilots as flight team members for data collection in natural resources based on multiple years of fieldwork experience, as well as examine the utility of outfitting specific manned aircraft with high-resolution, low-cost digital imaging payloads as a technique to augment existing visual-based methods of aerial censusing and analyses through photogrammetric means.

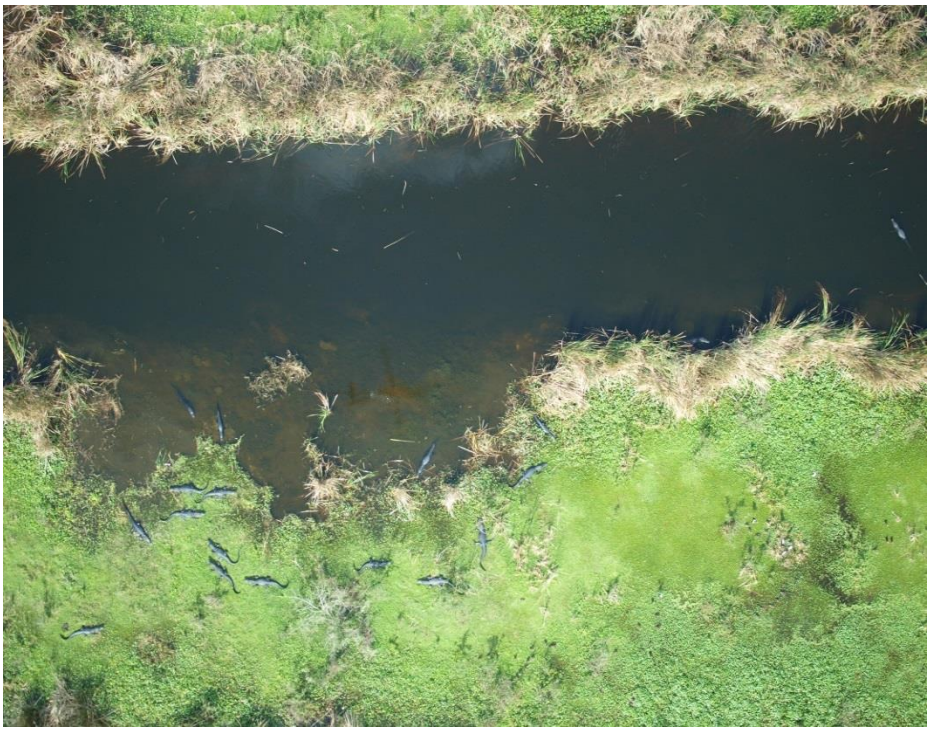


Image from low level flight of the South Florida Wildlife Management's Bell 407 equipped with the UAS payload mounted on the step. Features such as altitude, gps location, transect width, and alligator length, are measureable in the geo-referenced image.

Small Unmanned Aerial Systems for Wildlife Management and Habitat Assessment

UF Principal Investigator: Raymond R. Carthy
Colorado State University Principal Investigator: Lee Barber
Funding Agency: DOD/Legacy
Expected Completion: 05/31/2015 (UF PJ#00104660)
Graduate Students: M. Burgess

The collection of aerial imagery from small Unmanned Aircraft Systems (sUASs) flying at low altitude within strictly restricted airspace at the Patuxent River Naval Air Station (PAX NAS), Webster Field, and the Bloodsworth Island Naval Gunnery Range provides an installation-specific response to these challenges, demonstrating a "civilian" application of proven military technology using an approach that is applicable to all military installations with restricted airspace. The UF sUAS platform, Nova 2.1, has a payload which records low-altitude, high-resolution, precision-georeferenced aerial imagery. These data will be collected and analyzed to provide decision support to airfield and range operations. Objectives include mapping canopy heght and vegetative cover for forested and scrub –shrub wetlands and to delineation of uplands that might exist within those wetlands at Webster Field; evaluating the effectiveness of an sUAS for estimating the number of nesting birds within the great blue heron (*Ardea herodias*) rookery on Bloodsworth Island at a specific point in time , evaluating the effectiveness of an sUAS for estimating winter populations of migratory waterfowl at a specific point in time at selected areas within or adjacent to Bloodsworth Island to inform Bird Aircraft Strike Hazard (BASH) assessments and predict environmental impacts of aviation operations, define specific survey methodologies to serve as a foundation for use of sUASs on other military installations to provide scientifically defensible, statistically valid wildlife population estimates and vegetation mapping as an alternative to less rigorous wildlife counts and rapid habitat assessments.

The PAX NAS, Webster Field and Bloodsworth Island are extremely busy military operations and also within the influence of the airspace managed for Washington, DC. Our sUAS and operation are smaller than to which PAX NAS is accustomed. Military and civilian operations at PAX NAS and Webster Field have been most accommodating. We have an excellent collaborative relationship with the Center for Environmental Management of Military Lands, Colorado State University. The US FWS Blackwater National Wildlife Refuge has been gracious in providing logistical support for our flights at Bloodsworth Islands. This project has been officially completed. The UFUASRP completed its final report to the funding agency, DoD/Legacy, indicating that from our experience, the use of civilian sUAS to address natural resources-based scientific questions over military lands was extremely difficult primarily due to regulatory hurdles, inefficiency of collaborative efforts caused by lack of personnel continuity during periods of active military deployment, and multiple recurring instances of miscommunication, and overall difficulty in obtaining high level support at installations.

Monitoring vegetation change and wildlife use of Active Marsh Improvement sites

Principal Investigator: **H. Franklin Percival, Ray Carthy**
Funding Agency: SFWMD
Expected Completion: 02/28/15 (UF PJ#00117049)
Graduate Students: M. Burgess

Ongoing active marsh improvement (AMI) projects in Water Conservation Area 2A have restored areas that were once monoculture cattail into open sloughs that are now well established foraging sites for wildlife. On-the-ground vegetation transects and wildlife counts have been collected, but to date, the absence of spatially explicit vegetation and wildlife data make it difficult to establish connections among habitat, wildlife foraging and populations. Spatial and temporal data collection of low-altitude, high-resolution imagery could be an important tool for both wildlife population estimation and fine-scale vegetation mapping. However, the scope of work and date of completion for this project was modified when the original objectives became unfeasible, primarily due to insufficient water levels at the field sites. The project is now focusing on analyses of data collected as part of the UF/SFWMD "Box" project (see Project #118866). Emphasis on developing a workflow for imagery post-processing using current computer-based software tools is now a primary product. Specific ecological and restoration questions will be addressed based on statistical analyses of post-processed imagery collected by the District using hardware systems developed by the UFUASRP.

Low-altitude imagery to assess vegetation density, vegetation health, and wildlife use of the stormwater treatment areas

Principal Investigator: **Ray Carthy**
Funding Agency: SFWMD
Expected Completion: 09/30/16(UF PJ#00118866)
Graduate Students: M. Burgess

Vegetation is one of the primary mechanisms in Everglades Storm Water Treatmentt Areas (STA) phosphorus removal, either through physical and hydraulic resistance that helps with particulate settling, direct phosphorus uptake and eventual burial, or by providing a surface for periphyton and microbial colonization and activity. Previous studies suggest that the mode and scale of net phosphorus removal differ between emergent aquatic vegetation (EAV) and submerged aquatic vegetation (SAV) cells, particularly by phosphorus species, as different forms tend to accumulate in different vegetation communities. Surveys conducted to date have been limited to high altitude aerial flights (at ~13,000 ft) and limited spot ground surveys for SAV relative density. While imagery acquired from these high altitude flights has been useful in estimating coverage of EAV in STA cells, it does not allow for assessment of SAV coverage, density, or condition. In addition, high altitude flights are limited to fully clear weather condition. More frequent and lower altitude aerial vegetation surveys are needed to make more meaningful assessment of the influence of vegetation type, species, coverage, density, condition, and tissue composition on short-term and long-term phosphorus removal and transformations at a fine-scale resolution. As a project within Restoration Strategies, the focus is on the influence of spatial configuration of vegetation communities (community composition, coverage, density, health, stability, etc.) in flow-way P reduction performance and to better evaluate wildlife contributions/reductions of P in the STAs.
The University of Florida's Departments of Wildlife Ecology and Conservation, Forest Resources and Conservation, and Mechanical and Aerospace Engineering (University) have successfully designed and have been utilizing a camera payload in unmanned aircraft (UAS). In both October 2013 and January 2014, the University's UAS team worked cooperatively with District scientists and pilots to test the same payload using the District's helicopter.

Both tests were successful in testing the payload's ability to capture imagery for detailed plant species identification (including spatial coverage of SAV species, which was not previously possible) and wildlife surveys (waterfowl, wading birds, alligators, turtles, and pythons). Because of this, the District's scientists plan on using this technology for a five-year study on Evaluating Phosphorus Sources, Flux, and Transformation Processes in the Stormwater Treatment Areas. In addition, the same equipment can be made available for other studies or other assessments within the STAs or other areas.

The University built and delivered two aerial imagery camera payloads for dedicated District use. Each payload included: 18-megapixel, off-the-shelf digital SLR, one camera with infrared capability, a GPS-aided Inertial Navigation System that collects spatial position and pitch, roll, and yaw of the camera at the time the photo is taken to capture and geo-reference the data, a custom on-board computer to interface data, and an aluminum box to house the payload contents for proper mounting on the District helicopter. The equipment is currently being deployed and each payload unit is being tested. Additionally, the University of Florida Unmanned Aircraft Systems Research Program (UFUASRP) provided several trips of multiple-day, 'hands-on' instruction for operation, troubleshooting, and routine maintenance of the physical deliverables to supplement written documentation that was also delivered. Since the delivery, the UFUASRP has provided remote troubleshooting of several minor issues via phone, email, and shipment of replacement parts. The UFUASRP will be fine-tuning and upgrading the payload systems and imagery collected from a UF/ SFWMD "Box on a strut" project will be used to help generate data deliverables.

The District already has a license for the software required to generate hydro-ecological data from the imagery.

The camera payload will allow the District to acquire high-resolution, spatial vegetation data for use in Restoration Strategies. These data will be used to determine how vegetation communities and spatial configuration affect phosphorus retention, and to provide spatial vegetation data for other sub-sections of this project. As an added benefit, this technology can and will be used in other projects critical to the District's mission: Active Marsh Improvement, Decomp Physical Model, invasive exotic management, STA monitoring, emergency management, and operations (levee/structure inspections).

To Advance, Test and Quantify Unmanned Aircraft System Capabilities for the US Geological Survey

***Principal Investigator**:* H. Franklin Percival, Ray Carthy
***Co-Principal Investigator(s)**:* Peter Ifju, Benjamin E. Wilkinson and Scot E. Smith
Funding Agency: USGS
Expected Completion: 7/31/2016 (RWO#290, UF PJ#00116529)
Graduate Students: M. Burgess

The University of Florida Unmanned Aircraft Systems (UF UAS) Group, consisting of faculty and students from the Mechanical and Aerospace Engineering Department, the Wildlife Ecology and Conservation Program, and the Geomatics Program propose to develop and field test an unmanned aircraft system specifically tailored to the requirements of the US Geological Survey UAS Program (USGS UAS). The goal of the USGS UAS is to support the integration of UAS technology into the process employed by USGS scientists to support informed decision making across the Department of the Interior. It has worked closely with other agencies and academia in support of common interests in this emerging technology. The Dept. of the Interior acquired Raven-A fixed wing and T-Hawk rotor wing small UAS systems which had been retired from the Department of Defense. USGS has acquired numerous Certificates of Authorization (COA) to conduct proof-of-concept projects in many parts of the United States. They also have trained several teams of scientists to conduct such missions addressing DOI objectives within geology, fish and wildlife biology, mining, and related natural resource disciplines. The USGS UAS desires to advance their technological capabilities beyond the Raven A and T Hawk.

The UF UAS has worked more than 14 years producing several sUAS models prior to its current Nova 2.1 (Figure 1), the only UAS developed specifically for natural resources applications. The small unmanned aircraft is completely battery powered, weighs 14 pounds fully loaded, and has a nine-foot wingspan. The aircraft is hand-launched and flown over the target study area autonomously by a qualified three-person crew: 1) a FAA-rated manned aircraft pilot; 2) an experienced ground control station operator; and 3) a qualified visual observer. Each crew member also has Class G medical certification. Each of the flight crew members has specific duties during a flight, and should the need arise; manual control of the aircraft can be instantly obtained to mitigate any unplanned situations. A plethora of failsafes are also incorporated into the autopilot system to safely recover the aircraft if necessary. The Nova 2.1 was specifically designed at the University of Florida as an affordable mapping-grade aerial imagery-collecting platform for ecological and natural resources-oriented studies. Once airborne, the Nova 2.1 can be programmed to fly any number of routes. For example, when mosaiced images of a study area are desired, the Nova 2.1 can fly parallel transects over a target study area to ensure complete ground coverage imagery for 60 minutes at a time. After an area has been thoroughly photographed, and the battery voltage gets below a specific threshold, the aircraft proceeds to a predetermined rally waypoint downwind, then begins a controlled descent spiral, and autonomously lands itself into the prevailing wind at a predetermined waypoint on the ground. The UAS also can be programmed to fly alternative routes to supply individual or smaller mosaics of repeated or random samples.

The FAA has established (and continues to roll out) a rigorous protocol for operating UAS in the National Airspace. For the size and weight class that corresponds to our UAS platforms the FAA requires that a Certificate of Authorization (COA) be established through theto fly autonomously. Only a handful of universities in the United States have been granted COAs by the FAA. The University of Florida has been granted over 14 COAs over the past two years. Airworthiness certification was issued to the Nova 2.1 by the US Army Redstone Arsenal. Although our airworthiness has expired, the Jacksonville District continues to operate under an airworthiness certificate on a commercially built UAS which is essentially the Nova 2.1. We also are granted permission to fly within the US Navy airspace of Webster Field and Bloodsworth Island Naval Gunnery Range this summer. The COAs under which the UF UAS operates permits low-altitude (<366 m above ground level) flight over isolated and unpopulated areas within one nautical mile radius of the ground control station. The prototype aircraft produced under this contract will be designed to operate within FAA guidelines in various environmental and geological features across the US.

The UF UAS has a track record of developing prototype and production aircraft for survey purposes. We developed the NOVA 2.1 which is still utilized by the Army Corps of Engineers to conduct vegetation and infrastructure studies. That aircraft went into production through a company called Altavian in Gainesville, FL. Patents from intellectual property developed in our lab are also licensed by Prioria Robotics who produces a small UAS called the Maverick. Other spin-off UAS companies include Innovative Automated Technologies and System Dynamics International, both Gainesville based companies.

Figure 1. The NOVA 2.1 can be hand launched and landed on land or water.

The USGS UAS goal is production of a protoypye fixed-wing sUAS e designed to be hand launched, amphibiously landed and carrying a payload suite consisting of a high resolution digital still camera, multispectral camera, and an infrared sensor. Such a payload in a sUAS is now not known to exist as a prototype and certainly a production model. The sensor package will be integrated with an on-board inertial measurement unit (IMU), computer and sync module to synchronize the acquisition of the sensors with the metadata from the IMU, thus allowing for accurate direct georeferencing of the sensor data. Data are to be stored on-board and downloaded between flights. Since all instruments are to be employed simultaneously on one aircraft and all must be accurately positioned with respect to the IMU, a sensor support structure will be designed and implemented.

The aircraft will then be designed to accommodate that support structure. This support structure will also serve to protect the instruments during hard landings. As a result of the form-factor for the instruments/support structure, our existing NOVA 2.1 will need extensive modification in order to accommodate the increased size and weight of the payload. The sensor package will be designed first, then the support structure, then the aircraft. It is anticipated from initial calculations that the overall weight will not vary significantly from that of the NOVA 2.1; therefore the wing and tail-plane will require some modifications. The fuselage will need significant modification to allow for installation of the instrument support structure.
Additionally, the aircraft will have the ability to land on water, fly for at least one hour between battery changes, and pack into a portable carrying case much like the NOVA 2.1. Provisions for short take-off-and-landing, by incorporating flaps and/or air-brakes, will allow for a broader range of operating environments. It will be designed to operate (from launch, through the entire flight plan, and then land) via autopilot. The autopilot that will be utilized is produced by Procerus (Kestral 2.4 or newer) as well as the graphic user interface and ground station. The autopilot system has many built-in fail-safes for almost all anticipated incursions from manned aircraft into the operating airspace including RC pilot takeover, automatic rallying to a designated location or loitering in position. It also has lost com, low battery, low altitude and other built-in warnings.

It is anticipated that development of the first prototype will be accomplished before the end of the 2014 calendar year, while calibration of all instruments, testing and validation will be accomplished by May 2015. Field testing is proposed to be in the western US in a site or sites having significantly challenging geological features and an agricultural site near Atlanta, GA. Local tests and calibrations will be performed at our training/test facility at the Ordway-Swisher Biological Station (http://ordway-swisher.ufl.edu/) just 40 minutes from our campus lab. The UF UAS group also will provide training to USGS UAS on operation of the aircraft, autopilot and flight planning. Three workshops in Gainesville, FL with participants from USGS UAS and UF UAS are to be scheduled at the very beginning of the project to determine exact sensor models and specific direction of the project, in mid project after the initial construction of the sensor suite and aircraft, and at the end of the project to present the final prototype and findings. The final report shall consist of an operator's manual and FSP approved manuscripts describing the sensor suite and aircraft. Results of the field tests will be presented and a plan to collaboratively publish those results will be finalized at the last meeting.

Effects of Coastal Dynamics and Climate on Loggerhead Turtle Nest Success and Management

Principal Investigator: **Ray Carthy**
Co-Principal Investigator: Susan Jacobson
Funding Agency: USGS
Expected Completion: 9/30/2016 (RWO#285, UF PJ#00110535)
Graduate Students: Nia Haynes, Nichole Bishop

Sea turtle nesting beaches in the southeastern U.S. are vulnerable to a variety of anthropogenic, ecological and climatic stressors. Nesting success in these unique and diverse beach habitats is becoming increasingly dependent on management interventions. In response to coastal development, predation, high tidal fluctuations, erosion, and risk of inundation, actions may range from protected area designation down to nest relocation. The purpose of this project is to develop a better understanding of specific responses to nesting beach stressors, by both sea turtles and humans. This will be accomplished by surveying of sea turtle nesting and utilizing an array of monitoring techniques for the physical environment. A secondary objective of the project is to provide an educational training experience for the undergraduate interns involved in the Doris Duke Conservation Scholarship Program. The project will provide partial support for a Ph.D. student who will carry out the primary research.
This past summer, the Ph.D. student led a group of undergraduate students in the continuation of monitoring work that began in the summer of 2014. The students assessed beach profiles of three different beaches, including the 0.65 acre property in Summer Haven that was donated to the Archie Carr Center for Sea Turtle Research at the University of Florida. They evaluated slope, sand grain size, and gas exchange and will use these data to assess short- and long-term changes in coastal morphodynamics on this property. The team also conducted a natural inventory assessment of the property that allows for a Florida Natural Areas Inventory (FNAI) habitat classification along a beach to estuary ecotone. Finally, they collected data for a replicate study of Wood *et al*. (2000) that assessed sea turtle nest site selection based on nesting crawls on different beach types.

Doris Duke Charitable Foundation
National Educational Partnership for Conservation

At the Florida Cooperative Fish and Wildlife Research Unit, funding received from the USGS Directorship was put into a new RWO to fund research on the effects of climate change on coastal ecosystems and T&E species, and to support the graduate student mentors for the five UF DDCSP interns. A returning graduate student mentor, Nichole Bishop, a Ph.D. student, and Brian Smith, an M.S. student, were chosen to conduct research and to mentor the undergraduate students employed through the DDCSP on their summer research experience. This past summer they studied coastal and wetland ecosystems as they lived and worked at three sites: Seahorse Key Marine Laboratory on the west coast of Florida, where their hands-on lessons included ecology of tidal mud flats, oyster and clam bars, nesting shorebirds, herpetology and research on predator-prey relationships; the Whitney Laboratory on the east coast where they focused on beaches, barrier islands, effects of climate change, and participated in sea turtle research; and the Everglades, where the studied wetland ecology, invasives, and herpetofauna.

During their stay at the field sites, the interns selected and carried out individual projects based on their interests.

- Shar Siddiqui – Quantified the influx of nutrients (nitrate & nitrite) as a result of loggerhead sea turtle nests
- Monica Quintiliani – Quantified the effects of man-made oyster reefs on sediment composition in estuaries using particle size, bulk density and total carbon as indicators of change
- Megan Ely – conducted a faunal survey of mesopredators in a modified landscape adjacent to protected areas

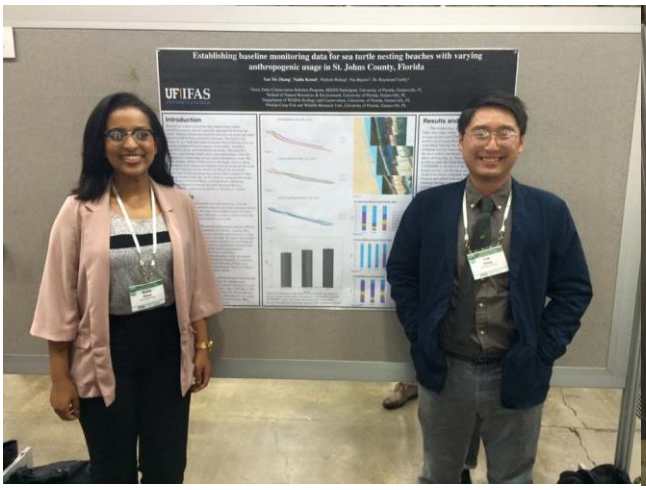
- Jeanelle Brisbane- Examined detectability of frog species by call surveys under varying environmental conditions to inform monitoring efforts.
- Charmaine Pedrozo- Determined the environmental factors affecting the probability of snake detection to optimize road cruising survey protocols.

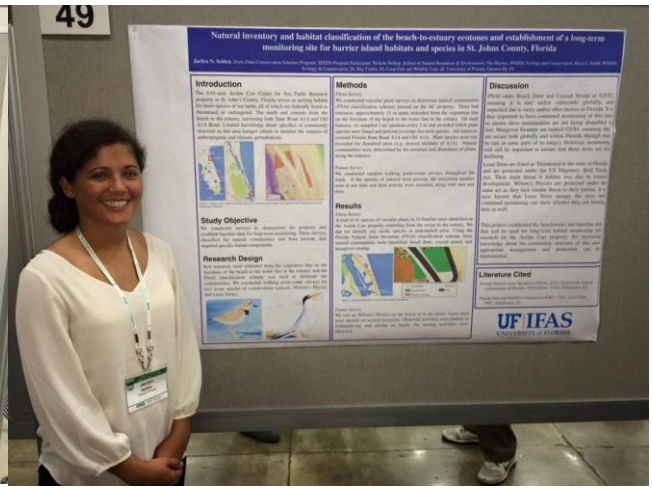
Our primary graduate student mentor, Nichole Bishop, has worked with the students both through their summer research experience and during the academic year. Nichole came to us with an outstanding academic background and track record of commitment to diversity issues and the natural resource field. She holds a Master's of Education degree, and in 2013 completed a second Master's on the ecology and physiology of wasting disease in sea grasses. She has been active in the program since January 2014 and assisted in planning the summer research experience for the interns, took part in their interview and selection process in February and March, and mentors the students throughout the academic year. USGS funding provided an initial stipend and research support for this outstanding student, whose background in both education and the natural sciences are greatly benefitting the DDCSP. In addition helping them develop their individual projects, Nichole led the interns on an intensive group project aimed at establishing physical and ecological baselines for long-term effects of climate change on Florida beaches. The students gained valuable experience in setting permanent transects and analyzing beach characteristics at Marineland Beach, Crescent Beach, and Guana Tolomato Matanzas National Estuarine Reserve (beach profiles, sand grain size, sand gas exchange), and cataloging natural communities and biodiversity. This cohort of interns was able to observe short- and long-term seasonal changes during their stay by continuing the monitoring efforts from the 2014 cohort. We hope that future interns can continue to learn about the effects of climate change over broader time scales as they continue to assess the data from these benchmarks. The field skills and technique knowledge that the interns acquired during the summer will likely serve them well in their second year of the program and beyond graduation.

The success of this program is evident from the success of the first (2014) cohort's post-graduation accomplishments. Jaclyn Selden now works as a biologist for the FWC and Nadia Kemal was accepted into Stanford Law School where she will be studying environmental law. Additionally, the 2014 cohort successfully presented their individual research projects in Baltimore, Maryland at the 100th annual meeting of the Ecological Society of America.

The active role that the USGS funding has allowed the Coop Unit faculty and students to play in the DDCSP has engendered a real synergy at the University level. The Chair of the Department of Wildlife Ecology and Conservation, Dr. Eric Hellgren, is committed to the success and continuation of the Program. Three Wildlife faculty members, Dr. Susan Jacobson, Dr. Bill Pine, and Dr. Christina Romagosa, and Dr. Todd Osborne from Biogeochemistry have engaged as PI's and/or mentors. Beyond the University, the USFWS, FWC, and the Florida Wildlife Federation have expressed strong interest in hosting DDCSP interns and helping to further their training and careers.

PHOTOS FROM THE ECOLOGICAL SOCIETY OF AMERICA'S 100TH ANNUAL MEETING





PHOTOS FROM 2015 COHORT

Freshwater Turtle Research & Conservation

Principal Investigator: Raymond Carthy
Funding Agency: UF
*Expected Completion:*12/31/18
Graduate Student: Nichole Bishop

Dermatemys mawii, commonly known as "hicatee", is a critically endangered fresh-water turtle endemic to Central America. For centuries, *D. mawii* meat has been consumed by indigenous human populations. However, overhunting has extirpated many local populations and *D. mawii* is now listed as one of the top 25 most endangered turtle species in the world. Although *D. mawii* has been an important cultural icon for centuries, relatively little is known about their biology or ecology, therefore conservation efforts are severely limited. The current state of knowledge regarding these turtles is mostly anecdotal evidence provided by local hunters or limited to research that is decades old. Past conservation efforts have failed in part due to lack of sound science and reliable information. More recently, *D. mawii* conservation efforts have identified captive breeding programs of individuals for wild release, in concert with conservation education, as potential avenues of restoring wild populations. The Hicatee Conservation Research Center (HCRC) at the Belize Foundation for Research and Environmental Education (BFREE) in collaboration with the Turtle Survival Alliance (TSA) are exploring the feasibility of a captive breeding program for release of individuals into protected areas in an effort to boost wild populations. This past year, HCRC at BFREE has successfully reared its first clutch of *D. mawii* and is expecting its second group of hatchlings in the summer of 2016.

Despite the success of this captive breeding program, relatively little is known about their wild diet, digestive performance or ecological role in nutrient cycling. A unique feature of *D. mawii* is that adults are entirely herbivorous (hatchlings and juveniles are assumed to be herbivorous as well, but this notion has yet to be confirmed). Herbivory in reptiles is relatively rare due to limitations imposed by ectothermy. Therefore, herbivorous reptiles have special behavioral and physiological adaptations related to processing plant materials. These adaptations have yet to be confirmed and/or studied in *D. mawii*. Another important aspect related to the captive management of *D. mawii* is that many species of freshwater turtles are capable of indeterminate growth, such that proper diet can lead to larger, more fecund turtles.

Due to the relationship between nutrition, body size and reproductive output, and due to the unique consequences of and considerations for herbivory in ectotherms, dietary related studies have been identified as a priority for successful implementation

of captive breeding programs for *D. mawii*. Over the past year, we have collaborated with the HCRC, BFREE and the TSA to improve our knowledge of *D. mawii* nutritional ecology to inform captive management and conservation efforts. Additional research on estimating the onset of sexual maturity was presented this past February (2016) at the 2nd Hicatee Conservation Forum and Workshop in Belize. The results of this research are currently being used to draft new legislation in the Belizean government related to harvest of *D. mawii* turtles. Finally, we have recently begun collaborating with the Jacksonville Zoo and Gardens, the only entity in the United States that possesses *D. mawii* turtles, to assist with their captive management of *D. mawii* in hopes of establishing a captive breeding program among zoos in North and Central America.

Sea Turtle & Escarpment Monitoring

Principal Investigator: Raymond Carthy
Funding Agency: MRD Associates
Expected Completion: 3/31/2015 (UF PJ#00104186)

The Florida Cooperative Fish and Wildlife Research Unit (Coop Unit) at the University of Florida has been conducting sea turtle surveys along Cape San Blas at the southern tip of the St. Joseph Peninsula since 1994. Prior to these surveys, little was known about species, nesting densities, site fidelity and distribution of nesting in this region. Since we initiated our surveys, our data has helped determined that the group of loggerhead turtles nesting in Northwest Florida is genetically distinct from loggerheads nesting throughout the southeast and that the St. Joseph Peninsula supports the greatest nesting density of these unique turtles. Our surveys involve nest marking, data collection, nest relocation, screening for predators when necessary, and hatching inventories. In 1998, the Coop Unit initiated a saturation tagging program that involves nightly surveys for nesting turtles. When a nesting female is encountered, she is tagged and morphometric data are collected. Tagging the turtle enables us to individually identify nesting females which helps estimate population size, site fidelity, and movement patterns. Since 1998, more than 500 turtles have been tagged. The Coop Unit will use the knowledge and many of the methods gained from conducting surveys for 18 seasons along Cape San Blas to survey nesting turtles on the adjacent 7.5 km along the St. Joseph Peninsula.

As sea levels rise, coastal habitat erodes and humans utilize various techniques to reduce erosion from damaging or destroying their homes and investments. Beach nourishment is rapidly becoming the primary method used to restore highly eroded beaches. However, effects of an ongoing nourishment project on nesting sea turtles are largely unknown. Data collected during this project will provide valuable information regarding effects of beach nourishment on abundance and distribution of sea turtle nests, nesting success, and hatching success.

OBJECTIVES:

Determine the effects of an active beach nourishment project on:

1) Nesting distribution
2) Nesting abundance
3) Nesting success, and
4) Hatching success of sea turtles nesting along the St. Joseph Peninsula

PROGRESS:
During the 2015 nesting season, 63 nests were documented on Eglin AFB property Cape San Blas (EAFB) and 170 nests were deposited on the St. Joseph Peninsula (SJP). Of all nests laid on Eglin, turtles were observed on 32 (49%) of those events and those 32 nests were deposited by 27 individuals. Of those 32 observed nesting events, 25 were deposited by apparent neophytes and 10 were deposited by remigrants. All nests on EAFB were laid by loggerheads. Of all nests laid on the SJP, turtles were observed on 124 (73%) of those events. Those 124 nesting events were deposited by 76 individuals. Of those 76 individuals, 60 (79%) were deposited by apparent neophytes and 16 (21%) were deposited by remigrants. Loggerheads laid 164 nests on SJP, and 6 nests were laid by greens.

The remigrants from both beaches were originally tagged in 2003, 2007, 2008, 2009, 2010, 2011, 2012, and 2013 which resulted in remigration intervals of 12, 8, 7, 6, 5, 4, 3, and 2 years respectively (mean 5.9 years). This mean observed remigration interval is longer than the long-term (14-year) mean of 4.4 years reported by Lamont et al. (2014). Over the past three years (2011-2013) we have observed an increase in the proportion of remigrants at our study site. From 1998-2011, remigrants made up only 7% of the tagged turtles, whereas from 2011 to 2015 remigrants have made up approximately 22% of the tagged turtles. Although the proportion of remigrants observed in 2015 (21%) was higher than that reported by Lamont et al. (2014), it is slightly lower than the average observed over the past 4 years. Continued tagging at this site will help us better understand the true remigration rate and nest production by adult females in this subpopulation.

SUMMARY:
As sea levels rise and coastal erosion increases, beach nourishment is rapidly becoming the primary method used to restore this habitat and protect homes and investments. Data collected during this project will provide valuable information regarding effects of beach nourishment on abundance and distribution of sea turtle nests, nesting success, and hatching success.

Habitats and resources used by threatened and endangered marine turtles

Principal Investigator: **Ikuko Fujisaki**
Funding Agency: USGS
Expected Completion: 8/15/16 (RWO#293, UF PJ#00120915)
Graduate Students: Thomas Selby

Thomas Selby and Andrew Crowder (USGS) pause momentarily before releasing a newly acoustic tagged hawksbill at Buck Island Reef National Monument.

Understanding patterns in habitat selection and resources use is important for effective conservation, especially for threatened and endangered species. In marine environment, marine protected areas are established as a management tool to regulate human use and conserve at-risk coral reef habitats. Buck Island Reef National Monument (BIRNM) in US Virgin Island (USVI) was established in 1961 to protect natural resources and coral habitats. BIRNM includes important nesting areas for multiple marine turtle species including federally endangered hawksbill turtles (E*retmochelys imbricata*), endangered green (*Chelonia mydas*) and leatherback (*Dermochelys coriacea*) turtles, and threatened loggerheads (*Caretta caretta*) (Hillis 1995, Boulon et al. 1996, Pollock et al. 2009). This study couple passive acoustic telemetry and in-water mark recapture to understand the movement and habitat use patterns of marine turtles in BIRNM.

OBJECTIVES:
The overall goal of this study is to gain understanding of how passive acoustic technology can be used to understand occupancy patterns of juvenile sea turtles at BIRNM. Specifically, this study has two objectives: 1) to range-test the existing array at BIRNM in order to understand how environmental conditions specific to the study site affect detection range and 2) to use the existing array to understand juvenile hawksbill temporal use of different areas of BIRNM and overall residency patterns within the monument's protected waters.

Thomas Selby free dives to remove one of many passive acoustic receivers at Buck Island Reef National Monument in order to download detection data stored on the device from tagged marine turtles.

PROGRESS:
This project is conducted as a thesis research by a MS student in WEC, Thomas Selby. In fall 2014 Thomas completed the course work required for quantitative ecology emphasis by WEC. During his second semester in spring 2015, Thomas presented the thesis proposal and it was approved by the committee members. In fall 2015, he completed a manuscript that will be one chapter of his thesis and submitted the manuscript to a refereed journal. He also presented the study at Florida Cooperative Fish and Wildlife Research Unit Meeting (poster presentation) and South Florida Graduate Research Symposium (poster presentation) and iTag (oral presentation), and submitted abstracts to Southeast

Regional Sea Turtle Meeting. Because his committee members are based on different locations, he provides near-weekly progress report to committee members.

SUMMARY:
The results from this study to identify the habitat used by juvenile hawksbill will provide BIRNM managers information for conservation planning. The results from the range testing will provide information on effectiveness of an acoustic array deployed in a spatially heterogeneous in-water habitat to monitor aquatic species, which could be used as a basis to select an appropriate locations to deploy additional receivers in the future.

Optimal Management of Migratory Bird Habitat and Harvest

Principal Investigator: Raymond Carthy
Funding Agency: USGS
Expected Completion: 08/14/2016 (RWO#272, UF PJ#00096823)

Optimal management of wildlife habitats and harvests depends on the ability of a manager to take periodic actions, which are conditioned both on the current state of the resource and on anticipated future resource conditions. Optimal solutions to these "sequential-decision problems" can often be calculated, provided there are clearly articulated management objectives, a set of alternative management actions, one or more models of resource dynamics, and a resource-monitoring program. This approach has been applied successfully to the national management of mallard harvests and to the local management of habitat for the threatened Florida scrub-jay. Managers are considering modifications to both programs, however. In the case of scrub-jays, habitat-restoration activities have failed to produce optimal conditions for scrub-jays in some areas of Merritt Island National Wildlife Refuge. Thus, there is a need to take advantage of recently acquired data concerning the dynamics of scrub habitat to develop more effective management strategies. In the case of mallards, it is the timing of decisions that may change. A draft Environmental Impact Statement suggests that there would be administrative benefits of shortening the timeframe of the regulatory process, such that hunting regulations would be issued each year prior to the availability of annual monitoring data. The potential impacts of this change on the mallard population and on allowable levels of harvest are largely unknown, however.

OBJECTIVES:

The objectives of this study focus on understanding the implications of resource models and decision timing on optimal management decisions and expected performance. Specifically, this study will:

A) Modify the existing optimization algorithms to account for potential changes in the models used to inform scrub-jay and mallard management; and

B) Evaluate the implications of those changes for managers, the resource, and resource users.

PROGRESS:
We have completed the requested work on Florida scrub-jays. We computed optimal management strategies for oak (Quercus spp.) scrub at MINWR. We found that managers would have to consider the option of cutting up to two potential territories (20 ha) of tall-mix scrub each year in each management unit in addition to the option of prescribed burning in order to keep scrub-jay abundance from declining. The optimal management strategy prescribes cutting when there is any tall-mix scrub, burning only when the unit is dominated by optimal-closed

scrub, and doing nothing when there is no tall-mix and a relatively homogenous mix of the other scrub types. Of particular concern in this study was the creation and maintenance of open scrub in areas with a legacy of fire suppression. Burning under ideal conditions in these areas can apparently create openings, but it did not appear to be particularly effective at setting back scrub height. Thus, linear, plowed openings that the refuge has created in some areas may be cause for concern if the openings act as fire lines, further impeding the spread of fire within a management unit.

With respect to mallard (Anas platyrhynchos) harvests, our concern is with the modification of a traditional Markov decision process (MDP) to account for those cases in which an action must be chosen after a significant time lag in observing system state, but just prior to a new observation. In order to calculate an optimal decision policy under these conditions, possible actions must be conditioned on the previous observed system state and action taken. We have demonstrated how to solve these problems when the state transition structure is known and when it is uncertain. Our focus is on the latter case, and we show how actions must be conditioned not only on the previous system state and action, but on the probabilities associated with alternative models of system dynamics. To demonstrate this framework, we calculated and simulated optimal, adaptive policies for MDPs with lagged states for the problem of deciding annual harvest regulations for mallards in the United States. In this particular example, changes in harvest policy induced by the use of lagged information about system state were sufficient to maintain expected management performance (e.g. population size, harvest) even in the face of an uncertain system state at the time of a decision.

The following articles have been published or are in review:

Johnson, F. A., M. A. H. Walters, D. R. Breininger, P. L. Fackler, G. M. Carter, And M. L. Legare. 2012. Strategic habitat conservation for the Florida scrub-jay at Merritt Island National Wildlife Refuge, Florida. USGS Administrative Report 1, Cooperative Agreement No. 1434-HQRU1544.

Johnson, F. A., Breininger, D. R., and M. L. Legare. 2013. Managing habitat for Florida scrub-jays at Merritt Island National Wildlife Refuge. The All-Bird Bulletin Winter 2013:10-11, 14-15.

Breininger, D., B. Duncan, M. Eaton, F. Johnson, and J. Nichols. 2014. Integrating land cover modeling and adaptive management to conserve endangered species and reduce catastrophic fire risk. Land 3:874-897.

Johnson, F. A., P. L. Fackler, G. S. Boomer, G. Zimmerman, B. K. Williams, J. D. Nichols, and R. M. Dorazio. State-dependent resource harvesting with lagged information about system states. PLos One: In review.

SUMMARY:

Many problems in wildlife management can be described formally as Markov decision processes (MDPs). This study seeks to apply MDPs to the optimal management of mallard harvests and the conservation of scrub-jay habitat.

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

Principal Investigator: **Robert Fletcher**
Funding Agency: U.S. ACOE (Jacksonville); USGS
Expected Completion: 7/31/2015 (UF PJ#00088028)
New Ongoing Project: 5/31/2016 (UF#00123210)
Graduate Students: Chris Cattau, Brian Reichert, Caroline Poli, Ellen Robertson
Personnel: Brian Jeffery, Whitney Haskell, Thomas Bacher, Lauren Diaz, Sarah Dudek, Jessica Padilla, Bradford Westrich

This report provides an annual update regarding ongoing population monitoring of the endangered snail kite (*Rostrhamus sociabilis plumbeus*). 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. This report concentrates on demographic data collected during the past five years, but also incorporates data collected since 1992. Demographic analyses reveal that snail kite abundance drastically declined between 1999-2008, with the population approximately halving from 2000 to 2002 and again from 2006 to 2008. Each of these two periods of population decline coincided, in part, with drought conditions throughout the southern portion of the kites' range. The 2001 drought significantly, yet temporarily, affected adult apparent survival, especially for kites within the Everglades region, and the reduced nesting and recruitment that have been observed since that time give us special concern about the recovery of the snail kite population. By coupling the vital rates measured over this time period with the changes in population size (using a Life Table Response Experiment), it became apparent that the primary demographic factors contributing to this decline were changes in adult fertility (which is the product of young fledged per adult and juvenile survival). Recent analyses also provide indications of an aging population in the southern portion of the breeding range, with problems inherent to older individuals, including increased adult mortality rates and decreased probabilities of attempting to breed, both of which have been shown to be exacerbated during times of harsh environmental conditions.
While from 1999-2008 population size declined, from 2009-2013 there were modest, but consistent positive population growth rates. During this time, we observed much greater recruitment of young birds, primarily driven by greater breeding activity in the northern portion of the breeding range. Between, 2013-2014 there was a much steeper positive growth rate, which is encouraging, although the population size is still much lower than before the 2001 drought.
Multiple factors may be limiting kite reproductive ability and reducing the carrying capacity of several of the wetland units throughout the state, although most are likely tied to both short-term natural disturbances (e.g., drought; Beissinger and Takekawa 1983) and long-term habitat degradations (e.g., the conversion of wet prairies to sloughs in Water Conservation Area WCA3A). These issues may alter both prey density and habitat conditions for foraging and successful reproduction. In general, during the period of observed declines, there was a notable decline in snail kite production from two critical snail kite habitats, WCA3A and Lake Okeechobee.

OBJECTIVES:
Snail Kite survival depends on maintaining hydrologic conditions that support these specific vegetative communities and subsequent apple snail availability in at least a subset of critically-sized wetlands across the region each year (Bennetts et al., 2002; Martin et al., 2006). The historical range of the Snail Kite once covered over 4000 km^2 (2480 mi^2) in Florida, including the panhandle region (Davis & Ogden, 1994; Sykes et al., 1995), but since

the mid-1900s it has been restricted mainly to the watersheds of the Everglades, Lake Okeechobee, Loxahatchee Slough, the Kissimmee River Valley (KRV), and the Upper St. Johns River of the central and southern peninsula (Fig. 1). After several decades of landscape fragmentation and hydroscape alteration, the kite population is now confined to a fragmented network of freshwater wetlands that remain within its historical range, and the viability of the population rests entirely on the conditions and dynamics of these wetland fragments (Bennetts & Kitchens, 1997; Martin, 2007). The Snail Kite is unique in that it is the only avian species that occurs throughout the central and south Florida ecosystem and whose population in the U.S. is restricted to freshwater wetlands in this region. The dependence of the Snail Kite on these habitats makes it an excellent barometer of the success of the restoration efforts currently underway (Kitchens et al., 2002) (e.g. USFWS *Multi-Species Transition Strategy for Water Conservation Area 3A*, 2010).

Wetland habitats throughout central and southern Florida are constantly fluctuating in response to climatic or managerial influences, resulting in a mosaic of hydrologic regimes and vegetative communities. Snail Kites respond to these fluctuations demographically and through movements within the network of wetlands in central and southern Florida (Bennetts & Kitchens, 1997; Kitchens et al., 2002; Martin et al., 2006, 2007a, 2007b). In order to optimize conservation strategies for the complex system inhabited by the Snail Kite in Florida, it is essential to have a thorough understanding of the kite's ability to move among wetlands, their resistance and resilience to disturbance events (e.g., droughts), and the demographic effects that specific management actions and other habitat changes have on the kite population.

The objective of this research is to monitor the birds' response to environmental changes (anthropogenic and natural) focusing on the most critical demographic parameters: survival, reproduction, recruitment, and population growth rate. Because those demographic parameters are heavily influenced by the behavior of the birds (i.e. their ability to move and select suitable habitats), movement studies constitute the other major aspect of the research. There are 2 overarching objectives: 1) to evaluate the underlying mechanisms and processes driving the population dynamics of the kites; 2) to provide reliable estimates of demographic parameters and movement probabilities to upgrade management models to optimize management decisions.

PROGRESS:

Mark-recapture models provide a powerful framework for estimating critical demographic (survival, population growth rate) and movement parameters. The recent advances in modeling allow for the combination of mark recapture and radio telemetry information, providing better estimates of survival and movement rates, and increasing power of statistical inferences (Williams et al 2002, Nasution et al. 2001).

By utilizing the long-term band-resight dataset, which began in 1976, we are able to identify senescence rates among the aging cohorts of the snail kite population. Senescence is defined as an increasing intrinsic rate of death, and is common among wild populations. Understanding how severe environmental conditions (such as droughts) disproportionally impact the survival probabilities of older snail kites will help to refine vital rates that are critical to our monitoring efforts.

Preliminary findings:

- Snail kites are more philopatric than previously anticipated.
- Our study also highlights the importance of taking into consideration the fact that kites movement are both distance dependent and affected by fragmentation, when managing the hydrology of wetlands used by this species.
- Snail kites do experience increased rates of mortality in their oldest ages
- Breeding probabilities of birds in different age classes are differentially affected by drought.

- In 2015, over 437 nestlings have been banded.

SUMMARY:
The objective of this research is to monitor the birds' response to environmental changes (anthropogenic and natural) focusing on the most critical demographic parameters: survival, reproduction, recruitment, and population growth rate. Because those demographic parameters are heavily influenced by the behavior of the birds (i.e. their ability to move and select suitable habitats), movement studies constitute the other major aspect of the research. There are 2 overarching objectives: 1) to evaluate the underlying mechanisms and processes driving the population dynamics of the kites; 2) to provide reliable estimates of demographic parameters and movement probabilities to upgrade management models to optimize management decisions.

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

Principal Investigator: **Robert Fletcher**
Co-Principal Investigators: **Chris Cattau, Brian Reichert**
Funding Agency: USGS
Expected Completion: 06/01/2016 (RWO#294, UF PJ#00123335)
Graduate Students: Caroline Poli

The endangered snail kite (*Rostrhamus sociabilis plumbeus*) is a dietary specialist raptor whose range in the U.S. is confined to a network of freshwater wetlands in the Greater Everglades (USFWS 1999). Rigorous scientific investigations conducted throughout the Greater Everglades in recent decades have contributed substantially to our understanding of snail kite population dynamics (e.g., Bennetts & Kitchens 1997, Martin et al. 2007, 2008, Fletcher et al. 2013), yet there are many remaining uncertainties that limit our ability to recover this critically endangered species.

The Snail Kite Coordinating Committee (SKCC) has made significant progress in identifying information gaps and research needs related to the ecology, conservation, and management of the snail kite, its habitat, and its primary prey. Continuing such a collaborative effort will be integral in working toward recovery of the kite population; however, organizing and ranking research priorities remains a challenge. Given the extinction risks faced by the snail kite and the limited resources available for conservation and management efforts, it is pertinent that we are asking the right questions and conducting research effectively and efficiently.

The workflow driving snail kite research can be conceptualized in a three-tiered hierarchical framework (Kite demography → Environmental factors → Management actions) in which knowledge gained from research at higher tier(s) help to generate research questions and set research priorities in subsequent tier(s). Therefore, first and foremost, it is necessary to have a quantitative understanding (from a demographic perspective) of how specific vital rates (e.g. breeding probabilities, nest success, juvenile survival) impact snail kite population growth and persistence. Given that the snail kite population is spatially structured and that environmental factors and management activities that impact kites often occur on local/regional scales, understanding spatial variation in vital rates and determining the relative contribution of particular locations to overall population growth are also essential.

We use demographically- and spatially-structured matrix population models to assess the influence of movement rates and local demographic parameters on ssnail kite population growth rate (Caswell 2000, 2007). Such analyses are recognized as valuable tools in conservation planning, as they add conceptual clarity and provide quantitative metrics that can be used to inform research and management decisions (Benton and Grant 1999, Gerber and Heppell 2004). Considering spatially-explicit population dynamics will allow us to identify the demographic rate(s)

most limiting population growth at both local and range-wide scales. In addition, it enables us to assess the contribution of specific wetlands to the overall population. This knowledge will provide a quantitative basis to help gauge the relative benefits of answering/addressing future snail kite research questions and can help guide the direction of the SKCC by identifying precisely (i) which information gaps are likely most critical to fill through further research, (ii) which ecological processes and snail kite life history stages/events may be most beneficial for management actions to target (or to mitigate impacts to) and in which locations will this have the greatest impact, and (iii) which wetlands/regions contribute most to snail kite population growth over the short and long term.

OBJECTIVES:

- To quantify the relative contribution of demographic parameters (at local and range-wide scales) to overall population growth of the snail kite.
- To estimate the patch value of individual wetlands (i.e., site-specific contributions to overall population growth).
- To identify sites functioning as sinks/sources, and to determine the demographic parameters most limiting/facilitating local population growth.
- Synthesize what is currently known about environmental factors that influence these key demographic rates and any known management issues that may influence these demographic rates.

PROGRESS:

We used estimates of snail kite movement, survival, and reproduction observed over the last 6 breeding seasons (2010-2015) to populate a demographically- and spatially-structured matrix population model, and preliminary results are as follows:

- Positive range-wide population growth rate.
- Population projections suggest that kite abundance in the KRV and Lake Okeechobee will increase substantially in the coming years, whereas abundances in the remaining regions are projected to remain relatively constant or to increase slightly.
- Perturbation analyses in which a given demographic rate was changed simultaneously across regions indicated that overall population growth rate is highly sensitive to absolute changes in both adult survival and fertility. Sensitivity analysis of the 5 lower-level parameters contributing to fertility indicated that population growth is most sensitive to changes in nest success, followed by juvenile survival. Sensitivities of other lower-level parameters were substantially lower, but were nonetheless modest.
- Perturbation analyses of region-specific demographic rates indicated that overall population growth rate is most sensitive to absolute changes adult survival in KRV, then to fertility in KRV, followed by adult survival and fertility in Okeechobee. Lower-level sensitivities were greatest for nest success in KRV, then juvenile survival in KRV, followed closely by nest success in Okeechobee.
- Regional demographic matrix models (which did not incorporate movement) indicated positive population growth rates in three regions (KRV, Okeechobee, Stormwater treatment Areas) and negative growth rates in two regions (Everglades, SJM). These findings, taken together with results from the multisite model, suggest that kite populations in the Everglades and SJM are being sustained by immigrants from other regions, and that the Everglades and SJM are likely functioning as population sinks.
- Patterns of sensitivity and elasticity of regional population growth rate to changes in regional demography were similar across regions and paralleled trends observed in the range-wide assessment. Regional population growth rates are highly sensitive to region-specific adult survival and (to a slightly lesser extent) fertility, with nest success having the greatest effect among the lower-level parameters, followed by juvenile survival.

SUMMARY:

Using demographically- and spatially-structured matrix population models will help us identify which ecological processes and snail kite life history stages/events may be most beneficial for management actions to target (or to mitigate impacts to) and in which locations will this have the greatest impact. By identifying environmental factors and management activities that impact kites on local/regional scales, while understanding spatial variation in vital rates and the relative contribution of particular locations to overall population growth, we will be able to provide recommendations that are most likely to efficiently facilitate snail kite recovery.

Linking Snail Kite Foraging Activity, Habitat Quality, and Critical Demographic Parameters to Guide Effective Conservation Efforts in the Southern Everglades

Principal Investigator: **Robert Fletcher**
Funding Agency: USGS
Expected Completion: 06/07/2015 (RWO#269, UF PJ#00088726)
Graduate Students: Rebecca Wilcox, Chris Cattau
Technicians: Daniel Cavanaugh, Ryan Diebler

Recent demographic studies reveal alarming trends in the snail kite population in Florida. Kite numbers have drastically declined since 1999, with the population essentially halving from 2000 to 2002 and again from 2006 to 2008. Concurrent with the population decline is a corresponding decline in nesting attempts, nest success, and the number of young fledged. A number of factors have likely contributed to these observed declines, including short-term natural disturbances (e.g., drought) and long-term habitat degradations (e.g., the conversion of wet prairies to sloughs in WCA3A). In relation to maintaining the long-term stability of the snail kite population, WCA3A is commonly recognized as stronghold for kite reproduction. However, snail kite reproduction in WCA3A sharply decreased after 1998. Given that reproduction may be largely limiting snail kite population growth and recovery, it is critical to understand the factors affecting reproduction in WCA3A. Natural resource managers currently lack a fully integrative approach to managing hydrology and vegetative communities with respect to the apple snail and snail kite populations. This report presents the status of our progress on (1) the integrated data synthesis effort, linking existing snail kite and apple snail data, and (2) the targeted field research being conducted to fill critical information gaps in our understanding of the interactions between/among hydrology, vegetation, snails and kites.

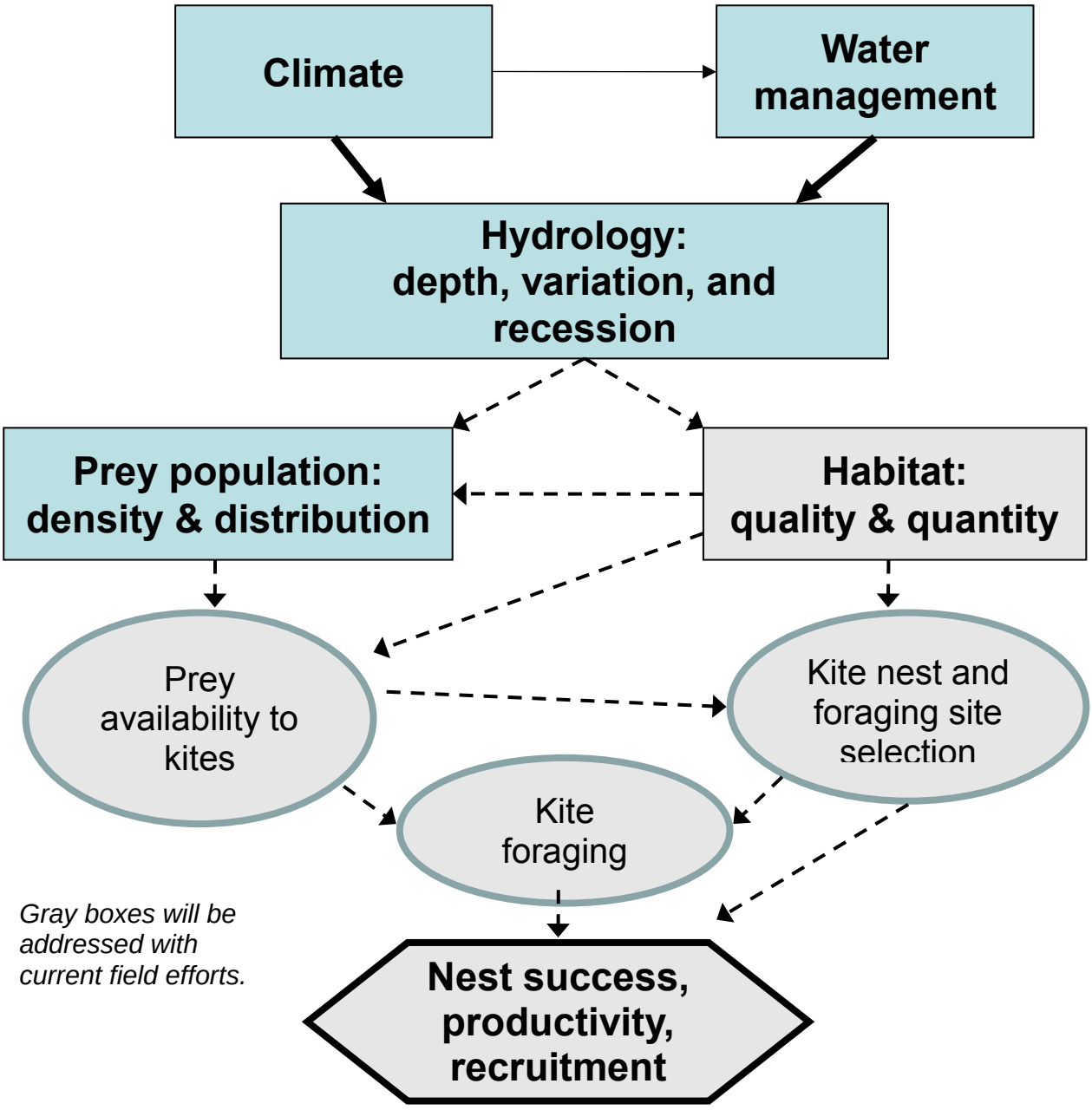
OBJECTIVES:

The endangered snail kite (*Rostrhamus sociabilis*) is a wetland-dependent species feeding almost exclusively on a single species of aquatic snail, the Florida apple snail (*Pomacea paludosa*). The viability of the kite population is therefore dependent on the hydrologic conditions (both short-term and long-term) that (1) maintain sufficient abundances and densities of apple snails, and (2) provide suitable conditions for snail kite foraging and nesting, which include specific vegetative community compositions. Many wetlands comprising the range of the snail kite are no longer sustained by the natural processes under which they evolved (USFWS 1999, RECOVER 2005), and hence, are not necessarily characteristic of the historical ecosystems that once supported the kite population (Bennetts & Kitchens 1999, Martin et al. 2008). In addition, natural resource managers currently lack a fully integrative approach to managing hydrology and vegetative communities with respect to the apple snail and snail kite populations.

Given the critically endangered status of the snail kite and the dependence of the population growth rate on adult fertility (Martin et al. 2008), it is imperative that we improve our understanding of how hydrological conditions effect kite reproduction and recruitment. In relation to maintaining the long-term stability of the snail kite population, WCA3A is commonly recognized as one of the 'most critical' wetlands comprising the range of the kite in Florida (see Bennetts & Kitchens 1997, Mooij et al. 2002, Martin et al. 2006, 2008). However, snail kite reproduction in WCA3A sharply decreased after 1998 (Martin et al. 2008), and alarmingly, no kites were fledged there in 2001, 2005, 2007, or 2008. Furthermore, Bowling (2008) found that juvenile movement probabilities away (emigrating) from WCA3A were significantly higher for the few kites that did fledge there in recent years (i.e. 2003, 2004, 2006) compared to those that fledged there in the 1990s. The paucity of reproduction in and the high probability of juveniles emigrating from WCA3A are likely indicative of habitat degradation (Bowling 2008, Martin et al. 2008), which may stem, at least in part, from a shift in water management regimes (Zweig & Kitchens 2008).

Given the recent demographic trends in snail kite population, the need for a comprehensive conservation strategy is imperative; however, information gaps (Fig. 1) currently preclude our ability to simultaneously manage the hydrology in WCA3A with respect to vegetation, snails, and kites. While there have been significant efforts in filling critical information gaps regarding snail kite demography (e.g., Martin et al. 2008) and variation in apple snail density to water management issues (e.g., Darby et al. 2002, Karunaratne et al. 2006, Darby et al. 2008), there is surprisingly very little information relevant for management that directly links variation in apple snail density with the demography and behavior of snail kites (but see Bennetts et al. 2006). The U.S. Fish and Wildlife Service (USFWS) and the Florida Fish and Wildlife Conservation Commission (FWC) have increasingly sought information pertaining to the potential effects of specific hydrological management regimes with respect to the apple snail and snail kite populations, as well as the vegetative communities that support them.

Figure 1. Conceptual model of environmental and biological variables affecting key demographic parameters of the snail kite population.



PROGRESS:

This study is complementary to the demographic study entitled "Continued Studies of the Demography, Movement, Population Growth and Extinction Parameters of the Snail Kite in Florida". In order to address the aforementioned objectives, we are currently analyzing the integrated historic snail kite and apple snail data, along with pertinent data related to hydrology and vegetation, as we attempt to elucidate environmental and biological variables affecting key demographic parameters of the snail kite population.

Integrated Synthesis of Existing Data

The Florida Cooperative Fish and Wildlife Research Unit (Coop) has conducted range-wide monitoring of the snail kite population since 1992 and has a wealth of demographic and behavioral data. Dr. Darby from the University of West Florida has sampled snail densities at various sites throughout the range of the snail kite from 2002 to present; however, snail sampling is time/labor intensive and was often conducted on a limited scale to address

specific research questions, thus the historic snail data is spatiotemporally sporadic, with only a few sites sampled during multiple consecutive years. Dr. Darby has provided us the complete datasets for all snail sites sampled in WCA3A from 2002-2010 (except 2008 in which no snail sampling occurred) so our current integrated synthesis analyses will focus on historic data from WCA3A.

We linked nesting data collected by the long-term snail kite monitoring program with 44 spatiotemporally-overlapping native snail density estimates collected in WCA3A from 2002–2010. We found evidence that key components of kite breeding biology–nest density and number of young fledged per successful nest–were positively related to snail density. While previous studies have shown that capture times for individual foraging kites begin to level off as snail densities exceed approximately 0.4 snails/m2, we found continued numerical responses in these reproductive parameters at higher snail densities. At occupied sites (i.e., snail sampling sites in which ≥1 snail kite nest was present within a 2-km radius during the primary sampling period: March–May) the average snail density was 0.45 snails/m2 (SE = 0.12, n = 17), while at unoccupied sites it was 0.12 snails/m2 (SE = 0.02, n = 27). Along the snail density gradient from 0.2 to 0.4 to 1.2 snails/m2, model predictions indicated that (1) the probability of kites nesting within 2 km of a snail sampling site increases from 0.48 to 0.69 to 0.90, (2) local nest abundance of occupied sites increases from 4 to 7 to 16 nests, and (3) the probability of a successful nesting attempt fledging more than one young increases from 0.02 to 0.07 to 0.43. We found no evidence of a snail density effect on nest survival.

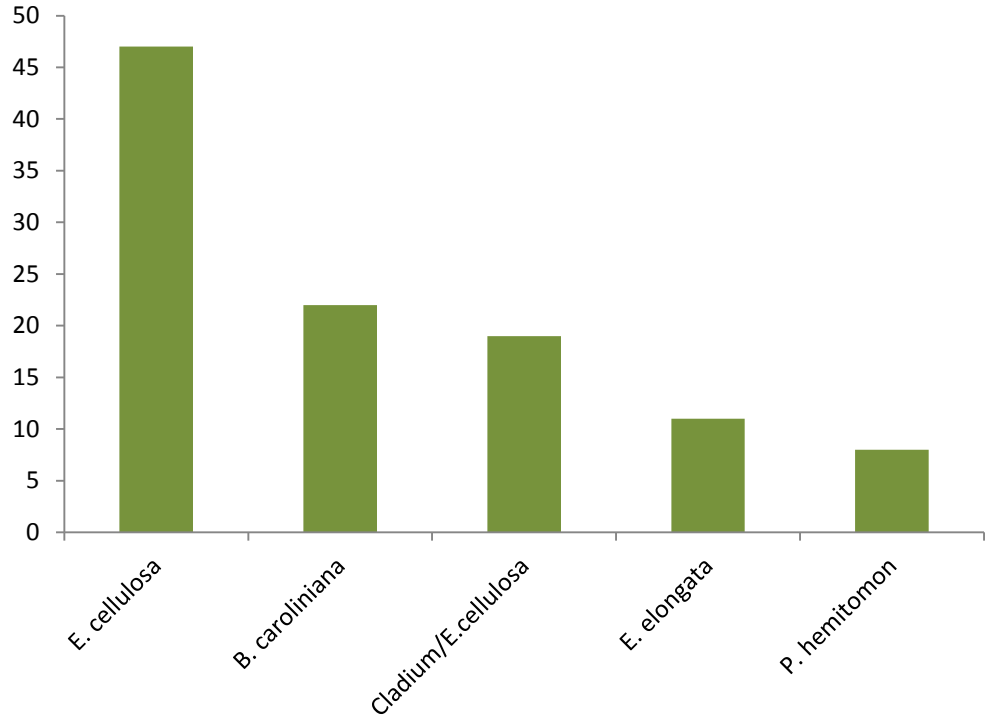
Determining the survival, movement probabilities, foraging polygons, snail capture rates, capture vegetation and nesting home ranges of kites

Foraging observations were conducted on breeding snail kites in WCA 3A throughout the 2011-2013 breeding seasons. During the observation period the length of time of each activity performed by the observed bird (perching, flying, foraging, sitting on nest, etc.) would be recorded to the nearest second. Additionally, spatial locations of perches, snail capture points, and attempted capture points were estimated using a rangefinder and digital compass. The dominant vegetation type at each was visually identified. Nests were revisited every 3-4 days, and observations were completed if the nest had not failed or fledged young. The spatial points were used to calculate 95% kernel polygons using ABODE in ArcGIS 9.3. These polygons and the associated foraging points were provided to Dr. Phil Darby, who then sampled them and determined a snail density for each polygon (2011-2012). Vegetation was sampled at various capture points from each observed nest, and snail shells underneath snail kite perches were collected and measured.

From February to May 2011, 21 nests were observed. Snail densities were estimated for four breeding snail kite home ranges.
From March to October 2012 observations were conducted on snail kites associated with 17 different nests. Snail densities were measured in WCA 3B.
From January to October 2013 observations were conducted on snail kites associated with over 50 different nests.

Additionally, vegetation sampling occurred at foraging points within each home range in 2011-2013. Analysis of 2011-2012 data shows that the dominant foraging community in both WCA3A and WCA3B was *E. cellulosa* (by more than twice the next community), followed by *B. caroliniana*, and *C. jamaicense/E. cellulosa* (Fig. 2). Using the landscape-scale data, we developed a multistate model to hindcast the availability of kite foraging habitat from 1996-2009 (Zweig and Kitchens *in press*), and in concert with the foraging data, we demonstrate that the most important kite foraging community (*E. cellulosa*) has been decreasing over time since approximately 2001.

Figure 2. Number of snail kite capture points within each of the five community clusters in WCA3A and WCA3B, 2011- 2012.



We will continue to examining the relationships between, foraging rates, home range area, vegetation communities, and snail densities.

SUMMARY:
Information gaps (identified in Figure 1) currently preclude our ability to simultaneously manage hydrology with respect to vegetation, snails and kites in WCA3A. Synthesizing and analyzing available overlapping datasets, as well as collecting additional targeted data, will help elucidate key components in this system's dynamics, which will aid management decisions for WCA3A and improve recovery planning efforts for the endangered snail kite.

Snail Kite Demography in the Upper St. Johns River Basin

Principal Investigator: **Robert Fletcher**
Funding Agency: St. Johns River Water Management District
Expected Completion: 9/30/16 (UF PJ#00105407)

The purpose of this project is to document snail kite usage and reproduction within the Blue Cypress Water Management Area (BCWMA) during the period of January 2015 to December 2015. To contextualize the findings, we also include comparisons with previous years and report additional demographic data at the scale of the whole population.

OBJECTIVES:
The objective of this work is to meet the snail kite monitoring requirement of the Biological Opinion. Data collected will also be used by staff to make appropriate water management decisions and to document changes in snail kite populations and distributions related to project construction and operation.

PROGRESS:
Fourteen surveys of BCWMA were conducted between January 2015 and December 2015, with at least one survey occurring in each month of the year. The maximum number of snail kites observed during any one survey was 12, which occurred in the middle of February 2015. A total of 3 snail kite nests were found in BCWMA during the 2015

breeding season, which is greater than the previous breeding season. There is evidence that BCWMA is important to snail kite persistence, especially when other wetlands experience droughts or drawdowns; however, its potential as a source of recruitment is less certain.

For the entire population, our recent demographic studies show the snail kite population increasing slightly over the past few years (2011-2014). Prior to 2011, snail kite numbers drastically declined from 1999-2008, with the population essentially halving from 2000 to 2002 and again from 2006 to 2008. These estimates, along with the increased number of fledglings counted during the 2011-2014 breeding seasons are encouraging trends. Overall, snail kites inhabit a network of wetlands, and the use of BCWMA has played, and will continue to play, an important role in the recovery of this endangered bird. We also make specific recommendations that may help guide management decisions aimed at increasing their population growth rate

SUMMARY:
The Upper St.John's River Basin is an integral part of the snail kite monitoring program that has allowed us to fill information gaps. The information gathered will help to improve population analysis and recovery efforts for the snail kite.

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

Principal Investigator: **Robert Fletcher**
Funding Agency: USGS
Expected Completion: 8/31/16 (RWO#274, UF PJ#00096834)
Graduate Students: Catherine Haase

Florida manatees range along the Gulf of Mexico coast from Florida to Texas and migrate to peninsular Florida for the winter. Florida manatees inhabit the northern range of their species distribution, and are therefore frequently exposed to water temperatures below their thermal comfort zone. Manatees thermoregulate by inhabiting natural and artificial warm-water sites, such as thermal outflows from power plants. There is only one artificial warm-water site along the coast of southwestern Florida, so habitat use in this region is not well understood. Preliminary work with telemetry data suggest the occurrence of naturally forming inverted thermal haloclines (trapping of warm salt water underneath cool freshwater flows), which provide thermal refuge for manatees in this area. Understanding the distribution and resource use of manatees in this area will be valuable for managing manatee habitat in the onset of power plant closures and removal of artificial warm-water sites. We will use existing data on manatee habitat use and movement to better understand resource selection of this endangered species in this region.

OBJECTIVES:
A) Identify specific resources used by manatees, including descriptions of freshwater, forage, and warm water availability in the southwestern coast of Florida
B) Using GPS telemetry, determine the extent of movements and seasonal site fidelity among identifiable manatees in these areas
C) Identify and assess warm water sites that are available for over-wintering manatees. Particular attention will focus on the mechanisms and reliability of these sites.
D) Compare habitat usage of the natural warm-water sites to artificial sites in the northern part of Florida.

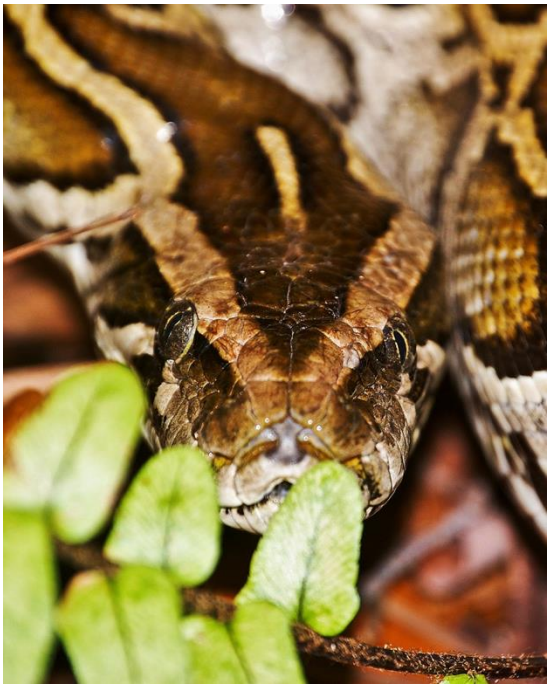
PROGRESS:
We recovered six out of seven water temperature sensors deployed in 2014 from Everglades National Park and Crystal River National Wildlife Refuge. We offloaded water temperature, salinity, and tidal data, and summarized data to compare to previous years. To determine movement responses to temperature, we used animal movement models to classify manatee behavioral states in the Everglades, and related time within each behavior to habitat and environmental covariates. Results suggest that distance between thermal and forage sites, in addition to water temperature, dictate how long manatees spend foraging during stressful water temperatures. Within non-stressful water temperatures, manatees adjust behavior time based on previous behaviors (foraging or warm-water use). We are continuing to develop habitat selection models to relate selection of forage and thermal sites to environmental, habitat, and distance measures. Finally, we plan to compare use across different thermal refuge types across the state.

SUMMARY:
Understanding resource selection in terms of thermoregulatory responses of thermally sensitive species is critically important for appropriate management aimed at recovering endangered populations. This project aims on understanding thermoregulatory use of warm-water sites and how best to implement management for the continuation of these suitable sites.

Optimal Control Strategies for Invasive Exotics in South Florida

Principal Investigator: Christina Romagosa
Funding Agency: USGS
Expected Completion: 08/14/2016 (RWO#273, UF PJ#00096829)

Within the constraints of their budgets, responsible agencies must routinely make tradeoffs inherent in controlling the spread of invasives; e.g., monitoring abundance in well-established areas vs. monitoring potential sites for colonization, eradicating large infestations vs. eradicating newly colonized sites, and monitoring populations vs. implementing control measures. There are also temporal tradeoffs that must be considered because decisions made now produce a legacy for the future (e.g., how long to wait before implementing controls). These tradeoffs can be investigated formally within the context of a decision theoretic framework, which can identify optimal actions based on management goals and constraints, available budgets and the demography of the invasive population. A key advantage of a decision-theoretic framework is the ability to make optimal decisions in the face of various sources and degrees of uncertainty, such as the rate at which an invasive will colonize new areas or the variable effectiveness of control measures. The product of this approach is a state-dependent management strategy that prescribes an optimal action for each time period for each possible state of the system. In this case, the state of the system would be characterized by extant knowledge of the spatial distribution and abundance of the target invasive. The state-dependent strategy can also be adaptive, as predicted and observed system responses are compared over time. The goal of this study is to apply decision science to the control of invasive species.



OBJECTIVES:
The goal of this study is to apply decision science to the control of invasive species. Specifically, this study will:

A) Develop a decision-making framework that has generic application for controlling invasives;

B) Parameterize that framework for illustrative purposes using relevant information on one (or several related) invasive species in South Florida; and

C) Derive an optimal control strategy for that (those) species and, if possible, evaluate its expected performance relative to control strategies being used or contemplated.

PROGRESS:
The research has been conducted principally by a postdoctoral associate, who was hired in January 2014. Work to date has focused on the extension of reaction-diffusion models to account for the effect of control actions on the growth and spread of invasive species. The model is being used to help support development of control strategies for the Burmese pythons in the Everglades. In 2015, research has/will focus on developing optimal control policies for multiple species (tegu and melaleuca) and on exploring the value information to the efficacy of control actions. A graduate-level structured decision-making course was taught by the PI and co-PI, and material from this project contributed to discussion and assignments.

One manuscript has been resubmitted to Ecological Modelling describing the new reaction-diffusion model, we hope to hear within a few weeks as to whether it was accepted.

Spatially Explicit Control of Invasive Species Using a Reaction-Diffusion Model.
Invasive species, which can be responsible for severe economic and environmental damages, must often be managed over a wide area with limited resources, and the optimal allocation of effort in space and time can be challenging. If the spatial range of the invasive species is large, control actions might be applied only on some parcels of land, for example because of property type, accessibility, or limited human resources. Selecting the locations for control is critical and can significantly impact management efficiency. To help make decisions concerning the spatial allocation of control actions, we propose a simulation based approach, where the spatial distribution of the invader is approximated by a reaction-diffusion model. We extend the classic Fisher equation to incorporate the effect of control both in the diffusion and local growth of the invader. The new reaction diffusion model that we propose accounts for the effect of control, not only on the controlled locations, but on neighboring locations, which are based on the theoretical speed of the invasion front. Based on simulated examples, we show the superiority of our model compared to the state of the art approach. We also provide a natural extension of our simulation framework that accounts for long-distance dispersal and secondary points of introduction. We illustrate the use of this model for the management of Burmese pythons in the Everglades (Florida, USA). Thanks to the generality of the new reaction-diffusion model, this framework is potentially suitable for a wide class of management problems and provides a tool for managers to predict the effects of different management strategies.

Dr. Bonneau, (post-doc) has participated in a variety of research projects on invasive species. His skills have been applied to the management of tegus and melaleuca. We are currently preparing a manuscript on the tegu work.

SUMMARY:
With the number of established exotic species now numbering well into the hundreds in South Florida, the potential impact of invasives has emerged as a high-priority issue in planning the restoration and conservation of the Greater Everglades. The problem can be framed generally as a Markov decision process for which optimal solutions can be derived, even in the face of various sources and degrees of uncertainty.

Experiential learning through wildlife research and management of invasive reptiles

Principal Investigator: **Christina Romagosa**
Funding Agency: USGS
Expected Completion: 08/30/2018 (RWO#292, UF PJ#00116791)
Personnel: Emma Hanslowe

Photo credit: Michelle McEachern. USGS. Intern Emma Hanslowe takes notes on an alligator nest within the vicinity of a radio-tagged *Tupinambis meriane*'s thermal refugia.

University programs that offer an education in wildlife ecology, conservation, and/or management are crucial for the continued conservation and management of biological resources. Graduates from these types of programs most often go into the academic (teaching and/or research) or natural resource management agency sectors. Students entering this field must have a working knowledge of many topics, such as natural history, wildlife management, ecology, critical thinking, decision-making, effective communication, research design, as well as technological and field techniques. While some of these topics can be taught in the classroom, some are best learned by experiential learning. The most effective graduates from wildlife programs are those that can link across these concepts and understand how to connect research with management, regardless of whether they are on the research or the management side. Individual research projects and agency internships can provide insight on how to best perform and communicate research to inform management, as well as providing professional field experience.

Many students emerging from wildlife programs continue their work in the states within which they were trained; therefore, some educational focus on the wildlife resources and issues within the state is necessary. Currently, Florida has more nonnative plants and animals than any state other than Hawaii, which creates a unique set of needs for training of wildlife researchers and professionals. As nonnative species introductions increase across the United States, so will the need for wildlife ecologists that are trained to address this complex issue. The Wildlife Ecology and Conservation Department (WEC) at the University of Florida has several research projects, as well as specific undergraduate and graduate courses, that have been developed to expand the knowledge base on nonnative species. Currently, there is no formal internship program within WEC to give undergraduate and graduate students the professional field experience needed to be effective wildlife researchers and professionals. The various agencies, universities and nongovernmental organizations that are currently engaged in nonnative species research and management in Florida provide an experiential-learning opportunity for students to gain field experience, and learn about resource management, and the science to inform management.

The U.S. Geological Survey is working with several federal and Florida state agencies on invasive reptile research focusing on the biology, ecology, and development of control tools for species such as the Burmese python (*Python molurus*) and tegu lizard (*Tupinambis merianae*). These species represent a serious threat to native biodiversity, including many threatened and endangered species. Currently, there is limited information on the ecology of these species in Florida and the tools available for control are

either lacking or need development. The problem of invasive reptiles will only increase over time, as more than 50 species have already established breeding populations within the state. The various projects related to these and other invasive reptile species largely depend on in-the-field work, and provides an opportunity for internships by which WEC students can participate in research and management on invasive species. The multi-agency, cross-cutting approach to these projects can help educate undergraduate and graduate students on how to bridge the research-management implementation gap, while giving them the invaluable field experience necessary to excel in their field.

OBJECTIVES:

1) Provide experiential learning opportunities with invasive reptiles to undergraduate and graduate students through a cooperative effort between UF and USGS.
2) Provide labor through internships and technicians to attain research goals for existing USGS invasive reptile research projects.
3) Increase research collaboration and research opportunities between USGS and UF researchers.

PROGRESS:

Our first intern, Emma Hanslowe, was hired in November 2014, and has recently been hired as a biological technician with our USGS team. We hired two additional interns (Sean McKnight and Alejandro Grajal) for the summer 2015 season. Work done with Emma Hanslowe has been presented at a conference, and a publication on the same work is in progress. While in her internship, Emma also published a note on two additional non-native snake species with her USGS collaborators. Eric Suarez (a current graduate student in Wildlife Ecology and Conservation), was hired in May 2015 to oversee the python diet work, a new component of our project.

Sara Moy, Kaycee Faunce, Jill Josimovich, and Molly Conway joined the intern project in August 2015-Jan 2016. Charles Calafiore, Noah Van Ee, and Katie Sykes have just begun work on the project in January. These interns tracked 30 tegus, and also performed road surveys for reptile monitoring.

SUMMARY:

Many students today enter wildlife programs with less outdoor knowledge than their predecessors, which requires a more concerted effort by these programs to fill that void to make these students competitive for future employment in academic and agency positions. The various agencies, universities and nongovernmental organizations that are currently engaged in nonnative species research and management in Florida provide an experiential-learning opportunity for students to gain field experience, learn about resource management, and the science to inform management. The USGS and UF have entered in an agreement that provides internships for students and graduates to gain experience in the field of wildlife ecology and management.

Burmese Pythons in the Greater Everglades: Movement, habitat use, impacts and control tools

Principal Investigator: **Christina Romagosa**
Funding Agency: USGS
Expected Completion: 08/16/2016 (RWO#291, UF PJ#00116762)
Graduate Student: Brian J. Smith

The establishment and spread of the nonindigenous Burmese Python (*Python molurus bivitattus*) is now a well-publicized issue facing land managers in Florida (Rodda et al. 2009). The Burmese python population is expanding steadily north and west from the core population in the southern Everglades. As a large ectothermic predator, this species poses a significant ecological risk to native wildlife (Snow et al. 2007a, Snow et al. 2007b, Dove et al. 2011), and has been implicated in the declines of mammals in this region (Dorcas et al. 2012). These large constrictors represent a management challenge as they are difficult to find due to their cryptic nature, and limited understanding of these species in the wild makes the design of a specific eradication program difficult (Reed and Rodda 2009).

While focused work has been conducted to determine the diet of the Burmese python, our understanding of daily activity, movements, home range, and general habitat-use is limited. Knowledge of seasonal movements, activity levels, and habitat preferences of invasive species, such as the Burmese python, can help inform management strategies. Given that the majority of current removal efforts involve road surveys for active pythons, generating the predictive power needed to determine when pythons are most likely to be active could significantly improve efforts to manage the invasive population. The USGS, in collaboration with University of Florida, performed preliminary work on python movements using VHF tags and GPS tags to document and characterize habitat use and movement patterns in Everglades National Park. This current project will expand on the use of GPS tags to understand Burmese python habitat use and daily activity.

OBJECTIVES:

1) Compare data collected by GPS tags to data collected by VHF tags. This objective serves to validate GPS technology as a useful method to collect daily python activity without affecting python behavior.

2) Identify the environmental factors that are most predictive of periods of activity in invasive Burmese pythons during in Everglades National Park

3) Analyze tracking and field data for specific resource-use patterns in Everglades National Park and along the invading front (Collier County)

PROGRESS:
A Master's student (Brian Smith) has nearly completed his coursework toward the completion of his degree. Hi research proposal has been approved by his committee, and he has begun to track pythons with GPS units in Everglades National Park. He currently has 7 snakes in the field that he is tracking. He is able to download data from snakes in the field if they are accessible, and he has begun to analyze those data.

SUMMARY:
Nonnative Burmese pythons have invaded Everglades National Park and have been implicated in causing severe, widespread declines in native mammals. Management of these giant constrictors has proven extremely difficult to implement and evaluate because of the species' intrinsically low detection probability (<0.01). Currently, the primary method of removal is to catch pythons opportunistically as they actively cross roads. Until more effective management methods are created, understanding daily python activity and movements can help managers optimize road surveys in order to maximize python removal rates.

Integrating Science and Management for Optimal Prevention and Control Of Aquatic Species in the Everglades

Principal Investigator: **Christina Romagosa**
Funding Agency: USGS
Expected Completion: 09/30/2017 (RWO#295)
Graduate Students: Brad Udell

With the number of established non-native species now numbering well into the hundreds in South Florida, the potential impact of invasives has emerged as a high-priority issue in planning the restoration and conservation of the Greater Everglades (South Florida Environmental Report, 2011, South Florida Water Management District). The recent biennial review of Everglades restoration by the National Research Council lauded the ongoing coordination of operational eradication efforts, but noted that there remains a lack of funding and strategic coordination, as well as no system-wide mechanism for prioritizing research and management of invasive species. (Progress Toward Restoring the Everglades: The Fifth Biennial Review, 2014, National Academies Press).

Strategic coordination of invasive species management efforts requires an understanding of the complex tradeoffs associated with the allocation of resources towards monitoring, control and research. These tradeoffs can be investigated formally within the context of a decision-theoretic framework, which can identify optimal actions based on management goals and constraints, available budgets, and the demography of the invasive population. This type of analysis is needed to help agencies in south Florida address the NRC findings.

In addition to the allocation of resources among monitoring and control efforts, we are also interested in the optimal allocation of resources for research. Such research might involve the development of better detection methods so that control can be more effective, or the investigation of potential biological control agents. The adaptive management (AM) approach we advocate essentially blends research and management into a "learn while doing" approach. In some cases, however, it may be more practical and effective to conduct basic research or management experiments in a "learn then do" approach. The relative merit of these approaches can be compared using the expected value of perfect information, which is a general method that allows one to determine the gain in performance expected from reduction or elimination of uncertainty.

While struggling to effectively manage already-established species, agencies also recognize that the most cost-effective approach to managing invasive species is prevention. Prevention can be implemented at two points along the invasion process: (1) before a non-native species is transported to a new geographic area, and (2) before a non-native species establishes a self-sustaining population. However, the approach to the importation of non-

native species, practiced in the U.S. and many other countries, is effectively an "open door" policy, where almost all species are allowed to enter until they are proved problematic.

Risk assessment for the prevention of the importation of potentially damaging species is best implemented on species that are not currently in or prevalent in trade. Unfortunately that leaves a great number of species that are already in trade, and imported in high numbers to the United States. The Greater Everglades is particularly at risk for non-native species introductions because the Port of Miami has been an important port of entry for plants and animals (~10 million invertebrates and ~ 33 million vertebrates imported annually from 1999-2010), many of which are suited to the sub-tropical/tropical climate found in southern Florida. In addition, southern Florida is also home to many plant and animal distribution centers where these imported species are kept. Due to the importance of southern Florida as a trade center for live plants and animals, many of these species have been introduced, accidentally or intentionally, into the wild. Some of these species have established populations in the Greater Everglades. Because of limited resources available to land managers to detect and address these introductions, some of these species have become problematic.

This project seeks to develop decision support tools needed to: 1) control established invasive exotic species and 2) prevent the establishment of new species by prioritizing non-native species for early detection-rapid response (EDRR) protocols based on the potential risks they pose to native species and habitats. It is formulated with the recognition that it is critical to integrate science and management into a rigorous and organized framework to make better management decisions. Our project focuses on research that will help make more efficient decisions regarding the control and prevention of invasive species in South Florida.

OBJECTIVES:
1) Working closely with regulatory agencies, we will develop decision support tools that identify the optimal allocation of resources needed to meet management objectives regarding two invasive species: tegus and melaleuca. The analytical methods developed for these case studies should help address the control of other species (e.g., Brazilian pepper).
2) Building on the outcome of the EDRR Decision Framework Technical Meeting in October 2015, we will develop a screening tool create an *a priori* list of species that will elicit immediate response should they be found in the Greater Everglades.

PROGRESS:
A postdoc with expertise on optimization (Nahid Jafari) was hired in September 2015, and another postdoc (Mathieu Bonneau) is partially supported on this project. A structured decision making workshop on the tegu resource allocation problem was held in August 2015, with participants from all agencies/institutions that currently cooperate on control and research of tegus. These agencies were the Florida Fish and Wildlife Conservation Commission, South Florida Water Management District, US Geological Survey, US Fish and Wildlife, National Park Service, Department of Interior-Office of Everglades Restoration Initiatives and University of Florida. Objectives and priorities for control of tegus were established, as well as gaps in knowledge for efficient control. The workshop is the first step toward creating an interagency tegu management plan. A manuscript is being developed from the expert elicitation exercise for estimating the current tegu population structure and population growth model. Results from the workshop were presented at the Everglades Restoration Initiatives Working Group/Science Coordination Group meeting in Oct 2015. We have also recruited a graduate student (Brad Udell) to join the project as a PhD student in Fall 2016.

SUMMARY:
This project seeks to develop decision support tools needed to:
1) control established invasive exotic species and
2) prevent the establishment of new species by prioritizing non-native species for early detection-rapid response (EDRR) protocols based on the potential risks they pose to native species and habitats.

Assessing Impacts of Invasive pythons on Gopher tortoises in Florida

Principal Investigator:
Christina Romagosa
Funding Agency: USGS
Expected Completion: 01/30/2018 (RWO#296)
Graduate Students:
Kodiak Hengestebeck

The establishment and spread of the nonindigenous Burmese Python (*Python molurus biviattus*) is now a well-publicized issue facing land managers in Florida. The Burmese python population is steadily expanding north and west from the core population in the southern Everglades. Burmese pythons are an adaptable species, and as it moves into more diverse habitats outside the Everglades, the use of new habitats and species interactions is expected.

The high water table in most of the Everglades ecosystem presents few opportunities for pythons to seek shelter below ground, as they are apt to do in their native range (Reed and Rodda 2009, Rahman et al. 2014). Southwest Florida (i.e., Collier County) includes a diverse array of upland habitats with sandy soils that are conducive to burrowing by fossorial animals. In particular, the state-designated Threatened gopher tortoise (*Gopherus polyphemus*) tortoise is a keystone species that provides significant resources for a variety other wildlife species in Florida by its construction of extensive burrows (gopher tortoise management plan 2012). These burrows serve as thermal and hydric shelters for commensal species, because of the burrow's relatively constant microhabitat and the protection it offers from fire and inclement weather. Commensal species include several species of conservation concern, such as gopher frogs (*Rana capito*); indigo snakes (*Drymarchon couperi*), Eastern diamondback rattlesnakes (*Crotalus adamanteus*), and burrowing owls (*Athene cunicularia floridana*; Jackson and Milstrey 1989, Martin and Means 2000).

As pythons invade upland habitats, they are documented to also use gopher tortoise burrows. In February 2015, a python was seen entering a tortoise burrow on Cape Sable in Everglades National Park – this is the southernmost population of gopher tortoises and pythons had not previously been seen in the area. In mid-March 2015, a large adult female python and at least six adult males were found in a breeding aggregation in an active tortoise burrow in Collier County. As these interactions increase, there will be as-yet-unknown effects on the gopher tortoise and the suite of burrow-commensal vertebrates.

OBJECTIVES:
Objectives for this project are to (1) Determine python occupancy of gopher tortoise burrows in the occupied range, (2) Examine seasonal use and behavioral interactions between pythons, gopher tortoises, and their

burrow commensals and (3) Assess burrow microhabitat as a suitable refuge for pythons north of their current range.

PROGRESS:
A MS student was recruited and began his program in Jan 2016. He is currently taking courses, and we are doing initial visits of the area to refine his research.

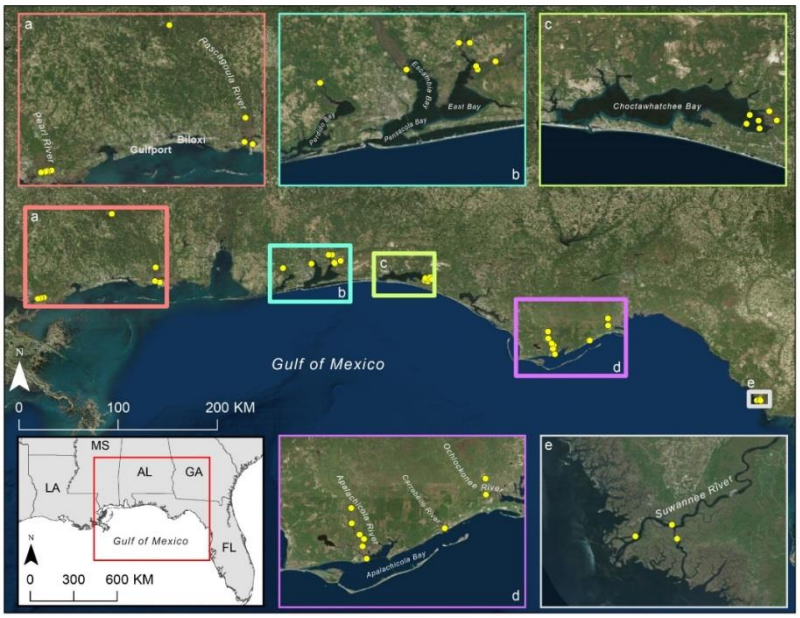
SUMMARY:
The Burmese python population is steadily expanding north and west from the core population in the southern Everglades. Burmese pythons is steadily expanding north and west into more diverse habitats outside the Everglades. Pythons are now interacting with additional species, such as the gopher tortoise, and the implications of these new interactions is unknown.

Resolving Uncertainties in Natural Mortality and Movement Rates of Gulf sturgeon using acoustic tagging data

Principal Investigator: **Bill Pine**
Funding Agency: USGS
Expected Completion: 08/31/2015 (RWO#289)
Graduate Students: Merrill Rudd

The Gulf of Mexico sturgeon (*Acipenser oxyrinchus desotoi*) or Gulf sturgeon was federally listed in 1991 by NOAA Fisheries and the U.S. Fish and Wildlife Service (56FR 49653). Though significant advances have been made in the synthesis of information for Gulf sturgeon, the 2009 Gulf Sturgeon Stock Assessment (Pine and Martell 2009) developed jointly for NOAA and USFWS identified large uncertainty in natural mortality rate estimates from life-history characteristics and traditional passive (PIT) tagging programs. This uncertainty propagates through the assessment and leads to divergent predicted population trajectories and current stock status

OBJECTIVES:
To address uncertainty in natural mortality rates, in 2009 NOAA and USFWS launched a large-scale cooperative acoustic telemetry tagging program, with the goal of tagging 20 individual sturgeon in five core rivers across the Gulf of Mexico (GOM) with long-life (5-year) acoustic tags. A large network of acoustic receivers was deployed in rivers of key management interest throughout the GOM including critical habitat rivers Suwannee, Apalachicola, Choctawhatchee, Yellow, Escambia, Pascagoula, and Pearl Rivers as well as the Ochlockonee and Blackwater rivers. River mouth receiver arrays monitor the movements of these tagged individuals into and out of their river habitats in order to improve estimates of exchange rates between management units and current estimates of natural mortality rates. This array has been tracking acoustically tagged Gulf sturgeon since fall 2010.An earlier RWO (RWO 275) facilitated our development of robust analytical techniques to evaluate the information from the acoustic array and utilize the new information to update the stock assessment and recovery plan for this species. We used a multistate model for analysis due to its ability to marine and river-specific survival rates, transition probabilities, and detection probabilities (Schaub et al. 2004, Nichols and Kendall 1995). However, these methods have not yet been applied to the full 5-year telemetry dataset as those data were not available until 2014-2015. We will apply these methods to the full 5-year data set now available.



SUMMARY:
We used our previously developed analytical approach to estimate natural mortality and movement patterns of Gulf sturgeon across the Gulf of Mexico. Our results identify high site fidelity based on natal river. We also identified higher mortality rates and lower precision for river systems in the western Gulf of Mexico (including Pearl and Pascagoula Rivers). These differences are of conservation concern.

Assessing fish responses to water releases from Glen Canyon dam

Principal Investigator: **Bill Pine**
Funding Agency: USGS
Expected Completion: 08/31/2015 (RWO#283, UF PJ#00102863)
Graduate Student: Kristen Pearson

n the Grand Canyon reach of the Colorado River, experimental flow operations as part of the Glen Canyon Dam Adaptive Management Program have been designed to restore sandbars and associated backwater habitats. Backwaters can have warmer water temperatures than other habitats, and native fish, including the federally endangered humpback chub Gila cypha, are frequently observed in backwaters, leading to a common perception that this habitat is critical for juvenile native fish conservation. However, it is unknown how fish densities in backwaters compare with that in other habitats or what proportion of juvenile fish populations reside in backwaters. In this RWO we completed work where we developed and fit multi-species hierarchical models to estimate habitat-specific abundances and densities of juvenile humpback chub, bluehead sucker Catostomus discobolus, flannelmouth sucker Catostomus latipinnis and speckled dace Rhinichthys osculus in a portion of the Colorado River. We found that densities of all four native fish were greatest in backwater habitats in 2009 and 2010. However, backwaters are rare and ephemeral habitats, so they contain only a small portion of the overall population. For example, the total abundance of juvenile humpback chub in this study was much higher in talus than in backwater habitats. Moreover, when we extrapolated relative densities based on estimates of backwater prevalence directly after a controlled flood, the majority of juvenile humpback chub were still found outside of backwaters. This suggests that the role of controlled floods, a widely discussed management action, in influencing native fish population trends may be limited in this section of the Colorado River.

Understanding how populations of federally endangered humpback chub Gila cypha respond to operations of Glen Canyon Dam is an identified research need by the Glen Canyon Dam Adaptive Management Program. This RWO also provided support to complete work where we test hypotheses concerning temporal variation in juvenile humpback chub apparent survival rates and abundance by comparing estimates between hydropeaking and steady discharge regimes over a 3-

year period (July 2009–July 2012). The most supported model ignored flow type (steady vs hydropeaking) and estimated a declining trend in daily apparent survival rate across years (99.90%, 99.79% and 99.67% for 2009, 2010 and 2011, respectively). Corresponding abundance of juvenile humpback chub increased temporally; open population model estimates ranged from 615 to 2802 individuals/km, and closed model estimates ranged from 94 to 1515 individuals/km. These changes in apparent survival and abundance may reflect broader trends, or simply represent inter-annual variation. Important findings include (i) juvenile humpback chub are currently surviving and recruiting in the mainstem Colorado River with increasing abundance; (ii) apparent survival does not benefit from steady fall discharges from Glen Canyon Dam; and (iii) direct assessment of demographic parameters for juvenile endangered fish are possible and can rapidly inform management actions in regulated rivers.

OBJECTIVES:

1) Develop appropriate statistical model and apply this model to estimate native fish density in multiple habitat types in the Grand Canyon reach of the Colorado River.

2) Estimate abundance and survival rates of juvenile humpback chub during experimental dam operations.

PROGRESS:

We published two papers in 2015 related to this project. One used hierarchical models to estimate native fish density in multiple habitat types. This work is the first to develop density estimates by habitat type of juvenile native fish in the Grand Canyon reach of the Colorado River and is important for informing management actions related to habitat creation such as experimental floods. The second paper examined patterns in abundance and survival of juvenile fish during experimental dam operations from 2009-2011. This paper documented that juvenile humpback chub are rearing in the mainstem Colorado River, an important research question that had not been assessed.

We also worked with USGS Colorado Cooperative Fish and Wildlife Research Unit staff in evaluating two manuscripts that focus on movement patterns of adult humpback chub in the Little Colorado River based on a recently developed autonomous PIT tag array. These manuscripts were published in 2015.

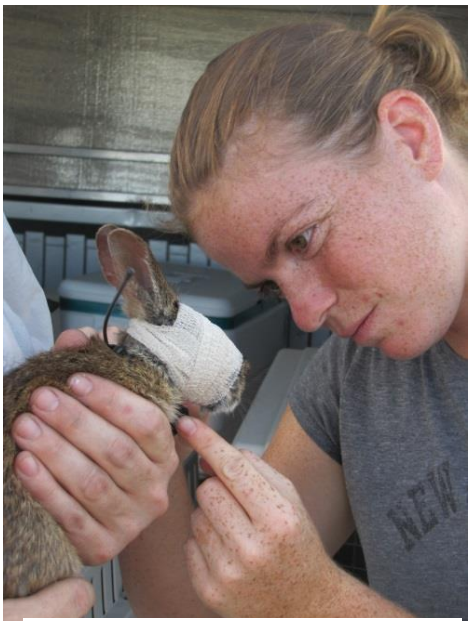
SUMMARY:

Our work also demonstrates that some individuals are surviving, growing, and recruiting in the mainstem Colorado River, a habitat formerly considered a sink for juveniles. These results are significant and demonstrate how new field efforts can inform operations of one of the most important dams in the US as well as aid in managing endangered fish populations in regulated rivers worldwide.

Translocation of Marsh Rabbits to Everglades National Park

Principal Investigator: **Robert McCleery**
CO-Principal Investigator(s): Dr. Kristen Hart, Dr. Robert Reed
Funding Agency: USGS
Expected Completion: 03/31/2015 (RWO#281 & #282, UF PJ#00101991 & #00102799)
Graduate Students: Adia Sovie
Biological Technicians: Elizabeth Dancer, Charlotte Robinson, Austin Waag, Michelle McEachern

Declines in mammal sightings in south Florida's Everglades National Park (ENP) over the last 10 years appear to correspond with the increased observations of invasive Burmese pythons (*Python molurus bivitatus*). We assessed the influence of pythons and other environmental factors on the distribution of marsh rabbits by sampling 84 randomly located plots of suitable habitat across south Florida from February 2013- May 2013. The distribution of marsh rabbits was best explained by a model with one variable, the distance from the origin of python invasion, Flamingo, FL, used to measure the influence of pythons. From this model the probability of occurrence for marsh rabbits was ≈ 0 in the vicinity of Flamingo and increased to > 0.93 150 km in any direction. In addition, we investigated the impact of pythons on marsh rabbit survival by translocating marsh rabbits to ENP. For comparisons we established two control populations in areas believed to be free of pythons. For the first control population we captured, radio-tagged and released rabbits at the site of capture. For a second procedural control population, we captured, radio-tagged, and translocated rabbits to a "python-free" site. In total, we tracked 94 marsh rabbits from 14 September 2012 to 27 July 2013. We estimated and compared known-fate survival using Kaplan-Meier survival curves and causes of mortality using cumulative incidence risk among treatments and sexes. Additionally, we used extensive systematic pellet surveys to determine that the reintroduced marsh rabbits in ENP failed to establish a self-sustaining population, despite high overwinter survival and successful breeding. The procedural control showed constantly lower survival then the other sites. Rabbits in ENP also had a significantly different survival curves than the control site (p=0.03) with ENP rabbits displaying higher rates of survival at the beginning of the study and lower rates of survival at the end of the study. Pythons were the dominant predator of our marsh rabbits in ENP, responsible for 77% (n=17) of known mortalities. In contrast, in control sites mammals were the dominant predator of rabbits, responsible for at least 50% (n=23) of mortalities. We only recorded 1 rabbit mortality from a mammal in ENP (5%). There was considerable seasonal variation in rates of survival of marsh rabbits when we consider only mortalities caused by pythons. Survival followed a distinct pattern with high weekly survival (S = 1.00) during the initial 6 week period, lower weekly survival (S = 0.98, CI 0.96-0.99) during a 30 week period of water levels below 750 cm in major sloughs or average weekly temperature below 25 °C, and low weekly survival (0.76, CI 0.59-0.86) when rabbits had been on the site > 6 weeks and temperatures > 25 °C and water levels were > 750cm. One explanation for this pattern is that high water levels concentrate rabbits on small areas of higher elevation. This, in turn, concentrates rabbit runs, latrines and other environmental cues that may have attracted pythons during times of their greatest activity. Regardless of the mechanism for this pattern, our research provides strong experimental evidence that pythons are responsible for reductions of mammals in the Greater Everglades Ecosystem. The continued removal of mammals from the system coupled with the replacement of the mammalian predator community with pythons undoubtedly has had, and will continue to have, strong cascading effects on the Everglades system.



Adia Sovie, Masters Candidate UF radio collars a marsh rabbit

OBJECTIVES:

- Evaluate the influence of environmental factors on the current distribution of marsh rabbits in south Florida.
- Reintroduce marsh rabbits to ENP and evaluate success of the population
- Quantify the impact of pythons on marsh rabbit survival in south Florida

PROGRESS:

We completed all field work for this project and have been analyzing data and publishing our results. Adia Sovie successfully submitted and defended her master's thesis in May. Additionally, we had one manuscript accepted and published in the Proceeding of the Royal Academy of Sciences and another manuscript is has been submitted

and is currently under review in Biological Invasions. We presented our results at 7 scientific conferences.

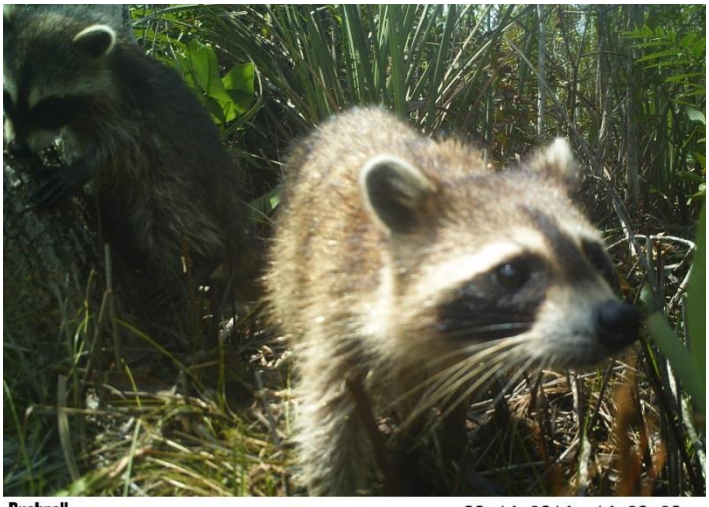
SUMMARY:

Our results provide strong empirical support for the hypothesis that pythons are the cause of mammal declines in ENP. Our models suggest that no rabbits exists in the core area of the python invasion (<60km from Flamingo) and yet in wetlands > 150 km from the epi-center of the python invasion, the probability of marsh rabbit occurrence approaches 100%.

Although the drastic changes in marsh rabbit occurrence with distance from Flamingo supports the hypothesis that pythons are responsible for mammal decline in south Florida, this relationship was correlative rather than causative. Nonetheless, our reintroduction experiment in the GEE more clearly establishes pythons as the causative agent of mammal declines. Pythons were by far the dominant predator of rabbits in ENP, accounting for 77% of overall mortalities and 89% of mortalities for which a predator could be identified. This was in stark contrast to our control sites where rabbits were not depredated by pythons, and mammalian predators accounted for 50% of all rabbit mortalities. Only one rabbit mortality in ENP could be attributed to mammals. These results were consistent with reports suggesting the python invasion has led to drastic reductions of mammalian carnivores in ENP (Dorcas et al. 2012).

Changes in Mammal Communities across the Greater Everglades Ecosystem

Principal Investigator: **Robert McCleery**
Funding Agency: USGS
Expected Completion: 03/31/2015 (RWO#281 & #288, UF PJ#00115929)
Graduate Students: Adia Sovie. Wesley Boone
Biological Technicians: Andrew Bro, Andrew Marx



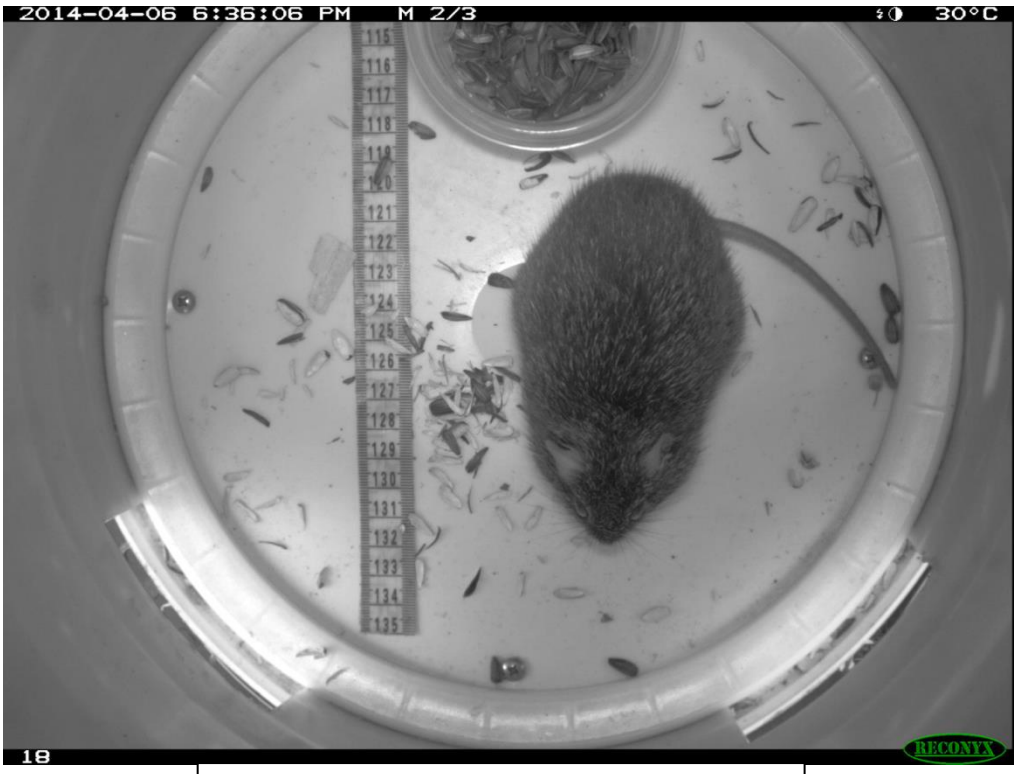
Camera trapping photo of raccoons from Loxahatchee NWR

The decline of mammal populations in Everglades National Park (ENP) and southern portions of the Greater Everglades Ecosystem GEE over the last 20 years (Dorcas et al. 2012) is likely to have a profound influence on the ecology of the Everglades system. Most evidence suggests that mammal declines are being caused by an invasion of non-native pythons that originated around Flamingo in ENP. Loxahatchee Nation Wildlife Refuge (NWR), located in Palm Beach County, encompasses ≈ 60,000 ha of remnant wetlands in the northern portion of the GEE. The southern boundary of the refuge is approximately 150 km from Flamingo and no large constrictors have yet been detected there despite monitoring since 2009. As such, Loxahatchee may have mammal communities yet to be altered by pythons. Accordingly, there is an urgent need to rigorously quantify the mammal communities with Loxahatchee NWR and lands adjacent to the refuge on the southern boundary. The areas within and adjacent to Loxahatchee NWR provide one of the few remaining opportunities to understand that baseline mammal might have looked like prior to their recent declines. Our effort constitutes the only current and rigorous effort dedicated towards understanding where and how mammal communities are changing in Loxahatchee NWR and throughout the GEE.

OBJECTIVES:

1) Establish the baseline prevalence of mammals in areas within and adjacent to Loxahatchee NWR prior to the occurrence of pythons.

2) Establish a long-term small mammal monitoring protocol to determine the population dynamics of small mammals within Loxahatchee NWR.



Cotton rat in bucket camera trap from small mammal sampling in Loxahatchee NWR

PROGRESS:

We conducted live trapped for small mammals in March and August. We trapped for 4 nights on 4 islands in Loxahatchee NWR at 74 points, accounting for 1,184 total trap nights. We captured 25 individual small mammals, totaling 47 captures. Black rats (*Rattus rattus*) were the most abundant individuals captured (12), followed by rice rats (*Oryzomys palustris*; 9) and cotton mice (*Peromyscus gossypinus*; 4). Unexpectedly, no cotton rats (*Sigmodon hispidus*) were captured at Loxahatchee NWR. Camera traps confirmed the presence of raccoons (*Procyon lotor*) and marsh rabbits (*Sylvilagus palustris*) at Loxahatchee NWR. Statistical analysis of these datasets is currently underway.

From the past 2 year of data we developed a multispecies occupancy model to understand what is shaping the patterns of mammal distribution across the Greater Everglades Ecosystem.

SUMMARY:

Mammal communities in Loxahatchee NWR differ considerably from most areas of the GEE to the south of the refuge. Preliminary data analysis suggests that there was a clear pattern of increasing mammal occurrence with increased distance from Flamingo and ENP. This pattern appeared to be particular strong with common species such as white-tailed deer, raccoon, opossum, bobcat and marsh rabbit and is consistent with previous work suggesting invasive pythons have greatly reduce mammal communities in the southern GEE.

Genomic Analysis of Peripheral Blood Cells from Sturgeon Exposed to Oil and Oil-Related Chemicals

Principal Investigator: **Dr. Nancy Denslow**
Funding Agency: USGS
Expected Completion: 12/31/2015 (RWO#279, UF PJ#00103064)

This project is a small part of a larger project that is designed to supplement on-going field investigations of potential injury to adult Gulf sturgeon from the Deepwater Horizon (MC 252) Oil Spill. The main objective of the overall project is to develop a fish health assessment for gulf sturgeon. This will be done by first conducting a controlled, laboratory exposure of a surrogate sturgeon species to MC 252 oil for generation of positive-control blood samples. The exposure of these fish to overall PAHs will be quantified chemically to know the actual dose of exposure. The blood samples will be evaluated for DNA injury via flow cytometry and for immune dysfunction by measuring genomic responses. The specific portion of the project that will be performed at UF is to develop cDNA sequence information for immune dysfunction using next generation DNA sequencers and to use this information to create a microarray to quantify the immune gene expression dysfunction. Samples from laboratory exposed surrogate sturgeon species and oil exposed gulf sturgeon species will be evaluated by the microarray.

OBJECTIVES:
The specific objectives of the project at the University of Florida are to develop cDNA sequence information for liver, kidney and blood cells of the surrogate species Atlantic sturgeon and cDNA sequence from white blood cells of gulf sturgeon and then to use the sequence to create a microarray for evaluating oil exposure in the gulf sturgeon species. The following specific objectives were developed for the project:

SOW 1. Preparation of Gulf sturgeon sequencing data
- a. Prepare normalized cDNA library from Gulf sturgeon blood samples.
- b. High throughput sequencing of the normalized cDNA from Gulf sturgeon using the 454 and the illumina massively parallel DNA sequencers at ICBR.
- c. Assembly and probe design

SOW 2. Microarray analysis
SOW 3. Verification of expression by Q-PCR
SOW 4. Reporting of the Results

PROGRESS:
Task 1: Obtain high quality RNA from Gulf Sturgeon and Atlantic Sturgeon blood and tissue samples. We have completed this task. We developed a new method to extract total RNA from red blood cells, which are nucleated in fish, which gave excellent quality of total RNA. The extraction was performed twice and then we use a clean-up column, as the final step.

Task 2: To obtain a normalized cDNA library of Gulf Sturgeon and Atlantic Sturgeon. We have completed this task. Staff at ICBR performed this part of the project. We obtained over 8,000 high quality sequences with very good annotation for the Atlantic and Gulf sturgeon.

Task 3: To annotate the Gulf Sturgeon and Atlantic Sturgeon gene sequences. We have completed this task. Dr. Fahong Yu at the ICBR was able to assemble the high throughput sequencing reads and annotate both the gulf sturgeon and atlantic sturgeon transcriptomes.

Task 4: To design and use a microarray for Gulf/Atlantic Sturgeon. We have completed this task. Dr. Fahong Yu re-designed a second “immuno” microarray for shovelnose sturgeon for the laboratory exposures matching as

much as possible with the microarray for gulf sturgeon and Atlantic sturgeon. These microarrays are enriched for the immune system.

We have completed all of the work for this project and are in the process of finalizing two papers, one on the laboratory study and one on the field study.

Laboratory study:

For this study we used a closely related sturgeon species – shovelnose, since gulf sturgeon is endangered. The objective of the study was to evaluate the effects of oil from the Deepwater Horizon spill on sturgeon in a laboratory setting using endpoints at various biological levels from the molecular to the cellular to the organ. We identified molecular pathways that were affected by the oil and potential adverse outcomes. This was a multiple laboratory study.

The USGS laboratory prepared high energy water accommodated fractions (HEWAF) of the oil, characterized the water/oil exposure media and performed the exposures for 7 or 28 days. The USGS lab also performed analyses of metabolites in fish bile and measured Cyp1A activity in the liver by EROD. The Denslow laboratory measured Cyp1A mRNA induction in the liver and performed the microarray studies and pathway analyses. This involved making total RNA from white and red blood cells and liver tissues. The RNA samples were labeled and hybridized to the oligonucleotide based microarrays. Prior to this step, the Denslow laboratory prepared the sequences for the microarray by Next Gen Sequencing and annotated the genes. Pathway studio was used to identify affected pathways. Additional Q-PCR experiments were performed with selected genes to validate the results from the microarrays.

Results:

1. Water chemistry showed that the exposures were stable over the 28 days.
2. There were no differences in liver weight, hepatosomatic index, spleen weight or spleen somatic index in fish exposed for 7 days, but there was a marked reduction in hepatosomatic index, spleen weight and spleen somatic index in fish exposed for 28 days.
3. Bile metabolites were evident in sturgeon exposed to HEWAF, again confirming the exposures. The main metabolites identified were 2-OH-FLU, 9-OH-PHE, 1-OH-PYR, 2-OH-Cry in fish exposed for 7 and 28 days. In addition 2-OH-BaP was evident in the 28 day exposed fish.
4. The EROD experiment for day 7 showed a statistically significant increase in EROD activity for the 7 day exposures but not for the 28 day exposures. Gene expression analysis corroborated the increase in Cyp1A for 7 days but also showed increased expression of Cyp1A at 28 days.
5. Microarray results suggested the following pathways were affected in the liver: drug toxicity, liver function, response to stress, carbohydrate metabolism, lipid metabolism, drug metabolism, ROS catabolism and mitochondrial protein transport.
6. In the red blood cells, the major pathways affected were G2/M transition, DNA damage and Response to DNA damage.
7. There were no statistical differences in measurements of percent of cells that were proliferating with either the 7 day or 28 day blood cells. However, DNA damage assessed via flow cytometry showed a statistically significant decrease in blood cells from exposed animals at 28 days.
8. Matching the data for DNA damage, there was significantly more DNA repair in blood cells from control animals after 28 days.
9. Pathway analysis of white blood cells showed the following perturbed pathways: neutrophil function, neutrophil recruitment, neutrophil activation, neutrophil differentiation, neutrophil adhesion and neutrophil chemotaxis.
10. Results from blood cell analysis showed that the percent of neutrophils in the white blood cell compartment increased significantly after 28 days. There was no difference at 7 days. Also there were no differences in thrombocyte percentages for either day.

Conclusions

1. Spectrofluorometry analysis can be used to estimate total extractable hydrocarbons in aqueous systems
2. Exposure to DWH HEWAF increased spleen weight, spleen somatic index, and hepatosomatic index
3. PAH metabolites could be measured in the bile of exposed shovelnose sturgeon

This paper is being finalized and will be submitted soon.

Field Study:

This study also was collaborative between USGS and the Denslow laboratory. USGS collected the fish and blood samples were analyzed by flow cytometry for a number of endpoints. The Denslow laboratory performed microarray analyses.

Results:

1. It was clear from the maps that the oil spill actually did come over the areas that the gulf sturgeon inhabits. Sturgeons normally are up in the rivers during the spring and come out into the gulf in the fall. So they would have missed the early impact of the oil. But, they would have experienced the oily waters in the fall/winter of 2010 till the spring of 2011 and then again in the fall/winter of 2011 till the spring of 2012. Samples for blood work were available for all the sampling times, however, samples for microarray were only available the second year. USGS performed the blood work analyses including hematology of white and red blood cells, and cytogenetics including DNA fragmentation, cell cycle and DNA repair protein, and the Denslow lab performed the microarray and pathway analyses.
2. Sturgeons from the following rivers were collected starting from the West towards the East: Bogue Chitto, Pascagoula, Escambia, Blackwater Yellow River, Choctawhatchee, Apalachicola, and Suwanee. In the first year, the distribution of collections was fairly even among the rivers, but in the second year, there were significantly more fish collected towards the East than towards the West.
3. There was more DNA fragmentation observed in blood samples from fish collected in the spring of 2011, after they had spent time in the gulf. There was more DNA fragmentation in fish collected in the West than in the East in year 1 and not much difference in year 2.
4. A few of the fish were captured in the fall and then recaptured in the spring. Those that were from the western most rivers showed a large increase in DNA repair variance in the spring of 2011 after they had spent 6 months in the Gulf compared to the fall of 2010 when they were first coming out into the Gulf. The variances were similar for year 2.
5. DNA repair protein was highest in the East in the fall of 2010.
6. Pathway analysis pointed to changes in the following pathways in white blood cells from animals collected in the Center compared to the East in the fall of 2011: ROS generation (upregulated), DNA damage, DNA repair (down regulated), response to DNA damage, DNA damage recognition, and DNA damage checkpoint. These pathways were similar to the data obtained from flow cytometry.
7. Pathway analysis in samples collected in the spring of 2012 (after spending 6 months in the gulf) comparing Center to East -- decrease in ROS generation, increase in DNA repair, DNA damage, response to DNA damage, DNA damage recognition, and DNA damage checkpoint.
8. There were significantly more neutrophils in the fall 2011 and these differences were mainly seen in the west and middle regions. In all rivers neutrophil percentages were higher in the second year on each of the rivers.

Conclusions:

1. Year 1 - DNA fragmentation was:
   Greater in sturgeon returning from the Gulf of Mexico
   Greater in sturgeon from western tributaries
2. DNA repair was lower in sturgeon returning from the Gulf of Mexico, especially those from the eastern region
3. Year 2 - Cell proliferation was significantly greater in sturgeon from the western tributaries as compared to those from the other two regions
4. Neutrophils were greater in sturgeon after apparent exposure, indicative of stress response
5. Recaptured individuals provide additional evidence for potential injury, based on DNA fragmentation and elevation of neutrophils in peripheral blood of Gulf sturgeon following time spent in the Gulf of Mexico
6. Gene expression patterns seemed to corroborate cell based measurements.

SUMMARY:

Studies by our USGS collaborators suggested that there was immune dysfunction and DNA repair issues in fish that were exposed to the oil from the Deep Water Horizon spill into the Gulf of Mexico. The microarray data also pointed to immune dysfunction as well as cellular injury, damage to DNA and oxidative stress. The Gulf Sturgeon are endangered and immune dysfunction and DNA damage is likely to result in major health issues for these sturgeons, possibly impacting them at the population level.

Genomic analysis of tissues from sturgeon exposed to oil and oil-related chemicals

Principal Investigator: **Dr. Nancy Denslow**
Funding Agency: USGS
Expected Completion: 12/31/2015 (RWO#286, UF PJ#00110588)

This project is a small part of a larger project that is designed to supplement on-going field investigations of potential injury to adult Gulf sturgeon from the Deepwater Horizon (MC 252) Oil Spill. The main objectives of the overall project are to develop a fish health assessment for gulf sturgeon. This will be done by first conducting a controlled, laboratory exposure of a surrogate sturgeon species to MC 252 oil for generation of positive-control blood samples. The exposure of these fish to overall PAHs will be quantified chemically to know the actual dose of exposure. The blood samples will be evaluated for DNA injury via flow cytometry and for immune dysfunction by measuring genomic responses. The specific portion of the project that will be performed at UF is to develop cDNA sequence information for immune dysfunction using next generation DNA sequencers and to use this information to create a microarray to quantify the immune gene expression dysfunction. Samples from laboratory exposed surrogate sturgeon species and oil exposed gulf sturgeon species will be evaluated by microarray.

OBJECTIVES:

SOW 1: Microarray analysis of sturgeon liver samples from fish exposed to oil compared to control fish
SOW 2: Verification of expression by Q-PCR
SOW 3: Pathway analysis of genes that are altered by oil exposures.

PROGRESS:

We have completed all of the work for this project and are in the process of finalizing a paper which incorporates data from this project along with data collected for project # 279 into the Laboratory study. The paper is summarized below.

Laboratory study:

For this study we used a closely related sturgeon species – shovelnose, since the gulf sturgeon is endangered. The objective of the study was to evaluate the effects of oil from the Deepwater Horizon spill on sturgeon in a laboratory setting using endpoints at various biological levels from the molecular to the cellular to the organ. We identified molecular pathways that were affected by the oil and potential adverse outcomes. This was a multiple laboratory study.

The USGS laboratory prepared high energy water accommodated fractions (HEWAF) of the oil, characterized the water/oil exposure media and performed the exposures for 7 or 28 days. The USGS lab also performed analyses of metabolites in fish bile and measured Cyp1A activity in the liver by EROD. The Denslow laboratory measured Cyp1A mRNA induction in the liver and performed the microarray studies and pathway analyses. This involved making total RNA from white and red blood cells and liver tissues. The RNA samples were labeled and hybridized to the oligonucleotide based microarrays. Prior to this step, the Denslow laboratory prepared the sequences for the microarray by Next Gen Sequencing and annotated the genes. Pathway studio was used to identify affected pathways. Additional Q-PCR experiments were performed with selected genes to validate the results from the microarrays.

Results:

11. Water chemistry showed that the exposures were stable over the 28 days.
12. There were no differences in liver weight, hepatosomatic index, spleen weight or spleen somatic index in fish exposed for 7 days, but there was a marked reduction in hepatosomatic index, spleen weight and spleen somatic index in fish exposed for 28 days.
13. Bile metabolites were evident in sturgeon exposed to HEWAF, again confirming the exposures. The main metabolites identified were 2-OH-FLU, 9-OH-PHE, 1-OH-PYR, 2-OH-Cry in fish exposed for 7 and 28 days. In addition 2-OH-BaP was evident in the 28 day exposed fish.
14. The EROD experiment for day 7 showed a statistically significant increase in EROD activity for the 7 day exposures but not for the 28 day exposures. Gene expression analysis corroborated the increase in Cyp1A for 7 days but also showed increased expression of Cyp1A at 28 days.
15. Microarray results suggested the following pathways were affected in the liver: drug toxicity, liver function, response to stress, carbohydrate metabolism, lipid metabolism, drug metabolism, ROS catabolism and mitochondrial protein transport.
16. In the red blood cells, the major pathways affected were G2/M transition, DNA damage and response to DNA damage.
17. There were no statistical differences in measurements of percent of cells that were proliferating with either the 7 day or 28 day blood cells. However, DNA damage assessed via flow cytometry showed a statistically significant decrease in blood cells from exposed animals at 28 days.
18. Matching the data for DNA damage, there was significantly more DNA repair in blood cells from control animals after 28 days.
19. Pathway analysis of white blood cells showed the following perturbed pathways: neutrophil function, neutrophil recruitment, neutrophil activation, neutrophil differentiation, neutrophil adhesion and neutrophil chemotaxis.
20. Results from blood cell analysis showed that the percent of neutrophils in the white blood cell compartment increased significantly after 28 days. There was no difference at 7 days. Also there were no differences in thrombocyte percentages for either day.
21. Liver analyses corroborated what was seen in the blood samples and also showed that detoxification pathways were involved.

Conclusions

4. Spectrofluorometry analysis can be used to estimate total extractable hydrocarbons in aqueous systems
5. Exposure to DWH HEWAF increased spleen weight, spleen somatic index, and hepatosomatic index
6. PAH metabolites could be measured in the bile of exposed shovelnose sturgeon

This paper is being finalized and will be submitted soon.

SUMMARY:

It is important to note that the changes seen in gene expression in the liver are similar to changes seen in white blood cells in the same animals. These animals were exposed to known concentrations of oil in a laboratory setting. These samples will serve as a comparison for the changes we see in wild Gulf sturgeon that have been exposed intermittently to oil. Data from microarrays suggests the exposure causes DNA damage and immune dysfunction.

COMPLETED PROJECTS of Florida Unit….

1. Winter Feeding Ecology of Black Skimmers on the Florida Gulf Coast,
   PI: L.D. Harris; Personnel: B. Black; Completion Date: 1981

2. Sinter Food Habits and Factors Influencing the Winter Diet of River Otter in North Florida.
   PI: L. Cooley; Completion Date: December 1983

3. Feeding Ecology of the Common Moorhen (*Gallinula Chloropus*) and Purple Gallinule *Porphyrula Martinica*) on Orange Lake, Florida. PI: R. Mulholland; Completion Date: December 1983

4. Monitoring River Otter Population: Scent Stations vs Sign Indices. PI: M. Robson;
   Completion Date: December 1983

5. Aspects of the Thermal Biology and Ecological Considerations of the Blue Tilapia.
   PI: J.A. McCann; Personnel: A.V. Zale; Completion Date: December 1984

6. Winter Food Habits & Factors Management Influencing the Winter Diet of River Otter in North Florida.
   PI: H.F. Percival; Personnel: L.S. Cooley

7. Habitat Preference of Early Life Stages of Fishes in Orange Lake, Florida With an Evaluation of Alligator Sampling Methods –Winter Ecology of Ring-Necked Ducks in North-Central FL.
   PI: H.F. Percival, J. Thul; Personnel: C.W. Jeske; Completion Date: August 1985

8. Reproductive Behavior & Florida Wild Turkey (Meleagris Gallopavo Osceola) Nesting.
   PI: L. Williams; Completion Date: December 1985

9. Evaluation of Alligator Hatchlings Removal From Wild Populations in Florida.
   PI: H.F. Percival; Personnel: M.L. Jennings, Completion Date: March 1986

10. Nest Site Selection and Habitat Use by Largemouth Bass. PI: R.W. Gregory; Personnel:
    N.A. Bruno; Completion Date: December 1984

11. Research/ Management Plan For the Crystal River West Indian Manatee Population Levy &
    Citrus Counties, FL. PI: R.W. Gregory, H.F. Percival; Completion Date: December 1983

12. Site-Specific Reduction of Manatee Boat/Barge Mortalities in Florida. PI: H.F. Percival,
    R.W. Gregory; Personnel: M.F. Kinnaird; Completion Date: May 1984

13. Mitigation of Fish & Wildlife Values in Rock-mined Areas of S. Florida. PI: R.W. Gregory,
    H.F. Percival; Personnel: R.W. Repenning; Completion Date: August 1984

14. Wildlife Values of Southeastern Bottomland Forests. PI: L.D. Harris; Completion Date: September 1984

15. The State of Knowledge of Gray Fox Harvest. PI: R.F. Labisky, S.R. Humphrey, H.F.Percival; Personnel: J.A. Hovis; Completion Date: January 1984

16. Foraging Habitat Requirements of the Red=Cockaded Woodpecker in Pine Habitats of North Florida.
    PI: R.F. Labisky; Personnel: M.L. Porter; Completion Date: September 1984

17. Habitat Suitability Index Models for Gulf of Mexico Coastal. PI: R.W. Gregory, H.F. Percival;
    Personnel: R. Mulholland; Completion Date: November 1984

18. Effect of Nutrient Leaching on Fish Spawning & Nursery Habitat in Great Lakes Nearshore Water. PI: R.W. Gregory, H.F. Percival; Personnel: L.C. Brasel; Completion Date: November 1984

19. Development of Hybrid Grass Carp Production Techniques. PI: J.V. Shireman; Completion Date: September 1984

20. Conceptual Model of Salt Marsh Management on Merritt Island, Florida. PI: C.L. Montague, H.F. Percival; Personnel: A.V. Zale; Completion: December 1984

21. Studies of Grass Carp in Aquatic Weed Control. PI: J.V. Shireman; Completion Date: October 1984

22. Factors Affecting Reproductive Success of Sea Turtles on Cape Canaveral Air Force Base. PI: R.F. Labisky; Completion Date: September 1984

23. Ecology & Management of Impounded Coastal Wetlands of the Georgia Bight. PI: C.L. Montague, H.F. Percival; Personnel: A.V. Zale; Completion: June 1985

24. Status Survey of the Rosemary Wolf Spider in Florida. PI: J. Reiskind; Completion Date: April 1985

25. Determination of the Food Habits of Manatees. PI: G.B. Rathbun, H.F. Percival; Personnel: L.A. Hurst, Completion Date: August 1985

26 Evaluation of Captive Breeding & Reintroduction of the Flroida Panther. PI: J.F. Eisenbert; Completion Date: June 1985

27. Biometrical support For GFC's Gainesville Research Laboratory. PI: H.F. Percival: Personnel: C.L. Abercrombie, T.O'Brien; Completion Date: June 1985

28. Black Bear Habitat Variables. PI: L.H. Harris, D. Maehr; Personnel: C.W. Jeske; Completion Date: July 1985

29. Status Survey of the Florida Grasshopper Sparrow. PI: M.L. Delany, H.F. Percival; Personnel: J. Cox; Completion Date: March 1985

30. Status Survey of the Schaus' Swallowtail in Florida. PI: T.C. Emmel; Completion Date: March 1985

31. Population Index & Mark/Recapture Methodology For the West Indian Manatee In Florida. PI: H.F. Percival, Completion Date: August 1985

32. Effects of Low Altitude Training Flights on Florida's Brown Pelican & Wading Bird Colonies. PI: M.W. Collopy, B.B. Black, P.G. Bohall; Completion Date: January 1985

33. Habitat Use & Management of Sherman's Fox Squirrel. PI: S.R. Humphrey; Personnel: A.T. Kantola; Completion Date: June 1986

34. Evaluation of Electro-fishing Systems for Quantitative Sampling of Blue Tilapia. PI: H. Schramm; Completion Date: May 1986

34. Pancreatic Necrosis Virus as a Pathogen of Striped Bass. PI: R.W. Gregory, W.M. Kitchens, J.V. Shireman; Personnel: S. Wechsler; Completion Date: May 1987

35. Production, Sterility, & Food Habits of Bighead Carp. PI: J.V. Shireman;

Completion Date: July 1987

36. Evaluation of Population Parameters of Black Duck. (RWO27) PI: H.F. Percival, M.J. Conroy, M. Haramis; Personnel: D.G. Krementz, B.R. Charest; Completion Date: July 1987

37. Status of the Cape Sable Seaside Sparrow in East Everglades. PI: W.R. Marion; Personnel: T.O'Meara; Completion Date: September 1987

38. Evaluation & Control of Bird Damage to Rice. PI: M. Avery, H.F. Percival, P. Lefebvre; Personnel: D. Daneke; Completion Date: December 1987

39. The Ecology & Management of Impounded Coastal Wetlands of the Georgia Bight: Workshop (RWO33) PI: C.L. Montague, H.F. Percival; Personnel: A.V. Zale; Completion Date: September 1987

40. Movement & Survival of Captive-Reared Gharials in the Narayani River, Nepal. PI: H.F. Percival; Personnel: T.M. Maskey; Completion Date: December 1988

41. Egg Viability From Four Wetlands in Florida. PI: H.F. Percival, A.R. Woodward: Personnel: M.L. Jennings; Completion Date: April 1988

42. The Ecology & Management of Hydric Hammocks (RWO24). PI: S.R. Humphrey; Personnel: S. Vince; Completion Date: July 1988

43. A Comparison of Passerine Feeding Habits in Two Tidal marsh Communities (RWO30). PI: G.W. Tanner, W.M. Kitchens; Personnel: L. Peterson; Completed: January 1989

44. Population Analysis & Roosting & Feeding Flock Behavior of Blackbirds Damaging Sprouting Rice in SW Louisiana. PI: R.R. Labisky, N.R. Holler; Completion: September 1989

45. Performance of the Female Habitat Use, Movements, Migration Patterns, & Survival Rates of Sub- Adult Bald Egles in Florida. PI: M.W. Collopy; Personnel: P.B. Wood; Completion Date: December 1991

46. Effectiveness of Wildlife Crossing Structures on Alligator Alley (I-75) For Reducing Animal/Auto Collisions. PI: S.R. Humphrey; Personnel: M.L. Foster; Completion Date:December 1991

47. Impact Assessment of Grass Delivery Program on Wading Carp (RWO34). PI: J.V. Shireman, W.M. Kitchens; Completion Date: September 1989

48. Status Survey of Three Florida Lizards (RWO35). PI: P. Moler, H.F. Percival, R.F. Labisky; Personnel: K. Enge; Completion Date: October 1986

49. Vegetation Management for Key Deer (RWO36) PI: S.R. Humphrey G.W. Tanner: Personnel: J. Wood, P. Carlson; Completion Date: December 1989

50. Status Survey of Seven Florida Mammals: Micro Cottontail Rabbit, Micro Cotton Rat, SE Beach Mouse, Goff's Pocket Gopher, Anastasia Island Cotton Mouse and Beach Mouse (RWO37). PI: S.R. Humphrey, M. Bentzien; Completion Date: July 1987

51. Relative Abundance, Size Class, Composition, & Growth Patterns of Wild Green Turtles at the Culebra Archipelago, Puerto Rico (RWO38) PI: J.A. Collazo, H.F. Percival; Personnel: T. Tallevast; Completion Date: December 1989

52. Effects of Modified Water Bird Nesting Success & Foraging Dispersion in Water Conservation.
PI: M.W. Collopy; Personnel: P.D. Frederick, Completion Date: April 1988

53. Effects of the Modified Water Delivery Program on Nest Site Selection & Nesting Success of Snail Kites in Water Conservation Area 3A (RWO40). PI: M.w. Collopy, s. Beissinger; Personnel: R. Bennett's; Completion Date: February 1988

54. Comparative Graminoid Community Composition & Structure Within the Northern Portion of Everglades Nat'l Park, NE Shark River Slough, Water Conservation Area 3A & 3B (RWO41)
PI: G.W. Tanner; Personnel: J.M. Wood; Completion Date: November 1986

55. Human/Wildlife Interaction J.N. "DING" Darling Nat'l Wildlife Refuge (RWO42).
PI: S.R. Humphrey, H.F. Percival; Personnel: M.V. Klein; Completion Date: June 1989

56. Status Survey of Two Florida Seaside Sparrows (RWO43). PI: K. McNab, V. MacDonald;
Completion Date: October 1988

57. Soil/Plant Correlation Studies in Florida (RWO46). PI: G.R. Best, W.M. Kitchens; Completion Date: March 1987

58. Reproductive cycles in Striped Bass Maintained in Recirculation Silos: Histological Analysis.
PI: L.J. Guillette, Jr.; Personnel: C.A. Goudie; Completion Date: October 1986

59. Aquatic Plant Management Technology Improvement (RWO47). PI: J.C. Joyce, W.T. Haller;
Personnel: V. Ramey, T. Willard; Completion Date: April 1988

60. Effects of Ground Water Levels Upon Reproduction success of American Crocodiles In Everglades Nat'l Park (RWO50). PI: F.J. Mazzotti; Completion Date: April 1989

61. Factors Affecting Productivity & Habitat Use of Florida SandHill Cranes: An Evaluation of Three Areas in Central Florida as Potential Reintroduction Sites for a Mommigratory Population of Whooping Cranes.
PI: M.W. Collopy; Personnel: M. Bishop; Completion: October 1988

62. Manatee Protection Project: Survey of Boat Usage Patterns. PI: J.W. Hutchinson, J.W. Alba;
Completion Date: September 1988

63. An Evaluation of Manatee Distribution Patterns in Response to Public Use Activities, Crystal River,) Florida. (RWO52) PI: W.M. Kitchens; Completion Date: December 1989

64. An Evaluation of Cumulative Impacts to the Habitat of The West Indian Manatee, Crystal River Nat'l Wildlife Refuge (RWO53) PI: W.M. Kitchens; Personnel: L.G. Pearlstine, C.Buckingham;
Completion Date: December 1989

65. Status Survey of The Florida Saltmarsh Vole (RWO54) PI: C.A. Woods; Personnel: L. Hay-Smith;
Completion Date: September 1988

66. Impact of Mosquito Control Pesticides on the Endangered Schaus Swallowtail & Related Insects in The Florida Keys (RWO56) PI: T.C. Emmel; Personnel: P. Eliazar; Completion Date: Jan 1989

67. Effects of Mosquito Control Pesticides on Non-Target Organisms in the Florida Keys (RWO57)
PI: D.H. Habeck; Personnel: M. Hennessey; Completion Date: October 1989

68. Development of Guidance Manual For Monitoring Water Quality & Vegetative Changes on Nat'l Wildlife Refuges (RWO58) PI: W.M. Kitchens; Completion Date: December 1988

69. Applicability & Comparison of Satellite Image Data to Delineation of Cover type in The Lower Suwannee River Region (RWO60) PI: W.M. Kitchens; Completion Date: December 1988

70. Distribution & Population Structure of Sea Turtles Inhabiting The Cape Canaveral Entrance Channel (RWO62) PI: A.B. Bolten, K.A. Bjorndal; Completion Date: December 1991

71. Determination of the Causes of Low Response with the Water Fowl Hunter Questionnaire & Estimation of the Resultant Biases (RWO76) PI: H.F. Percival; Personnel: R.J. Barker, P.H. Geissler: Completion Date: September 1990

72. The Ecology of Manatees in Georgia with Emphasis on Cumberland Sound (RWO65) PI: H.F. Percival, B.J. Zoodsma; Completion Date: December 1990

73. Scientific Review of Alligator Export Proposals to USFWS (RWO69) PI: H.F Percival; Personnel: P.N. Gray, F. Nunez-Garcia; Completed: July 1990

74. Fish Community Structure in Naturally Acid Florida Lakes (RWO73) PI: W.M. Kitchens; Personnel: C.A. Jennings, D.E. Canfield, Jr.; Completed: July 1990

75. Development & Application of A Habitat Succession Model For the Wetland Complex of the Savannah river Nat'l Wildlife Refuge (RWO30) PI: W.M. Kitchens; Personnel: L.G. Pearlstine, P. Latham, L. Peterson, G. Tanner; Completion Date: December 1990

76. Plant species Association Changes & Interactions Across a Gradient of Fresh, Oligohaline & Mesohaline Tidal Marsh of the Lower Savannah River (RWO30) PI: W.M. Kitchens; Personnel: P.J. Latham; Completion Date: December 1990

77. Biology of Florida's Mottled Duck. PI: H.F. Percival; Personnel: P.N. Gray; Completed: May 1992

78. Modeling Waterfowl Harvest & The Effects of Questionnaire Non-response on Harvest Estimate. PI: H.F. Percival; Personnel: R.J. Barker, J.D. Nichols; Completion Date: May 1992

79. Environmental Influences on Reproductive Potential & Clutch Viability of the American Alligator From Seven Study Sites in Florida. PI: H.F. Percival; Personnel: G.R. Masson; Completion Date: July 1992

80. Nesting Biology of the American Alligator in Florida. PI: H.F. Percival; Personnel: K.G. Rice; Completion Date: September 1992

81. Alligator Egg Viability & Population Trends on Lake Apopka, Florida. PI: H.F. Percival, L.J. Guillette, Jr.; Personnel: G.R. Masson, K.G. Rice, Completed: June 1993

82. Alligator Nest Production Estimation in Florida. PI: H.F. Percival; Personnel: K.G. Rice, A.R. Woodward; Completion Date: August 1992

83. Habitat Use By Migratory Shorebirds at the Cabo Rojo Salt Flats, Puerto Rico (RWO78) PI: J.A. Collazo, H.F. Percival; Personnel: J.S. Grear; Completion Date: August 1992

84. Wading Bird Use of Wastewater Treatment Wetlands in Central Florida (RWO83) PI: P.C. Frederick; Completion Date: December 1992

85. Evaluating The Regional Effects of Citrus Development on The Ecological Integrity of South-West Florida. PI: F.J. Mazzotti, W.M. Kitchens; Personnel: L.A. Brandt, L.G. Pearlstine; Completion Date: May 1992

86. Workshop in Florida Manatee (*Trichechus Mantus*) Population Biology (RWO88)

PI: T.J. O'Shea, H.F. Percival; Personnel: B.B. Ackerman; Completed: October 1993

87. Issues & Options Related to Management of Silver Springs Rhesus Macaques.
PI: C.L. Montague, H.F. Percival; Personnel: J.F. Gottgens; Completed: December 1993

88. Sea Turtles Inhabiting The Kings Bay, St. Mary's Entrance Channel: Distribution & Population Structure (RWO72) PI: K.A. Bjorndal, A.B. Bolten; Completed: September 1983

89. Wading Bird Nesting Success Studies in The Everglades (RWO110) PI: P.C. Frederick, Completed: December 1993

90. Captive Propagation & Restoration Ecology of The Endangered Stock Island Tree Snail (RWO94) PI: T.C. Emmel; Completion Date: October 1993

91. Status Monitoring & Experimental Reintroduction of The Endangered Schaus Swallowtail (RWO84) PI: T.C. Emmel, P.J. Eliazar, M.C. Minno; Completed: September 1993

92. Conservation Status of The Freshwater Mussels of The Apalachicola River Basin (RWO86)
PI: J.D. Williams; Personnel: J.C. Brim-Box; Completion Date: October 1993

93. Statistical Aspects of Line Transect Sampling (RWO68) PI: K.M. Portier, Completed: 1993

94. A Geographic Information System Model of Fire Damage & Vegetation Recovery in The Loxahatchee Nat'l Wildlife Refuge. PI: W.M. Kitchens; Personnel: J.E. Silveira, J.R. Richardson; Completion Date: December 1993

95. Mercury Concentrations in Blood & Feathers of Nestling Bald Eagles (RWO108)
PI: P.B. Wood; Personnel: J.H. White, A. Steffer, H.F. Percival; Completed: December 1994

96. Effects of Artificial Lighting on Nesting Adult & Hatchling Sea Turtles (RWO75)
PI: K.A. Bjorndal, A.B. Bolton; Personnel: B.E. Witherington; Completed: September 1994

97. Summary Report of Air Quality Studies Done at Chassahowitzka Nat'l Wildlife Refuge (RWO102)
PI: E.R. Allen; Completion Date: June 1994

98. Evaluations of The Efficacy of Exotics as Aquaculture & Management Species in Florida (RWO109)
PI: J.V. Shireman; Personnel: J.E. Weaver, K. Opusbynski; Completed Date: February 1994

99. Assessing The Impact of Vehicular Traffic on Beach Habitat & Wildlife, Cape San Blas, FL
PI: H.F. Percival; Personnel: J.H. Cox, Jr., S.V. Colwell; Completion Date: June 1994

100. Early Life History & Relative Abundance of Sturgeon In The Suwannee River (RWO61)
PI: J.V. Shireman, J.P. Clugston, A.M. Foster; Completion Date: October 1994

101. Distribution, Population Structure & Exploitation of Sea Turtles in The Bahamas (RWO67)
PI: K.A. Bjordnal, A.B. Bolton; Completion Date: September 1994

102. Sea Turtle Populations in The Eastern Gulf of Mexico: Biology, Distribution & Population Structure (RWO77) PI: K.A. Bjordnal, A.B. Bolten; Personnel: J.R. Schmidt; Completion Date: September 1994

103. Distribution & Status of The Red-Cockaded Woodpecker on The Eglin Air Force Base, Florida.
PI: H.F. Percival, R.J. Smith; Completion Date: March 1994

104. Factors Affecting Abundance of Spotted Sea trout & Year-Class Strength (RWO81)

PI: H.F. Percival, N.A. Funicelli, J.V. Shireman; Completion Date: June 1994

105. Re-establishment of the Anastasia Island Beach Mouse (*Peromyscus Polionotus Phasma*)
PI: S. Humphrey; Personnel: P.A. Frank; Completion Date: January 1994

106. Captive Propagation and Habitat Reintroduction for the Schaus Swallowtail Following Hurricane Andrew. PI: T.C. Emmel; Personnel: J.C. Daniels A. Sourakov, P.J. Eliazar;
Completion Date: September 1994

107. Development Abnormalities of the Reproductive System of Alligators From Contaminated & Control Lakes in Florida. PI: H.F. Percival; Completion Date: May 1994

108. Land Management Practices in the Mountain Region of Puerto Rico: Monitoring Bird Reproductively in Carite State Forest PI: H.F. Percival; J.A. Collazo;
Personnel: F. Nunez-Garcia; Completion Date: December 1995

109. Methods For Determining change in Wetland Habitats in Florida (RWO95)
PI: W.M. Kitchens; Personnel: J. Silviera, W. Bryant; Competed: September 1995

110. Population Ecology of Bartram's Ixia (RWO101)
PI: G.W. Tanner; Personnel: A. Miller; Completed: October 1995

111. Maintenance, Propagation, and Restoration of the Endangered Stock Island Tree Snail Following Hurricane Andrew (RWO106). PI: T.C. Emmel; Personnel: K.A. Schwarz, R.A. Worth, N.D. Eliazar; Completion Date:: October 1995

112. Changes in Salinity & Vegetation Following Re-establishment of Natural Hydrology on the Lower Savannah River (RWO117). PI: W.M. Kitchens; Personnel: P.J. Latham, L.P. Peterson;
Completion Date: March 1995

113. Follow-Up of a 14 Year Old Crested Wetland/Upland Landscape on Phosphate-Mined Land in Central Florida (RWO120) PI: G.R. Best, W.M. Kitchens; Completed: March 1995

114. Trends, Status & Aspects of Demography of The Red-Cockaded Woodpecker in The Sandhills of Florida's Panhandle (RWO124). PI: H.F. Percival; Personnel: J.L. Hardesty, R.J. Smith;
Completion Date: March 1995

115. Status & Distribution of The Florida Scrub Jay on Cape Canaveral, Flordia (RWO127)
PI: H.F. Percival; Personnel: J.L. Hardesty, D.B. McDonald; Completion Date: May 1995

116. Mercury Contamination in Great Egrets in Southern Florida (RWO132).
PI: P.G. Frederick; Personnel: M.G. Spaulding, M.S. Sepulveda: Completed: September 1995

117. The Acute Toxicity of Malathon to Glochidia & Freshwater Mussels (RWO133)
PI: E.J. Philips; Personnel: A.E. Keller; Completion Date: March 1995

118. The Role of Environmental Contaminants in The Prevalence of Fish Infected With A Wading Bird Parasite (RWO134). PI: D.J. Forrester; M.G. Spaulding; Personnel: D. Morrison;
Completion Date: September 1995

119. Development of an Ecologically Stable Cost Efficient Biological Water Treatment system & Technology Transfer System (RWO135) PI: J.V. Shireman; Personnel: N.A. Furnicelli;
Completion Date: September 1995

120. Status & Distribution of the Florida Scrub Jay on Cape Canaveral, FL (RWO136)

PI: H.F. Percival; Personnel: D.B. McDonald, J.L. Hardesty; Completed: October 1995

121. Disruption of Endocrine Function & Reproductive Potential By Environmental Contaminants on Lake Apopka's Alligators & Other Taxa (RWO137) PI: H.F. Percival; Personnel: L.J. Guillette, T.S. Gross, K.G. Rice; Completed: October 1995

122. The Epidemiology of Upper Respiratory Tract Disease in Desert Tortoises at Three Sites in The California Deserts (RWO138) PI: M. Brown; Personnel: I.M. Schumacher, P.A. Klein;
Completion Date: April 1995

123. The Relationships Between Host Plant & Habitat For The Distribution of Three Potentially Endangered S. Florida Butterfly Species (RWO145) PI: T.C. Emmel; Personnel: R.A. Worth;
Completion Date: September 1995

124. Snail Kite Census PI: W.M. Kitchens; Completion Date: December 1995

125. Refinement of Population Estimation Techniques For Wild Turkeys YR 3.
PI: G.W. Tanner; Completion Date: June 1995

126. Egg Viability, Sexual Development, Hatchling Viability & Growth in Alligators From Lake Apopka & Lake Beauchair. PI: H.F. Percival; Personnel: C.L. Abercrombie, A.R. Woodword, K.G. Rice;
Completion Date: July 1995

127. Mineral Interactions Between embryo, Eggshell & Substrate in Developing Sea Turtles (RWO92)
PI: K.A. Bjorndal; Personnel: A.B. Bolten, R.R. Carthy; Completion Date: August 1996

128. Ecological Correlates of Red-cock Woodpecker Foraging Preference, Habitat Use, & Home Range Area on Eglin Air Force Base, Florida (RWO99) PI: H.F. Percival; Personnel: R.J. Smith, J.L. Hardesty; Completion Date: March 1996

129. Understory Response to Longleaf Pine-Sandhill Restoration Techniques (RWO111)
PI: G.W. Tanner; Personnel: J.L. Hardesty, Completion Date: March 1996

130. Habitat Associations, Reproduction, and Foraging Ecology of Audubon's Crested Caracara in South-Central Florida (RWO114). PI: S.R. Humphrey; Personnel: J.L. Morrison, S.M. McGehee;
Completion Date: May 1996

131. Landscape Dynamics of Scrub Lizard on Avon Park Air Force Range (RWO122)
PI: L.C. Branch; Personnel: D.G. Hokit, B.M. Stith; Completion Date: September 1996

132. Post Hurricane Density & Recovery Status of the Key Largo Woodrat and Cotton Mouse (RWO123)
PI: H.F. Percival; Personnel: K. Miller, B.W. Keith; Completion Date: August 1996

133. Evaluation of Sampling and Analytical Protocols for Manatee Capture-Recapture and Telemetry Data (RWO125) PI: H.F. Percival; Personnel: L.W. Lefebvre: Completed: July 1996

134. Community Response to Restoration Techniques in Degraded Florida Sandhill Systems (RWO 128)
PI: G.W. Tanner; Personnel: D.R. Gordon, H.F. Percival; Completion Date: March 1996

135. Marine Turtle Nesting Biology & Assessment of Anthropogenic Disturbances to Hatchling Orientation at Eglin Air Force Base (RWO129) PI: H.F. Percival; Personnel L.G. Pearlstine,
Completion Date: April 1996

135. Necropsies of Ill and Dying Desert Tortoises From California and Elsewhere in The Southwestern

United States (RWO131) PI: B.L. Homer; Personnel: E.R. Jacobson, K.H. Berry;
Completed: March 1996

137. Potential Effects of Endocrine Disrupting Contaminants (RWO140)
PI: T.S. Gross; Personnel: H.F. Percival, K.G. Rice, A.R. Woodward; Completed: June 1996

138. Interactions Among Cavity Dependent Species in Longleaf Pine Forests: The Roles of Snags and Red-Cockaded Woodpecker Cavities (RWO143) PI: J.D. Harris; Personnel: R. Costa, J.J. Kappes, Jr.; Completion Date: August 1996

139. Habitat Assessment in a Landscape Context: Analysis of The Factors Affecting The Distribution & Abundance of Florida Scrub Lizard (RWO156) PI: L.C. Branch; Personnel: D.G. Hokit,
Completion Date: April 1996

140. Estimation & Environmental Correlates of Survival & Dispersal of Snail Kites in Florida.
PI: W.M. Kitchens; Personnel: P.C. Darby; Completion Date: February 1996

141. Egg Viability & Population Trends of Lake Apopka Alligators: Relation Ships Among Populations & Biographical Parameters. PI: H.F. Percival; Personnel: K.G. Rice; Completed: July 1996

142. Evaluation of S.R.46 Wildlife Crossing.
PI: H.F. Percival; Personnel: J.C. Roof, J.B. Wooding; Completion Date: May 1996

143. An Ecosystem Approach To Public Education & Information at Eglin Air Force Base (RWO107)
PI: S.K. Jacobson; Personnel: S.B. Marynowski; Completion Date: September 1997

144. Genetic Analysis of Sea Turtle Populations in The Western Atlantic Ocean With Emphasis on The Southeast United States (RWO115) PI: B.W. Bowen, A.B. Bolten; Completion Date: June 1997

145. Cape San Blas Ecological Study (RWO126)
PI: W.M. Kitchens, H.F. Percival, R.R. Carthy; Completion Date: August 1997

146. Enhancement & Evaluation of a Designated Watchable Wildlife Site (RWO130)
PI: J.M. Schaefer, S.K. Jacobson; Completion Date: January 1997

147. Research Objectives to Support The S. Florida Ecosystem Initiative-Water Conservation Areas, Lake Okeechobee & The East-West Waterways (RWO139) PI: W.M. Kitchens;
Completed: September 1997

148. Trends, Status and Aspects of Demography of The Red=Cockaded Woodpecker in the Sandhills of Florida's Panhandle, PartII (RWO146) PI: H.F. Percival, J.L. Hardesty; Personnel: K.E. Gault,
L.F. Phillips; Completion Date: March 1997

149. Use of Unionid Mussels as Bioindicators of Water Quality in Escambia Conecuh River System (RWO149) PI: E.Philps; Personnel: A. Keller; Completion Date: June 1997

150. Captive Propagation & Experimental Reintroduction of Florida's Schaus Swallowtail (RWO151)
PI: T.C. Emmel; Personnel: J.P. Hall, K.M. Wilmott, J.C. Daniels; Completed: December 1997

151. Testing & Implementation of Selected Aquatic ecosystem Indicators in The Mississippi River System, 1995: Potential Effects of Endocrine Disrupting Contaminants (RWO153)
PI: T.S. Gross; Completion Date: September 1997

152. Wading Bird Population Monitoring, Environmental Correlates of Adult Foraging Success & Measurement of Nesting Energetic Needs in The Everglades: Part I (RWO158)

PI: P.C. Frederick; Personnel: J.Surkick, J.Salantas; Completion Date: April 1997

153. Marine Turtle Conservation on The Caribbean Coast of Nicaragua (RWO171)
PI: L.J. Guillette, Jr.; Personnel: C.L. Campbell; Completed: December 1997

154. Evaluating The Ecological Role of Alligator Holes In The Everglades Landscapes.
PI: E.J. Mazzotti, H.F. Percival; Personnel: L.A. Brandt; Completion Date: December 1997

155. Two GIS & Land Use Analysis of Freshwater Mussels in The Apalachicola River Drainage (RWO164) PI: J. Mossa; Personnel: J. Howard; Completion Date: July 1997

156. Egg Viability & Population Trends of Lake Apopka Alligators. PI: H.F. Percival; Personnel: K.G. Rice; Completion Date: July 1997

157. Effect of Marine Pollution on Juvenile Pelagic Sea Turtles (RWO66) and Biology of and the Effects of Marine Debris (RWO118) PI: K.A. Bjorndal; A.B. Bolten; Completed: June 1998

158. Enhancement of Natural Dune building & Re-vegetation Processes on Santa Rosa Island (RWO159)
PI: D.L. Miller, Mack Thetford; Completion Date: August 1998

159. Pathogenic, Molecular, and Immunological Properties of Herpersvirus Associated with Green Turtle Fibropapillomatossis: Phase I Virus Isolation & Transmission (RWO161) PI: P.A. Klein; Completion Date: June 1998

160. Migrations & Habitat Use of Sea Turtles in The Bahamas (RWO166). PI: K.A. Bjornal, A.A. Bolten: Completion Date: September 1998

161. Population Genetic Structure of Marine Turtles In The Southeastern United States and Adjacent Caribbean Region (RWO167) PI: B.W. Bowen, A.L. Bass; Completed: June 1998

162. Distribution and Abundance of Sensitive Wildlife at Avon Park Air Force Base Range (RWO169)
PI: R. Franz; Completed: December 1998

163. Red-Cockaded Woodpecker Cavities & Snags in Longleaf Pine Forest: Cavity Nester Use & Nesting Success (RWO170) PI: K.E. Sieving; Completion Date: September 1998

164. Plant & Invertebrate Community Responses to Restoration Techniques In Degraded Florida Sandhills: YR3 Post-Treatment (RWO174) PI: G.W. Tanner, D.R. Gordon; Completed: July 1998

165. Demographics, Genetic Relationships & Impacts From Rd Imported Fire Ants on The Florida GrasshopperSparrow (RWO175A) PI: H.F. Percival; Completion Date: March 1998

166. Red Imported Fire Ants on The Endangered Florida Grasshopper Sparrow (RWO175B)
PI: H.F. Percival, Completion Date: June 1998

167. Wading Bird Population Monitoring, Environmental, Correlates of Adult Foraging Success & Measurements of Nestling Energetic Needs in The Everglades Phase II (RWO176)
PI: P.C. Frederick; Completion Date: April 1998

168. Population characterization of Kemp's Ridley Sea Turtles in The Big Bend Area, Gulf of Mexico, Florida Monitor, Assess, and Predict Status of Impacts to Protected Species & Their Ecosystems (RWO177) PI: R.R. Carthy; Completion Date: September 1998

169. Breeding & Reintroduction of The Endangered Schaus Swallowtail (RWO179)
PI: T.C. Emmel; Completion Date: July 1998

170. Estimating Survival & Movements in Snail Kite Population (RWO183)
PI: W.M. Kitchens, R.E. Bennetts; Completion Date: July 1998

171. Tree Island Biological Inventory: Landscape Level Assess and Determination of Island Aream Shape & Vegetation Zones (RWO184) PI: W.M. Kitchens, L.A. Brandt; Completion Date: September 1998

172. Biological Diversity in Florida: And Evaluation of Potential Species in Relation to Habitat and Existing Reserves (RWO 98) PI: W.M. Kitchens, L.G. Pearlstine, S.E. Smith, J.L. Hardy; Completion Date: September 1998

173. Improving Survey Methods and Assessing Impoundment Effects on Waterfowl Ecology at the Merritt Island National Wildlife Refuge (RWO 186) PI: R.R. Carthy; Completion Date: June 1999

174. Effects of Prescribed Fire on Soil Nutrients, Forage Quality and Plant Community Composition and on Breeding Bird Communities on the Florida Panther NWR (RWO 168) PI: M.B. Main; Completion Date: July 1999

175. Florida Gap Analysis (RWO 187) PI: L.G. Pearlstine, S.E. Smith; Completion Date: December 1999

176. Modeling and Simulation Support for ATLSS (RWO 154a) PI: P.A. Fishwick; Completion Date: December 1999

177. The Effect of Everglades Food Items (Prey) on Crocodilian Growth Development and Fertility (RWO 154b) PI: P.T. Cardielhac; Completion Date: December 1999

178. American Alligator Distribution, Thermoregulation and Biotic Potential Relative to Hydroperiod in the Everglades National Park (RWO 154c) PI: H.F. Percival, K.G. Rice; Completion Date: December 1999

179. Nesting, Growth and Survival of American Crocodiles in Northeastern Florida Bay, Everglades National Park- Phase I (RWO 178) PI: F.J. Mazzotti, L.A. Brandt; Completion Date: April 2000

180. Creation of Upland Cover Map of Florida PI: L.G. Pearlstine, W.M. Kitchens; Completion Date: August 1999

181. Orientation of Digital Aerial Images and Protocol Development PI: L.G. Pearlstine, S.E. Smith; Completion Date: April 1999

182. Produce a Manual of Sea Turtle Research and Conversation Techniques PI: K.A. Bjorndal, A.B. Bolten; Completion Date: July 1999

183. Wildlife Refuge Waterfowl Survey Database (RWO 202) PI: R.R. Carthy, E. McMichael, R. Subramaniya; Completion Date: December 2000

184. Movements, Spatial Use Patterns and Habitat Utilization of Radio-Tagged West Indian Manatees (*Trichechus Manatus*) Along the Atlantic Coast of Florida and Georgia (RWO 163)
PI: H.F. Percival, B.J. Deutsch, L.W. Lefebvre; Completion Date: July 2000

185. Pathogenic, Molecular and Immunological Properties of a Virus Associated with Sea Turtle Fibropapillomatosis, Phase II: Viral Pathogenesis and Development of Diagnostic Assays (RWO 180) PI: P.A. Klein, E.R. Jacobson, D.R. Brown, S.S. Coberly, D. Bagley; Completion Date: June 2000

186. Dry Down Tolerance of Florida Apple Snail (*Pomacea Paludosa*): Effects of Age and Season

(RWO 182) PI: H.F. Percival, P.C. Darby, Z.C. Welch; Completion Date: August 2000

187. Effects of Coastal Erosion on Nesting sea Turtles Along the Florida Panhandle (RWO 185) PI: R.R. Carthy, M.M. Lamont; Completion Date: May 2000

188. A Comparison Between the Population of the Potential Tumor-Promoting Dinoflagellate, Prorocentrum SPP and the Incidence of Fibropapillomatosis in Green Turtles (*Chelonia Mydas*) in Florida and Hawaii PI: R.R. Carthy, Y.C. Anderson; Completion Date: December 1999

189. Incubation Temperatures and Sex Ratios of Loggerhead Sea Turtles (*Caretta Caretta*) Hatched on Northwest Florida Beaches (RWO 197a) PI: R.R. Carthy, M.L. Maglothin; Completion Date: Aug. 2000

190. Biology of Nesting Sea Turtles Along the Florida Panhandle (RWO 197b) PI: R.R. Carthy, M.M. Lamont; Completion Date: August 2000

191. A Comparison Between Hawaii and Florida: The Potential Link Between the Tumor-Promoting Dinoflagellate, Prorocentrum SPP and the Prevalence of Fibropapillomatosis in Green Turtles (RWO 210) PI: R.R. Carthy, Y.C. Anderson; Completion Date: December 2000

192. Feeding Ecology and Habitat Affinities of Kemp's Ridley Sea Turtles in the Big Bend, Florida (RWO 189) PI: R.R. Carthy, J.S. Staiger; Completion Date: August 2001

193. Time Lapse Landscape Ecology: Merritt Island National Wildlife Refuge (MINWR) (RWO 189) PI: R.R. Carthy, J.B. Wooding, W.J. Barichivich; Completion Date: December 2001

194. Application of the Species at Risk Conservation for the Florida Army National Guard at Camp Blanding Training Site, Clay County, Florida (RWO 201) PI: R.R. Carthy, C.J. Gregory, A.J. Gruschke, L.G. Pearlstine; Completion Date: August 2001

195. Hydrological Characterization of the White River Basin (RWO 203) PI: W.M. Kitchens; Personnel: M.A. Craig, M.R. Wise; Completion Date: September 2000

196. A Multimodel Implementation Supporting ATLSS: Across Trophic Level System Simulation (RWO 204) PI: P.A. Fishwick; Personnel: R.M. Cubert, L.K. Dance; Completion Date: December 2001

197. Relations of Environmental Contaminants, Algal Toxins and Diet with the Reproductive Success of American Alligators on Florida Lakes (RWO 193) PI: H.F. Percival, T.S. Gross; Personnel: B. Bradford; Completion Date: August 2001

198. Further Strategies for Evaluating the Etiological Role of a Tumor-Associated Herpesvirus in Marine Turtle Fibropapillomatosis (RWO 194) PI: E.R. Jacobson, P.A. Klein; Personnel: D.A. Bagley, S.S. Coberly, R. Hirschman; Completion Date: September 2001

199. Evaluation of Desert Tortoises in and Around Fort Irwin for Exposure to a Tortoise Herpesvirus (RWO 196) PI: E.R. Jacobson, P.A. Klein; Personnel: F.C. Origgi, S. Tucker; Completion Date: April 2001

200. Response of Nesting Seat Turtles and Foraging Shorebirds to Barrier Island Dynamics (RWO 206) PI: P.C. Frederick; Personnel: J.D. Semones, R.A. Hylton, G.A. Babbitt, J.A. Heath; Completion Date: April 2002

201. Ecological Inventory of Moody Air Force Base and Surrounding Properties (Z 038) PI: W.M. Kitchens; Personnel: C.J. Gregory, M.M. Lamont; Completion Date: March 2003

202. Ecological Inventory of Moody Air Force Base and Surrounding Properties (Z 039) PI: R.R. Carthy;

Personnel: C.J. Gregory; Completion Date: March 2003

203. Large Scale Habitat Monitoring for Migratory Birds: Digital Video Mosaics in Multi-Level Images (RWO 215) PI: B.D. Dewitt, L.G. Pearlstine; Personnel: G. Trull, S.R. Gonzales, G.P. Jones, IV; Completion Date: August 2003

204. Inventory and Monitoring of the Amphibians of Everglades National Park, Big Cypress National Preserve and Virgin Islands National Park (RWO 208) PI: H.F. Percival, K.G. Rice, R.R. Carthy, J.D. Nichols; Personnel: C.D. Bugbee, M.E. Crockett, A.D. Dove, B. Jeffrey, A.J. Maskell, J.H. Waddle; Completion Date: December 2003

205. American Alligator Distribution, Thermoregulation and Biotic Potential Relative to Hydroperiod in the Everglades (RWO 199) PI: H.F. Percival, K.G. Rice; Personnel: M.D. Chopp, A.G. Finger, P. George, B. Jeffrey, M.T. Tuten; Completion Date: December 2003

206. Sereopidemiological Studies of Herpesvirus-Associated Diseases of Marine Turtles: Fibropapillomatosis and Lung-Eye-Trachea Disease (RWO 213) PI: R.R. Carthy, P.A. Klein, E.R. Jacobson; Personnel: D.A. Bagley, S.S. Coberly (Curry), R. Hirschman; Completion Date: December 2003

207. An Estimate of Population Age Structure for Gulf of Mexico Sturgeon, Acipenser O. Desotoi, on the Yellow River (RWO 214) PI: M.S. Allen; Personnel: J. Berg; Completion Date: December 2003

208. Contaminant Screening to Investigate Wildlife Mortality on Lakes in Central Florida (RWO 196) PI: H.F. Percival, J.P. Ross; Personnel: Y. Temsiripong; Completion Date: April 2003

209. Hibernation vs Migration Overwintering Strategies of Juvenile Sea Turtles in the Florida Panhandle (UF Project #00037385) PI: R.R. Carthy, E. McMichael; Personnel: R. Scarpino; Completion Date: August 2004

210. Estimation of Critical Demographic Parameters of the Florida Snail Kite During and After Drought Conditions (RWO 216) PI: W.M. Kitchens; Personnel: J. Martin, C. Cattau, C. Rich, D. Piotrowicz; Completion Date: December 2004

211. Demographic Movement and Habitat Studies of the Endangered Snail Kite in Response to Hydrological Changes (RWO 207) PI: W.M Kitchens; Personnel: J. Martin, C. Cattau, A. Bowling, D. Huser, M. Conners; Completion Date: March 2005

212. Monitoring of Wading Birds Nesting Activity in WCAS I, II and II of the Everglades and Study of Wood Stork Survival and Movements (RWO 218) PI: P.C. Frederick; Personnel: R. Hylton, J.D. Sermones, M. Bokach, J. Heath, J. Simon, K. Williams; Completion Date: March 2005

213. Evaluation of Sea Turtle Hatchling Disorientation and Assessment of Techniques for Minimizing Lighting Impacts at Tyndall AFB, Bay County Florida (RWO 217) PI: R.R. Carthy; Personnel: R. Scarpino; Completion Date: March 2005

214. Partnership in Case Studies for Training and Outreach (UF Project #00050944) PI: H.F. Percival, M. Monroe; Personnel: K. Bender; Completion Date: August 2005

215. Continued Vegetation Monitoring of the Savannah River Tidally Influenced Marshes PI: W.M. Kitchens; Personnel: K. Lindgren, Z. Welch; Completion Date: December 2005

216. Geomorphic Assessment of Channel Changes along a Modified Floodplain Pascagoula Basin, Mississippi PI: J. Mossa; Personnel: D. Coley, J. Rasmussen, R. Godfrey, A. Villegas; Completion Date: December 2005

217. Geomorphic Assessment of Channel Changes along a Modified Floodplain Pascagoula Basin, Mississippi PI: J. Mossa; Personnel: J. Williams; Completion Date: June 2006

218. Factors Affecting Population Density and Harvest of Northern Bobwhite (*Colinus Virginianus*) in Babcock/ Webb Wildlife Management Area, Charlotte County, Florida PI: H.F. Percival, R. Dimmick, M. Oli; Personnel: S. Dimmick, S. Brinkley, J. Hostetler, G. Coker, A. Brinkley, C. Jones; Completion Date: June 2006

219. Cost and Accuracy of Analysis of Gopher Tortoise Population Estimation Techniques PI: R.R. Carthy, M. Oli; Personnel: E. Langan, J. Wooding, S. Nomani, E. Cantwell, K. Miller, M. Voight; Completion Date: July 2006

220. Surveys of Snail Kite Breeding and Habitat Use in the Upper St. John's River Basin PI: W.M. Kitchens; Personnel: J. Martin, C. Cattau, A. Bowling, S. Stocco, B. Reichert; Completion Date: February 2006

221. Qualitative Analysis Supporting Reptile and Amphibian Research in Florida's Everglades PI: H.F. Percival, F. Mazzotti; Personnel: M. Miller; Completion Date: August 2006

222. Sea Turtle Habitat Use and Interactions with Humans in the Coastal Zone PI: R.R. Carthy; Personnel: R. Scarpino; Completion Date: August 2006

223. Southeastern Adaptive Management Group (SEAMG) PI: H.F. Percival, R. Dorazio, F. Johnson; Completion Date: June 2006

224. Development of Unmanned Aerial Vehicles for Assessment Wildlife Populations and Habitats Phase 2 PI: H.F. Percival, B. Dewitt, P. Ifju, L. Pearlstine; Personnel: J. Duberstein, D. Grant; Completion Date: December 2006

225. Toho V-A Proposal to Document Floral and Faunal Succession Following Alternative Habitat in a Large Central Florida Lake PI: W.M. Kitchens; Personnel: J. Brush, M. Desa, C. Enloe, J. Reyes; Completion Date: June 2006

226. Population Structure of a Loggerhead Turtle (*Caretta Caretta*) Nesting Colony in Northwestern Florida as Determined Through Mitochondrial DNA Analysis PI: R.R. Carthy; Personnel: R. Scarpino; Completion Date: April 2006

227. Conservation, Ecology and Propagation of Florida *Orchidacea Eulophia Alta* (*Linnaeus*) FA WCWRR and RENDLE PI: M. Kane; Completion Date: December 2006

228. Rapid Delineation of Provenance for Florida Sea Oats Used for Beach and Dune Stabilization PI: M. Kane; Personnel: N. Philman, P. Sleszynksi, S. Stewart, D. Dutra; Completion Date: September 2006

229. Radio Telemetry and Mark Recapture Studies of Demographic, Movement and Population Dynamics of Endangered Snail Kites (RWO 221) PI: W.M. Kitchens; Completion Date: March 2006

230. Wading Bird Colony Local, Sizing, Timing, & Wood Stork Nesting Success Cost & Accuracy PI: P. Frederick; Completion Date: October 2006

231. Development of Unmanned Aerial Vehicles for Assessment of Wildlife Population and Habitat Phase 2 PI: H.F. Percival; Personnel: A. Watts, S. Bowman; Completion Date: December 2006

232. Assessing Belowground Consequences of Forest Dieback and Climate Change in Coastal Cypress Swamps PI: H.F. Percival; Completion Date: July 2006

233. Vegetative Habitat Responses to Hydrological Regimes in Everglades Water Conservation Area 3A
PI: W.M. Kitchens; Personnel: C. Zweig, E. Powers, T. Hotaling, S. Fitz-William;
Completion Date: September 2006

234. Gopher Tortoise Population Estimation Techniques PI: R.R. Carthy; Personnel: E. Langan, J. Wooding, S. Nomani; Completion Date: May 2006

235. Floral and Faunal Succession Following Alternative Habitat Restoration Techniques in a Large Central Florida Lake (PJ50773) PI: W.M. Kitchens; Personnel: Melissa Desa, C. Enloe, B. Shoger, A. Schwarzer; Completed: June 2007

236. American Alligator Distribution, size, and Hole Occupancy and American Crocodile Juvenile Growth and Survival (RWO225) PI: H.F. Percival, Frank Mazzotti; Personnel: M Cherkiss; Completion Date: April 2007

237 Radio Telemetry & Mark Recapture studies of Demography, Movement & Population Dynamics of The Endangered Snail Kite (53729) PI: W.M. Kitchens; Personnel: C.Cattau, A.Bowling: Completed December 2006

238. Continued Snail Kite Monitoring Studies: Population Growth, Extinction, and Movement Patterns. (RWO231) PI: W.M. Kitchens; Completion Date: November 2007

239. Status, Ecology, Propagation Science & Recovery of Imperiled FL Orchidaceous: Habenaria Distans. PI: M. Kane: Completed Date: November 2007

240. Update Marsh Succession Model & Provide Technical Assistance Savannah Harbor Expansion (60411) PI: W.M. Kitchens; Completion Date: April 2006

241. St. George Island Lighting Project. PI: R.R. Carthy; Completion Date: July 2006.

242. Vegetation Habitat Responses to Hydrologic Regimes In Everglades Water Conservation Area 3A
PI: W.M. Kitchens, C. Zweig; Personnel: T. Hotaling, P. Wetzel, S. Fitz-Williams
Completion Date: March 2008 (53972)

243. American Alligator Distribution, Size, and Hole Occupancy & American Crocodile Juvenile Growth and Survival. PI: H.F. Percival, F.J. Mazzotti; Completion Date: June 2007 (50174)

244. Conservation, Ecology & Propagation of Florida Orchidaceae-Eulophia alta and Cyrtopodium punctatum. PI: M. Kane; Personnel: T. Johnson, D. Dutra Completion Date: December 2007

245. Snail Kite Population Studies: Demography, Population Trends, and Dispersal Relative to Environmental correlates, and Habitat Sudies PI: W.M. Kitchens. Completion Date: February 2008

246. Lake Apopka North Shore Restoration Area Alligator Monitoring Study. PI: H. Franklin Percival.
Co-PI: R. Carthy. Personnel: R. Throm, E. Lamivee. Completion Date: February 2008.

247. Lake Apopka North Shore Restoration Area Amphibian Monitoring Study. PI: Raymond R.Carthy
Co-PI:H.F. Percival. Personnel: R. Throm, E. Lamivee. Completion Date: February 2008.

248. Continued Snail Kite Monitoring Studies: Demographic, Population Growth, Extinction and Movement Parameters. PI: Wiley M. Kitchens. Personnel: B. Reichert, C. Cattau, A. Bowling. Completion Date: March 2008.

249. Status, Ecology, and Conseration of Rare and Endangered Florida Orchidaceae-Bletia purpurea. PI: M. Kane. Personnel: S. Stewart, T. Johnson, d. Dutra, P. Kauth. Completion Date: June 2008.

250. Radio Telemetry and Mark-Recapture Studies of Demographic, Movement and Population Dynamics of the Endangered Snail Kit. PI: W.M. Kitchens. Personnel: Br. Reichert, C. Cattau, A. Bowling. Completion Date: June 2008

251. Technical Assistance for Continuing Development of Content for Focal Species Website and Bird Conservation Node Website. PI: H. F. Percival. Personnel: E. Martin, A. Schwarzer. Completion Date: July 2008.

252. Evaluating Endocrine Disruption in Fish Exposed to Waters at Turkey Creek. PI: N. Denslow; Co-PI: N. Sazbo. Personnel: R. Weil, I. Knoebl. Completion Date: September 2008.

253. Assessment of Beach Compaction and Associated Effects on Loggerhead Sea Turtles (Caretta caretta) Nesting on Natural and Nourished Beaches in Northwest Florida. PI R. Carthy; Co-PI: M. Lamont; Personnel: Lori Brinn, J. Solis. Completion Date: September, 2008.

254. Effects of Environmental Mercury Exposure on Development and Reproduction in White Ibises. PI: P. Frederick; Personnel: N. Jayasena. E. Adams, L. Straub, B.J. Sampson. Completion Date: September 2008

255. ERDC Participation in 2008 USACE UAS Program. PI: H.F. Percival. Co-PI: P. Ifju, B. Dewitt, S. Smith. Personnel: A. Watts, J. Perry, W. Bowman, M. Morton. Completion Date: September 2008.

256. An Assessment of the Use of Unmanned Aerial Systems for Surveys of Wading Birds in the Everglades. PI: P. Frederick. Personnel: A. Watts, A Abd-Elrahman, A. Mohamed, B. Wilkinson, J. Perry, K. Lee, Y. Kaddoura. Completion Date: September 2008.

257. St. Joseph Peninsula Beach Restoration Project. PI: R. Carthy, Co-PI: M. Lamont. Personnel: F. Solis, J. Solis, M. Weisel, C. Warner. Completion Date: October 2008.

258. To Document Floral and Faunal Succession Following Alternative Habitat Restoration Techniques in a Large Central Florida Lake Tohopekaliga. PI: W.M. Kitchens; Personnel: Melissa DeSa, Zach Welch Carolyn Enloe, Brad Shoger, Amy Schwarzer. Completion Date: December 2008.

259. Adaptive Habitat Management for Florida Scrub-Jays at Merritt Island National Wildlife Refuge. PI: H. F. Percival; Co-PI: F. Johnson. Completion Date: December 2008.

260. Assessing the Effects of Coastline Alteration on Sea Turtle Nesting and Faunal Assemblages at Cape San Blas, Florida. PI: R. Carthy, Co-PI: M. Lamont, Personnel: R. Scarpino, C. Warner, J. Solis, F. Solis Michelle Weisel, L. Brinn. Completion date: March, 2009.

261. Development of a Sea Turtle Education Program for Gulf County, FL. PI: R. Carthy. Co-PI: M. Lamont. Completion Date: March 2009.

262. Regional Distribution of Soil Nutrients – hierarchical Soil Nutrient Mapping for Improved Ecosystem Change Detection. PI: T. Osborne. Co-PI: M. Cohen. Personnel: S. Lamsal, B. White. Completion Date: March 2009.

263. Monitoring of Wading bird Reproduction in WCAS 1, 2, and 3 of the Everglades – UAV. PI: H. F. Percival. Personnel: A. Watts, J. Perry, M. Burgess, S. Ingley. Completion Date: March 2009.

264. Science Fellowship for Assessment of Coastal Habitats and Listed Species. PI: Raymond R. Carthy

Co-PI: M. Lamont. Completion Date: April 2009.

265. Historic Pond Restoration in the Florida Panther National Wildlife Refuge. PI: C. Reinhardt-Adams. Co-PI: M. Kane. Personnel: S. Stewart, D. Watts, N. Steigerwalt, C. Wiese, S. McCauley. Completion Date: May 2009.

266. Rapid Delineation of Provenance for Florida Sea Oats Used for Beach and Dune Stabiliation. PI: M. Kane. Personnel: N. Philman, P. Sleszynski, S. Stewart, D. Dutra. Completion Date: June 2009.

267. Ecology and Conservation of Snowy Plovers In the Florida Panhandle. PI: Steven Johnson. Completion Date: June 2009

268. Wildlife Usage and Habitat Development on Spoil Islands in Lake Tohopekaliga, Florida. PI: W. M. Kitchens Personnel: Melissa DeSa, Carolyn Enloe, Brad Shoger, Amy Schwarzer, Jonathan Chandler. Completion Date: August 2009.

269. Techniques for Field Establishment and Reintroduction of Calopogon tuberosus var. tuberosus. PI: M. Kane. Co-PI: P. Kauth. Completion Date: August 2009.

270. Conservation of South Florida's Orchids—Developing Reintroduction Methods for Eight Native Species Including the State Endangered Ghost Orchid (Dendrophylax lindenii). PI: M. Kane. Personnel: D. Dutra, P. Kauth, T. Johnson, N. Philman. Completeion Date: August 2009.

271. Wading Bird Colony Location, Size, Timing and Wood Stork Nesting Success. PI: P. Frederick. Personnel: J. Simon, K. Williams. Completion Date: September 2009.

272. Development of Unmanned Aerial vehicles for Assessment of Wildlife Populations and Habitats: Phase 3. PI: H.F. Percival; Co-PI: P. Ifju; Personnel: M. Burgess. Completion Date: December, 2009.

273. Experimental Evaluation of a Habitat Enhancement Project for Fish and Wildlife at Gant Lake, Florida. PI: W.M. Kitchens: Co-PIs: M. Allen, H.F. Percival. Completion Date: December, 2009.

274. Structured Decision Making, Ecological Thresholds and the Establishment of Management Trigger Points. PI: W.M. Kitchens. Research Staff: J. Martin. Completion Date: December 2009.

275. An Assessment of Gulf Sturgeon Population Status in the Gulf of Mexico. PI: W. Pine. Research Staff: H. Jared Flowers. Completion Date: December 2009.

276. Spectral and response Assessment of Turtle-Friendly Lighting Study. PI: R. Carthy. Co-PI: M. Lamont. Research Staff: F. Solis, J. Solis. Completion Date: April 2010.

277. Supplement to "Directing Succession Through Adaptive Management in National Wildlife Refuges: Reed Canary. PI: C. Reinhart-Adams. Research Staff: L. Cobb, D. Haskell. Completion Date: July 2010.

278. Factors Affecting Population Density & Harvest of Northern Bobwhite. PI: M. Clark. Co-PI: T. Osborne. Graduate Student: D. Watts. Research Staff: T. Oh, J. Vogel. Completion Date: September 2010.

279. Ridge-Slough Mosaic in Response to Climate Change and Water Management. PI: M. Clark. Co-PI: T. Osborne. Graduate Student: D. Watts. Research Staff: T. Oh, J. Vogel. Completion Date: September 2010.

280. Adaptive Management of Gulf Coast Salt Marshes Considering the Sea Level Rise and Recovery of the Endangered Florida Salt Marsh. PI: F. Percival. Research Staff: M. Burgess. Completion Date: September 2010.

281. Surveys of Snail Kite Breeding and Habitat Use in the Upper St. Johns River Basin. PI: W. Kitchens. Graduate Students: J. Olbert, K. Pias. Completion Date: December 2010.

282. Monitoring of Wading Bird Reproduction In WCAs 1,2,3 of the Everglades. PI: P. Frederick. Research Staff: J. Simon, C. Winchester, L. Venne. Completion Date: December 2010.

283. Gopher Tortoise Population Survey for St. Marks NWR- Line Transect Distance Sampling. PI: R. Carthy. Co-PI: M. Lamont. Completion Date: August 2011.

284. Population Genetic Analysis and Assessment of Hybridization between Calopogon tuberosus var. tuberosus and var. Simsonii. PI: M. Kane. Co-PI: P. Kauth. Completion Date: August 2011.

285. Interplanting of Grass Species Among Native Vegetation to Reduce or Eliminate Aircraft Bird Strike Incidence by Dove at Hurlburt Field. PI: Bill Pine. Completion Date: September 2011.

286. Strategic Habitat Conservation for the Florida Scrub-Jay at Merritt Island National Park. PI: Franklin Percival. Research Staff: M. Walters, F. Johnson. Completion Date: September 2011.

287. Assessing Natal Sources of Juvenile Native Fish in Grand Canyon: A Test with Flannelmouth Suckers and Other Native Fish. PI: Bill Pine. Completion Date: September 2011.

288. St. Joe Beach Restoration. PI: R. Carthy. Research Staff: S. Farris, C. Hackett, M. Lamont, J. McKenzie, B. Stephens. Completion Date: January 2012.

289. Effects of Climate Change on Barrier Island Habitat and Nesting Sea Turtles. PI: R. Cathy. Co-PI: M. Lamont. Research Staff: A. Daniels, J. Gross, J. Hill, J. Kime, E. Nordberg, H. Ronco, N. Williams, B. Stephens, S. Farris. Completion Date: May 2012.

290. Directing Succession Through Adaptive Management in National Wildlife Refuges: Reed Canary Grass Control and Transition to Wetland Forests and Meadows. PI: C. Reinhart-Adams. Co-PI: S. Gatowitsch, E. Lonsdorf, F. Percival. Completion Date: July 2012

291. Foraging & Nesting Habitat Characteristics, Exotic snail utilization and nest failures of the Everglade Snail kite on the Kissimmee Chain of Lakes. PI: W. Kitchens. Research Staff: K. Pias, J. Olbert. Completion date: December 2012.

292. Nesting, Recruiting, and Foraging Ecology of the Florida Snail Kite in Lake Tohopekaliga. PI: W. Kitchens. Research Staff: K. Pias, J. Olbert. Completion Date: March 2013.

293. The Effects of Shoreline Armoring Structures on Nesting Loggerhead turtles. PI: R. Carthy. Completion Date: March 2013.

294. Incubation temperatures of loggerhead turtle (caretta caretta) nests on NW Florida Beaches. PI: R. Carthy. Research Staff: M. Lamont, B. Stephens. Completion Date: March 2013.

295. A Land of Flowers on a Latitude of Deserts: Aiding Conservation Management of Florida's Biodiversity by Using Predictions from Down-Scaled AOGCM Climate Scenario in Combination with Ecological Modeling. PI: F. Percival. Research Staff: C. Zweig. Completion Date: May 2013

296. Alligator Capture Database. PI: Franklin Percival. Research Staff: A. Subramaniam Ravi. Completion Date: June 2013.

297. SE Adaptive Management Group (SEAMG). PI: Franklin Percival. Completion Date: June 2013

298. Collection of Digital Aerial Imagery in Support of Aquatic Invasive Species Program and CERP. PI: F. Percival. Research Staff: M. Burgess. Completion Date: June 2013.

299. Socio-Cultural Constructions of Values and Attitudes Toward Wildlife and Nature: Attracting Underrepresented Groups to Wildlife Professions. PI: S. Jacobson. Research Staff: N. Haynes. Completion Date: June 2013.

300. Management of Functionally Connected Dune Habitat for Endangered Beach Mice on Fragmented Landscapes. PI: L. Branch. Co-PI: D. Miller, M. Stoddard. Completion Date: July 2013.

301. Reassessing the status of the endangered Florida salt marsh vole, Phase 1 & 2. PI: R. McCleery. Completion Date: September 2013

302. Coastal ecosystems and Climate Change: Effects on Habitat and Species. PI: R. Carthy. Completion Date: December 2013.

303. Translocation of Marsh Rabbits to Everglades National Park. PI: R. McCleery. Completion Date: December 2013.

304. Remote sensing of nesting sea turtle tracks: development and application of computer vision algorithms.PI: R. Carthy. Completion Date: April 2014.

305. Loggerhead Nest Content Collection to Determine Impacts from the Deepwater Horizon Spill PI: R. Carthy. Completion Date: July 2014

306. Conduct f feasibility study to evaluate the use of Unmanned aerial systems imagery payload for fine scale aerial survery. PI: F. Percival. Completion Date: September 2014

306. Using an Unmanned Aircraft systems payload to evaluate fine-scale remote sensing data for emergent and slough automated vegetation mapping PI: F. Percival. Completion Date: September 2014.

307. Effects of Coastal Dynamics & Climate on Loggerhead Turtle Nest Success & Management PI: R. Carthy. Completion Date: September 2014.

308. Nesting Loggerhead Turtles on the St. Joseph1 Peninsula, FL. PI: R. Carthy. Completion Date: December 2014

Publications 2015

Reichert, B.E., C. E. Cattau, R. J. Fletcher, Jr., P. W. Sykes, Jr., J. A. Rodgers, Jr. and R. E. Bennetts. 2015. Snail Kite (Rostrhamus sociabilis), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/171 doi:10.2173/bna.171

Wilcox, R.C. 2015. Foraging preference and the links between foraging behavior and habitat quality of the endangered snail kite (*Rostrhamus sociabilis plumbeus*). M.S. Thesis, University of Florida, Gainesville

Finch, C., Pine, W.E., Yackulic, C.B., Dodrill, M.J., Yard, M., Gerig, B.S., Coggins, L.G. and Korman, J., 2015. Assessing juvenile native fish demographic responses to a steady flow experiment in a large regulated river. *River Research and Applications*.

Dodrill, M.J., Yackulic, C.B., Gerig, B., Pine, W.E., Korman, J. and Finch, C., 2015. Do management actions to restore rare habitat benefit native fish conservation? Distribution of juvenile native fish among shoreline habitats of the Colorado River. *River Research and Applications*.

McCleery, R. A, A.R. Sovie, R. Reed, M. Cunningham, M. Hunter, K. Hart. 2015. Marsh Rabbit Mortalities Tie Pythons to the Precipitous Decline of Mammals in the Everglades. Proceedings of the Royal Society B: 282:20150120.

Presentations 2015

Burgess, M.A., H.F. Percival, R.R. Carthy, P.G. Ifju, B.E. Wilkinson, T.J. Whitley, T.S. Ward, J.G. DiRodio, S.E. Smith, A.H. Abd-Elrahman, and P.C. Frederick. The University of Florida Unmanned Aircraft Systems Research Program: an update on selected natural resources applications and lessons learned. Invited slide presentation. The 2015 U.S. Geological Survey National Workshop on Unmanned Aircraft Systems (UAS). Reston, Virginia. May 2015.

Burgess, M.A., T.J. Whitley, T.S. Ward, R.R. Carthy, B.E. Wilkinson, J.G. DiRodio, P.G. Ifju, S.E. Smith, P.C. Frederick, A.H. Abd-Elrahman, C.L. Zweig, S. Newman, M.I. Cook, and H.F. Percival. The use of small unmanned aircraft systems for natural resources: lessons learned, and selected applications by the University of Florida Unmanned Aircraft Systems Research Program (UFUASRP). Slide presentation and static display. Florida Cooperative Fish and Wildlife Research Unit Annual Coordinating Committee Meeting. Gainesville, Florida. May 2015.

Burgess, M.A., C.L. Zweig, S. Newman, M.I. Cook, H.L. Rodgers, R.R. Carthy, B.E. Wilkinson, T.J. Whitley, T.S. Ward, J.G. DiRodio, P.C. Frederick, P.G. Ifju, S.E. Smith, and H.F. Percival. Applications of high-resolution aerial imagery and a small unmanned aircraft system in Everglades science. Invited slide presentation. Special session title: 'Advancing Technologies in Everglades Ecosystem Restoration'. The 2015 Greater Everglades Ecosystem Restoration Conference. Coral Springs, Florida. April 2015.

Burgess, M.A., R.R. Carthy, B.E. Wilkinson, T.J. Whitley, T.S. Ward, J.G. DiRodio, P.C. Frederick, P.G. Ifju, S.E. Smith, A.H. Abd-Elrahman, and H.F. Percival. The use of small unmanned aircraft systems for natural resources: lessons learned, and selected application by the University of Florida Unmanned Aircraft Systems Research Program (UFUASRP). Invited slide presentation. University of Florida Wildlife Techniques course (WIS 6934), and Remote Sensing Applications Geomatics course (SUR 5385). Gainesville, Florida. April 2015.

Burgess, M.A., R.R. Carthy, B.E. Wilkinson, T.J. Whitley, T.S. Ward, J.G. DiRodio, P.C. Frederick, P.G. Ifju, S.E. Smith, A.H. Abd-Elrahman, and H.F. Percival. The University of Florida Unmanned Aircraft Systems Research Program: lessons learned and an update on selected natural resources applications. Invited slide presentation and panel. Session titled: 'Recent Developments in the Use of Unmanned Aviation Systems (UAS) for Scientific Research'. The 2015 George Wright Society Biennial Conference on Parks, Protected Areas, and Cultural Sites. Oakland, California. March 2015.

Cronin, A., A. Wynn, B. Smith, N. Bishop and R.R. Carthy. 2015.Potential for ghost crab predation on sea turtle nests on driving and non-driving beaches in St. Johns County, Florida.100th Meeting, Ecological Society of America, Baltimore, Maryland, 9-14 August 2015.

Goforth, K.M. and R.R. Carthy. 2015. Effects of tidal pumping on gas exchange in sea turtle nesting beaches. Florida Undergraduate Research Conference, Daytona Beach, FL., 27-28 February, 2015.

Haase, Catherine G., Daniel H. Slone, James P. Reid, and. Robert J. Fletcher, Jr. 2015. Influence of the spatial distribution of water temperature on manatee behavioral decisions. USGS Florida Cooperative Fish and Wildlife Unit Coordinating Committee Meeting. Gainesville, FL. Poster Presentation.

Haase, Catherine G., Daniel H. Slone, James P. Reid, and. Robert J. Fletcher, Jr. 2015. Influence of previous states and the spatial distribution of water temperature on manatee behavior. The Florida Chapter of the Wildlife Society. Jacksonville, FL. Poster Presentation.

Lavelle, C., Mehinto, A., Jenkins, J.A, Olivier, H. M., Alvarez, D. A., Denslow, N.D., Tillitt, D. E. Transcriptomic and Cell Process Pathways Altered by Laboratory Exposure of Shovelnose Sturgeon to Oil from the Deepwater Horizon Event. Platform presentation, SETAC, 36th Annual Meeting, Salt Lake City, Utah, Nov. 1-5, 2015, Abstract # 391, p107.

McCleery, R. A. 2015. Rabbits reveal south Florida's conservation challenges. 2015. Auburn University School of Forestry and Wildlife, seminar series. (Invited Seminar).

McCleery, R. A. 2015. Understanding the loss of mammals in the greater Everglades, U.S. Fish and Wildlife Service Field Office, Vero Beach, FL. (Invited Seminar).

McCleery, R. A., A. Sovie, R. Reed, M. Cunningham, M. Hunter, K. Hart. 2015. Marsh Rabbit Mortalities Tie Pythons to the Precipitous Decline of Mammals in the Everglades. Annual meeting of the Society for Conservation Biology, Montpelier, France.

McCleery, R.A., A. Sovie, K. Hart. 2015 Understanding the Loss of Mammals across the Greater Everglades. Greater Everglades Ecosystem Restoration Conference, Coral Springs FL.

McCleery, R.A. 2015. Understanding the Loss of Mammals across the Greater Everglades. Annual Florida Co-op unit collaborators meeting, Gainesville, FL.

Selden, J., N. Bishop, B. Smith and R.R. Carthy. 2015. Natural inventory and habitat classification of the beach-to-estuary ecotones and establishment of a long-term monitoring site for barrier island habitats and species in St. Johns County, Florida. 100th Meeting, Ecological Society of America, Baltimore, Maryland, 9-14 August 2015.

Selby T.H., Hart K.M., Fujisaki I., Smith B.J., Pollock C.J., Hillis-Starr Z., Lundgren I., Oli M.K. (October, 2015) Passive Can You Hear Me Now? Range-testing a Submerged Passive Acoustic Receiver Array in a Caribbean Coral Reef Habitat. Talk at: Integrated Tracking of Aquatic Animals in the Gulf of Mexico Annual Meeting. St. Petersburg, FL.

Selby T.H., Hart K.M., Fujisaki I., Smith B.J., Pollock C.J., Hillis-Starr Z., Lundgren I., Oli M.K. (October, 2015) Range-testing a Submerged Passive Acoustic Receiver Array in a Caribbean Coral Reef Habitat to Assist with Long-term Monitoring of Highly Marine Animals. Poster at: South Florida Graduate Student Symposium. Davie, FL.

Sovie, A., R. McCleery. 2015. Can You Teach An Old Rabbit New Tricks? Understanding How Predator Risk Influences Marsh Rabbit Habitat Selection. The Wildlife Society Annual Conference, Winnipeg, Manitoba

Sovie, A., McCleery, R. A., R. Reed, M. Cunningham, M. Hunter, K. Hart. Marsh Rabbit Mortalities Tie Pythons to the Precipitous Decline of Mammals in the Everglades. 2015. Annual Herpetology Conference, Gainesville, FL

Zhang, X.M. N. Kemal, B. Smith, N. Bishop and R.R. Carthy. 2015. Establishing baseline monitoring data for sea turtle nesting beaches with varying anthropogenic usage in St. Johns County, Florida. 100th Meeting, Ecological Society of America, Baltimore, Maryland, 9-14 August 2015.

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