A photograph of a bat hanging from a rock over water in a cave. The bat is the central focus, with its wings spread and its body hanging down. The rock is dark and textured, and the water below is dark and still, reflecting the bat. The text is overlaid on the top half of the image.

# **Florida Cooperative Fish and Wildlife Research Unit**

**Annual Report  
January-December 2011**

## ***2011 Annual Report Dedicated to***

### ***Dr. John Hayes***

Dr. John P. Hayes is a PhD product of the New York Cooperative Research Unit, and was a collaborator of the Oregon cooperative Research Unit at Oregon State University, where he was a faculty member and leader of several different programs for 14 years. The University of Florida, Department of Wildlife Ecology and Conservation was fortunate to have him serve as Department Chair from 2006 until 2011, when he accepted the position of Interim Dean for Research and Director of the Florida Agricultural Experiment Stations. He remains the Director of the Ordway Swisher Biological Station which has seen vast growth and improvement under his leadership, including becoming a National Ecological Observatory Network site. Hayes has been a valued colleague and a tireless and effective advocate for the Florida Cooperative Research Unit. He also “graduated” to the position of President of National Association of University Fish and Wildlife Programs, wherein he has been an advocate of the national Cooperative Unit Program.

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



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## ***FLORIDA COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT INTRODUCTION***

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

Between 1979 and 2011, 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, 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.

## ***RESEARCH MISSION STATEMENT***



*2011 Photo Contest Winner, Lara K. Drizd, FL CRU – “Slow Motion”*

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***“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. “***

## ***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.
- James W. Fleming -** Southern Supervisor, Cooperative Research Units, U.S. Geological Survey, Biological Resources Division, Atlanta, Georgia.
- Cynthia Dohner -** Regional Director, U.S. Fish and Wildlife Service Southeast Region, Atlanta, Georgia.
- Donald F. McKenzie –** Field Representative, Wildlife Management Institute, Ward, Arkansas.

## ***BIOGRAPHICAL PROFILES OF UNIT SCIENTIST***

**H. Franklin Percival –** Unit Leader, Courtesy Associate Professor, Department of Wildlife Ecology and Conservation and College of Natural Resources and the Environment at the University of Florida. His research interests lie in wetland wildlife, and have conducted long term collaborative projects on various aspects of alligator and migratory bird biology. He has teamed with geomaticists and aeronautical engineers to develop an unmanned aerial vehicle for assessment of wildlife populations and habitats. He has a special interest in natural resources administration, especially multidisciplinary, collaborative, and interagency research programs.

**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.

**Wiley M. Kitchens –** Associate Unit Leader, Ecologist, Courtesy Professor, Department of Wildlife Ecology and Conservation and College of Natural Resources and the Environment at the University of Florida. Dr. Kitchens' expertise is wetlands ecology with an emphasis on conservation and restoration of wetlands ecosystems. Given the restoration focus of his research, most of his projects are long-term, multidisciplinary, and targeted to resolving vegetation succession and faunal responses to hydrologic perturbations, both natural and anthropogenic. The approach generally involves identifying quantifying the factors that operate at multiple spatial and temporal scales in regulating ecologic structure and function of wetland ecosystems. In recent years, his research has focused on the endangered snail kite, a wetland dependent species endemic to the Everglades and lacustrine wetlands of Central and South Florida. Given its endangered status and the generally perturbed state of these wetlands the approach has been to document population trends, demography, and movement patterns of the kites in response to habitat structure and quality in these wetlands. The overall goal is provide restoration managers information pertinent to the restoration of these systems.

## ***AGENCY PERSONNEL CO-LOCATED WITHIN FLORIDA UNIT***

**Robert M. Dorazio** – Research Statistician, Florida Integrated Science Center, USGS and Courtesy Associate Professor, Department of Statistics, University of Florida. He conducts scholarly research in the general areas of quantitative population dynamics, community ecology, and conservation biology. He develops and applies novel sampling designs and novel statistical models in quantitative investigations of exploited or imperiled fauna. He is also responsible for developing both theory and practice of adaptive natural resource management.

**Fred A. Johnson** – Research Wildlife Biologist, Southeastern Ecological Science Center, U.S. Geological Survey. His principal interest is in the application of decision science to problems in natural resource management. Such applications require a multi-disciplinary approach to engage stakeholders in the decision-making process, to predict the responses of ecological systems to controlled and uncontrolled drivers, to elicit societal values regarding the consequences of management policy, and to develop monitoring programs to compare predicted and realized system behaviors. He is particularly active in migratory bird management, with experience in problems of recreational and subsistence harvest, pest control, and habitat management. His scientific expertise is mostly in the areas of population ecology, statistical inference, dynamic systems modeling, and optimal decision making.

**Elizabeth Martin** – NBII Bird Conservation Node Manager, National Biological Information Infrastructure (NBII), U.S. Geological Survey, and PhD student, Department of Wildlife Ecology and Conservation, University of Florida. Her principal responsibility with NBII is management of the NBII Bird Conservation Node and coordination with partners to support development of web-based information products useful in management and conservation of North American birds. Her interests include the application of information technologies to avian conservation, and research on tradeoffs in resource use by migratory shorebirds.

## ***COOPERATIVE UNIT PERSONNEL***

**M. Gay Hale, BA** – Administrative Assistant, 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.

**Janet Fay**– Student Assistant, Florida Cooperative Fish and Wildlife Research Unit. She is primarily responsible for visa 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.

**Alexis Martin, BA** – Office Assistant, Florida Cooperative Fish and Wildlife Research Unit. She is primarily responsible for maintaining federal and state vehicle logs while maintaining DOI database for Florida Coop-Unit. She also works on manuscript processing, copying, filing, and organizing of publications and data entry.

**David Wolfe** – Student Assistant, Florida Cooperative Fish and Wildlife Research Unit. He is primarily responsible for p-card processes within the University financial system, and updating the database. He left the Unit in August 2011 to finish his undergraduate degree in Sociology.

## **COOPERATORS**

### **University of Florida:**

A-mr Abd-Elraham  
Alan B. Bolten  
Robert M. Cubert  
Peter C. Frederick  
Aaron Higer  
Elliott R. Jacobson  
Michael Kane  
Martha Monroe  
Debbie Miller  
William (Bill) Pine  
J. Perran Ross  
Mark Hostetleer

Michael S. Allen  
Lya Brand  
Bon A. Dewitt  
Bill Guiliano  
Mark Hostetler  
Susan Jacobson  
Paul A. Klein  
Frank Mazzotti  
Madan Oli  
Carrie Reinhart-Adams  
Scot E. Smith

Karen A. Bjorndal  
Matthew J. Cohen  
Robert Fletcher  
John Hayes  
Peter G. Ifju  
Steven Johnson  
Leda Kobziar  
Robert McCleery  
Todd Osborne  
Carlos H. Romero  
Marilyn G. Spalding

### **Florida Fish and Wildlife Conservation Commission:**

Joe Benedict  
Janell Brush  
Patrick Delaney  
Rebecca Hayman  
Julien Martin  
Stephen W. Rockwood  
Rio Throm  
Blair Witherington

Joan Berish  
Larry Campbell  
Harry J. Dutton  
Lindsay Hord  
Henry Norris  
Scott Sanders  
Zach Welch  
Allan R. Woodward

Arnold Brunell  
Cameron Carter  
Jim Estes  
Richard Kiltie  
Tim O'Meara  
Lawson Snyder  
Nick Wiley  
Terry Doonan

### **U.S. Geological Survey:**

Beverly Arnold  
Paul Conrads  
Robert M. Dorazio  
James Hines  
Lynn W. Lefebvre  
Kelly McDonald  
Kenneth G. Rice  
J. Michael Scott  
Kenneth Williams

G. Ronnie Best  
Fred Johnson  
Michael Conroy  
William L. Kendall  
Cynthia S. Loftin  
Clinton Moore  
Michael Runge  
Daniel Slone

Jaime A. Collazo  
Donald L. DeAngelis  
Tara Y. Henrichon  
Catherine Langtimm  
Elizabeth Martin  
James D. Nichols  
John Sauer  
Pamela Telis

### **U.S. Fish and Wildlife Service:**

Laura Brandt  
Stan Howarter  
John Kasbohm  
Fred Martin  
Heath Rauschenberger  
Heather Tipton  
Kathy Whaley

Larry Williams  
Chuck Hunter  
Mike Legare  
Lorna Patrick  
Sandra Sneckenberger  
Paul Tritaik  
Billy Brooks

Andrew Gude  
Michael Jennings  
Shannon Ludwig  
John Robinette  
Paul Souza  
Russell Webb

### **U.S. Army Corps of Engineers**

Kristin A. Farmer  
Jon S. Lane  
Glenn G. Rhett  
Larry Taylor

Michael T. Hensch  
Jon M. Morton  
David J. Robar  
Damon A. Wolfe

John K. Kilpatrick  
Gina Ralph  
Adam N. Tarplee  
William C. Zattau

### **St. Johns Water Management District:**

Roxanne Conrow  
Steven Miller

James Peterson  
Mike Coveney

### **U.S. Parks Service**

Leonard Pearlstine  
Bob Miller

### **U.S. Air Force**

Bruce Hagedorn

### **Idaho Fish and Game**

Pete Zager

### **University of Idaho**

Janet Rachlow

### **University of Central Florida**

Llewellyn M. Ehrhart  
Dean Bagley

### **University of West Florida**

Phillip C. Darby

### **Innovative Health Applications LLC**

Eric D. Stolen  
David Breininger

### **Environmental Project:**

Ritchie H. Moretti  
Sue A. Schaf

### **Others:**

Tommy C. Hines  
Lovett E. Williams

Russell Hall

## ***RESEARCH PERSONNEL***

### **Ikuko Fujisaki, PhD**

Position: Quantitative Ecologist

Research: Analyzes data for the American Alligator monitoring and assessment program (MAP ), IFAS, Fort Lauderdale Research and Education Center

### **Dan Gwinn, PhD**

Position: Post-Doctoral Associate

Research: Climate change impacts on Florida freshwater fisheries

### **David Kaplan, PhD**

Position: Post-Doctoral Associate

Research: Mechanisms of Ridge-Slough Maintenance and Degradation across the Greater Everglades

### **Philip Kauth, PhD**

Position: Post-Doctoral Associate

Research: Population Diversity in the Florida Endangered Orchid *Cypripedium punctatum*

### **Margaret Lamont, PhD**

Position: Post-Doctoral Associate

Research: Examining how coastal species, such as sea turtles and shorebirds, are affected by natural and anthropogenic dynamics of barrier island systems and oil spill effects on sea turtles.

### **Nancy Philman, PhD**

Position: Biological Scientist

Research: Population Genetic Analysis and Assessment of Hybridization between *Calopogon tuberosus var. tuberosus* and *var. simpsonii*

### **Jennifer Seavey, PhD**

Position: Post-Doctoral Associate

Research: Climate change, sea-level rise, and biodiversity

### **Ross Tsai, PhD**

Position: Post-Doctoral Associate

Research: Wading Bird Colony Location, Size, Timing and Wood Stork and Roseate Spoonbill Nesting Success

### **Christa Zweig, PhD**

Position: Post-Doctoral Associate

Research: Climate change research in coastal wetlands in the Big Bend area of Florida and snail kite habitat changes and how they affect population.

### **Kathy Bibby, MS**

Position: FWS Project-Wide Coordinator

Research: Reed Canary Grass Control & Transition to Wetland Forests and Meadows

### **Matthew Burgess, MS**

Position: Wildlife Ecologist/UAS Program Coordinator/Doctoral Candidate

Research: Unmanned Aircraft Systems research project

### **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

### **Melissa Ann DeSa, MS**

Position: Project Coordinator

Research: Climate change in the northern Gulf of Mexico: impacts on coastal plant and small mammal communities

**Brian Jeffrey, MS**

Position: Wildlife Biologist/Alligator Project Manager

Research: American alligator and crocodile monitoring and assessment program, (MAP). IFAS, Fort Lauderdale Research and Education Center

**Matthew Walters, MS**

Position: Wildlife Biologist

Research: Habitat conservation for the Florida scrub-jay and Climate Change in the northern Gulf of Mexico

**Christine Wiese, MS**

Position: Lead Biologist

Research: Reed Canary Grass Control & Transition to Wetland Forests and Meadows

**Chris Winchester, MS**

Position: Research Coordinator

Research: Wading Bird Colony Location, Size, Timing and Wood Stork and Roseate Spoonbill Nesting Success

**GRADUATE STUDENTS**

**Matthew Burgess**

Degree sought: PhD, Wildlife Ecology and Conservation

Graduation Date: August 2014

Research: Collection of Digital Serial Imagery in Support of Aquatic Invasive Species Program and CERP

Advisor: H. Franklin Percival

---

**Chris E. Cattau**

Degree sought: PhD, Wildlife Ecology and Conservation

Graduation Date: December 2012

Research: Demography and movement of the Snail Kite

Advisor: Wiley Kitchens

---

**Kathryn Garland**

Degree sought: PhD, Wildlife Ecology and Conservation- Human Dimensions focus

Graduation Date: December 2011

Research: Consumptive use and conservation of marine turtles in Pearl Lagoon, Nicaragua. Implications of historic taste preferences, cultural norms and local attitudes for the human dimensions of conservation.

Advisor: Ray Carthy

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**Yuan Jing**

Degree sought: PhD, School of Natural Resources and the Environment

Graduation Date: August 2012

Research: Mechanisms of ridge-slough maintenance and degradation across the Greater Everglades

Advisor: Matt Cohen

---

**Timothy Johnson**

Degree sought: PhD, Wildlife Ecology and Conservation

Graduation Date: August 2011

Research: seed physiology, seed ecology, and restoration biology of the grass pink orchid (*Bletia purpurea*)

Advisor: Michael Kane

---

**Jame McCray**

Degree sought: PhD, Wildlife Ecology and Conservation

Graduation Date: May 2013

Research: Wildlife legislation and management in Florida: Sea turtles, a test case for creating effective policy

Advisor: Madan Oli and Ray Carthy

---

**John H. Perry**

Degree sought: PhD, Geomatics, School of Forest Resources and Conservation (NSF Fellow)

Graduation Date: May 2012

Research: Remote sensing research associated with UAS project

Advisor: Bon E. Dewitt

---

**Brian E. Reichert**

Degree sought: PhD, Wildlife Ecology and Conservation

Graduation Date: December 2012

Research: Snail kite monitoring of population demographics; exploring senescence and other aspects of survival.

Advisor: Wiley Kitchens

---

**Margo Stoddard**

Degree sought: PhD, Wildlife Ecology and Conservation

Graduation Date: April 2012

Research: Management of Functionally Connected Dune Habitat for Endangered Beach Mice on Fragmented Landscapes

Advisor: Lyn Branch

---

**Zoltan Szantoi**

Degree sought: PhD, Geomatics, School of Forest Resources and Conservation

Graduation Date: August 2011

Research: Pattern recognition and texture analysis of invasive plants from remote imagery.

Advisor: Scot E. Smith

---

**Louise Venne**

Degree sought: PhD, Wildlife Ecology and Conservation

Graduation Date: April 2012

Research: Response of wading birds to fire effects in the Everglades

Advisor: Peter Frederick

---

**Adam C. Watts**

Degree sought: PhD, School of Forest Resources and Conservation

Graduation Date: December 2012

Research: Fire ecology in cypress domes in Big Cypress National Preserve

Advisor: Leda Kobziar

---

**Danielle Watts**

Degree sought: PhD, School of Natural Resources and Conservation

Graduation Date: December 2012

Research: Mechanisms of ridge slough maintenance and degradation across the greater everglades

Advisor: Matt Cohen

---

**Benjamin E. Wilkinson**

Degree sought: PhD, Geomatics, School of Forest Resources and Conservation

Graduation Date: December 2012

Research: Remote sensing from UAS platform

Advisor: Bon E. Dewitt

---

**Jeff Beauchamp**

Degree sought: M.S., Wildlife Ecology and Conservation

Graduation Date: August 2012

Research: American Alligator Distribution, Size, and Hole Occupancy & American Crocodile Juvenile Growth

Advisor: Frank Mazzotti

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**Brittany Burtner**

Degree sought: M.S., School of Natural Resources and the Environment

Graduation Date: December 2011

Research: Wading bird ecology and the impact of land and water management on birds in the Everglades ecosystem

Advisor: Peter Frederick

---

**Stephen Casey**

Degree sought: M.S., Wildlife Ecology and Conservation

Graduation Date: August 2012

Research: Mechanisms of ridge-slough maintenance and degradation across the Greater Everglades

Advisor: Matt Cohen

---

**J. Patrick Delaney**

Degree sought: M.S., School of Natural Resources and Environment

Graduation Date: December 2012

Research: Using GIS to assess nest site selection and nest abundance by American alligators

Advisor: Kenneth E. Rice and H. Franklin Percival

---

**Mike Dodrill**

Degree sought: M.Sc., Aquatic Sciences

Graduation Date: August 2013

Research: Assessing natal sources of juvenile native fish in Grand Canyon

Advisor: Bill Pine

---

**Lara K. Drizd**

Degree sought: M.S. Wildlife Ecology and Conservation

Graduation Date: December 2011

Research: S. Florida vegetation (hydrilla) by apple snails in Lake Toho

Advisor: Wiley Kitchens

---

**Brandon Evers**

Degree sought: M.S. Aeronautical Engineering

Graduation Date: May 2011

Research: Airframe optimization of the Nova 2.1 UAS

Advisor: Peter G. Ifju

---

**Jason Fidorra**

Degree sought: M.S., Wildlife Ecology and Conservation

Graduation Date: August 2012

Research: Wading bird ecology and the impact of land and water management on birds in the Everglades ecosystem

Advisor: Peter Frederick

---

**Colton Finch**

Degree sought: M.Sc., Aquatic Sciences

Graduation Date: August 2013

Research: Assessing natal sources of juvenile native fish in Grand Canyon

Advisor: Bill Pine

---

**Brandon Gerig**

Degree sought: M.S., Wildlife Ecology and Conservation

Graduation Date: April 2012

Research: Site occupancy and habitat selection of Endangered Humpback Chub during experimental flow releases from Glen Canyon Dam in the Colorado River in Grand Canyon, Arizona

Advisor: Bill Pine

---

**Tae Go Oh**

Degree sought: M.S., Wildlife Ecology and Conservation

Graduation Date: August 2012

Research: Mechanisms of ridge-slough maintenance and degradation across the Greater Everglades

Advisor: Matt Cohen

---

**Anthony Lau**

Degree sought: M.S., Wildlife Ecology and Conservation

Graduation Date: December 2011

Research: Ecology of Gopher Tortoises (*Gopherus polyphemus*)

Advisor: Ray Carthy and Kenneth Dodd

---

**Ryan Lynch**

Degree sought: M.S., Wildlife Ecology and Conservation

Graduation Date: August 2011

Research: American Alligator Distribution, Size, and Hole Occupancy & American Crocodile Juvenile Growth

Advisor: Frank Mazzotti

---

**Jean M. Olbert**

Degree sought: M.S., Wildlife Ecology and Conservation

Graduation Date: December 2012

Research: Nest predation analysis of snail kites.

Advisor: Wiley Kitchens

---

**Kyle E. Pias**

Degree sought: M.S. Wildlife Ecology and Conservation

Graduation Date: December 2012

Research: Snail kite monitoring, habitat use of breeding snail kites.

Advisor: Wiley Kitchens

---

**Sarah Reintjes-Tolen**

Degree sought: M.S., Wildlife Ecology and Conservation

Graduation Date: December 2012

Research: Chytrid fungus and amphibian populations in Florida.

Advisor: Ray Carthy

---

**Thomas J. Rambo**

Degree sought: M.S. Aeronautical Engineering

Graduation Date: August 2012

Research: Airframe construction techniques for the Nova 2.1 UAS

Advisor: Peter G. Ifju

---

**Thomas W. Reed**

Degree sought: M.S. Aeronautical Engineering

Graduation Date: December 2012

Research: Airframe construction techniques for the Nova 2.1 UAS.

Advisor: Peter G. Ifju

---

**Merrill Rudd**

Degree sought: M.Sc., Fisheries and Aquatic Sciences

Graduation Date: August 2013

Research: Resolving Uncertainty in Natural Mortality and Movement rates of Gulf of Mexico sturgeon

Advisor: Bill Pine

---

**Amy C. Schwarzer**

Degree sought: M.S., School of Natural Resources and Conservation

Graduation Date: August 2011

Research: Body condition and prey selection of wintering and migratory Red Knots in Florida.

Advisor: Jaime Collazo and H. Franklin Percival

---

**Rio W. Throm**

Degree sought: M.S. School of Natural Resources and Conservation

Graduation Date: August 2012

Research: Juvenile alligator movements in Lake Apopka, FL

Advisor: Kenneth G. Rice and H. Franklin Percival

---

**Natalie Williams**

Degree sought: M.S., Wildlife Ecology and Conservation

Graduation Date: August 2012

Research: Sea turtle conservation

Advisor: Ray Carthy and Karen Bjorndal

## ***TECHNICIANS***

### Global Climate Change

Simon Fitz-Williams	Rodney Hunt
Matthew Walters	Forest Hayes
Brandon Miller	

### Snail Kite surveys, reproductive success and banding

Shannon Behmke	Eran Brusilow
BJ Byers	Daniel Cavanaugh
Emily Evans	Siria Gamez
Sanders Ho	Ashley Holmes
Amanda Lee	Kristen Linner
Sarah Norton	Juan Pagan
Eric Riddell	Shrey Sangel
Cari Sebright	Rebecca Wilcox
Jeremy Wood	Emily Butler
Chris Hansen	Nick Belfry
Megan Ford	Carley Jennings
Katie Montgomery	

### Sea turtle research and monitoring

Joseph Dirodio	Melissa Ethridge
Seth Farris	Kathryn Frey
Caitlin Hackett	Desmond Ho
Henry Legett	Jessica McKenzie
Christopher O'Bryan	Brail Stephens
Charles Wilford	

### Reed Canary project

Leah Cobb

### Alligator Research

Gareth Blakemore	Matthew Denton
Michael Rochford	Adam Daughtery
Edward Larrivee	Emily Pifer

### Orchid Projects

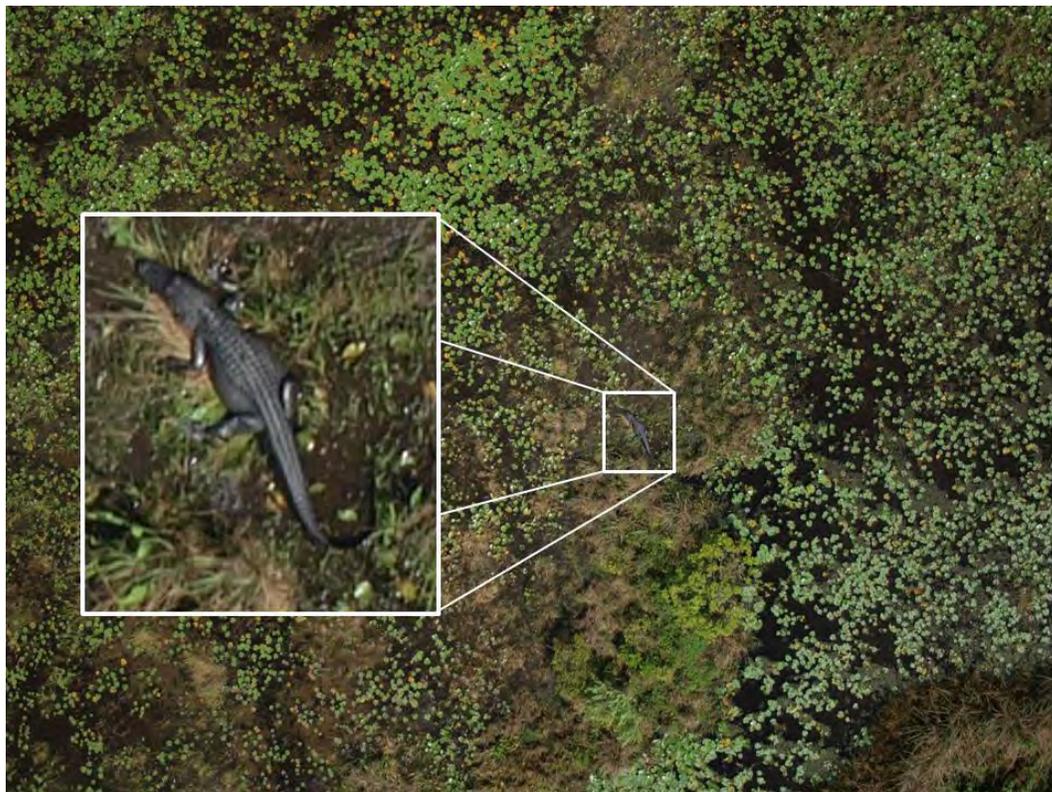
Dr. Charles Guy

### Ridge-Slough Maintenance

Larry Korhnak



***CURRENT PROJECTS  
COOPERATIVE RESEARCH***



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

**Principal Investigator:** Wiley M. Kitchens

**CO-Principal Investigator:** Robert Fletcher

**Funding Agency:** USGS/Army Corps of Engineers

**Expected Completion:** 4/30/2013 (UFPJ#00088028)

**Graduate Students:** B. Reichert, C. Cattau, K. Pias, J. Olbert



This report concentrates on demographic data collected in 2010, but also incorporates data collected since 1992. Recent demographic results reveal alarming trends concerning the snail kite population in Florida. First we found that kite abundance has drastically and steadily declined since 1999, with the population essentially halving from 2000 to 2002 and again from 2006 to 2008. Each of these two periods of population decline coincided, in part, with a severe regional drought throughout the southern portion of the kites' range. The 2001 drought significantly, yet temporarily, affected adult survival, especially for kites within the Everglades region; however, the nesting patterns and lack of recruitment that have been observed since that time give us special concern about the recovery of the snail kite population. A life table response experiment (LTRE) shows that 80% of the reduction in the stochastic population growth rate is attributable to adult fertility (i.e., the product of (1) young fledged per adult and (2) juvenile survival). A population viability analysis (PVA) conducted in 2006 predicts very high extinction probabilities in the next 50 years, and the estimate of population size for 2008 (i.e., 685 individuals) suggests that the extinction risk may be even greater than previously estimated.

Multiple factors may be limiting the reproductive ability of the kites and reducing the carrying capacity of several of the wetland units throughout the state, and the reasons for this severe decline in population viability are probably tied to both short-term natural disturbances (e.g., drought) and long-term habitat degradations (e.g., the conversion of wet prairies to sloughs in WCA3A). Of particular concern is the lack of snail kite production from the Everglades region, as no kites were observed fledging out of the Water Conservation Areas during the breeding seasons of 2005, 2007, or 2008. In this report we detail new findings related to snail kite demography, movement, foraging, and genetics. We also make specific recommendations that may help guide management decisions aimed at increasing snail kite population growth.

### **OBJECTIVES:**

The snail kite (*Rostrhamus sociabilis*) is an endangered raptor whose distribution in the United States is restricted to the South Florida Ecosystem including watersheds of the Everglades, Lake Okeechobee, Kissimmee River, and Upper St. Johns River. Human-induced degradation of the hydrologic functioning of these watersheds has prompted large-scale restoration efforts (e.g. the Central and South Florida Project Restudy, Kissimmee River Restoration, and the South Florida Ecosystem Restoration Initiative).

During the first half of this century, snail kite populations declined dramatically. More recently, since the mid-1960's the population appeared to stabilize and perhaps even increase. However, our recent studies suggest the population is currently undergoing an alarming declining phase. The population size appears to have progressively and substantially decreased since 1999. The population in 2003 was estimated to be half its estimated size in 1999, and the population in 2008 was estimated to be half that in 2003. The altered hydrology of wetlands representing its critical habitat is probably the primary environmental influence on the population. These include loss of habitat and changes in foraging and nesting habitat structure.

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:**

This study is complementary to the demographic study entitled “Demographic, movement, and habitat studies of the endangered snail kite in response to hydrological changes”.

Our radio telemetry study conducted in 1992 to 1995 helped identify the critical kite habitat. However given the dynamics of those habitats (changes in hydrology, plant communities), it is reasonable to expect some spatial shifts in the use of those habitats after more than 8 years (for instance large number of kites used Lake Okeechobee between 1992 and 1994, but stop using this area after 1995). Radio telemetry is the most efficient if not only way to track those changes.

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).

Senescence is defined as an increasing intrinsic rate of death, and is common among wild populations. 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. Understanding how severe environmental conditions (such as droughts) disproportionately 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.
- Preliminary aircraft radio surveys have also enabled us to obtain more precise survival estimates during dry wetland conditions.
- Our analyses of radiotelemetry, using multistate models, indicate that snail kite movements are not as extensive as previously thought especially between habitats that have been altered by fragmentation.
- 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

All young fledged and radioed in the Kissimmee Chain of Lakes (KCOL) in 2008, stayed in the KCOL through the entire year.

## **SUMMARY:**

Very little is known about the extent of a numerical versus behavioral response of the snail kite to a disturbance event (such as a drought). Radio telemetry is the only way to assess the ability for the bird to resist a regional drying event. Further, it enables determination of the factors which are generating movement patterns such as patch size, distance between patches, and the carrying capacity of a specific wetland. This is particularly interesting when considering the effect of fragmentation on the dispersal abilities of the kites, as fragmentation typically reduce patch size and increases the linear distance between patches.

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### ***Nesting Habitat & Nest Failures of Everglade Snail Kite on Kissimmee Lakes***

***Principal Investigator:*** Wiley M Kitchens

*Funding Agency:* FWCC

*Expected Completion:* 3/30/2013 (UF PJ#89466)

*Graduate Students:* Jean Olbert, Kyle Pias

*Field Technicians:* Cari Sebright, Shannon Behmke, Emily Evans, Kristen Linner, Amanda Lee, Siria Gamez, Ashley Holmes, Carley Jennings, Nick Belfry, Megan Ford, Emily Butler, Jeremy Wood, Chris Hansen, Katie Montgomery



The Snail Kite is a federally endangered raptor whose population in Florida has recently undergone precipitous declines. The remaining population remains heavily dependent upon the Kissimmee Chain of Lakes (KCOL), a group of lakes in central-Florida that is subject to many anthropogenic influences, including water and vegetation management. It is therefore crucial to gain an understanding of how the habitat on these lakes influences kite reproduction as well as determining reasons for nesting failure and success. We studied the role that habitat on the KCOL plays in reproductive success by radio-tagging and observing adult breeding Snail Kites by airboat. We calculated 90% home ranges using a kernel density estimator and quantified foraging effectiveness through time activity budgets. Additionally we studied the role that nest patch structure, local avian assemblages and predation plays in nesting success by setting up professional research cameras and performing regular avian point counts at nest locations as well as quantifying aspects of the selected nest patch structure.

#### **OBJECTIVES:**

This study has two main components. One is to examine the relationships between habitat use, foraging ecology, and nesting success. The other is to determine the major source of egg/nestling mortality and nesting failure.

The primary objectives of the habitat use study are to quantify the areas of and vegetative communities composing the home ranges of breeding snail kites and determine how vegetation composition, search time, and apple snail capture rate relate to home range size of breeding kites. These relationships will provide information pertaining to habitat selection, habitat quality, and ultimately carrying capacity. This will be done through the use of radio-transmitters that will allow specific birds to be followed over time and information on foraging and habitat use will be collected via behavioral observations and GPS/GIS techniques.

The primary objectives of the nest predation study is to examine reasons for snail kite nesting failure by looking at the vegetative communities that supply nesting substrate, presence of predators, and the role that interspecific avian assemblages play on the success rate of the nests. Snail kites often nest in cattail (*Typha spp.*) or bulrush (*Scirpus validus*) stands or patches of varying sizes and densities, especially during times of low water levels (Rodgers et al. 2001). By looking at aspects of the local avian community within the nest patch we hope to determine if there is a relationship between breeding Icterids, which may defend patches from predators, and snail kites with regard to nest predation, nest abandonment and decreased kite feeding due to harassment. Further, we will be able to determine whether snail provisioning rates relate to fledgling health and nest success. This research will provide managers with the critical information needed to manage for the survival of this endangered species.

#### **PROGRESS:**

For the habitat use study a total of 39 breeding snail kites were monitored over the course of the 2010 and 2011 breeding season (January to September) on the Kissimmee Chain of Lakes. Data was collected from a total of 43 nests over the two breeding seasons as some adults bred multiple times. Observations on the breeding adults were carried out every 3-4 days until the nests either failed or fledged. Home ranges are currently being constructed from spatial locations using kernel density estimator in ABODE in ArcGIS 9.3. Least square cross validations smoothing methods are being applied and polygons are drawn at 90% kernel.

For the nest predation portion of the project, a total of 95 nests were monitored during the 2010 and 2011 breeding season (January to September). Nesting outcomes were successfully recorded on 86 of the cameras. Throughout the two breeding seasons 13 causes of nesting failure and brood reduction were documented along with several other potential predators. The leading causes of nest failure were abandonment by the adults and predation by yellow rat snakes (*Elaphe obsoleta quadrivittata*). Currently data involving daily survival rates, provisioning rates and nest patch characteristics are in the process of being entered and organized for data analysis.

*Female snail kite returning to her nest*

*Young snail kites photographed by a nest camera*



#### **SUMMARY:**

This proposed study will provide critical information regarding snail kite breeding biology by looking at the vegetative communities that supply nesting substrate and adult forage as well as determining reasons of nesting failure.

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

**Principal Investigator:** Wiley M Kitchens

*Co-Principal Investigator:* R. Fletcher

*Co-principal Investigator:* C. Zweig

*Funding Agency:* U.S. Geological Survey

*Expected Completion:* 6/08/2012 (RWO 269, PJ#88726)

*Graduate Students:* Chris Cattau, Kyle Pias

*Field Technicians:* Dan Cavanaugh, Juan Andres Pagan, Eric Riddell

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.

#### **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. We are also conducting further field research on snail kite habitat use, foraging activity, survival and reproduction that is necessary to fill the critical information gaps identified in Figure 1 (below).

#### **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. In the last status update (December 2010), we reported some preliminary findings based on the limited snail data that we had access to at that time (i.e., snail density estimates from sample sites closest to active kite nests and foraging observations within WCA3A, 2002-2009). Dr. Darby has since provided us the complete datasets for all snail sites sampled in WCA3A from 2002-2010 (except 2008 in which no snail sampling occurred). Complete snail datasets for other wetlands were not provided, as these samples were deemed unsuitable for synthesis analyses due to their spotty spatial coverage, lack of temporal continuity and, in many cases, their potential to introduce selection bias because of the original narrowly-focused research questions some samples were meant to address. It was also discovered that there was very limited overlap in snail data and kite data from these other wetlands. Therefore, our integrated synthesis analyses will focus on historic data from WCA3A. We are currently addressing hypotheses related to the effects of snail density, hydrology and vegetation on snail kite nest success, productivity and density, and kite occupancy as outlined in Table 1. We provide preliminary results from some of these analyses below. In order meet the objectives previously stated, we have planned for regular biweekly conference calls with Dr. Darby to occur throughout the Spring of 2012.

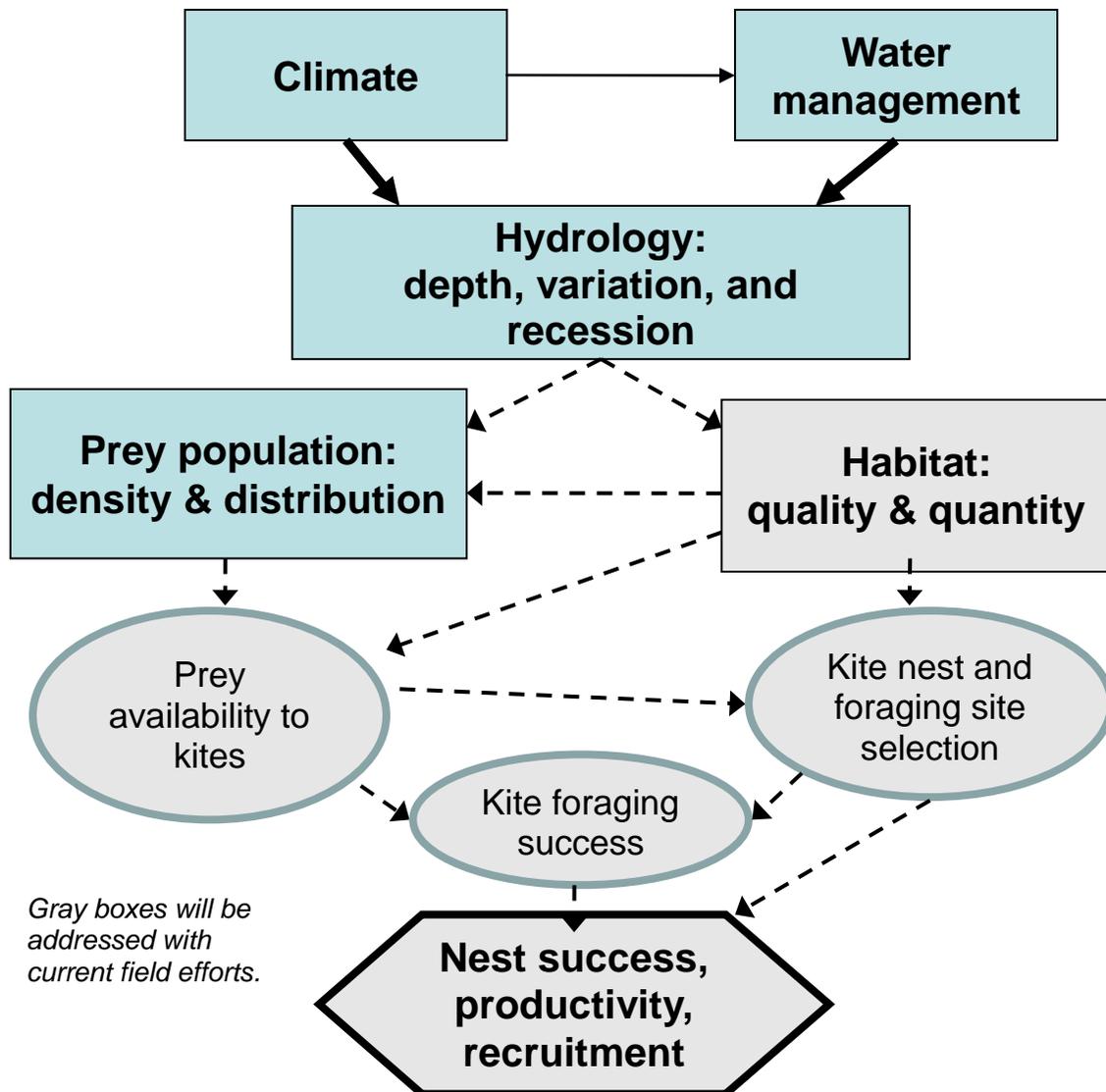


Figure 1. Conceptual model of environmental and biological variables affecting key demographic parameters of the snail kite population

The following objectives of the proposed work are meant to directly address the gaps in knowledge that are identified in Figure 1:

1. To determine how hydrology, habitat quality, and prey density affect snail availability for foraging and nesting snail kites.
2. To determine how snail availability affects kite foraging success, and nest and foraging site selection.
3. To determine how snail availability affects nest success and recruitment.
4. To determine the role of kite foraging success and nest and foraging site selection on nest success and recruitment.
5. To determine kite foraging habitat quality within foraging polygons and determine its relationship to hydrology and vegetation communities.

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

Foraging observations were conducted on breeding snail kites in WCA 3A throughout the 2011 breeding season. 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. 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, observations were made of 26 breeding birds, representing a total of 21 nests. Snail densities were estimated for four breeding snail kite home ranges.

We are currently examining the relationships between, foraging rates, home range area, and snail densities.

Additionally, data is currently being collected in the field for the 2012 breeding season, and efforts are being made to increase the number of foraging observation with associated snail densities. Additionally, finer resolution snail sampling data is being provided for the 2011 season, which will allow us to refine our models examining the relationship between snail kite foraging 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.

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### ***Strategic Habitat Conservation for Florida Scrub-Jays at Merritt Island National Wildlife Refuge***



***Principal Investigator: H. Franklin Percival***  
Co-Principal Investigator: Fred Johnson  
Funding Agency: U.S. Geological Survey  
Expected Completion: 12/31/11 (PJ#81315)

Bare ground is an important component of habitat for Florida scrub-jays (photo by B. Powell).

This project involves the development of a management strategy for oak (*Quercus* spp.) scrub that will maximize the long-term demographic performance of Florida scrub-jays (*Aphelocoma coerulescens*). The project focuses on the Happy Creek Scrub Reserve Unit of Merritt Island National Wildlife Refuge, which is an area with an ecological legacy of fire suppression. Although old-growth oak scrub at Happy Creek has largely been restored to the early-successional state preferred by jays, the scrub generally lacks patches of bare ground. Bare ground is thought to mediate the spread of fire, and thus help maintain the heterogeneous height structure that was characteristic of the

scrub prior to human settlement. Prescribed burning has not been successful at creating or maintaining patches of bare ground and so tends to produce large areas of short scrub, which act as demographic sinks for scrub-jays. The objective of this project is to determine how creation of bare ground by plowing could supplement prescribed burning to help maintain better habitat conditions for Florida scrub-jays.

### PROGRESS:

We computed optimal management strategies for oak (*Quercus* spp.) scrub at Merritt Island National Wildlife Refuge (MINWR). Optimal management strategies are those that are expected to maximize the long-term demographic performance of Florida scrub-jays (*Aphelocoma coerulescens*). A Markov decision process was used to characterize the scrub-management problem and stochastic dynamic programming was used to derive optimal solutions. We calculated management strategies for a hypothetical management unit consisting of ten potential scrub-jay territories (100 ha) in either primary or secondary habitat. Each year, an optimal management action can be identified based on the number of potential territories in each of five scrub types. Scrub types were defined by a combination of scrub height and the presence of bare ground (i.e., short-open, short-closed, optimal-open, optimal-closed, tall-mix). Only scrub-jays breeding in optimal-height scrub are expected to have annual recruitment that exceeds mortality, with scrub-jays in optimal-open scrub outperforming those in optimal-closed. We estimated the probability of scrub transitioning between types by relying on classification of aerial imagery of the refuge from 2004 to 2009.

Using all available data, 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. In spite of the challenges, however, MINWR has made demonstrable progress over the last decade in managing oak scrub for the benefit of Florida scrub-jays. The program currently in place to monitor scrub habitat and the demographic responses of scrub-jays is seen as essential to the delivery and evaluation of future management efforts on the refuge.



*Plowing recently burned scrub at Merritt Island NWR to improve habitat for Florida scrub-jays (photo by M. Legare).*

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***Southeastern Adaptive Management Group (SEAMG)***

***Principal Investigator: H. Franklin Percival***

Co-Principal Investigators: Robert M. Dorazio, Fred A. Johnson

Funding Agencies: Florida Fish & Wildlife Conservation Commission / U.S. Geological Survey / U.S. Fish & Wildlife Service

Expected Completion: 12/31/2012 (PJ#89837)

***The Southeastern Adaptive Management Group (SEAMG)*** was created in 2001 for the purpose of achieving a better science-based approach to wildlife conservation and management. The principal mission of the group is “To better integrate research and management for the purpose of improving how natural resource management decisions are made. As part of this mission, the SEAMG is responsible for exploring and developing quantitative tools that improve and facilitate the integration of research and management. A distinguishing feature of the SEAMG is that it seeks ways to achieve a heightened level of integration between researchers and managers. At this level of integration, management actions themselves are viewed as opportunities for learning through experimentation, and the selection of management actions generally includes compromises between the (possibly) long-term value of learning and the short-term value of achieving more immediate management objectives. However, practical considerations also are expected to constrain the selection of management actions in most, if not all, resource management problems. A truly integrated program of research and management potentially offers great rewards; however, it is far more difficult and more costly to achieve than the more common situation where research is conducted in support of management without any direct involvement in the selection of alternative management actions. The SEAMG is interested in finding ways to achieve higher levels of integration in the activities researchers and managers to improve the decisions in problems of natural resource management and conservation. Institutional arrangements for establishment and operation of the SEAMG are described in a formal Cooperative Agreement among signatories of the U.S. Geological Survey (USGS), the U.S. Fish and Wildlife Service (USFWS), and the Florida Fish and Wildlife Conservation Commission (FFWCC). It is guided by a Steering Committee Statistics and the Program for Environmental Statistics at the University of Florida. SEAMG scientists interact loosely with scientists and managers of cooperating organizations to solve problems of natural resource management.

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*Possible levee defect noted during the first  
Herbert Hoover Levee mission*

***Collection of Digital Serial Imagery in  
Support of Aquatic Invasive Species  
Program  
And CERP***

***Principal: H. Franklin Percival***

Co-Principal Investigator: Peter Ifju, Scot E. Smith, Matthew A. Burgess

Funding Agency: U.S. Army Corps of Engineers

Expected Completion: 12/31/2011 (UF Projects #88394, 88395, 88396)



Aerial imaging serves as a fundamental intermediary between satellite imagery and ground-based observations. Unmanned aircraft (UA) provide a method of obtaining aerial imagery without the added risk of putting a human

life in the air. An interdisciplinary team of researchers at the University of Florida, with funding from the U.S. Army Corps of Engineers, have developed the Nova 2.1 small Unmanned Aircraft System (sUAS) designed specifically as a low-cost, autonomous, aerial imaging tool for ecological research and monitoring.

Through an evolution of experience, UF has developed a sUAS photographic platform in support of the Corps' operational missions throughout Florida. The design and construction of both an amphibious UA and an optical payload capable of repeatedly working over Florida's aquatic environments presented a series of challenges elevating the difficulty of the endeavor. Additionally, the Federal Aviation Administration (FAA) has continued to be slow in integrating UAs into the National Airspace System (NAS) which has introduced further delays. However, through our partnership with the USACE, the UF sUAS research team has been able to secure Certificates of Airworthiness (COA) from the United States Army Aviation Directorate (USAAD) for our Nova series of UAs, and through the USAAD's Memorandum of Agreement (MOA) with the FAA, the UF/USACE partnership is able to fly low altitude missions throughout large portions of the south Florida NAS, including Lake Okeechobee and the Everglades.

The FAA obviates flying sUAS >366 m (1,200 ft) above sea level and beyond 1 nautical mile line-of-sight from the operator. Areas of invasive vegetation infestations are generally many miles from appropriate land-based launch and recovery sites, therefore, the sUAS has to be transported to the remote field location, often by boat, and hand launched to be operated legally within FAA restrictions. The UF team has developed the capability to address operational missions of the USACE by combining pilots, ground control operators, mission planners, and photogrammetry experts at UF with USACE airboats, airboat operators, and qualified visual observers.

Operational targets of interest for the USACE Jacksonville District have included the identification, location, and spread of invasive aquatic plants, effects of herbicide treatments on said plants, and changes in plant community structure over time. Additional operational targets of interest for the USACE have included sUAS aerial imagery flights over water control structures such as levees and pump stations, as well as construction and maintenance of these facilities. The UF sUAS team has the experience of collecting aerial imagery over all of these target types, and is poised to develop additional research applications using USACE operational targets.

#### **OBJECTIVES:**

- 1) Fly optical missions over dikes and levees in order to investigate the Nova 2.1 sUAS ability to detect/measure physical characteristics indicative of leaks, seeps, and boils. The topographic characteristics inherent to dikes and levees deem these sites suitable candidates for 3-dimensional analysis and Digital Elevation Model (DEM) generation. An important component of this objective includes an investigation into the Nova sUAS 3-dimensional error budget. Defining these parameters will improve image processing procedures while exploiting platform capabilities essential to the mission planning process. We anticipate performing these missions over Herbert Hoover Dike located near Belle Glade, FL.
- 2) Fly optical missions over water hyacinth and water lettuce in areas of Lake Okeechobee scheduled for immediate herbicide treatment. We anticipate conducting flights over Fisheating Bay that are scheduled to be treated with herbicide to collect additional imagery for temporal analyses. Re-flying these treated areas three to four weeks after spraying yielded significant results on the efficacy of the 2010 treatments. Additionally, we look to examine vegetative community re-growth 'one year later' in areas that were treated in 2010. As part of this objective, we look to continue assessing the utility of the Nova optical payloads as tools for differentiating invasive *Luziola* from native vegetation. Four out of six aquatic plant classifications in the 2010 Fisheating Bay study site were identified using color spectral signatures; however, difficulty was experienced in differentiating *Luziola* from native cupscale grass. We believe use of the existing optical system at a lower altitude or utilization of multispectral imaging may assist in differentiating these two similar species.

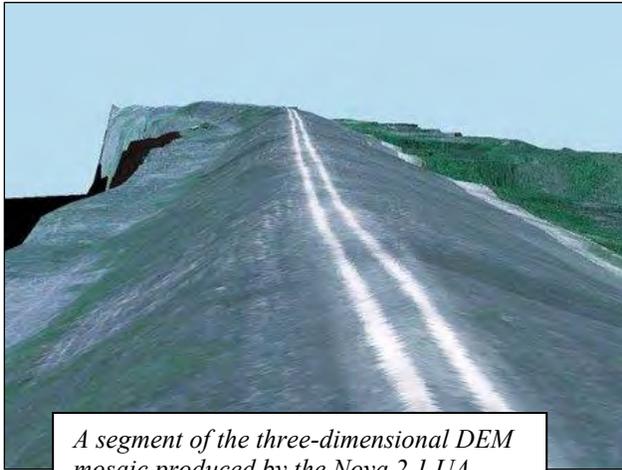
#### **PROGRESS:**

The UFUASRG/USACE partnership has two Nova 2.1 UAV aircraft, one Nova 2.1 UAV trainer, two red-blue-green optical payloads, one near-infrared optical payload, and two ground control stations ready for deployment to field sites for USACE Jacksonville District operational missions. Due to funding complications, ongoing Federal funding resolutions, and the inability to get USACE money to UF, the field-based data collection phase of the

program was on hold for most of spring 2011. During the spring, work was continued in the UFUASRG construction shop to improve ground station operation, and streamline field-based procedures for future missions. Without funding however, we were unable to get as much accomplished in the spring as was anticipated. In March 2011, Mr. Damon A. Wolfe of the USACE Jacksonville District came to UF, and picked up one of the two USACE Jacksonville District image processing computers previously purchased by the USACE, so that he could begin to post-process Nova 2.1 sUAS imagery that was collected in 2010.

In the late spring, the UFUASRG was awarded a portion of the USACE funding expected for this project which allowed us to make a field mission to the Herbert Hoover Levee (May 9-10, 2011) to collect necessary data to accomplish project objective 1. Additionally, this mission was used as an orientation session for the USACE Jacksonville District UAS team members on Nova 2.1 sUAS flight operational procedures. Just prior to the mission, highly accurate ground-based elevation data of the targeted portion of the Hoover Levee were collected by UF and USACE Jacksonville District geomatics personnel for ground-based DEM production and comparative analysis upon return to UF. Although the wind was particularly gusty and perpendicular to the pre-determined flight lines for the levee mission, the Nova 2.1 sUAS did an exceptional job of collecting imagery data during two flights over a segment of the eastern portion of the Lake Okeechobee Hoover Levee, both directly over and just south of the Port Mayaca Lock. Significant pre-flight planning is accomplished in the laboratory before arrival at any UAS mission site, and the UAS crew generally modifies the pre-planned flight waypoints and flight lines based on wind conditions encountered at the launch and recovery site. The UFUASRG prefers to fly the Nova 2.1 UA directly into the prevailing wind for decreased ‘crabbing’ effects of the aircraft, and for optimum imagery data which aids post-processing efforts. However in this mission, due to the target of interest being a linear segment of levee, the orientations of the flight lines were not able to be adjusted for the wind. Because this was also a USACE Jacksonville District UAS team orientation session, it was actually fortuitous that the wind direction was less than ideal as it provided a valuable teaching tool. The two flights for the objective 1 mission totaled 46 minutes and 35 seconds of air time for imagery collection, and covered a total of  $\approx 6.4$  km of the Hoover Levee. Imagery captured during the two flights conducted had sufficient overlap and clarity for post-processing. As part of the post-processing, a mosaic of the Port Mayaca Lock was produced, and a DEM of the Hoover Levee just south of the Lock was created based on the imagery collected by the Nova 2.1 UA (Figure 1). This DEM produced with the UA imagery was compared to a DEM produced from the ground-based elevation data for statistical comparisons.

Due to low water conditions in Lake Okeechobee for both late spring and through the summer of 2011, previous invasive vegetation study areas near Fisheating Bay were high and dry. The UFUASRG/USACE partnership attempted to wait for significant routine afternoon thundershowers and/or a hurricane to raise the water levels in Lake Okeechobee to permit re-flight of the Fisheating Bay experimental site and complete program objective 2; however, by mid-July water levels were still too low. The USACE Jacksonville District UAS team members were anxious to get another mission accomplished as a replacement for the proposed objective 2, and also serve as an additional orientation mission for the USACE Jacksonville District UAS team members. Based on Nova 2.1 sUAS post-processed imagery collected as part of objective 1, a notable fan of sand was spotted by USACE engineers just below the water level at a specific location along the Herbert Hoover Levee indicating the possibility of a potential defect in the structure (Figure 2). With this in mind, the USACE Jacksonville District UAS team decided to have the UFUASRG fly an additional Hoover Levee mission with the USACE Jacksonville District UAS team, continuing geographically south of the earlier conducted 2011 Hoover Levee mission as a replacement to the stated objective 2 in the contract.



*A segment of the three-dimensional DEM mosaic produced by the Nova 2.1 UA imagery of the Herbert Hoover Levee.*

The second Hoover Levee mission took place July 18-22, 2011 as a continuation of levee inspections conducted earlier in the year. A series of 12 flights in total were conducted over an  $\approx 23$  mile stretch of the Hoover Levee south of the areas imaged in objective 1. The first two flights of Hoover Levee mission #2 were conducted with UFUASRG personnel launching the Nova 2.1 UA, and closely monitoring the USACE Jacksonville Districts' Ground Station Operator (GSO) Mr. Jon M. Morton, and UA Operator (UAO) Mr. Tomas M. Spencer through their first flights on a mission. The remaining 10 flights of the mission encompassing the remainder of the first flight day, and the subsequent two days of the Hoover Levee mission

were completed solely by USACE Jacksonville District UAS team personnel, with UFUASRG personnel available on a

standby basis. The three days of imagery collection for the mission took a total of 4 hours, 13 minutes, and 54 seconds of flight time, and covered  $\approx 36.8$  km of levee imagery. The mission was completed using a combination of both of the USACE Jacksonville District Nova 2.1 UAs; indicating that both aircraft were capable of mission-oriented flights and data collection.

On July 28, 2011, Mr. Larry E. Taylor, the USACE Jacksonville District UAS team liaison, sent an email to all Nova 2.1 sUAS associates (both UFUASRG and USACE Jacksonville District UAS team members) stating that the USACE Jacksonville District UAS program was immediately moving forward in a different direction. The new direction would essentially be without the UFUASRG; the UF involvement would continue in only a very small manner. He also stated in the email that he wanted all USACE Jacksonville District UAS and operational equipment housed at UF ready for delivery to the USACE Jacksonville District within two weeks time; considerably earlier than the previously arranged date of October 1, 2011, and significantly earlier than the December 31, 2011 date stated in the contract agreement. On August 11, 2011, Mr. Michael T. Hensch of the USACE Jacksonville District came to UF and retrieved the USACE Jacksonville District UAS trailer containing all the USACE airframes, payloads, ground stations, and operational equipment. The remaining USACE Jacksonville District UAS image processing computer remains at UF so that imagery from the USACE Jacksonville District-modified objective 2 could be initially post-processed and the existing post-processing methods could be further refined and streamlined.

#### **SUMMARY:**

The fieldwork and post-processing of imagery collected for program objective 1 were completed. Due to low water levels in Lake Okeechobee in the spring and summer of 2011, the program objective 2 was replaced by another Hoover levee mission along southeastern Lake Okeechobee at the request of the USACE Jacksonville District.

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### ***Optimal Management of Migratory Bird Habitat and Harvest***

***Principal Investigator: Franklin Percival***

***Project Officer: Fred Johnson***

Funding Agency: USGS

Expected Completion: 02/28/2012 (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 advertised for a postdoctoral associate to conduct this research; the application period closes on January 6, 2012. We do not anticipate substantive progress on this project until this position is filled.

**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.

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***Optimal Control Strategies for Invasive Exotics in South Florida***

***Principal Investigator: Franklin Percival***

***Project Officer: Fred Johnson***

Funding Agency: U.S. Geological Survey

Expected Completion: 02/28/2013 (UF Project #96829)

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:**

We have advertised for a postdoctoral associate to conduct this research; the application period closes on January 6, 2012. We do not anticipate substantive progress on this project until this position is filled.

**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.

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*Effects of Climate Change on Barrier Island Habitat and Nesting Sea Turtles*

**Principal Investigator:** R.R. Carthy

Co-PI: M. Lamont

Funding Agency: USGS/Eglin Air Force Base

Expected Completion: 05/31/2012 (RWO#254, PJ# 00078317)

Research Staff: Brail Stephens, Seth Farris, Caitlin Hackett, Desmond Ho, Henry Legett, Alexandra Stewart, Jessica McKenzie

As the global climate changes it is likely to have significant effects on coastal habitats and the species that rely on this habitat for survival. Warmer temperatures and rising seas can increase beach erosion, altering oceanographic patterns and influencing sand temperatures. These changes to the coastal environment may greatly affect species such as sea turtles. Sea turtles spend most of their life at sea but rely on the shoreline for one critical life-history phase: nesting. Changes to beach topography, sand temperatures and oceanographic patterns may impact nesting success, change incubation rates and influence nesting site fidelity. Determining the effects of climate change on nesting sea turtles will help provide better management information for this threatened species.

Eglin Air Force Base (EAFB) owns approximately 250 hectares along Cape San Blas, Florida. Research conducted by the Florida Cooperative Fish and Wildlife Research Unit from 1994 to 1997 indicated that this property supports the greatest density of loggerhead turtle nesting in the Florida panhandle. In 1998 it was determined that turtles nesting in Northwest Florida are genetically distinct therefore EAFB property on Cape San Blas is critical for the success of this nesting group. Although this region supports a significant group of nesting sea turtles, it has also been determined that Cape San Blas experiences one of the greatest rates of erosion in Florida. Portions of the west beach of Cape San Blas lose approximately 10 meters of sand per year, while sections of the east beach gain about 4 meters per year. These fluxes may increase substantially when influenced by tropical storms.

**OBJECTIVES:**

This project aims to further elucidate specific components of sea turtle ecology and climate change by:

- a. continuation of a long-term tagging study and nest monitoring
- b. investigating effects of changes in beach morphology on sea turtle movements during the inter-nesting period
- c. examining effects of erosion debris fields on nesting success
- d. identification and GIS mapping of Coast Guard Station debris onshore and off-shore
- e. statistical comparison of mean number of false crawls in debris areas versus non-debris areas

- f. researching effects of climate change on incubation length

**PROGRESS:**

In 2011, we recorded 39 false crawls and 27 nests along Eglin AFB property on Cape San Blas for a total of 66 emergences. This represents a 41% nesting success which is identical to the 2010 nesting success and very similar to the 17 year mean nesting success of 40% for this beach. Of all 66 crawls, 67% occurred on east beach and 24% occurred on north beach (the remaining 8% occurred on the cape spit). Of all false crawls, 69% occurred on east beach and only 18% occurred on north beach and a similar proportion was seen with nest distribution: 63% were laid on east beach and 37% were deposited on north beach. Of the 27 nests deposited, we observed turtles laying 16 (59%) of them. This low percentage was due primarily to severe erosion that hampered our ability to access the entire 5-kms of beach each night. The 16 nests that we observed were deposited by 10 individual turtles. Four of those turtles (40%) had been tagged in a previous nesting season and were re-migrants during 2011 which is a significantly larger proportion of re-migrants than typically seen (mean = 7%) over this 17-year study. Five GPS-capable satellite tags were deployed on nesting females this summer to observe inter-nesting behavior and correlate movements with environmental variables. These data are being analyzed as part of project #94704.

Overall emergence success was 9.7% which is far below the long-term mean of 58.1% along Cape San Blas. Of all 27 nests, 16 (59%) showed no sign of emergence and all eggs were un-hatched. One nest was completely depredated by coyotes and one nest was partially depredated. Three nests hatched on east beach for a mean emergence success of 61.4% and one nest hatched on north beach with a 13.9% success.

**SUMMARY:**

As the global climate changes it could have significant effects on coastal habitat and species that rely on this habitat for survival. Warmer temperatures and rising seas can increase beach erosion, altering oceanographic patterns and influencing sand temperatures. These changes to the coastal environment may greatly affect species such as sea turtles.

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***Gopher Tortoise (*Gopherus polyphemus*) Population Survey  
For St. Marks NWR-Line Transect Distance Sampling***

***Principal Investigator: Raymond R. Carthy***

Co-PI: Margaret Lamont

Funding Agency: US Geological Survey

Expected Completion: 4/30/12 (RWO#265, UF PJ#00089566)

Research Staff: Melissa Ethridge, Christopher O'Bryan

The gopher tortoise (*Gopherus polyphemus*), unlisted range, is among the U.S. Fish and Wildlife Ecological Services 2008 priorities as a "preclude the need to list" species. This project furthers the Strategic Habitat Conservation process by providing critical information necessary for biological planning at St. Marks NWR for an umbrella / keystone species, and outcome-based monitoring whereby future conservation actions can be targeted to improve habitat and restore populations.

The study was designed and implemented by the Florida Cooperative Fish and Wildlife Research Unit, St. Marks NWR staff, and staff at J.W. Jones Ecological Research Center at Ichauway to provide baseline data and deliver reliable, unbiased and precise estimates of density and abundance of gopher tortoises on the refuge. It includes a standardized approach to monitoring this species, allowing for subsequent detection of population trends within known confidence intervals, and prioritization of future appropriate management actions under a scenario of limited resources. Line transect distance sampling was employed to provide this information in a time and cost-efficient manner while delivering statistically robust estimates of precision and capturing the spatial variability of the population. This method minimizes biases inherent in landscape-scale surveys, offers estimates of detectability of the species being studied and integrates existing technological resources such as handheld sub-meter accuracy GPS units and GIS capabilities with Program DISTANCE 6.0, a freeware software package that offers a streamlined sampling and analysis approach.

A study design with proper field methods was created that met all critical assumptions for distance sampling (Buckland et al., 2001). Following guidelines provided by Stober and Smith, 2010, Meyer et al. 2008, and Nomani et al. 2008; a sampling frame was created by analyzing suitable soil, elevation and habitat data as developed and determined by St. Marks NWR and Jones Center staff. The pilot survey was implemented by St. Marks NWR and determined the encounter rate of tortoises (per linear transect distance) within various strata. Within the most suitable soil types on the refuge, an encounter rate of between 1 tortoise per 0.5 Km and 1 tortoise per 1.5 Km was recorded. The encounter rate was used to determine the total line transect length needed to obtain an adequate sample size of 60 – 80 tortoises. Utilizing an equation (Smith and Stober, 2010, Meyer et al. 2008, Buckland et al. 2001) to determine total transect lengths to achieve a predefined coefficient of variation (15%), we determined that 132 Km of transects must be surveyed within the 2,201 hectares that constituted the sampling frame. A stratified sampling design was created in Program DISTANCE 6.0 and ArcGis 9.3 using Hawth's Analysis Tools to determine the placement of east-west oriented transects across the sampling frame at an interval of 160 m north-south. The result was a series of 328 unique transect lines with a mean length of 418 m and a combined length of 137.1 Km.

### **PROGRESS:**

Surveys were carried out from June 1, 2011 through July 31, 2011. The three-person survey team used a Trimble Nomad handheld computer running ArcPad 7.1.1 and a sub-meter real-time corrected GPS to navigate to each transect line, and located all burrows along the central transect line and no less than 20 m perpendicular from the centerline. Burrow scoping was done with a color camera system modified from <http://www.amazingmachinery.com/video-econo-products.html>. The crew surveyed 5,500 acres (2,200 hectares) of habitat. This included the most suitable soils for tortoises on the refuge plus a 100-meter buffer, and minus wetlands and any areas that were 8' or less above sea level.

Data collection followed guidelines provided by Smith and Stober (2010) including: start and end points; transect ID, distance of burrow from transect line, burrow diameter, burrow scoping status; occupants observed, burrow length, and burrow activity status. Both active and inactive burrows were scoped when encountered to avoid biasing occupancy rates by time and space, and by season and time-of-day (Breininger et al. 1991, Nomani et al. 2008). All burrows were classified as 1) "occupied", if a gopher tortoise was observed in the burrow; 2) "not occupied", if no tortoise was observed; 3) "abandoned", if the burrow was collapsed or extensively modified by armadillo use; or 4) "undetermined", if observers were unable to manipulate the camera scope to the end of the burrow.

All other occupants observed in gopher tortoise burrows were documented and recorded in a comprehensive database, including the date, time, and location of each occupant observed. This data will likely prove useful for future conservation efforts of burrow occupants and will potentially provide some baseline data as to the presence / absence of such species (including imperiled tortoise burrow commensal species with historical refuge occurrence records such as Eastern Indigo Snake, Southern Hognose Snake, Florida Pine Snake and Gopher Frog) across the refuge.

The analyses on the completed dataset from all 137.1 Km of transects surveyed and tortoise observations recorded were performed in accordance with Buckland et al., 2001, Meyer et al. 2008, Nomani et al. 2008, and Smith and Stober, 2010 by Michael Keys, refuge biologist. Program DISTANCE 6.0 (Thomas et al., 2003) was used for the majority of data analysis. Burrow locations were plotted on a histogram at various distances from the transect line; the outer 5% of burrows are difficult to model and were truncated prior to modeling. Next, the variation of detection for each transect was calculated to determine the spatial distribution of burrows. Additionally, data was grouped into cutoff points by distance of burrows from the line to increase robustness and the precision of the density estimate. Several models were analyzed using Akaike's information criterion (AIC) to determine the detection function that best fit the data according to a goodness of fit test. Density was estimated using the model or models that best fit the data (lowest AIC value). Finally, the detection probability and the rate of occupancy was estimated using program MARK (White and Burnham 1999), and was applied to the estimate of burrow density for the final evaluation of gopher tortoise density in each stratum across the refuge.

**SUMMARY:**

The final analyses are currently underway, and upon the successful completion of this project refuge managers and biologists will be able to re-survey transects used for this project and thus begin monitoring trends in gopher tortoise populations over time.

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***Incubation temperatures of loggerhead turtle (*Caretta caretta*) nests  
On NW Florida Beaches***

**Principal Investigator: Raymond R. Carthy**

Co-PI: Margaret Lamont

Funding Agency: US Fish and Wildlife Service

Expected Completion: 3/1/11 (RWO#266, UF PJ#00089694)

Research Staff: Brail Stephens

The ratio of males to females in a population is an important feature of population structure. Sex ratio directly relates to reproductive rate and adaptive capability of a population (Ridley 1993) and is necessary for determining size, status, and dynamics of the population. For all species of sea turtles, basic knowledge of natural existing sex ratios has been missing until recently and is still not complete for most nesting groups. Sex determination of sea turtles is dependent upon the temperature at which the eggs are incubated (Yntema and Mrosovsky 1982). Several features of nesting beaches have been shown to impact incubation temperatures



therefore understanding temperatures of the beach in which eggs incubate is critical to our knowledge of sex ratios.

Factors influencing temperatures of nesting beaches include beach orientation, position of the nest on the beach, weather conditions, and sand characteristics (Hays et al. 1995, Leslie et al. 1996, Ackerman 1997). Northwest Florida provides reproductive habitat for a small but genetically distinct group of loggerhead turtles. This area is higher in latitude than the more productive nesting beaches on Florida's east coast and generally has whiter, finer grain sand beaches than the east coast. It is unknown whether these characteristics influence incubation temperatures, and thereby sex ratios of sea turtle nests in Northwest Florida.

**OBJECTIVES:**

The objectives of this study are to:

1. Determine sand temperatures and loggerhead nest incubation temperatures in Northwest Florida
2. Determine the relationship between sand temperatures and incubation temperatures
3. Examine variations in incubation rates, sand temperatures, and incubation temperatures at several nesting beaches throughout Northwest Florida.

**PROGRESS:**

**SAND TEMPERATURES: 1998-2001**

Results indicated that mean sand temperatures from 1998-2001 along the Florida Panhandle increased from west to east, with warmer sand temperatures on St. George Island (28.8° C) and cooler sand temperatures on all sites west (Perdido Key 27.7° C, Walton County Beach 28.1° C, and St. Joseph Peninsula 27.9° C;  $p \leq 0.05$  . This trend occurred within each year also with a few exceptions; in 1998 Walton County Beach (28.86° C) was not different than St. George Island (28.85° C) and in 2000, while St. George Island was warmer than all other sites (29.37° C), Perdido Key (28.00° C), Walton County Beach (27.86° C), and St. Joseph Peninsula (28.00° C) were statistically similar ( $p \geq 0.05$ ). Sand temperatures also differed among years with 2001 (27.2° C) being significantly cooler than 1998 (28.7° C), 1999 (28.4° C), and 2000 (28.3° C).

**NEST TEMPERATURES: 1998-1999**

Results indicated that nest temperatures increased from west to east, with mean nest temperatures warmer on St. George Island (30.2° C) and cooler at all sites west (28.8° C) ( $p \leq 0.05$ ). Within year results were similar with nest temperatures warmer on St. George Island than all other sites in both 1998 and 1999 ( $p \leq 0.05$ ).

**INCUBATION RATES**

Mean incubation rates were shorter on St. George Island (57 days) than Perdido Key (63 days), Walton County Beach (62 days), and St. Joseph Peninsula (60 days) ( $p \leq 0.05$ ).

**SUMMARY:**

Sex determination of sea turtles is dependent upon the temperature at which the eggs are incubated (Yntema and Mrosovsky 1982). Several features of nesting beaches have been shown to impact incubation temperatures therefore understanding temperatures of the beach in which eggs incubate is critical to our knowledge of sex ratios.

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***Pre-assessment Plan to Determine Potential Exposure and Injuries of Nesting and Hatching Loggerhead Sea Turtles***

***Principal Investigator: Raymond R. Carthy***

Co-PI: Margaret Lamont

Funding Agency: US Fish and Wildlife service

Expected Completion: 3/1/11 (UF PJ#00090003)

Potential impacts of oil and dispersants from the Mississippi Canyon 252 (MC 252) incident on the gulf coast population of loggerhead sea turtles could range from mortality to sublethal stress and chronic impairment, including potential deleterious effects on reproduction and recruitment. Response and cleanup efforts may also

cause loggerhead sea turtle loss and impairment. The objectives of this study were to 1. Assess nesting female physical condition, inter-nesting movements and blood chemistry; egg and hatchling toxicity; and hatching and emergence success as a function of pre-release, concurrent-with-release, and post-release concentrations of MC 252 oil in and on nesting females, hatchlings, eggs and nesting substrate to determine the relationship between potential MC 252 oil exposure and injury, and to 2. Measure chemical, toxicological and physiological levels for MC 252 oil and constituents (e.g., polycyclic aromatic hydrocarbons (PAHs)) in sand samples, nesting females, eggs and hatchlings along beaches in the Gulf of Mexico to evaluate potential exposure



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to MC 252 oil and determine if there is a concentration gradient of MC 252 oil across the study area. The intent is to achieve these objectives by conducting nesting female physical evaluations, satellite tracking of nesting female inter-nesting and post-nesting movements, collecting blood from nesting females, collecting viable eggs, collecting non-viable eggs and hatchlings, and assessing hatchling and emergent success along beaches with significant nesting activity that also correspond to areas that are anticipated to exhibit a gradient of MC 252 oil concentrations. Samples will be analyzed for MC 252 oil (including PAHs) and physiological parameters.

#### **OBJECTIVES:**

The objectives of this study are to:

1. Nesting female physical condition, inter-nesting movements and blood chemistry will be assessed as a function of pre-spill, concurrent-with-spill, and post-spill concentrations of oil and dispersants in and on nesting females and nesting substrate to determine the relationship between oil and dispersant exposure and magnitude of injury.
2. A toxicological and physiological baseline will be established in nesting females by comparing beaches in the Gulf of Mexico within the impact zone to beaches outside the impact zone.

These objectives will be met by conducting nesting female physical evaluations, satellite tracking nesting female inter-nesting and post-nesting movements, collecting blood from nesting females, collecting viable eggs, along beaches within the oil spill impact zone and beaches outside the oil spill impact zone. Samples will be analyzed for hydrocarbons and physiological parameters.

#### **PROGRESS:**

Intensive nighttime surveys for nesting loggerhead turtles were conducted at three sites: Dry Tortugas, Casey Key, and the St. Joseph Peninsula, Florida. One of the study sites (SJP) is located in the Florida Panhandle, and two of the sites (Dry Tortugas and Casey Key) are located in Southwest Florida. The St. Joseph Peninsula supports the greatest density of nesting by loggerhead turtles in Northwest Florida. Casey Key supports the greatest density of nesting loggerhead turtles along the Gulf Coast, while the Dry Tortugas represents the southernmost nesting beach for loggerhead turtles along the U.S. Gulf Coast (FWC Marine Turtle Nesting data [http://research.myfwc.com/features/category\\_sub.asp?id=2309](http://research.myfwc.com/features/category_sub.asp?id=2309)). In combination, these sites correspond to areas with significant historical nesting activity that also are anticipated to exhibit a gradient of MC 252 oil concentrations.

Surveys were conducted nightly from July 1 through August 31 and consisted of paired personnel traveling along the beach by foot or on ATV/UTV (or via boat/kayak in the Dry Tortugas). All nesting turtles encountered on all surveys were fitted with metal Inconel flipper tags and a Passive Integrated Transponder (PIT) tag was inserted into the triceps muscle complex. Turtles were measured and any abnormalities or signs of injury (lesions, etc) recorded. A 10 cm square section of the highest point of the carapace was swabbed with a gauze pad that was immediately placed in a sterile pre-certified chemically clean glass container. One egg was collected as it was deposited by the nesting female. The egg was placed immediately into a sterile, chemically-cleaned glass container. In addition, epibionts on the carapace of the turtle were removed and stored in sterile chemically-cleaned glass containers.

For each nesting female encountered, field personnel attempted to collect 10 milliliters of blood from the cervical sinus of each turtle that received a satellite tag using vacutainer needles and tubes. Blood samples were partitioned for possible chemical analysis for MC 252 petroleum contaminants, clinical chemistry and hematology, and immune function assessment. These health measures may assess whether the nesting female has been sub-lethally injured.

Satellite tags capable of transmitting GPS positions (Wildlife Computers; Redmond, WA; <http://wildlifecomputers.com/>) were deployed on turtles to evaluate potential exposure and movement patterns. The tags provide data on turtle location, dive time, water depth and temperature, day and time that the turtle's location is recorded, and an estimate of location accuracy. It should be possible for all tagged turtles to be tracked for a minimum of six months. During tracking, movement and behavior will be characterized in relation to potential exposure to MC 252 oil-impacted areas or the lack thereof.

Sand samples were collected adjacent to each nest deposited within the study site (including randomly observed nesting events). Within 12 hours of egg deposition, a sand core was collected at a site one-meter directly left (90 degrees) of each clutch (with back to the water). Cores extended to a 50-cm depth and were immediately placed into

a stainless steel container, mixed to produce a homogeneous sample, and then transferred to a chemically clean, sterile, glass jar for temporary storage on ice or refrigerator until shipment to the appropriate laboratory.

The nests laid by these females were marked and tracked throughout incubation. After emergence or 90 days into incubation, the nests excavated and randomly selected samples (unhatched eggs, hatched eggs, pipped eggs, dead hatchlings) were sent to the lab for processing and analysis.

### *Nesting and Emergence Success*

From July 1 through August 31, in 2010, daily nesting surveys were conducted on beaches from Alabama east to the Florida Panhandle and south to the Dry Tortugas. The beaches surveyed for this Plan were those that have been consistently monitored in prior years for nesting densities and nesting success.

All nests marked on beaches in the four nesting female assessment study areas were excavated three days after hatchling emergence, or after 90 days incubation. Emergence success was calculated by dividing the number of hatchlings that emerged from the nest by the total number of eggs deposited in the nest (Johnson et al. 1996).

A comparative analysis of previously collected data on nesting densities and frequency, hatching success and emergent success on nesting beaches pre-release, during release, and post release may provide an assessment of the potential injury resulting from the MC 252 event. In addition, hatching success for nests deposited in 2010 will be compared to historical hatching success along identical beaches. Hatching success data has been collected from loggerhead nests laid along the St. Joseph Peninsula since 1994 by personnel at the University of Florida (SJP). Mote Marine Laboratory has been collecting data on hatching success along Casey Key for 28 years, and hatching success has been recorded in the Dry Tortugas since 1995 by personnel at the NPS and USGS.

During the 2010 nesting season, satellite tags were deployed on 4 loggerheads nesting along the St. Joseph Peninsula, Florida. The turtle's tracks can be seen at [http://www.seaturtle.org/tracking/?project\\_id=530](http://www.seaturtle.org/tracking/?project_id=530). Biopsy samples were collected from each female along with a swipe of her carapace. Blood samples were also collected. In addition, samples of unhatched eggs were collected from loggerhead nests deposited throughout the Gulf coasts of Florida and Alabama. All of these analyses are being conducted by NRDA laboratories and results are confidential.

### **SUMMARY:**

The Mississippi Canyon 252 (MC 252) incident is unparalleled in the scope of its potential geographic impact. Marine and estuarine ecosystems from Texas to Florida are in immediate danger and the potential impacts of oil and dispersants on loggerhead turtles range from mortality to sub-lethal stress and chronic impairment, including potential deleterious effects on reproduction and recruitment.

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## ***The Effects of Shoreline Armoring Structures on Nesting Loggerhead Turtles***

**Principal Investigator: Raymond R. Carthy**

Co-PI: Margaret Lamont, Dr. Chris Houser (Texas A&M)

Funding Agency: Florida Department of Transportation

Expected Completion: 12/31/2012 (UF PJ#00094704)

Research Personnel: Brail Stephens, Seth Farris

Interest in conducting this research developed as a result of the Florida Department of Transportation (FDOT) District 3's recently proposed long term improvements at the SR 30E Stump Hole in Gulf County, Florida. Proposed improvements included two options: either construction of an enhanced revetment structure, which is a form of coastal armoring, or a bridge. SR 30E is a coastal roadway that forms an essential link between the St. Joseph Peninsula and the mainland. The two-lane roadway is currently reinforced with a riprap rock revetment to

protect the road from storm damage. The revetment was first constructed in 1995/1996 following Hurricane Opal. Subsequent storm events coupled with severe coastal erosion have continued to result in overtopping and rock displacement, requiring frequent repairs. Work will take place in an area important for nesting sea turtles in the Florida panhandle. Potential nesting sea turtle species include: the threatened loggerhead sea turtle (*Caretta caretta*), endangered green sea turtle (*Chelonia mydas*), endangered leatherback sea turtle (*Dermochelys coriacea*), and endangered Kemp's ridley sea turtle (*Lepidochelys kempii*). The FDOT and Federal Highway Administration (FHWA) determined that the long-term improvement alternatives are likely to adversely affect nesting and hatchling sea turtles, and the U.S. Fish and Wildlife Service (Service) concurred with their effect determination. The St. Joseph Peninsula is a closed barrier island system. Sand from relict deposits located offshore of the Cape San Blas spit served as sediment for formation and maintenance of this barrier island until rising sea levels drowned these deposits. As sand is eroded from these areas, it is carried northward by longshore drift where it is deposited along the northern tip of the Peninsula (Lamont 2002). The longshore pattern of erosion and deposition is greatly dependent on how the currents and waves are forced by the antecedent shoreface morphology. Modeling of the wave and current patterns along Cape San Blas prior to and after installation of the revetment will yield important insights into the underlying causes of shoreline retreat and the potential (present and future) undermining of the protective structures by identifying the forces generating this pattern of sand movement.

#### **OBJECTIVES:**

The opportunity to correlate loggerhead turtle nesting and reproductive success in areas impacted by shoreline stabilization devices, coupled with wave modeling and data on environmental variables is a unique chance to view an area from three perspectives: 1. a loggerhead turtle dependent on the nearshore habitat for cues used in nest site selection, 2. the forces responsible for driving the dynamics of this coastal habitat (ocean currents, wind patterns, and bathymetry), and 3. a visual representation of these dynamics over time, prior to and after installation of the SR 30E revetment. This will provide valuable information about the nearshore environment: how it is affected by shoreline stabilization devices and its role in the ecology of nesting loggerhead turtles. It will also allow recommendations for future actions to improve or repair the current revetment and to build similar structures in other highly dynamic coastal areas.

#### **PROGRESS:**

Locations of turtle nests deposited on Cape San Blas between 1994 and 2010 were sent to Dr. Chris Houser at Texas A&M University for inclusion in the MIKE21 model. The model is currently running and takes about one-month to analyze one-year of data. In addition, GPS-capable satellite tags were deployed on 5 loggerhead turtles upon completion of nesting. Tracks from these turtles are available to the public at [www.seaturtle.org](http://www.seaturtle.org). Location and depth data from these tracks were also provided to Dr. Houser for inclusion in the model. Once modeling is complete, data will be summarized in a final report and publication.

#### **SUMMARY:**

The longshore pattern of erosion and deposition on barrier islands is greatly dependent on how the currents and waves are forced by the antecedent shoreface morphology. Modeling of the wave and current patterns along a barrier peninsula in the northern Gulf of Mexico, Cape San Blas, prior to and after installation of a rock revetment will yield important insights into the underlying causes of shoreline retreat and the potential (present and future) undermining of the protective structures by identifying the forces generating this pattern of sand movement. Changes to these patterns may alter the cues used in nest site selection by loggerhead turtles thereby influencing a turtle's ability to select the optimal site to emerge and lowering nesting success

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### ***St. Joseph Peninsula Beach Restoration***

***Principal Investigator: Raymond R. Carthy***

Co-PI: Margaret Lamont

Funding Agency: MRD Associates

Expected Completion: 1/31/2012 (UF PJ# 00096816)

Research Personnel: Jessica McKenzie, Brail Stephens, Seth Farris, Caitlin Hackett

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 along one of the most important loggerhead nesting beaches in the northern Gulf of Mexico.

**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:**

In the 2011 nesting season, a total of 145 crawls were observed on the St. Joseph Peninsula and 89 of them were nesting emergences. Nesting success was 61% which is above the 10 year mean of 54%. We observed turtles during 99 (85%) of those 116 nesting events. Those 99 nesting events were conducted by 52 individual turtles. Of those 52 turtles, 23% were neophyte nesters and 77% were returns. Of the 77% returns, 42% were re-migrants from previous nesting seasons and 35% were returns from within the 2011 nesting season (inter-nesters). This is the largest proportion of re-migrants we have observed throughout the extent of our tagging program (1998-2011). Continuing our saturation tagging project through the 2012 nesting season will provide information to help elucidate the reasons for these observations.

In addition to the flipper tagging that we have been conducting since 1998, we also deployed GPS-capable satellite tags on 5 females that nested along the St. Joseph Peninsula in cooperation with Dr. Chris Sasso at the NMFS Southeast Fisheries Science Center in Miami, FL. Tracks from these tags can be viewed online at [http://www.seaturtle.org/tracking/?project\\_id=638](http://www.seaturtle.org/tracking/?project_id=638). All 5 of these tags were deployed early in the nesting season so inter-nesting movements could be documented.

Overall emergence success for nests deposited on the Peninsula was 63% for the 2011 nesting season. This is below the emergence success of 75% reported during the nourishment project in 2010. Eggs were influenced greatly by Tropical Storm Lee that impacted the Peninsula on September 4-5 and resulted in the loss of 23 (26%) nests.

**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.

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***American Alligator Distribution, Size, and Hole Occupancy and American Crocodile Juvenile Growth and Survival***

***Principal Investigator: Frank Mazzotti***

Co-Principal Investigators: Kristen Hart, Laura Brandt, Michael Cherkiss

Funding Agencies: U.S. Army Corps of Engineers

Expected Completion: 03/31/2015

(RWO#268, Project #89747, #89760)



Research Staff: Brian Jeffery, Rafael Crespo, Ryan Lynch, Michael Rochford, Adam Daughtery, Matthew Denton, Edward Larrivee, Emily Pifer, Jeffery Beauchamp, Gareth Blakemore

The Water Resources Development Act (WRDA) of 2000 authorized the Comprehensive Everglades Restoration Plan (CERP) as a framework for modifications and operational changes to the Central and Southern Florida Project needed to restore the South Florida ecosystem. Provisions within WRDA 2000 provide for specific authorization for an adaptive assessment and monitoring program. A Monitoring and Assessment Plan (MAP) (RECOVER 2004, 2006) has been developed as the primary tool to assess the system-wide performance of the CERP by the REstoration, COordination and VERification (RECOVER) program. The MAP presents the monitoring and supporting research needed to measure the responses of the South Florida ecosystem to CERP implementation.

At all life stages, crocodilians integrate biological impacts of hydrologic conditions (Mazzotti and Brandt 1994, Mazzotti 1999, Mazzotti and Cherkiss 2003, Rice et al. 2005). Florida's two native species of crocodilians—the American alligator (*Alligator mississippiensis*) and the American crocodile (*Crocodylus acutus*)—are important indicators of health of the Everglades ecosystem because research has linked three key aspects of Everglades' ecology to them: (1) top predators such as crocodilians are directly dependent on prey density, especially aquatic and semi-aquatic organisms, and thus they provide a surrogate for status of many other species, (2) drier (nests) and wetter (trails and holes) conditions created by ecosystem engineers like alligators provide habitat for plants and animals that otherwise would not be able to survive. This increases diversity and productivity of Everglades marshes (Kushlan and Kushlan 1980, Palmer and Mazzotti 2004, Campbell and Mazzotti 2004) and, therefore, alligator monitoring can indicate overall health of the marsh (3) the distribution and abundance of crocodilians in estuaries is directly dependent on timing, amount, and location of freshwater flow (Dunson and Mazzotti 1989, Mazzotti and Dunson 1989); crocodiles and alligators exhibit an immediate response to changes in freshwater inputs into the estuaries.

RECOVER's conceptual ecological models (CEMs) for the Total System, Biscayne Bay, Southern Marl Prairies, Ridge and Slough, and Mangrove Estuarine ecosystems identify three major stressors to wetlands that are affecting populations of alligators and crocodiles: (1) water management practices (affecting hydrology); (2) agricultural and urban development (affecting habitat loss and hydrology); and (3) decreased freshwater flow to estuaries (affecting salinity regimes) (U.S. Army Corps of Engineers (USACE) 2004). Results of this proposed MAP project will increase certainty of CEM linkages hypothesizing population responses to the restoration of freshwater flow and salinity patterns in estuaries and the return of more natural hydropatterns in interior wetlands and alligator holes.

Restoration success or failure can be evaluated by comparing recent and future trends and status of crocodilian populations with historical population data and model predictions, as stated in the CERP hypotheses related to alligators and crocodiles (CERP MAP section 3.1.2.5 and 3.1.2.6, USACE 2004). Importantly, these data can be used in an analysis designed to distinguish between effects of CERP and those of non-CERP events such as hurricanes or droughts. The CERP and RECOVER MAP hypotheses and goals related to crocodilians are as follows:

#### Alligators

- Restoration of hydropatterns (depth, duration, distribution, and flow) in Southern Marl Prairies/Rocky Glades will expand the distribution and abundance of reproducing alligators and active alligator holes and will restore the keystone role of alligator holes as refugia for aquatic fauna.
- Restoration of estuarine salinity regimes will expand distribution and abundance of reproducing alligators into oligohaline portions of estuaries.
- Restoration of hydropatterns in ridge and slough landscape will sustain current populations of alligators and improve body condition of alligators in ridge and slough landscape.

#### Crocodiles

- Restoration of freshwater flows and salinity regimes to estuaries will increase growth and survival of crocodiles.
- Restoration of location of freshwater flow will result in an increase in relative density of crocodiles in areas of restored flow, such as Taylor Slough/C-111 drainage.

Concerns about these indicators relate primarily to their respective roles as top predator, keystone species, and ecosystem engineer (American alligator), and top predator, flagship species, estuarine dwelling, and federally threatened species (American crocodile). Reproduction, growth, and survival of crocodilians are dependent on food availability—birds, mammals, fish, and macroinvertebrates, which in turn are dependent on hydrologic conditions. Loss of flow and relatively dry hydrologic conditions resulting from water management practices over the past several decades, and loss of habitat (due partly to reduced areas of inundation, increased drydowns, and increased salinization) in portions of the Everglades have adversely affected alligators and crocodiles (Mazzotti and Brandt 1994, Mazzotti and Cherkiss 2003, Rice et al. 2005, Mazzotti et al. 2009). Loss of habitat in Southern Marl Prairies and Rocky Glades and reduction in depth and period of inundation in remaining Everglades wetlands have reduced abundance of alligators and alligator holes in these habitats (Craighead 1968). Other areas are impacted by ponding and altered timing of increased water depths, resulting in nest flooding (Kushlan and Jacobsen 1990) and reduced body condition (Dalrymple 1996). Reduced prey availability throughout the system as a result of hydrologic alterations corresponds with lower growth, survival, and reproduction of alligators (Mazzotti and Brandt 1994).

Both alligators and crocodiles have been affected by loss of freshwater flow to estuaries. This loss of flow corresponds with a reduction in distribution and abundance of alligators (Craighead 1968). Although there are higher numbers of crocodiles in more places today than when the species was declared endangered, virtually all of the increase is due to crocodiles occupying and nesting in man-made habitats such as the Turkey Point Power Plant site and along the East Cape Canal (Mazzotti and Cherkiss 2003, Mazzotti et al. 2007). The mangrove back-country of northeastern Florida Bay has consistently been considered core habitat of the American crocodile in Florida (Kushlan and Mazzotti 1989, Mazzotti 1999, Mazzotti et al. 2007). Today this physically unaltered area suffers from diversion of fresh water (McIvor et al. 1994). This area also has the lowest rates of growth and survival of crocodiles anywhere in Florida (Mazzotti and Cherkiss 2003, Mazzotti et al. 2007).

Because of its unique geographic location and subtropical climate, the Greater Everglades is the only place in the world where both alligators and crocodiles occur. The most important factors affecting regional distribution and abundance of these crocodilians are loss of habitat, changing hydroperiod, altered water depth, and changing salinity (Mazzotti and Brandt 1994, Mazzotti 1999, Mazzotti and Cherkiss 2003, Rice et al. 2005, Mazzotti et al. 2007). Water management has changed the pattern of water levels in the southern Everglades, causing unnatural flooding events and mortality of alligator nests (Kushlan and Jacobsen 1990). Increasing drought frequency and depth of drying have reduced the suitability of Southern Marl Prairie and Rocky Glades habitats and occupancy of alligator holes by alligators. Increasing drought frequency and depth of drying have also increased the time required for fish and macroinvertebrate populations to recover to levels considered representative of the historical Everglades (Trexler et al. 2003). When drying events occur repeatedly at less than a 3- to 8-year interval, fish and macroinvertebrate populations are continually recovering from past droughts and may fail to reach densities sufficient to sustain large predators such as alligators (Loftus and Eklund 1994, Turner et al. 1999, Trexler et al. 2005). Diminished prey density is correlated with lower growth and reproductive rates for alligators in the Everglades compared to other parts of their range (Mazzotti and Brandt 1994). Repeated drying events may also wipe out entire age classes, as alligators are forced to congregate in remaining bodies of water where they may suffer from predation and cannibalism.

Changes in water salinity patterns also affect populations of crocodilians (Dunson and Mazzotti 1989, Mazzotti and Dunson 1989). Although American crocodiles are more tolerant of saltwater than alligators, both species prefer fresh to brackish water (Mazzotti 1983). The distribution of alligators in estuaries has been affected by intrusion of saltwater (Craighead 1968, Mazzotti and Brandt 1994). In northeastern Florida Bay occurrence of alligators corresponds with presence of fresh water (Mazzotti 1983). Regionally, lack of fresh water has been correlated with lower growth and survival of crocodiles (Moler 1992, Mazzotti and Cherkiss 2003, Mazzotti et al. 2007).

In a particularly encouraging finding, Mazzotti et al. (2007) reported that after Buttonwood and East Cape canals in Everglades National Park were plugged in the 1980s to reduce saltwater intrusion into interior areas of Whitewater

Bay and Cape Sable, crocodiles responded positively by increasing local nesting effort and success. This clear result suggests that restoring historical salinity patterns in estuaries can have a positive effect on this indicator species and that long-term monitoring is effective at determining population-level responses. It also indicates that nesting phenology, effort, and success should be added to growth and survival as monitoring parameters.

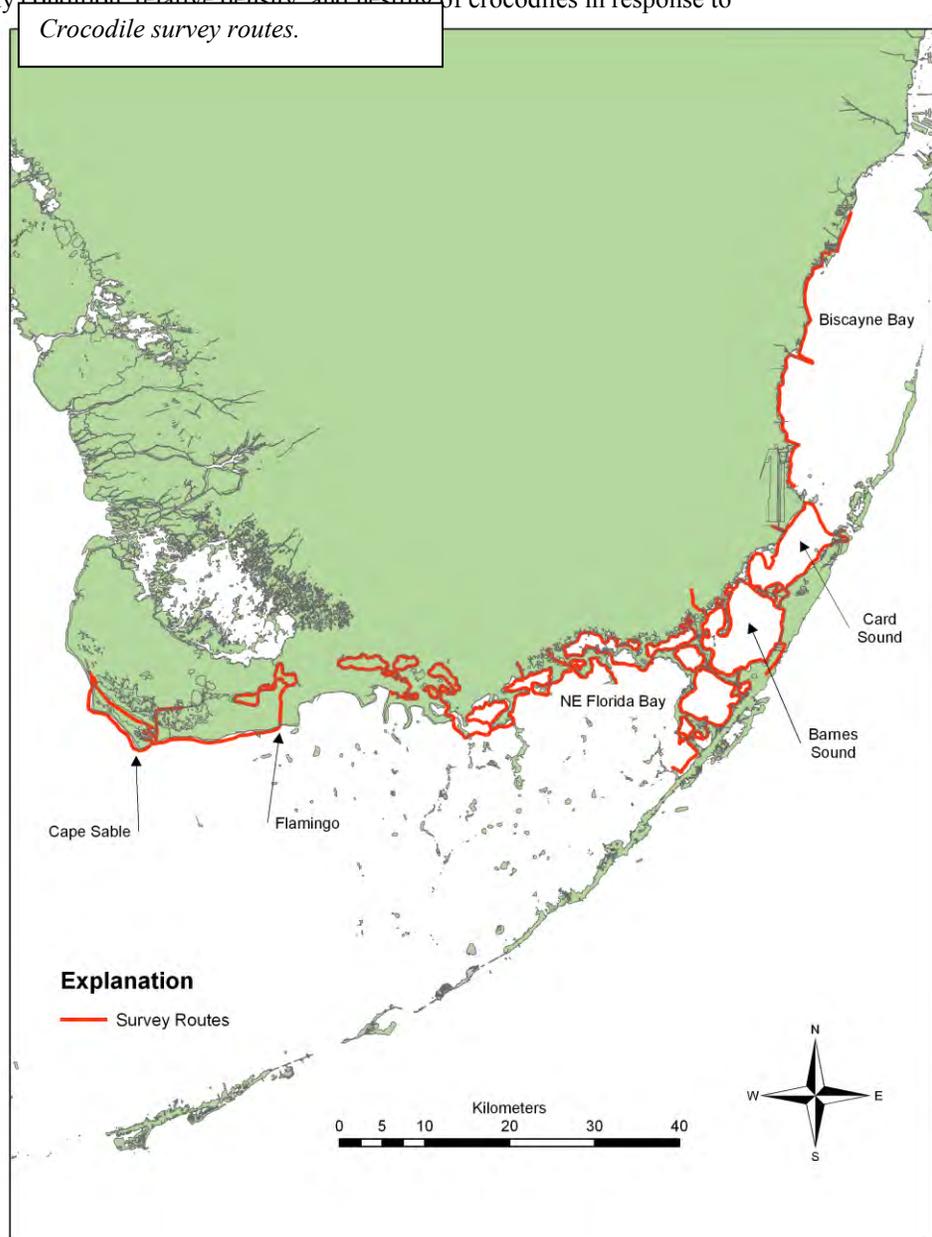
**OBJECTIVES:**

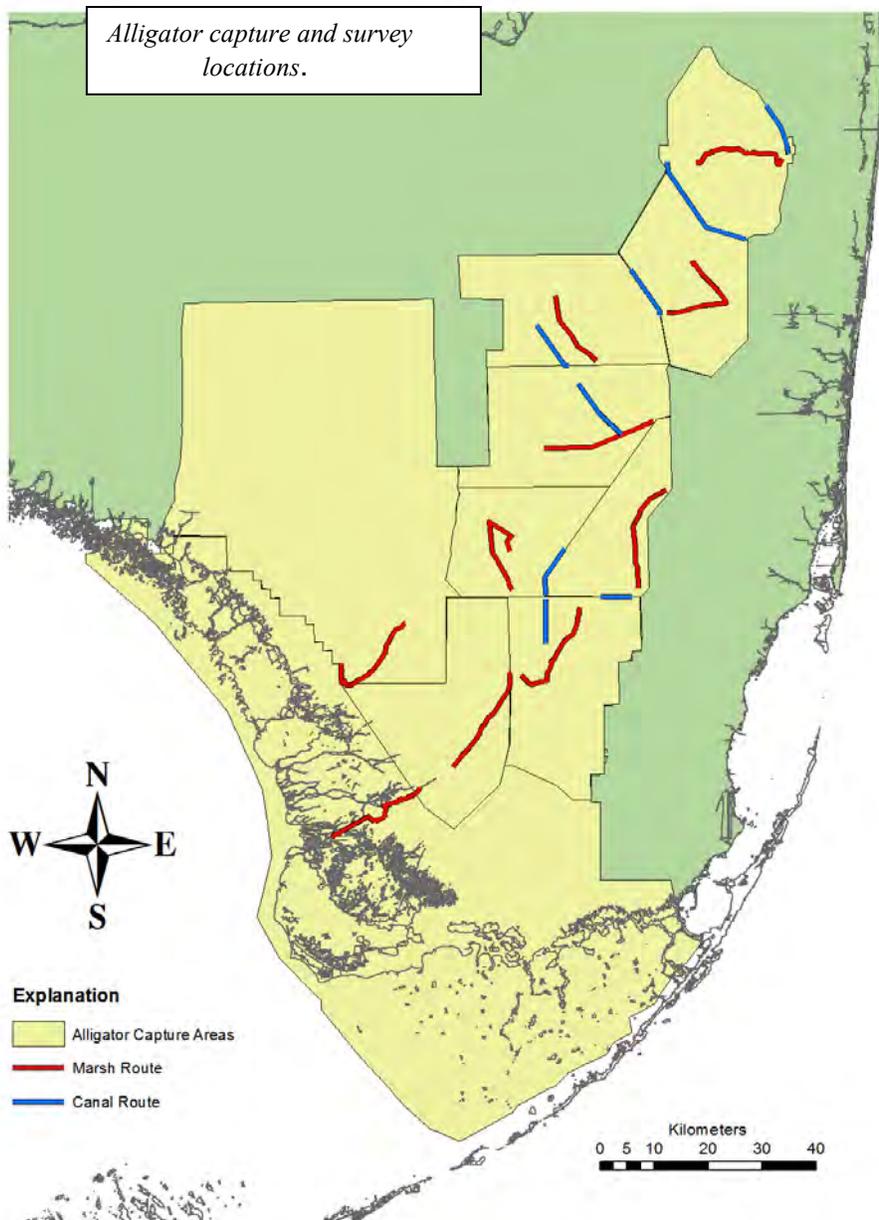
1. Monitor changes in alligator populations resulting from restoration over short-term (body condition), medium-term (distribution, relative density, hole occupancy) and long-term (demography) temporal scales
2. Monitor changes in growth, survival, body condition, relative density, and nesting of crocodiles in response to CERP projects.

**PROGRESS:**

**Alligator captures:** A total of 69 (34 female and 35 male) alligators were captured in the spring at 5 areas (ENP-EST, LOX marsh and canal, and WCA3A-HD marsh and canal; Figure 1) due to an extreme drought. Of those captured, 61 were new individuals and 8 were recaptured individuals. Captured alligators ranged from 125.2 cm to 293.2 cm. A total of 160 (77 female and 83 male) alligators were captured in the fall in 10 areas (Figure 1). Of those captured, 134 were new individuals and 26 were recaptured individuals. Captured alligators ranged from 113.1 cm to 310.8 cm.

**Alligator Surveys:** Spring alligator surveys were conducted in 4 marsh, 5 canal, and 1 estuary areas due to the extreme drought. Alligator encounter rates ranged from 0.0/km to 23.4/km in the marsh/estuary and 1.4/km to 39.2/km in canals. Fall alligator surveys were conducted in 9 marsh and 1 estuary areas. Alligator encounter rates ranged from 0.0/km to 6.9/km.





Alligator Hole Occupancy: Spring alligator hole occupancy flights were conducted in 3 areas and ranged from 16.83% to 53.14% of hole observed had alligators present.

Crocodile Surveys: - Survey areas included ENP, Key Largo, and most accessible coastal and estuarine shorelines from the western boundary of ENP around the coast to the mouth of the Miami River (Figure 1). During the period from October 1, 2010 -June 30<sup>th</sup>, 2011 surveys resulted in 174 crocodile observations, 49 alligator observations, and 217 indistinguishable eyeshines. Seventy captures were made of crocodiles during nightlight surveys. Of the 70 captures, 42 were recaptures. Personnel at TP and FWC originally each marked six of the recaptured crocodiles, and the University of Florida originally marked the remaining 23. Data from the surveys performed from November – December 2011 are in the process of being entered and proofed and will be available upon completion.

Crocodile Nesting: One-hundred and six confirmed nests were located by the University of Florida during the 2011 nesting season. Of those, 101 were within ENP, one depredated nest was located at Chapman Field County Park, one successful nest located at Deering Bay and Ocean Reef on North Key Largo and 2 located at the Crocodile Lake National Wildlife Refuge. For nests whose fate was known, 103 (97%) were successful, two (2%) were depredated by raccoons and the remaining one failed for unknown reasons. A total of 849 hatchlings were captured, 831 from nests within ENP.

**SUMMARY:**

Hydrology influences alligator densities and body condition and crocodile juvenile growth and survival in the Everglades.

## ***Resolving Uncertainty in Natural Mortality and Movement rates of Gulf of Mexico Sturgeon***

**Principal Investigator:** Robert Ahrens

*Co-PI:* Dr. Bill Pine

*Funding Agency:* National Marine Fisheries Service

*Expected Completion:* 08/31/2012 (UF Project #95689, RWO 275)

*Graduate Student:* Merrill Rudd



The Gulf of Mexico sturgeon (*Acipenser oxyrinchus desotoi*) or Gulf sturgeon was federally listed during 1991 by NOAA Fisheries and the U.S. Fish and Wildlife Service (56FR 49653). Gulf sturgeon are a subspecies of the Atlantic sturgeon (*A. o. oxyrinchus*) (Vladykov 1955), and this fish species ranges along the Gulf coast from Florida to the Mississippi River (Grunchy and Parker 1980, Wooley and Crateau 1985). Winters are spent in estuarine and marine habitats and much of the rest of the year is spent in coastal rivers (Odenkirk 1991; Foster 1993; Clugston et al. 1995).

A variety of life-history, feeding ecology, movement, genetics, and population viability studies has been conducted on Gulf sturgeon throughout their native range (Huff 1975, Mason and Clugston 1993, Carr et al. 1996, Stabile et al. 1996, Sulak and Clugston 1999, Zehfuss et al. 1999, Fox et al. 2000, Pine et al. 2001, Berg 2004, Kynard and Parker 2004, Ross et al. 2004, Pine et al. 2006). Collectively these studies have provided a baseline of information about basic Gulf sturgeon life history attributes and have also provided relative snapshots of the status of Gulf sturgeon stocks in individual rivers. Though significant advances have been made in the synthesis of information of Gulf sturgeon, the 2009 assessment (Pine and Martell 2009) identified a number of key uncertainties yet to be resolved that significantly impact assessment results. Resolving uncertainty in natural mortality rates and movement rates between management units and river basins was identified as very high priority and in 2009 NMFS launched a cooperative telemetry tagging program to try and provide an alternative approach to estimating mortality than those available in Pine and Martell (2009)

We propose to utilize available acoustic telemetry data collected through the NMFS cooperative sturgeon-tagging program to assess natural mortality and movement rates for gulf sturgeon within and between rivers of key management interest including the Suwannee, Apalachicola, Choctawhatchee, Pascagoula, and Pearl rivers. The 2009 Gulf sturgeon stock assessment identified large uncertainty in natural mortality rates estimates from life-history characteristics and traditional passive (PIT) tagging programs. This uncertainty propagates through the assessment and leads to divergent assessment of current status of the stocks. To address this uncertainty a large telemetry program, where 20 individual sturgeon were tagged in 5 core rivers across the Gulf of Mexico (GOM) with long-life (3 year) acoustic tags array, was initiated. A large network of acoustic receivers was deployed throughout the GOM to monitor the movements of these tagged individuals in order to improve estimates of exchange rates between management units and improve the current estimates of natural mortality rates. This array has been tracking acoustically tagged Gulf sturgeon since fall 2010 and there is a need to develop robust analytical techniques to evaluate the information from the array and utilize the new information to update the stock assessment and recovery plan for this species.

Within the context of this project the analysis of the data will result in a hierarchical model for estimating mortality within a Brownie framework (see Hightower et al. 2001) as well as an occupancy model to determine Markovian transition probabilities between key management areas such as recovery plan identified stocks.

### **OBJECTIVES:**

The objectives of this project are to produce:

- (1) An analytical tool for estimating natural mortality and movement rates from acoustic tag data
- (2) Recommendations for revising and updating current telemetry programs
- (3) Comparison of mortality estimates with currently available estimates
- (4) Incorporate new information on natural mortality rates into population assessment to revise stock status estimates and provide a framework to establish recovery targets.

**PROGRESS:**

During the first four months of this project significant progress has been made. Telemetry information up to 2010 has been entered and obtained from the National Marine Fisheries Service. A simulation evaluation framework has been developed to assess the appropriate model structure to be used in program MARK to assess mortality and movement rates. The stock reduction analysis used to assess gulf sturgeon status has been revised to allow for population assessment at the level of spawning river. Three presentations were given to the Gulf Sturgeon working group at the annual meeting in November outlining the current status of the project.

**SUMMARY:**

Resolving the uncertainty in natural mortality rate as well as movement rates of Gulf Sturgeon between river systems within the Gulf of Mexico is critical for assessing the status and setting recovery targets for this ESA listed threatened species.

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***Assessing natal sources of juvenile native fish in Grand Canyon: A test with flannelmouth suckers and other native fish***

**Principal Investigator:** Dr. William Pine

**Funding Agency:** U.S. Geological Survey

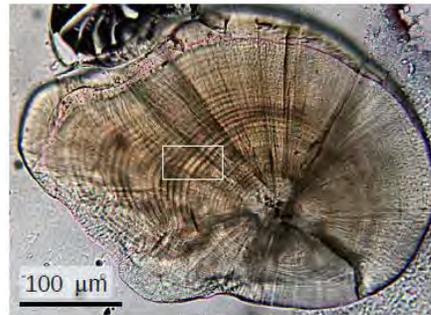
**Expected Completion:** 09/30/2011 (RWO 259)

**Research Staff:** Colton Finch, Brandon Gerig, Mike Dodrill

Fish otolith and water chemistry were assessed in the Grand Canyon reach of the Colorado River and its tributaries. Aqueous strontium and selenium (in ratio to calcium) and carbon stable isotopic ratios were identified as markers with excellent potential to track the provenance and movements of native fish including the endangered humpback chub *Gila cypha*. We originally proposed to use flannelmouth suckers *Catostomus latipinnis* as a surrogate species for humpback chub

because we did not think humpback chub samples would be available. Humpback chub samples did become available, so we used these samples instead of the surrogate species because humpback chub are the species of primary research interest. Although otolith  $\delta^{13}C$  and Sr:Ca varied proportionately to water chemistry and provided a framework for detailed study of humpback chub movements, otolith Se:Ca showed ambiguous tracking of known water chemistries. As an application, we document the natal source and movement dynamics of n=10 humpback chub and compare these findings from otolith microchemistry to the current paradigm of humpback chub spawning ecology. We found that seven of ten fish follow the current early life history paradigm and were spawned in the Little Colorado River and subsequently emigrated to the mainstem Colorado River as juveniles. However, the otolith markers of three fish suggest an alternative early life trajectory with unknown provenance. Age and growth analyses demonstrate seasonally higher growth rates in the warmer Little Colorado River compared to the Colorado River. Combining natural markers with age and growth reconstructions provides a powerful tool for assessing habitat use and success of humpback chub in Grand Canyon.

**OBJECTIVES:**



Distinct, broad daily growth rings



slow growth  
← transition  
rapid growth

Determine whether trace elements found in water were incorporated into humpback chub otoliths and whether these elements could be used to establish provenance of humpback chub in the Grand Canyon reach of the Colorado River.

**PROGRESS:**

The project is complete and an extended final report is available and attached to this document.

**SUMMARY:**

We documented the natal source and movement dynamics of humpback chub and compared these findings from otolith microchemistry to the current paradigm of humpback chub spawning ecology. We found that seven of ten fish follow the current early life history paradigm and were spawned in the Little Colorado River and subsequently emigrated to the mainstem Colorado River as juveniles. However, the otolith markers of three fish suggest an alternative early life trajectory with unknown provenance.

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***A Land of Flowers on a Latitude of Deserts: Aiding Conservation and Management of Florida's Biodiversity by using Predictions from "Down-Scaled" AOGCM Climate Scenario in Combination with Ecological Modeling***

**Principal Investigator:** *Dr. H. Franklin Percival*

**Project Officer:** *Tom Smith*

**Co-PI:** *Dr. Wiley M. Kitchens, Dr. Christa L. Zweig, Dr. Michael S. Allen*

**Funding Agency:** U.S. Geological Survey

**Expected Completion:** 09/30/2011 (RWO 261)

**Research Staff:** *Melissa DeSa, Rodney Hunt*

This project is part of a larger research objective examining the potential climate change impacts for peninsular Florida using predictions from down-scaled AOGCM climate scenarios. The focus herein is the low energy coastline of the Suwannee River-Big Bend ecosystem and specifically the small mammal, raptor, vegetation and fish communities that characterize the region. Baseline data will be collected for future monitoring and to help understand how climate predictions might impact the species and communities of concern.

The endangered Florida salt marsh vole (*Microtus pennsylvanicus dukecampbelli*) resides in the Lower Suwannee National Wildlife Refuge and has only been captured 43 times since 1979. Its rarity makes it extremely difficult to study in a statistically meaningful way, so while efforts continue to learn more about *M. pennsylvanicus*, focus has shifted towards more common small mammal marsh inhabitants. The rice rat (*Oryzomys palustris*) and cotton rat (*Sigmodon hispidus*) are known to occupy the marshes in higher numbers and represent an important class of herbivores that influence their vegetative environment. Occupancy estimates in various coastal habitats will be obtained in order to understand current population patterns and how climate change may impact these animals.

Raptors that forage the marsh for small mammals and other prey items will also be studied, as they are important predators in marsh ecosystems and tied to prey availability. Point count surveys will contribute to understanding their general presence in the area and whether or not they may be foraging on marsh mammals.

Baseline vegetation information will also be collected and methods developed for continued monitoring to inform a succession model. Remote sensing will be used to extend the period of record for habitat and link hydrologic and vegetation relationships at multiple scales.

Fisheries data has been collected over several years through the Fisheries Independent Monitoring program through the Fish and Wildlife Conservation Commission in the Lower Suwannee River. Discharge from the river has been shown to influence growth and survival of juvenile fishes inhabiting the estuary. Predictions of future river discharge scenarios from down-scaled climate models will be tied to models of fish recruitment and occurrence in the estuary.

**OBJECTIVES:**

1. To develop the knowledge necessary to make accurate predictions of the response of species and their ecosystems to climate change.
2. To link marsh inhabitants (primarily small mammals, secondarily raptors) to predicted changes in water availability from downscaled climate predictions from Atmospheric-Ocean General Circulation Models (AOGCMs) to peninsular Florida.

**PROGRESS:**

To date, all trapping, vegetation and raptor data has been collected. More work to catch the endangered vole continues, as does evaluation of camera traps as a substitute for live traps. All data is in the process of analysis and we anticipate that most results will be available by April of 2012 when the AOGCM climate data may be provided.

**SUMMARY:**

Understanding the relationship between the vegetation, small mammals, and raptors in the salt marshes of Florida's Suwannee River-Big Bend region will allow us to understand how downscaled climate predictions for the region might affect this ecosystem.

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***Wading Bird Colony Location, Size, Timing and Wood Stork  
And Roseate Spoonbill Nesting Success***

*Foam alligators used by Brittany Burtner and Peter Frederick to investigate the relationship between alligators and wading bird nesting colonies in the Everglades.*

**Principal Investigator:** Peter Frederick

**Funding Agency:** U.S. Army Corps of Engineers

**Expected Completion:** 3/30/2011 (RWO 264 )

**Research Staff:** John Simon, Chris Winchester, Brittany Burtner, Louise Venne, Ross Tsai, Jason Fidorra



The proposed work is to continue a long-term monitoring project that annually monitors responses of breeding wading birds to hydrological conditions in the water conservation areas of the Everglades, and to monitor reactions of Wood Storks (*Mycteria americana*) to hydrological change. While this work continues the work carried out over the past decade, this project expands the area covered to include nesting in Big Cypress National Preserve and Everglades National Park, and to facilitate and standardize surveys occurring in Florida Bay and Lake Okeechobee.

**OBJECTIVES:**

This work is to continue a long-term monitoring project that annually documents responses of breeding wading birds to hydrological conditions and restoration efforts, and to expand the coverage of these surveys to include Everglades National Park and Big Cypress National Preserve. In addition, we hope to document specific responses of Wood Storks to restoration activities. A final goal is to ensure coordination and standardization of breeding wading bird surveys in the entire watershed, from Lake Okeechobee to Florida Bay. This will greatly enhance our ability to detect both system-wide responses, and to compare responses in different parts of the ecosystem.

**PROGRESS:**

1. Preparation of 2011 Annual Report.
2. Solicitation and evaluation of technician applications for 2012 field season.

3. Repair and maintenance of equipment and vehicles in preparation for 2012 field season.
4. Search for housing for 2012 field season.
5. Migration of the South Florida Wading Bird Report to a UF website.
6. Preparation of December 2011 status report.
7. Migration of this project to direct contracting with USACE

**SUMMARY:**

This research and monitoring project is designed to enhance restoration of Everglades wading bird populations through understanding of the mechanisms by which wading birds reproduce, particularly in relation to hydrological manipulations. In addition, this project is also aimed at gathering key information that will allow defensible projections of the demographics of endangered Wood Storks.

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***Resource use by Florida manatees in the northern Gulf of Mexico***

**Principal Investigator: Robert Fletcher**

Funding Agencies: USGS

Expected Completion: 9/30/2012 (RWO 274, UF#96834)

Florida manatees range along the Gulf of Mexico coast from Florida to Texas. Little is known about manatee use areas and habits along the Gulf coast west of the Suwannee River. Several warm water refuges exist in this region that manatees use during winter. Correlated with a documented increase in the Crystal River subpopulation, winter use at alternate natural springs in northwestern Florida is increasing. However the distribution of manatees along the northern Gulf of Mexico (NGOM) west of the Suwannee River is not well understood. Sighting records show use near freshwater sources during the warm season along the NGOM, and use of natural and artificial warm water sources in winter. Trends in sighting data suggest recent increases in use by manatees of near-shore coastal areas of western Florida, Alabama, Mississippi, Louisiana, and Texas. Understanding the distribution and resource use of manatees in this area will be valuable for managing manatee habitat at the northern extent of their Gulf coast range. We will use existing data on manatee habitat use and movement to better understand resource selection of this endangered species in this region.

**OBJECTIVES:**

- Identify specific manatee resources and characterize sites used by manatees, including characterization descriptions of freshwater and warm water availability and forage, of overwintering, foraging, and freshwater access sites, and profile manatees use of these resources.
- Using GPS telemetry, determine the extent of movements and seasonal site fidelity among identifiable manatees.
- Identify and assess warm water sites that are available for over-wintering manatees. Particular attention will focus on the importance of natural springs accessible to manatees in the Suwannee and Wakulla rivers.
- Analyze tracking and field data for specific resource use patterns, including identification and characterization of overwintering, foraging, and freshwater access sites.

**PROGRESS:**

We have advertised for a graduate student position for this project. We received over forty applicants and have had phone interviews with three of the applicants. We are currently in the process of finalizing interviews and making an offer to the top applicant. Once the student is enrolled, he/she will begin analyzing data to interpret resource use by manatees in this region.

**SUMMARY:**

Understanding resource selection is critically important for appropriate management aimed at recovering endangered populations. As environments continue to change, animals will be dynamic in their use of new and variable resources—this project aims to understand resource selection of manatees in such novel situations.

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### ***Determination of Population Diversity in the Florida Endangered Orchid *Cyrtopodium punctatum****

**Principal Investigator: Michael E. Kane**

Funding Agencies: U.S. Department of Interior, USGS

Expected Completion: 9/30/2012 (RWO 251, UF#77491)

Research Staff: Timothy Johnson, Philip Kauth, Nancy Phiman, JJ Sadler

*Cyrtopodium punctatum*, the cigar orchid, is an endangered plant in the state of Florida. The species distribution ranges from Florida and the West Indies. The genus *Cyrtopodium* comprises about 35 species, with *C. punctatum* being the only epiphytic member and northernmost ranging species. *Cyrtopodium punctatum* is a very large showy orchid that bears showy flowers. Due to its appeal, the species has been over-collected during the past century and today only a limited number of plants still exist in inaccessible and protected areas. Three distinct populations are located in Unit 51 (ca. 7 plants), 54 ca. 14 plants) and an 3 plants in Unit 38 at the Florida Panther National Wildlife Refuge (FPNWR; Collier Co., FL). With previous funding from the FPNWR, a seed propagation protocol has been developed for the future reintroduction of *C. punctatum*. Since breeding system type is one of the most important determinants of the genetic composition of plant populations, pollination biology and breeding system studies have been completed in two FPNWR *C. punctatum* populations to better understand the ecology and population genetics of this species *in situ*. However, the current genetic diversity and population structure in the FPNWR *C. punctatum* populations is not known. This information is critical for development of ecologically sound integrated conservation plans. Leaf samples from individual plants were harvested and DNA was successfully extracted and amplified via AFLP. Genetic marker analysis using GeneMarker software is being completed to determine genetic differences within and between *Cyrtopodium* populations.



#### **OBJECTIVES:**

- Determine genetic diversity of *C. punctatum* populations in the FPNWR.
- Compare genetic diversity between and within *C. punctatum* populations
- Interpret results in light of ongoing reintroduction efforts with this species.

OBJECTIVE 1: Determine genetic diversity of *C. punctatum* populations in the FPNWR.

TASKS: Collect tissue samples from newly developed leaves from all known plants throughout the FPNWF (totaling about 21 plants). Extract DNA using DNeasy Plant Mini Kits. Purify DNA and subject to Amplified Fragment Polymorphism (AFLP) to generate genetic markers..

OBJECTIVE 2: Compare genetic analysis between and within *C. punctatum* populations.

TASKS: Analyze AFLP data using GeneMarker software, Use POPGENE software to estimate fixation indexes ( $F_{IS}$ ,  $F_{IT}$ , and  $F_{ST}$ ), effective population size ( $N_m$ ),  $H_o$ , and expected Nei's and Shannon's heterozygosity estimates ( $H_E$ ). Use the program STRUCTURE v 2.2 for population assignment and

principle coordinate analysis of data. Interpret results with respect to development of a ecologically-sound re-introduction program for *C. punctatum*.

**PROGRESS:**

Leaf samples were collected from twenty-one *C. punctatum* plants and the DNA from each were extracted, purified and then sent to the Interdisciplinary Center for Biotechnology Research (ICBR) Genetic Analysis Laboratory at the University of Florida for AFLP analysis. The required genetic markers have been successfully generated and the AFLP genetic marker data set has been provided for final analysis using GeneMarker Software. We must now complete the final analysis, Graduate students who were trained to complete the analysis have graduated and Nancy Philman, Biological Scientist, unexpectedly took early retirement due to medical reasons. Dr. Doug Soltis, Laboratory of Molecular Systematics and Evolutionary Genetics at the University of Florida will be consulted with regards to obtaining assistance in completing the final genetic analyses.

**SUMMARY:**

This project is a continuation of Florida orchid conservation research efforts to insure that native orchids, such as *Cyrtopodium punctatum*, will continue to thrive in their natural habitats. Knowledge of the population genetic diversity within and between populations is critical to development of a developmentally sound conservation plan for this native orchid species.



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***Seed Ecology, Habitat Characterization, and Reintroduction Methods of Rare and Endangered Florida Orchidaceae—Bletia purpurea and Eulophia alta***

**Principal Investigator: Michael Kane**

**Co-Principal Investigator: Tim Johnson**

**Funding Agencies: U.S. Department of the Interior, USFWS**

**Expected Completion: 9/30/2012 (UF Project #69301)**

**Biological Scientist: Nancy Philman**

**Research Staff: Nancy Philman, Dr. Philip Kauth, Dr. Charles Guy**

North America possesses approximately 250 unique species of both epiphytic and terrestrial orchids with Florida having 118 of those species. Florida native orchids are faced with a constant onslaught of habitat loss due to land conversion to agricultural uses or home site construction, exotic plant invasion, poaching, and habitat mismanagement. While no Florida native orchid is federally listed as endangered or threatened, many of the state's orchid species face the immediate possibility of extinction if conservation and recovery plans are not investigated and instituted. This research is designed to study the seed ecology, habitat preferences and reintroduction methods of the native Florida terrestrial orchids *Bletia purpurea* (Lamark) de Candolle and *Eulophia alta* (Linnaeus) Fawcett & Rendle. At the current time, these species have no formal conservation plan. A study of the biotic and abiotic factors that influence seedling recruitment in order to develop reintroduction protocols and implement best management practices for *B. purpurea* and *E. alta* is proposed.



*The ecology & reproductive biology of the native FL orchid species, Eulophia alta.*



## OBJECTIVES:

- 1) Identify the critical biotic and abiotic features of sites containing *B. purpurea* and *E. alta* populations, and use the data to predict suitable sites for reintroductions.
- 2) Conduct symbiotic germination experiments on *B. purpurea* and *E. alta* under greenhouse and semi-natural conditions to determine the timing of germination, germination percentage *in situ*, and rates of seedling growth *in situ*.
- 3) Confirm the identity of germination-promoting mycobionts of *B. purpurea* and *E. alta* from field grown seedlings and use these data to validate conclusions about *in vitro* fungal specificity.
- 4) Assess the intra- and inter-population genetic diversity of *B. purpurea* on the FPNWR and interpret these results in the context of pending reintroduction efforts.
- 5) Develop integrated management practices that protect existing populations and promote the recruitment of seedlings in existing and new populations.

*Flower of Bletia purpurea, the pine-pink orchid*

## PROGRESS:

**Objective 1:** Soil analysis and accompanying species data has been completed for *Eulophia alta* at two sites: Public Trail (PT) and Western Refuge (WR). Key results of this study include that soils and accompanying species at these two sites are distinct. PT soils were found to have a higher pH, detectable soil phosphorus, total Kjeldahl nitrogen, organic matter, and moisture content with lower bulk density than WR soils. Principal coordinate analysis of species presence/absence data reveals some overlap in species compositions at the two sites, but indicates that the two sites have detectably distinct plant communities.

Soil characterization and vegetation data has been completed for *Bletia purpurea*. Principle coordinate analysis of data is currently underway. Preliminary examination of the data indicates that Pistol Pond, McBride's Pond and Western Helipad sites where *B. purpurea* are located each have distinct vegetation and soils characteristics. This may result in different selection pressures at these sites.

**Objective 2:** Two attempts were made to examine the effect of burial on symbiotic seed germination of *E. alta* under greenhouse conditions. Results of the second run of this experiment revealed that seeds had lost their viability during cold storage. A new set of experiments will be conducted to examine how storage affects viability, germinability, and symbiotic germination of *E. alta* seeds since seed storage appears to be a major obstacle to experimentation. The results of this study indicate that storage of fresh seed at -10°C is detrimental to seed viability and that this effect is compounded when seeds are not stored with desiccant. Room temperature storage appears to be an acceptable alternative to cold storage. Seeds from various treatments are currently being examined using transmission electron microscopy to look for signs of freeze damage. An additional experiment is underway to examine the effect of moisture content on seed storage at -10°C. Statistical analysis and repetition of this experiment is currently ongoing. Following the identification of suitable storage conditions, viably seeds were once again co-cultured with a symbiotic fungus that had previously promoted germination of *E. alta*. In this experiment, the fungus was found to no longer support germination. It is possible that artificial selection in culture has led to this change.

Two attempts were made to isolate germination promoting fungi from *B. purpurea* roots for symbiotic seed germination in July 2002 and again in December 2007. None of the isolates tested supported symbiotic seed germination. Attention has thus been turned to optimizing asymbiotic seed germination procedures. From these experiments, it has been found that germination in darkness is dependent upon exogenous carbohydrates (sucrose, fructose, glucose and trehalose were all suitable for promoting germination and development). Seeds are able to germinate under illuminated conditions without a carbohydrate source, though sucrose enhances germination and development. Contrary to previous reports with other orchid species, *B. purpurea* is not able to utilize sugar alcohols. These findings have been accepted for published in Plant Growth Regulation (Johnson et al, in press). Production of seedlings is hampered by the inability of small seedlings to produce corms and substantial leaves. Experiments have been conducted to see if this is due to asymbiotic media, light environment or media depletion. However, the problem persists.

**Objective 3:** Objective 3 could not be met during this period due to limitations in seed viability of *E. alta* seeds and lack of symbiotic fungi for *B. purpurea*.

**Objective 4:** In 2007, leaf tissue was collected from three populations of *B. purpurea* on the FPNWR and stored over silica gel desiccant. DNA extracted from these samples was degraded, likely due to slow drying of the fibrous leaves of *B. purpurea*. Fortunately DNA extracted from fresh material was high quality. A living library of 126 plants from three FPNWR sites (Pistol Pond, McBride's Pond and Western Helipad) and Fakahatchee Strand State Preserve has been collected and is currently kept at UF-Gainesville. DNA extraction is underway.

As an accompaniment to this study, a three year investigation of the breeding system of *B. purpurea* on the FPNWR has also been completed. Results are that exclusion of pollinators did not limit capsule set, indicating that cleistogamy may be the dominant or exclusive mode of reproduction for this species. In light of these results, the genetic diversity and adaptability of *B. purpurea* populations on the FPNWR are expected to be very low. This may pose a considerable challenge to management and conservation of this species. An investigation of the genetic diversity of this species throughout its range in Florida may be needed.

**Objective 5:** At the completion of this project, management plans and suggestions for additional study will be developed for *E. alta* and *B. purpurea*. It appears that *E. alta* populations on the west side of the FPNWR and those found near the public access site occupy very different habitats, though it is not clear if they require different management strategies. Observations of these two populations over two years indicates that both populations are healthy, flowering copiously, and producing numerous capsules per inflorescence.

*Bletia purpurea* populations also persist on the FPNWR in diverse habitats. Pollen-limitation is not an issue since plants are cleistogamous and produce large quantities of seed each year. However, cleistogamy leads to homozygosity making genetic diversity a potential management challenge. It is disconcerting that germination promoting fungi have not yet been successfully isolated since symbiotic seed germination would be the preferred method of propagation for reintroductions. However, asymbiotic seed germination methods have worked well with this species in the past and may be the most reliable method of propagation for future reintroductions. In addition to the direct conservation goals associate with this project, *B. purpurea* is emerging as an important model for understanding orchid seed germination and propagation.

#### **SUMMARY:**

This project is a continuation of efforts to insure that native Florida orchids will continue to thrive in their natural habitats as independent organisms. The development of successful procedures for the propagation and conservation of these native orchid species will allow others to apply these same procedures to other orchid species throughout Florida.

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#### ***Population Genetic Analysis and Assessment Of Hybridization between Calopogon tuberosus var. tuberosus and var. simpsonii***

**Principal Investigator: Michael E. Kane**

Co-Principal Investigator: Philip Kauth

Funding Agencies: USGS

Expected Completion: 8/30/2011 (RWO 262,  
UF#84877)



*Calopogon tuberosus var. tuberosus*

*Calopogon tuberosus* is a widespread terrestrial orchid of eastern North America. In Florida two varieties exist: var. *tuberosus* and var. *simpsonii*. Variety *tuberosus* is found as far south as Collier and Broward counties while var. *simpsonii* is found in pure stands in only extreme south Florida. Both varieties are found in the Florida Panther National Wildlife Refuge (FPNWR), making this one of the only locations where both varieties grow together. Using AFLP genetic analysis Goldman et al. (2004a) found that var. *simpsonii* formed a coherent group. This was also supported by distinct morphologically features between var. *tuberosus* and var. *simpsonii* (Goldman et al.

2004b). However, based on isozyme analysis, Trapnell et al. (2004) reported low genetic identity for var. *simpsonii*. They suggested that var. *simpsonii* has been reproductively isolated from var. *tuberosus* for a long period of time. On closer examination of the FPNWR population, many plants exhibit morphological similarities of both varieties. Hybridization between the two varieties may exist through gene flow in transitional habitats located from Naples to northward to Stuart, FL (Goldman et al., 2004b), which directly contrasts Trapnell's suggestion of reproductive isolation. As orchid populations are becoming threatened with extinction from habitat loss, identifying and investigating the genetics of populations and hybridization is necessary to assess their conservation status. In a possible hybrid zone, selecting donor plants for propagation purposes may be facilitated by differentiating hybrids from the species. The existence of both *Calopogon* varieties and possible hybrids at FPNWR, provides an opportunity to generate base line genetic analysis which will be critical for interpretation of future studies of the breeding systems and the pollination biology of the *C. tuberosus* varieties

**OBJECTIVES:**

Determine the genetic composition of *C. tuberosus* var. *tuberosus* and var. *simpsonii* populations on the FPNWR and in pure stand populations outside of the FPNWR using AFLP-based genetic analysis.

Determine the existence and extent of hybridization occurring between the *C. tuberosus* varieties on the FPNWR.

Determine the genetic composition of *C. tuberosus* var. *tuberosus* and var. *simpsonii* in pure stand populations outside of the FPNWR using AFLP-based genetic analysis.

**TASKS**

- Plants from each variety and possible hybrids between var. *tuberosus* and var. *simpsonii* will be identified
- Plant morphometric data will be taken for each variety and hybrid plants
- Leaf samples from each variety and potential hybrid plants will be collected
- DNA will be extracted from leaf samples
- Isolated and purified DNA will be sent to the ICBR lab at the University of Florida for AFLP analysis

**PROGRESS:**

Forty leaf samples were collected in May 2010 from three populations at the Florida Panther National Wildlife Refuge and ten samples from a population at the Fakahatchee Strand Preserve. Morphometric analysis (including flower and whole plant measurements) was also performed on all plants from which leaf samples were collected. The morphometric analysis of all plants was completed, and the final report is included as an attachment. DNA was isolated over four months from June-September 2010. Initially what was thought to be good quality DNA was isolated and 51 samples were sent to the ICBR Genetic Analysis Lab at the University of Florida for AFLP analysis in October 2010. A sample from a population of *Calopogon tuberosus* var. *tuberosus* in north central Florida was also included as a true var. *tuberosus* sample. Unused leaf samples and DNA were stored at -80 C at the University of Florida Environmental Horticulture Department. In repeated attempts, the ICBR Genetic Analysis Laboratory technicians were not able to successfully generate the necessary AFLP reactions to generate the generate markers

and then subsequently conduct the genetic analysis. In 2011, the ICBR Genetic Analysis Laboratory made numerous attempts but was not able to determine the cause of this problem. Dr. Charles Guy, Environmental Horticulture Department, conducted further analysis of the quality of a subset of the extracted DNA samples and was only able to obtain partial amplification. It appeared that the DNA in the *Calopogon* tissue samples becomes degraded during the extraction/purification procedure. This may result from the presence of degradation products and nucleases. Generation of the genetic analysis data is critical for interpretation of the morphometric analysis data.



**SUMMARY:**

*Calopogon tuberosus* is a widespread terrestrial orchid of eastern North America. In Florida two varieties exist: var. *tuberosus* and

var. *simpsonii*. Both varieties are found in the Florida Panther National Wildlife Refuge (FPNWR), making this one of the only locations where both varieties grow together, and many plants exhibit morphological similarities of both varieties. In a possible hybrid zone, selecting donor plants for propagation purposes may be facilitated by differentiating hybrids from pure species. The existence of both *Calopogon* varieties and possible hybrids at the FPNWR, provided an opportunity to generate base line genetic analysis which could be critical for interpretation of future studies and reintroduction studies. Goldman found that var. *simpsonii* can be separated from var. *tuberosus* by shorter corms, longer leaves, shorter sepals, and narrower labella and columns. However, our morphometric data do not show clear groupings among the different *C. tuberosus* varieties or the putative hybrid at the FPNWR. Although we did not find clear groupings, var. *tuberosus* tended to group around a greater number of flowers and open flowers. Several parameters could be influencing the lack of clear morphometrics groupings. First, introgression may be occurring and only hybrids exist in the sampled population. Second, var. *simpsonii* may not actually exist on the FPNWR, but seed dispersal from another hybrid population could have mixed with this population. Finally, the existence of var. *simpsonii* is likely, but because plants were selected randomly, we may have missed characteristic var. *simpsonii* plants. Determining whether var. *simpsonii* and *tuberosus* are actually hybridizing is rather difficult from our morphometrics data. We were unsuccessful in our attempts to isolate quality DNA for AFLP analysis of *C. tuberosus*.

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### **Management of Functionally Connected Dune Habitat for Endangered Beach Mice on Fragmented Landscapes**

**Principal Investigator:** Lyn Branch

*Co-Principal Investigator:* Debbie Miller, Margo Stoddard

*Funding Agency:* USFWS/USGS

*Expected Completion:* April 30, 2012 (UF PJ# 93978, RWO 270)

*Graduate Student:* Margo Stoddard

*Foraging (GUD) tray used to measure the amount of risk (of predation) beach mice perceive under different conditions*

Fragmentation of habitat remains a key conservation concern in many landscapes, including the Gulf Coast of the U.S. In this region, multiple factors can exacerbate the negative effects of fragmentation on sensitive, dune-dependent species, such as beach mice (*Peromyscus polionotus* spp). Weather-related disturbances such as tropical storms and hurricanes affect patch size and connectivity; real estate development can create barriers to gene flow; and artificial lights and generalist predators may affect populations directly through predation or have behavioral consequences (e.g., reduce movement). We implemented a project to understand whether these threats interact and affect how beach mice use the landscape. This project involved experimentally altering the risk mice perceive in particular habitats and measuring their response to landscape features under different risk scenarios. We are using foraging trays to relate the amount of food eaten (surrogate for perceived risk) to microhabitat and landscape structure (e.g., vegetation cover, patch size, and connectedness) under ambient and heightened (lights or predator cues present) risk conditions. Results from this study will be used to identify potential beach mouse habitat, refugia from storms, and restoration priorities at current and potential future conditions under different sea level rise scenarios.



#### **OBJECTIVES:**

*Objective 1: Evaluate whether and how artificial lights, predators, and resources interact with landscape structure to affect functional connectivity of landscapes.*

We are using a 3-tiered approach to meet *Objective 1*. First, we are determining the relative effect of three different predators on foraging behavior of beach mice to identify whether direct cues (e.g., scent) of known predators affect predation risk at the microhabitat scale. Next, we are determining whether and how landscape structure influences perceived risk of predation under ambient and heightened risk by comparing foraging in experimental connected and

unconnected vegetation patches treated with artificial light (indirect cue) and predator scent and predator models (direct cue). Finally, we are assessing how perceived risk relates characteristics measured over entire landscapes under ambient and heightened (e.g., artificial light) risk conditions.

We measured perceived risk using depletable foraging patches (“GUD trays”, photo 1). Trays comprised covered plastic sandwich trays baited with 5 g of dried millet seeds mixed evenly into 3 l of sifted beach sand. Trays were elevated to prevent access of non-target animals, and wooden dowels were placed for mice to access trays. To determine GUDs, seeds were sifted from trays every 2 days over a 6-day session, and the average weight of seeds was calculated. Trays were rebaited on the 2<sup>nd</sup> and 4<sup>th</sup> days. All field work was conducted between the last and first quarter of the moon (dark phase).

At the microhabitat scale, we compared the effects of 3 predator cues (photos 2-4) and two controls on foraging in GUD trays in the open (exposed) and at paired points 3-5 m away under vegetation. One predator cue or one of two control treatments was applied randomly to each pair of trays (or point). Cues were: 1. Fox: fox urine and 3-D model of fox; 2. Cat: cat feces and 2-D silhouette of cat; Owl: great horned owl (*Bubo virginianus*) calls played between dusk and dawn and 3-D model of owl on 3-m pole; control scent: water applied to dowels leading to trays; control call: sea gull calls played between dusk and dawn. All treatments or controls were placed 3-5 m equidistant from each tray at a point.

We used an experimental approach to determine how connectivity and patch size influenced predation risk under heightened and ambient risk. Experimental plots comprised 4 patch types, each with a 1-m<sup>2</sup> and 2.5-m<sup>2</sup> patch of transplanted broomsedge (*Andropogon virginicus*). Two patches were connected by a 10-m strip (0.5 m width) of broomsedge (photo 5) and two were separated by a 10-m gap (photo 6, unconnected). One GUD tray was placed in either the small or large patch in the unconnected patch type and one in either the small or large patch in the connected patch type. At each plot, we randomly applied an artificial light (photos 5-6), owl cue, or light plus owl cue treatment, or a control. We used 60 W incandescent lights placed over and in-between each patch in a patch type.

At the landscape scale we placed GUD trays in a 10 x 10 grid with 10-m spacing in 4 different landscapes. An owl treatment was applied (owl model and call broadcast at 5 points evenly distributed throughout the landscape) to two landscapes, and the other two landscapes were controls.

*Objective 2: Evaluate whether created berms facilitate movement of beach mice between patches of development.*

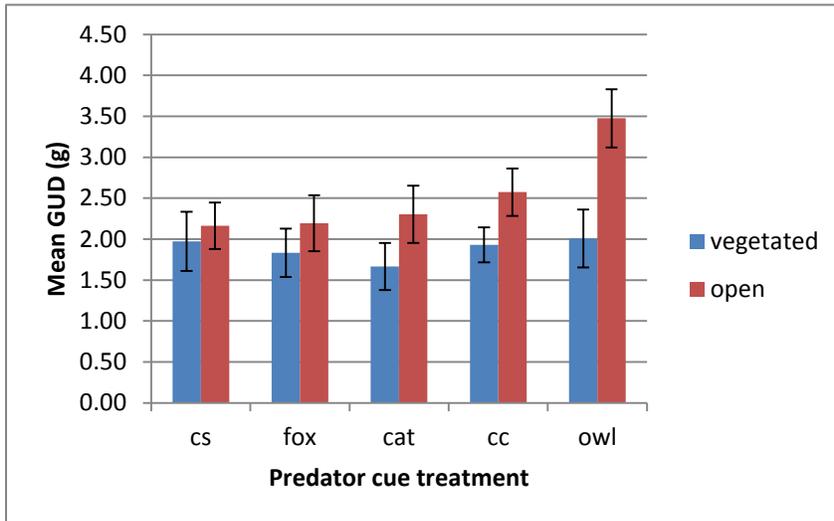
The research is being conducted on Santa Rosa Island, a barrier island 46 km long and 0.5 km wide that is located along the northern Gulf Coast of Florida (30°24'N, 81°37'W). Field work to meet *Objective 1* is being done on a ~20-km section of Santa Rosa Island administered by Eglin Air Force Base. Potential sites for field work to address *Objective 2* were assessed on private and public (Gulf Islands National Seashore, FL State parks) lands on Santa Rosa Island and Perdido Key.

## **PROGRESS:**

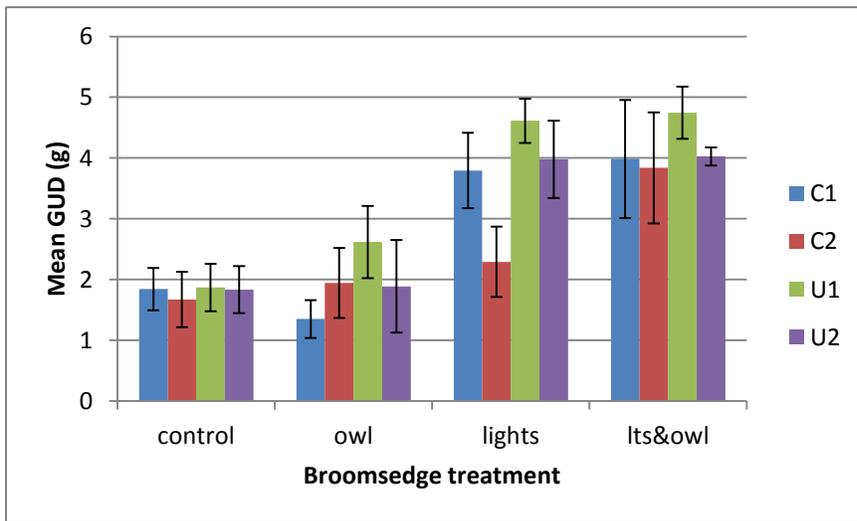
Between December 2010 and June 2011, field work to address *Objective 1* was conducted. We have completed the first study on the influence of predator cues on foraging, and continue data processing and analysis on data collected from the broomsedge experiment (experimental vegetation plots) and from grids at the landscape scale. Results of analysis of data collected in 2011 are being used to refine field studies that will be implemented in Spring 2012. Additional experiments using artificial lights at the intermediate and landscape scales are planned. Initial findings from the predator cue and broomsedge experiments are presented below:

We deployed 18-21 paired trays per predator cue or control for the predator cue study. Based on all data, overall mean GUDs were influenced by microhabitat (Figure 1; F-value=10.17,  $p > F= 0.002$ ), but not by predator cue treatments (F-value=1.88,  $p > F= 0.12$ ). When microhabitats were considered separately, mean GUDs differed among predator cue treatments in the open (F-value=2.55,  $p > F= 0.045$ ) but not vegetated microhabitats (F-value=0.19,  $p > F= 0.95$ ). The owl cue had the greatest effect on GUDs in the open microhabitat compared to that of other treatments. Based on contrasts, mean GUDs under the owl treatment differed from those under all other treatments (at  $\alpha= 0.05$ ), but the difference with the control call treatment was weak (F-value=3.64,  $p > F= 0.0596$ ).

Based on data from 7 of 15 installed broomsedge plots, treatments including artificial lights appeared to influence foraging activity of mice, with mice foraging less when lights were present compared to the owl treatment or the control (Figure 2). Trays in the smallest (1 m<sup>2</sup>) unconnected plots where risk was elevated had the highest GUDs (i.e., mice foraged less) compared to other plots under the same treatment, suggesting mice may perceive small, isolated vegetation patches to be riskier than larger or connected patches. We present these results to show trends to date, as not all data from this experiment have been processed and are not included in results.



**Figure 1:** Mean Giving Up Densities (GUD) in foraging trays in different microhabitats (vegetated vs. open) and under different predator cue treatments. Trays were originally baited with 5 g of millet seeds. Lower GUDs (fewer seeds left in tray by mice) correspond to lower perceived predation risk. cc = control scent (water); cs = control call (sea gull).



**Figure 2:** Mean Giving Up Densities (GUD) in foraging trays in experimental vegetation plots with different patch sizes and connectedness, and under predator and/or lighting treatments. Trays were originally baited with 5 g of millet seeds. Lower GUDs (fewer seeds left in tray by mice) correspond to lower perceived predation risk. C = connected; U = unconnected; 1 = 1 m<sup>2</sup> patch; 2 = 2.5 m<sup>2</sup> patch. Note: 1-2 treatments were applied to each patchsize/connectedness combination, but results presented above do not account for effect of specific plot ID.

After evaluating potential sites on Santa Rosa Island and Perdido Key for addressing *Objective 2*, we determined access to multiple sites on private land would be necessary to assess use of berms by beach mice beyond what is currently being done by the Florida Fish and Wildlife Conservation Commission (FWC, see below), and conducting field work in these areas is infeasible due to the high amount of foot traffic by the public. Trapping results from recent high-effort beach mouse monitoring efforts by the FWC along Perdido Key show that location of trapped mice can only be explained by use of berms by mice. We are consulting with biologists from FWC to determine what new information or field work might help understand value of berms for movement of beach mice.



*Experimental plots of broomsedge (*Andropogon virginicus*) were used to measure how patch size, connectedness of patches, a predator (owl) cue, and artificial lights influence the amount of predation risk mice perceive. A connected (left) and isolated plot (right) with the lighting treatment are shown.*

#### **SUMMARY:**

Using an experimental approach, this project will be the first to identify how threats to coastal systems associated with development (e.g., artificial lights, introduced predators) interact with natural processes (storm-related impacts on habitat) to affect the foraging and movement ecology of beach mice (*P.p. leucocephalus* spp), at both fine and broad spatial scales. Results will inform management decisions regarding lighting near dune habitat, the need for predator control, and restoration efforts in storm-damaged areas that benefit beach mice and other coastal species.

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### ***Mechanisms of Ridge-Slough Maintenance and Degradation Across the Greater Everglades***

#### **Principal Investigator: Matt Cohen**

*Co-Principal Investigator:* Todd Osborne, Mark Clark, Jim Heffernan

*Funding Agency:* US ACOE, USGS MAP/RECOVER

*Expected Completion:* 08/15/2015 (RWO#267, PJ#89993&89994)

*Personnel:* David Kaplan, Larry Korhnak

*Graduate Students:* Danielle Watts, Tae Go Oh, Yan Jing, Stephen Casey

This project seeks to understand the mechanisms of vertical soil elevation divergence and landscape pattern in the ridge slough mosaic of the Everglades. The prevailing hypothesis has two parts: 1) the vertical divergence observed in the soils of the best conserved areas of the ridge-slough mosaic (i.e., soil elevation bimodality) are controlled by point-scale ecosystem carbon budgets, and that the historical rates of net C accumulation have been profoundly altered by hydrology modification. 2) The emergence of the striking landscape pattern arises because of landscape scale interactions between upstream flows and the capacity of the landscape to route that flow. In short, longitudinally interconnected sloughs act as the principal conduit of water, and an increase or decrease in their prevalence and connectivity affects the resulting hydroperiod of the landscape. Because lengthening hydroperiod favors slough expansion, and expanding sloughs act to reduce hydroperiod, this process is self-tuning. In short, we are testing the hypothesis that the landscape pattern arises from the feedbacks between pattern and landscape hydraulics, which we contrast against other more well examined mechanisms of landscape pattern genesis. In addition to examining the underlying mechanisms of patterning, this project seeks several additional outcomes of practical importance to monitoring and evaluating the condition of the ridge slough landscape. First, we have previously observed the marked accumulation of phosphorus on ridges in the best conserved areas of the ridge-slough landscape, and the loss of that accumulation signal in areas with significant hydrologic modification. One of the hypotheses for the patterning of the landscape invokes preferential accumulation of P in higher elevation sites, which prompts higher primary production. We are collecting primary data that will explicitly evaluate the plausibility of that mechanism. Second, we are using a variety of mapping and remote sensing tools to identify

metrics that capture the early onset of landscape pattern loss. Previous work indicated that vegetation pattern is a lagging indicator of serious landscape shifts, with vestigial elongation (the primary metrics of pattern health used to date) present long after the loss of vertical differentiation. This means that existing landscape performance metrics may fail to detect the extent and progression of degradation. Using soil bimodality as the primary indicator of condition, we are screening a large number of site and landscape metrics in an effort to document which pattern and spectral metrics represent those that respond early to changing underlying conditions. Finally, we have developed a suite of landscape hydrologic models (both spatially explicit hydrodynamics, and simplified conceptual) that explore the role of pattern on hydrologic behavior and the feedbacks that we predict shape the landscape. This project, slated to be a 5 year project ending in 2015, was cut as part of MAP/RECOVER funding declines, and will end in 2012. Partial funding will be provided via another source, so this is also the final report for this project.

#### **OBJECTIVES:**

We have four primary project objectives: 1) evaluate the carbon budget for the marshes of the ridge-slough mosaic spanning a gradient of hydrology modification, 2) model the hydrologic effects (and ultimately the peat accretion effects) of changing landscape patterning (slough connectivity via ridge elongation), 3) evaluate mechanisms that lead to changing soil TP concentrations on ridges, and 4) identify and extrapolate key remote indicators of declining ridge-slough landscape condition.

#### **PROGRESS:**

There are 6 elements to the project. Below we document progress on each element:

**1** – We have completed 8 months of net ecosystem exchange measurements that we are using to test hypotheses about C accretion. To date, we have obtained significant support for the contention that the Everglades marshes are net autotrophic in the hydrologically best conserved areas (both ridges and sloughs), are net heterotrophic in the drained settings, and are mixed in overly wet settings. Measurements to date have been under fully wetted conditions; investigation of net autotrophy during dry periods is of critical relevance, and will be accomplished in the coming months. As part of this, we have established relationships between respiration and net ecosystem production and both water depths and PAR (photosynthetically active radiation). The fitted models are exceedingly strong given the use of chamber methods, and suggest that the C budget data will provide relatively well resolved insight into the peat accretion dynamics of the various landscape elements in response to hydrologic modification.



**2** – We have initiated investigation patterns of soil phosphorus. We have obtained over 20 long cores (to bedrock) which we will section finely to determine the total mass of P in the column, and the shape the P vs. depth relationship. This will help establish whether P mining by sawgrass roots can explain the enrichment observed in hydrologically well conserved settings. We have also deployed high resolution level logging equipment to measure the lateral hydraulic gradient (along with myriad other hydrologic processes including ET and groundwater fluxes) that has been proposed to explain the P enrichment observation. Both studies have completed phase I sampling, and will be augmented in response to ongoing data analysis.

**3** - We have completed our proposed research of ridge senescence, developing a repeatable typology, and a synoptic inventory of the phenomenon. There is a clear hydrologic driver to prevalence, but we were unable to develop comparable measures for incidence. Further research in this area is warranted because of the dramatic implications of the process on the carbon budget.

**4** – We have initiated a meso-scale hydraulic modeling effort that investigates water flow using a distributed 2-D hydraulic model. We first are seeking to explore the role of patterning on hydroperiod (the core feedback of the

self-organizing canal hypothesis). This model will be coupled to a simple C budget model to allow fully flexible landscape self-organization to unfold, and will be used as a tool for evaluating the hydraulic performance of different elements of the Everglades landscape in response to restoration.

**5** – We have developed a rigorous framework for the identification, enumeration and evaluation of landscape pattern metrics of ridge-slough condition. Our previous work showed that vegetation striping was a lagging indicator of pattern change, with apparently intact sites according to simple pattern metrics lagging behind soil elevation bimodality (in space). We seek in this work to identify metrics (both spatial and spectral) that are leading or at least simultaneous indicators. Our work to date has been on the development of the suite of metrics, their implementation to high resolution vegetation maps, and basic investigation of the patterning that currently exists. Ultimately, this work should help inform restoration performance and help elucidate historic rates of landscape change.

**6** – We have developed a meta-ecosystem model that investigates the coupling of laterally and longitudinally connected patches. Simple hydrologic connectivity wherein flow through one patch affects flow and stage in the other allows us to test the hypothesis that this coupling, along with point scale models of peat accretion, creates spontaneous patterning, and that the effects are anisotropic (i.e., the feedbacks are more strongly exerted perpendicular to flow than parallel to it) creating the observed landscape pattern. We show that spontaneous divergence of soil elevation occurs (creating ridges and sloughs) over some set of parameter ranges. Crucially, we observed that there are model settings wherein the patterned (i.e., vertically divergent) state is the only stable configuration, but also regions where the homogeneous state (both patches the same type) is also stable. The presence of this global bi-stability has deep implications for ecosystem restoration, and suggests a strong prioritization for conserving those settings where the landscape remains intact today.

#### **SUMMARY:**

- The underlying mechanisms of landscape patterning are the foundation of “getting the water right” in the Everglades, and this project seeks to understand what those mechanisms are, focusing on the hypothesis that the governing hydrologic variable is hydroperiod and that landscape pattern exerts profound control on that variable.
- As a peat accreting wetland, the factors that control the carbon balance of the landscape elements is of foundational importance to management and restoration; this work is among the first to rigorously measure NEE along seasonal, hydrologic modification, and patch-type gradients.

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### ***Directing Succession Through Adaptive Management in National Wildlife Refuges: Reed Canary Grass Control & Transition to Wetland Forests & Meadows***

***Principal Investigator: Carrie Reinhardt-Adams***

***Project officer: Clinton Moore***

Co-PIs: Susan Galtowitsch, Eric Lonsdorf, Franklin Percival

Funding Agency: U.S. Geological Survey

Expected Completion: 7/1/2012 (RWO 237, PJ#66026)

Research Staff: Christine Wiese, Leah Cobb, Kathy Bibby

Invasive species present a challenge to the efforts of National Wildlife Refuges (NWRs) to preserve appropriate plant community habitat. Reed canary grass (*Phalaris arundinacea*, RCG) is an invasive plant species that presents such a challenge. This species has partially or heavily infested approximately 37,400 acres of NWRs located in U.S. Fish and Wildlife Service Region 3 (Midwest Region) and Region 6 (Mountain-Prairie Region). To improve management of RCG and assist in the recovery of degraded wet meadow and floodplain forest ecosystems within these NWRs, an adaptive management (AM) framework will be utilized. Through AM, the goal of this project is to generate the information needed for refuge managers to *make good and defensible decisions about when, where, and how to treat RCG for purposes of maintaining or restoring target communities and the wildlife they support* (from RCG Workshop Problem Statement, July 2006, Williams et al. 2007).

#### **OBJECTIVES:**

**YEAR 1: 2007**

- Conduct initial coordination meeting and annual coordination meeting
- Conduct visits by the science team to the participating refuges to facilitate the selection of experiment sites
- Launch project website
- Design experiments and select sites
- Create a study plan and field protocols
- Train participants and collect initial vegetation monitoring data, seed bank samples and soil samples

**YEAR 2: 2008**

- Implement experiments and collect pre-treatment and response data
- Collect pre-treatment vegetation data
- Implement herbicide treatments at selected sites
- Conduct visits by the science team to participating refuges
- Collect response data
- Conduct annual coordination meeting
- Implement re-vegetation treatments

**YEAR 3: 2009**

- Continue treatments (including broadcast seeding) and data collection
- Implement follow-up herbicide treatments
- Collect response data
- Conduct visits by the science team to participating refuges
- Conduct annual coordination meeting

**YEAR 4: 2010**

- Continue treatments (including broadcast seeding) and data collection
- Implement follow-up herbicide treatments
- Collect response data
- Complete revegetation management actions
- Develop draft model description
- Conduct annual coordination meeting
- Create final report

**YEAR 5: 2011**

- Refine and adaptively update model
- Develop reduced long-term monitoring protocol
- Collect response data
- Write and submit supplement on revegetation efforts to final report (July 1, 2012)

**PROGRESS:****Data collection**

Treatments and data collection are complete for 2011; these data represent continued opportunity to assess response to treatments and analysis is on-going. Treatments including herbicides (glyphosate and fusilade) and broadcast seeding are currently being implemented and data is being collected for the 2011 growing season.

Refuges have completed the third and final round of seed trap sample collection to support the determination of natural seed rain from adjacent floodplain forests. No seed traps will be collected in 2011. Analysis of 2010 seed trap data is currently underway. A preliminary analysis of the data has been completed (Figure 12), but additional comparisons will be examined over the next few months.

**Results from Response data**

The science team has discussed what form the data should be in order to effectively determine transition states. We concluded that using dominance data in the form of guilds would be the best form. In order to determine dominance data, cover classes are converted to cover guilds.

The following guilds will be used.

1 NP

- 2a NPG/IPG
- 2b NPF/IPG
- 3 NP/IPF
- 4 IPG
- 5 IPF
- 6 IPG/NPG or NPF
- 7 IPF/NPG or NPF

The dominant cover guild is identified. We are currently discussing the rules for dominance. The dominance data will then be used to conduct sensitivity analysis, ie. how many plots should be monitored, for the long term monitoring protocol.

### **Modeling Progress**

From August 2010 to May 2011, we made some major progress in modifying the reed canary grass model and linking it more explicitly to the monitoring data to guide management. We developed the first all-in-one stochastic dynamic program-driven adaptive management tool using Microsoft SharePoint and Access. To do this, we developed a stochastic dynamic program, which integrates vegetation cover state (RCG and Native perennial) and transition (response to management actions) model with our desire to make low-cost improvements to guide decision making. A Microsoft Access (the platform of data entry) database is being constructed as of December 2011, which includes all data collected from 2008-2011, so that data inputs and management recommendations can be organized in the same programming environment by an eventual coordinator. Finally, we combined the access database with an internet –based data entry and reporting platform using Microsoft SharePoint 2010 so that refuge biologists or managers can enter their data directly into the centralized database and also find the updated recommendations. Using this database we will also analyze response data to further refine the decision tool.

### **SUMMARY:**

The overall goal of the project is to effectively use Adaptive Management to create a decision-making model for long-term control of reed canary grass and subsequent regeneration of wet meadows and floodplain forests throughout the Mid-western United States.

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## **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 *Porphyryla 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 Florida 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. bennetts; Completion Date: February 1988
54. Comparative Graminoid Community Compositon & 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. Bjorndal, 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. Bjorndal, A.B. Bolten; Personnel: J.R. Schmid; 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 Seatrout & 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. Silveira, W. Bryant; Completed: 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, Florida (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 Tranfer 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 Beauclair. PI: H.F. Percival; Personnel: C.L. Abercrombie, A.R. Woodward, 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. Pearlstone, 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 Florid'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 Herpesvirus Associated with Green Turtle Fibropapillomatosis: 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 Grasshopper Sparrow (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 Crocodylian 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 Sea 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. Tamsiripong; 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 III 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 Studies 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. Thom, 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. Thom, 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. Completion 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. 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.
281. 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.

## **Publications 2011**

Evers, B.S., T.J. Rambo, T.M. Reed, and J.H. Perry. 2011. Areal coverage optimization in variable wind conditions for parallel-track flight plans for sUAS-based remote sensing applications. *Proceedings of the 2011 AUVSI Unmanned Systems North America Conference*. 18pp.

Perry, J.H., B.S. Evers, T.J. Rambo, T.M. Reed, and M.A. Burgess. 2011. Natural resource management with a small unmanned aircraft. *Proceedings of the 2011 AUVSI Unmanned Systems North America Conference*. 19 pp.

DeSa, M.A., C.L. Zweig, H.F. Percival, W.M. Kitchens, J.W. Kasbohm. *In press*. Comparison of small mammal sampling techniques in tidal salt marshes of the central Gulf coast of Florida. *Southeastern Naturalist*.

Cherkiss MS, Romanach SR, Mazzotti FJ (2011) The American Crocodile in Biscayne Bay, Florida. *Estuaries and Coasts*. DOI 10.1007/s12237-011-9378-6

Mazzotti, F.J., and M.S. Cherkiss. 2011. A monitoring program for the American crocodile in Northeastern Florida Bay, Everglades National Park. University of Florida, Fort Lauderdale Research and Education Center. Fort Lauderdale, FL.

Johnson, T. and M.E. Kane 2011. Effects of temperature and light on germination and early seedling development of the pink orchid (*Bletia purpurea*). Plant Species Biology DOI: 10.1111/j.1442-1984.2011.00347.x

Johnson, T, M.E. Kane. 2011. Differential germination and developmental responses of *Bletia purpurea* (Orchidaceae) to mannitol and sorbitol in the presence of sucrose and fructose. Journal of Plant Nutrition (accepted).

Johnson, T. R., M. E. Kane, H. E. Perez. 2011. Examining the interaction of light, nutrients and carbohydrates on seed germination and early seedling development of *Bletia purpurea* (Orchidaceae). Plant Growth Regulation 63:89-99.

Frederick, P.C., A. Cambell, N. U. A. Jayasena and R. R. Borkhataria 2011. Survival of White Ibises (*Eudocimus albus*) in response to chronic experimental methylmercury exposure Ecotoxicology 20, 358 - 364.

Williams, K.A., P.C. Frederick and J. D. Nichols. 2011. Use of the superpopulation approach to estimate breeding population size: an example in asynchronously breeding birds. Ecology 94: 821-828.

del Lama, S., C.D. Rocha, W. Figureedo Jardim, J. Tsai, and P.C. Frederick. 2011. Sedentary nestlings of Wood Stork as monitors of mercury contamination in the gold mining region of the Brazilian Pantanal. Environmental Research 111:1091-1095.

Reinhardt Adams C, P.J. Kauth, J. Sorenson. 2011. Assessing competition between reed canary grass (*Phalaris arundinacea* L.) and swamp white oak (*Quercus bicolor* Willd.). *Ecological Restoration* 29:332-338

## **Presentations 2011**

Kaplan, D.A. †, R. Paudel, D.L. Watts\*, J.W. Jawitz, J.B. Heffernan and M.J. Cohen. 2011. Orientation matters. The role of landscape hydraulic geometry on coupled feedbacks between flow, depth and ecological processes in the Everglades ridge-slough mosaic. American Geophysical Union, San Francisco CA

Larson, J. and C. Reinhardt Adams. 2011. Forest recruitment in RCG dominated landscapes. Bottomlands Restoration Ecosystem Conference. Collinsville, IL.

Olbert, Jean. 2011, Determining Reasons of Nesting Failure and Brood Reductions at Snail Kite (*Rostrhamus sociabilis plumbeus*) Nests on the Kissimmee Chain of Lakes. Raptor Research Foundation Annual Meeting, Duluth, MN.

Pias, Kyle. 2011, Foraging Ecology of Breeding Snail Kites (*Rostrhamus sociabilis plumbeus*) on the Kissimmee Chain of Lakes, Florida. Raptor Research Foundation Annual Meeting, Duluth, MN.

Burgess, M.A., J.H. Perry, B.S. Evers, T.J. Rambo, T.M. Reed, H.F. Percival, P.C. Frederick, J.C. Simon, P.G. Ifju, S.E. Smith, B.A. Dewitt, Z. Szantoi, L.E. Taylor, and J.S. Lane. *A small unmanned aircraft system for ecological research and monitoring*. Invited presentation. University of Florida Department of Wildlife Ecology and Conservation Seminar Series. Gainesville, Florida. January 10, 2011.

Frederick, P.C. and J. Tsai. 2011. "Wood Stork habitat analysis and conservation". Webinar for the National Fish and Wildlife Foundation "In-the Field" webinar series. February 2011.

Frederick P.C. "Fires, floods and heavy metal: restoration of wading birds in the Everglades". Presented at the Florida State University Coastal and Marine Laboratory Conservation Lecture Series. February 10, 2011

Frederick, P.C. "The unexpected dynamics of mercury contamination and wading birds in the Everglades: a tale of three scientific surprises". Mary Murphy Endowed Lecture in Biology at Clarke University. Dubuque, IA March 2011.

Percival, H.F., M.A. Burgess, J.H. Perry, B.S. Evers, T.J. Rambo, T.M. Reed, P.C. Frederick, J.C. Simon, P.G. Ifju, S.E. Smith, B.A. Dewitt, Z. Szantoi, L.E. Taylor, and J.S. Lane. *A small unmanned aircraft system for ecological research and monitoring*. Invited presentation. University of Idaho Department of Fish and Wildlife Resources. Moscow, Idaho. March 7, 2011.

Percival, H.F., M.A. Burgess, J.H. Perry, B.S. Evers, T.J. Rambo, T.M. Reed, P.C. Frederick, J.C. Simon, P.G. Ifju, S.E. Smith, B.A. Dewitt, Z. Szantoi, L.E. Taylor, and J.S. Lane. *A small unmanned aircraft system for ecological research and monitoring*. Invited presentation. Idaho Fish and Game Department. Boise, Idaho. March 8, 2011

Stoddard, M.A., L. Branch, D. Miller. Interactive effects of artificial light and predators on the functional connectivity of beach mouse habitat. 3<sup>rd</sup> Annual Beach Mouse Workshop, Daphne, AL, 15-17 March, 2011.

Ifju, P.G. *Using UAVs for wildlife surveys*. Invited presentation. Northwest Florida Chapter Meeting of the American Society for Mechanical Engineers. University of Florida Research and Engineering Education Facility (REEF). Shalimar, Florida. March 21, 2011.

Ifju, P.G. *University of Florida UAVs*. Invited presentation. University of Florida Systems Engineering Workshop. University of Florida Research and Engineering Education Facility (REEF). Shalimar, Florida. March 22, 2011.

Stephens B, Lamont M, Carthy R and Patrick L. 2011. Incubation temperatures for loggerhead turtle (*Caretta caretta*) nests deposited on Northwest Florida beaches. 31<sup>st</sup> Annual International Sea Turtle Symposium, San Diego, CA. April 24-28, 2011. Poster Presentation.

Evers, B.S., J.H. Perry, T.J. Rambo, and T.M. Reed. *Areal coverage optimization in variable wind conditions for parallel-track flight plans for sUAS-based remote sensing applications*. Poster presentation. Annual USGS Florida Cooperative Fish and Wildlife Research Unit Coordinating Committee Meeting. Austin Cary Memorial Forest. Gainesville, Florida. May 3, 2011.

Perry, J.H., M.A. Burgess, B.S. Evers, T.J. Rambo, T.M. Reed, S.E. Smith, P.G. Ifju, and H.F. Percival. *Assessing invasive species management of aquatic vegetation using small unmanned aircraft: the Fisheating Bay case study*. Poster presentation. Annual USGS Florida Cooperative Fish and Wildlife Research Unit Coordinating Committee Meeting. Austin Cary Memorial Forest. Gainesville, Florida. May 3, 2011.

Stoddard, M.A., L. Branch, D. Miller. Interactive effects of artificial light and predators on the functional connectivity of beach mouse habitat. (poster) FL Co-op Coordinating Committee Meeting, Gainesville, FL, 3 May 2011.

Wolfe, D.A. and J.H. Perry. *Small unmanned aircraft: a rapid, scalable approach to infrastructure assessment*. Invited presentation. 2011 USACE Infrastructure Systems Conference. Hyatt Regency Hotel. Atlanta, Georgia. June 13-17, 2011.

Szantoi, Z. *Classification of marl prairie and marsh vegetation communities in the Everglades National Park*. PhD dissertation defense. School of Forest Resources and Conservation, Geomatics Program. University of Florida. Gainesville, Florida. July 2011.

Evers, B.S., T.J. Rambo, T.M. Reed, and J.H. Perry. *Areal coverage optimization in variable wind conditions for parallel-track flight plans for sUAS-based remote sensing applications*. Poster presentation. 2011 AUVSI Unmanned Systems North America Conference. Walter E. Washington Convention Center. Washington, DC. August 16-19, 2011.

Perry, J.H., B.S. Evers, T.J. Rambo, T.M. Reed, and M.A. Burgess. *Natural resource management with a small unmanned aircraft*. Invited presentation. 2011 AUVSI Unmanned Systems North America Conference. Walter E. Washington Convention Center. Washington, DC. August 16-19, 2011.

Burgess, M.A. and H.F. Percival. *Chinook salmon redds and pygmy rabbits in Idaho – potential use of a small unmanned aircraft system as a tool to supplement current population estimation techniques*. Invited presentation. University of Florida IFAS Statistics Seminar. Gainesville, Florida. October 3, 2011.

Burgess, M.A. and H.F. Percival. *Potential for use of a small unmanned aircraft system as a tool to supplement current population and habitat estimation techniques for Chinook salmon redds and pygmy rabbits in Idaho*. Invited presentation. University of Florida Wildlife Techniques course (WIS 4945C). Orange Lake, Florida. October 21, 2011.

Evers, B.S. *Variable camber optimization for sUAS-based remote sensing applications*. MS thesis defense. Department of Mechanical and Aerospace Engineering. University of Florida. Gainesville, Florida. October 26, 2011.

Stephens B, Lamont M, Carthy R and Patrick L. 2011. Incubation temperatures for loggerhead turtle (*Caretta caretta*) nests deposited on Northwest Florida beaches. 18<sup>th</sup> Annual Conference of the Wildlife Society, Waikoloa, Hawaii, November 5-10, 2011. Poster Presentation.

Ahrens, R. N. M. 2011. Incorporating habitat changes into the Gulf Sturgeon assessment. 13th Annual Gulf Sturgeon Workshop. November 16-18. Niceville, FL.

Burgess, M.A., H.F. Percival, and P.G. Ifju. *Use of a small unmanned aircraft system as a tool for aerial imagery applications*. Invited presentation. University of Florida Office of Research seminar and visit with Dr. Thomas Russell, Director of the United States Air Force Office of Scientific Research. Gainesville, Florida. November 16, 2011.

Pine, B. 2011. Extinction risk in Gulf Sturgeon populations. 13th Annual Gulf Sturgeon Workshop. November 16-18. Niceville, FL.

Rudd, M. 2011. Resolving Uncertainties in Natural Mortality and Movement Rates for Gulf Sturgeon. 13th Annual Gulf Sturgeon Workshop. November 16-18. Niceville, FL.



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Dr. Jennifer Seavey, WEC Post-doctoral Associate, works with Drs Rob Fletcher and Bill Pine on patterns of change related to climate change in Florida's Big Bend