Florida Cooperative Fish and Wildlife Research Unit

Annual Report
January – December 2012

2012 Annual Report Dedicated to

Timothy E. O'Meara

Timothy O'Meara, Wildlife Research Section Leader, has been the administrative pivot point for the Unit within the FL Fish and Wildlife Conservation Commission for almost 2 decades. It was not just his job but seemed to be a personal commitment. He was steadfast, dependable, supportive, omnipresent, trustworthy, and, invariably detailed. Taking the connection between his agency, the university and USGS quite seriously, Tim also was FWC's representative for the Southeast Adaptive Management Group and the Program for Environmental Statistics. The latter two initiatives involved formal cooperative agreements, multiple agencies, and multiple participating agency scientists and faculty. Again, his commitment was invariably as a leader. The notion in the Southeast Adaptive Management Group was that the Chairmanship of the group would rotate among signatory agency representatives. Tim was the first Chairman and the position never rotated to anyone else; trustworthiness again won the day! He has always been a good writer, editor and thinker. When the Unit was first operable ca 1980, O'Meara was a biologist assigned to and backbone of the research program of one of the wildlife faculty at UF. He rapidly made himself known to Unit scientists and was always cooperative and interactive. Many of those early wildlife graduate students will remember Tim as being as helpful and influential to them with their research and theses as faculty. Never a formal graduate committee member, he spent many long hours with graduate students on research design and edited more than a fair share of theses. The Jacksonville District of the US Army Corps of Engineers administers the lion's share of Everglades restoration funds, much of which has supported Unit and UF research via the Research Work Order process. O'Meara prepared the contract, conducted the research, and wrote the report on the first RWO with the Corps (*Status of the Cape Sable Seaside Sparrow in East Everglades*). We honor Tim for his long, productive and valued contribution to the spirit of cooperative wildlife research.

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 2012, 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

2012 Photo Contest Winner, Brail Stephens, FL CRU – "Honey Boo Boo"

"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.

Steven Williams – President, Wildlife Management Institute, Gardners, PA.

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 he has 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 purchasing card processes within the University financial system, and the tracking and recording of spent funds on all grants and state funds. She also maintains the database and helps with general office procedures.

Hannah Taylor- Office Assistant, Florida Cooperative Fish and Wildlife Research Unit. She is primarily responsible for property management, and federal vehicle reporting. She also oversees safety training records and manages the Unit website through the Digital Measures system in addition to general office procedures and occasional field technician duties.

COOPERATORS

University of Florida:

A-mr Abd-Elraham	Robert Ahrens	Michael S. Allen	Karen A. Bjorndal
Alan B. Bolten	Lya Brand	Matthew J. Cohen	
Robert M. Cubert	Nancy Denslow	Bon A. Dewitt	Robert Fletcher
Peter C. Frederick	Bill Guiliano	John Hayes	
Aaron Higer	Mark Hostetler	Peter G. Ifju	
Elliott R. Jacobson	Susan Jacobson	Steven Johnson	
Michael Kane	Paul A. Klein	Leda Kobziar	
Martha Monroe	Frank Mazzotti	Robert McCleery	
Debbie Miller	Madan Oli	Todd Osborne	
William (Bill) Pine	Carrie Reinhart-Adams	Carlos H. Romero	
J. Perran Ross	Scot E. Smith	Marilyn G. Spalding	

Florida Fish and Wildlife Conservation Commission:

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

U.S. Geological Survey:

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

U.S. Fish and Wildlife Service:

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

U.S. Army Corps of Engineers

Kristin A. Farmer	Michael T. Hensch	John K.Kilpatrick
Jon S. Lane	Jon M. Morton	Gina Ralph
Glenn G. Rhett	David J. Robar	Adam N. Tarplee
Larry Taylor	Damon A. Wolfe	William C. Zattau

St. Johns Water Management District:		U.S. Parks Service
Roxanne Conrow	James Peterson	Leonard Pearlstine
Steven Miller	Mike Coveney	Bob Miller

U.S. Air Force	Idaho Fish and Game	University of Idaho
Bruce Hagedorn	Pete Zager	Janet Rachlow

University of Central Florida	University of West Florida	Innovative Health Applications LLC
Llewellyn M. Ehrhart	Phillip C. Darby	Eric D. Stolen
Dean Bagley		David Breininger

Environmental Project:	Others:	
Ritchie H. Moretti	Tommy C. Hines	Russell Hall
Sue A. Schaf	Lovett E. Williams	

Florida Cooperative Fish and Wildlife Research Unit
Research Personnel 2012

(Names in red are supervised by Percival, Kitchens, and/or Carthy)

Post-Doctoral Associates:

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

David Kaplan, PhD
Supervisor:
Research: Mechanisms of Ridge-Slough Maintenance and Degradation across the Greater Everglades

Philip Kauth, PhD
Supervisor: Mike Kane
Research: Population Diversity in the Florida Endangered Orchid Cytopodium punctatum

Margaret Lamont, PhD
Supervisor: Ray Carthy
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
Supervisor: Mike Kane
Research: Population Genetic Analysis and Assessment of Hybridization between *Calopogon tuberosus var. tuberosus* and v*ar. simpsonii*

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

Ross Tsai, PhD
Supervisor: Peter Frederick
Research: Wading Bird Colony Location, Size, Timing and Wood Stork and Roseate Spoonbill Nesting Success

Christa Zweig, PhD
Supervisor: Wiley Kitchens
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

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

David Kaplan, MS
Position: PhD Student
Research: Mechanisms of Ridge-Slough Maintenance and Degradation across the Greater Everglades

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

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: 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: PhD, Wildlife Ecology and Conservation
Graduation Date: May 2014
Research: Foraging ecology and energetics of snail kites
Advisor: Wiley Kitchens

Yuan Jing
Degree: 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

Jame McCray
Degree: PhD, Wildlife Ecology and Conservation
Graduation Date: August 2014
Research: Wildlife legislation and management in Florida: Sea turtles, a test case for creating effective policy
Advisor: Madan Oli and Ray Carthy

Brian E. Reichert
Degree: PhD, Wildlife Ecology and Conservation
Graduation Date: May 2014
Research: Snail kite monitoring of population demographics; exploring senescence and other aspects of survival.
Advisor: Wiley Kitchens

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

Margo Stoddard
Degree: PhD, Wildlife Ecology and Conservation
Graduation Date: April 2012
Research: Mammal declines and invasive pythons in the Everglades
Advisor: Lyn Branch

Louise Venne
Degree: PhD, Wildlife Ecology and Conservation
Graduation Date: April 2012
Research: Response of wading birds to fire effects in the Everglades
Advisor: Peter Frederick

Danielle Watts
Degree: 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

Jeff Beauchamp
Degree: 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

Stephen Casey
Degree: 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: 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: M.Sc., Aquatic Sciences
Graduation Date: August 2013
Research: Assessing natal sources of juvenile native fish in Grand Canyon
Advisor: Bill Pine

Jason Fidorra
Degree: 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: 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: 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: 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

Ryan Lynch
Degree: 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

Jessica McKenzie
Degree: M.S., Wildlife Ecology and Conservation
Graduation Date: December 2015
Research: Human Dimensions of Sea Turtle Conservation
Advisor: Ray Carthy

Jean M. Olbert
Degree: M.S., Wildlife Ecology and Conservation
Graduation Date: May 2013
Research: Nest predation analysis of snail kites.
Advisor: Wiley Kitchens

Kyle E. Pias
Degree: 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: M.S., Wildlife Ecology and Conservation
Graduation Date: December 2012
Research: Chytrid fungus and amphibian populations in Florida.
Advisor: Ray Carthy

Merrill Rudd
Degree: 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

Rio W. Throm
Degree: 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: M.S., Wildlife Ecology and Conservation
Graduation Date: August 2012
Research: Sea turtle conservation
Advisor: Ray Carthy and Karen Bjorndal

TECHNICIANS

Snail Kite Surveys, reproductive success and banding

Birttany Burtner
Daniel Cavanaugh
Amanda Lee
Eric Riddell
Rachel Smith
Erin Brusilow
Siria Gamez
Ryan Meinerz
Genevieve Rozhon
Rebecca Wilcox

Sea Turtle research and monitoring

Joseph Dirodio
Kathyrn Frey
Jessica McKenzie
Seth Farris
Caitlin Hackett
Brail Stephens

UAS Research

Abraham Balmori
Dillon Everidge
Steven Marr
Chris Stewart
Travis Whitley
Yun Ye
Jesse Durrance
Adam Hoyt
Daniel Schulman
Tylar Ward
Kevin Wilt

Global Climate Change

Rodney Hunt
Forest Hayes

Orchid Project

Dr. Charles Guy

Reed Canary Project

Leah Cobb

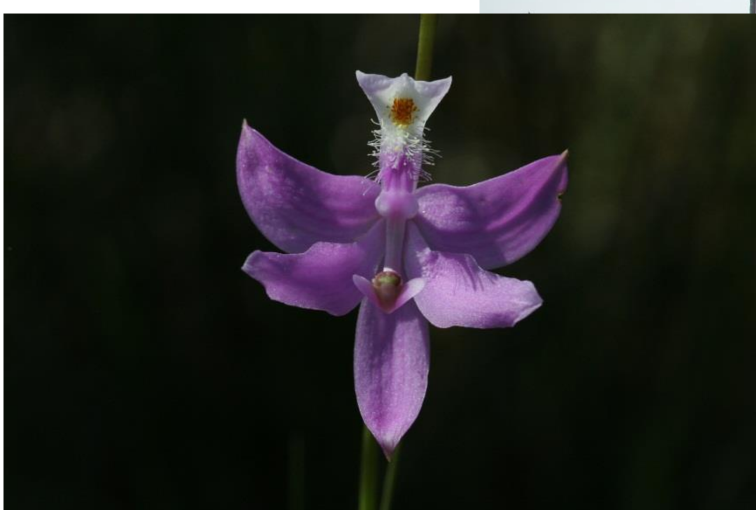
Ridge-Slough Maintenance

Larry Korhnak

Alligator Research

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

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: 03/31/2015 (UFPJ#00088028)
Graduate Students: B. Reichert, C. Cattau, K. Pias, J. Olbert

This report concentrates on demographic data collected during 2011, but also incorporates data collected since 1992. Recent demographic results reveal alarming trends concerning the Snail Kite population in Florida. Snail Kite abundance has drastically 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, and 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) has shown 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). Preliminary results from a population viability analysis (PVA) conducted in 2010 predict a 95% probability of population extinction within 40 years. These results are especially concerning, as the risk of extinction has increased as compared to results from a previous PVA conducted in 2006 (Martin, 2007). As juvenile recruitment has been lacking since 1999, recent analyses provide indications of an aging population with problems inherent to older individuals, including increased adult mortality rates and decreased probabilities of attempting to breed which have been shown to be exacerbated during times of harsh environmental conditions.

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). There has been a notable decline in Snail Kite production from two critical Snail Kite habitats, Lake Okeechobee and WCA3A. Okeechobee, which from 1985 to 1995 was a productive breeding site, has been only a minor contributing unit (in terms of reproduction) since 1996. In 2010 and 2011, nesting was observed on Okeechobee for the first time since 2006, which may represent an increase in habitat quality.

Reproduction within WCA3A has been suppressed in recent years, as no young were fledged there in 2005, 2007, 2008 or 2010; however, in 2011, there were 11 successful nests in WCA3A. Nonetheless, the low level of nest productivity in WCA3A observed this year suggests that habitat conditions may remain poor.

The decline of Lake Okeechobee and WCA3A as productive kite habitats has left the population heavily concentrated in and dependent upon the Kissimmee River Valley (KRV), particularly Lake Tohopekaliga (Toho), which accounted for 41% of all successful nests and 57% of all fledged young that were documented on a range-wide basis from 2005-2010. Toho remained productive in 2011, accounting for 33% and 36% of all successful nests and fledged young, respectively. During the 2011 breeding season, an unprecedented amount of breeding activity occurred on East Lake Toho (60 active nests, 39 successful nests), likely due in large part to the foraging opportunities at the adjacent Lake Runnymeade.

While the estimated population size for 2011 (i.e., 925 individuals, up from 826 in 2010) along with the increased number of fledglings counted during the 2011 breeding season are encouraging trends, it remains unclear whether such trends may potentially signify the beginning of a recovery phase. In this report we detail new findings related to Snail Kite demography, movement, and foraging. We also make specific recommendations that may help guide management decisions aimed at increasing Snail Kite population growth.

OBJECTIVES:

Snail Kite survival depends on maintaining hydrologic conditions that support these specific vegetative communities and subsequent apple snail availability in at least a subset of critically-sized wetlands across the region each year (Bennetts et al., 2002; Martin et al., 2006).

The historical range of the Snail Kite once covered over 4000 km2 (2480 mi2) in Florida, including the panhandle region (Davis & Ogden, 1994; Sykes et al., 1995), but since the mid-1900s it has been restricted mainly to the watersheds of the Everglades, Lake Okeechobee, Loxahatchee Slough, the Kissimmee River Valley (KRV), and the Upper St. Johns River of the central and southern peninsula (Fig. 1). After several decades of landscape fragmentation and hydroscape alteration, the kite population is now confined to a fragmented network of freshwater wetlands that remain within its historical range, and the viability of the population rests entirely on the conditions and dynamics of these wetland fragments (Bennetts & Kitchens, 1997; Martin, 2007). The Snail Kite is unique in that it is the only avian species that occurs throughout the central and south Florida ecosystem and whose population in the U.S. is restricted to freshwater wetlands in this region. The dependence of the Snail Kite on these habitats makes it an excellent barometer of the success of the restoration efforts currently underway (Kitchens et al., 2002) (e.g. USFWS Multi-Species Transition Strategy for Water Conservation Area 3A, 2010).

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

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

PROGRESS:

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

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) disproportionally impact the survival probabilities of older snail kites will help to refine vital rates that are critical to our monitoring efforts.

Preliminary findings:

- Snail kites are more philopatric than previously anticipated.
- 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
- Breeding probabilities of birds in different age classes are differentially affected by drought.
- All young fledged and radioed in the Kissimmee Chain of Lakes(KCOL) in 2008, stayed in the KCOL through the entire year.

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

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, UF PJ#84066)
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 were constructed from spatial locations using the kernel density estimator in ABODE in ArcGIS 9.3. Least square cross validations smoothing methods were used and polygons were drawn at 90% kernel. A total number of 27 nests were monitored across 2010 and 2011. The results indicate that foraging substrates that occur off the main body of Lake Toho may have higher snail availabilities, but that snail kite nests built in off-lake areas may be more vulnerable to predation. Therefore, in spite of relatively lower snail availabilities, foraging substrates that occur on Lake Toho may be more valuable to snail kites than off-lake areas. The availability of snails in on-lake foraging substrates is likely driven in part by water levels, highlighting the role of water management in maintaining foraging habitat for breeding snail kites.

For the nest predation portion of the project, a total of 92 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. Predation was found to be the primary cause of nesting failure, with the yellow rat snake (*Elaphe obsoleta quadrivittata*) as the most common predator. Additionally, results indicate that habitat characteristics of snail kite nesting areas on Lake Toho were found to have an effect on predation events with different predators influenced by different habitat variables. For some terrestrial predators nest access was affected by distance of the nest patch to the shore and nest height, while aquatic predators were influenced by distance of the nest patch to shore, water depth, and minimum daily temperature.

Male snail kite feeding two young

Female snail kite next to her nest of three young

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 in relation to habitat characteristics.

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.

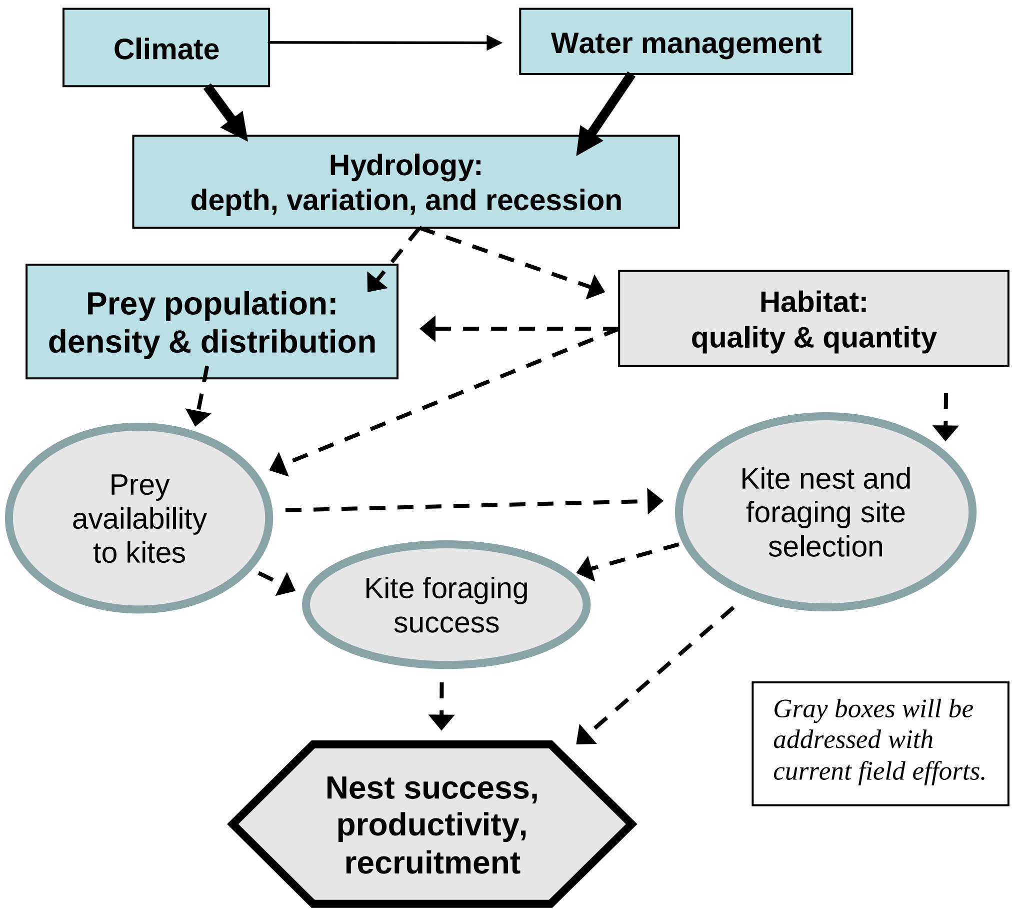
OBJECTIVES:
The endangered snail kite (Rostrhamus sociabilis) is a wetland-dependent species feeding almost exclusively on a single species of aquatic snail, the Florida apple snail (Pomacea paludosa). The viability of the kite population is therefore dependent on the hydrologic conditions (both short-term 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).

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.



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.

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.

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.

Adaptive Management for Northern Bobwhites on the Babcock-Webb Wildlife Management Area
(Fred Johnson, Principal Investigator)

Research conducted during 2002-2009 confirmed the bobwhite population on the Babcock-Webb Wildlife Management Area (WMA) in Southwest Florida is incapable of supporting desired levels of sport harvest. Research findings also suggest that increasing the size of the population and its ability to provide harvest opportunity will likely involve changing both harvest and habitat management practices. A key challenge, however, is to determine the precise nature of those changes. Only minimal variation in management practices occurred during the period of field research, thereby limiting inference about the effects of alternative management treatments. The application of decision science has been suggested as a means to assist managers in determining the best course of action to improve the status of bobwhites on the WMA. A workshop was held at the WMA during February 26-27, 2013 to assess the value of information. The value of information is the potential management return (i.e., benefits net costs) that is foregone when managers have to make decisions in the face of continued uncertainty. Thus, the value of information is the increase in management performance that could be expected if a source of uncertainty were to be reduced or eliminated. The expected increase in management performance can then be compared with the cost of the monitoring program or other research that will be required to reduce the uncertainty. Results and implications from the workshop are currently being compiled. Preliminary results suggest that the biggest increase in management performance could be realized by reducing uncertainty about the effects of hunting and the associated human disturbance.

Collection of Digital Serial Imagery in Support of Aquatic Invasive Species

***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: 6/30/2013 (UF Project #88394, 88395, and 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.

Evaluating the Use of High-Resolution Aerial Photography Acquired by Unmanned Aerial Systems for Use in Mapping Everglades Wetland Plant Communities

Daniel Gann, Jennifer Richards, and Christa Zweig

<u>Objective 1:</u> Determine accuracy of visual plant community interpretation at the species level
Initial visual quality assessment of two geo-referenced aerial mosaics we had received ("WEST" and "EAST"), revealed that the positional accuracy and the resolution of the data is not uniform across each mosaic. The image quality for the major part was excellent, but in some areas high distortion and blurriness were encountered. In addition, a quick analysis of 10 reference locations provided a non-uniform shift of between 5 and 7 meters in both dimensions. In order to be able to perform ground-referencing work for training and accuracy assessment we determined that the positional accuracy was not acceptable. Therefore, the mosaics were geo-rectified (polynomial 2nd order) using 1ft resolution ortho-rectified photography acquired in 2011.

A post-rectification positional accuracy assessment will be performed during the next ground referencing survey in March. The final image quality evaluation will provide percent estimates for the study area in 3 grade categories, and the effects of image quality on recognition of different species and community classes.

For the visual interpretation of the imagery, we overlaid a 2 m resolution grid over the geo-referenced images. For the study area "WEST" we generated a stratified random sample of 10 samples per each of 9 classes (90 samples total). The classes we considered were (1) Cladium jamaicense, 2) Typha ssp., 3) Salix caroliniana, 4) Peltandra virginica, 5) Blechnum serrulatum, 6) broadleaf mix of Sagittaria lancifolia, Pontederia cordata, and Crinum americanum, 7) floating vegetation Nymphaea odorata, including periphyton and open water, 8) mixed Shrubs, and 9) Trees; these classes had been mapped at 2m resolution using WorldView 2 images by Gann and Richards in 2010. Classes for Eleocharis spp., Rhynchospora spp., and Panicum spp. were not mapped as they represented a minor fraction of the landscape with insufficiently large contiguous areas. The visual interpretation of the 90 samples was conducted by 2 interpreters independently, and we are currently evaluating the outcome of the initial interpretation, which will be followed-up by a ground referencing survey conducted in March. The outcome of this work will finalize the training phase.

Objective 2: Evaluate stability and validity of plant community definitions at multiple scales
We finalized the Beta version of the R script that will generate the data and results to evaluate the plant community scaling procedures. We are currently testing the script performance and fine-tuning of parameters.
Objective 3: Determine accuracy of spectral and texture-based plant community interpretation at community level
Using Feature Analyst for ArcGIS, we are delineating trees, shrubs, and emergent communities, as well as four types of sloughs (open, emergent, sparse emergent, and periphyton slough) and three types of sawgrass communities (degraded, shrubby, and continuous). Initial classifications are finished and are being finalized and evaluated for accuracy.

Testing Natural Resource Applications Using a Small Unmanned Aircraft System

Principal Investigator: **H. Franklin Percival**
Research Personnel: Matt Burgess, Joe Dirodio
Funding Agencies: U.S. Geological Survey
Expected Completion: 08/31/2014 (RWO# 284, Project#00102993)

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

OBJECTIVES:
1. Assess the potential advantages and limitations of the UF Nova 2.1 sUAS as a scientific tool to augment and assist in existing natural resource data collection and estimation efforts.The evolution of the Nova 2.1 was spawned by rapid technological developments such as miniaturization of digital cameras, new frontiers in battery and materials technology, and the rapid development of high capacity memory components. While this has meant many teams are developing UAS worldwide, the UF effort has always been driven by the desire to solve specific ecological questions. Now that the Nova 2.1 is aeronautically and electronically stable, the next big frontiers are image postprocessing, machine learning, image recognition, novel statistical techniques, and application driven adaptations.

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

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

2. To test the photogrammetric parameters of the UF Nova 2.1 optical payload deployed on a Cessna© 172-model Skyhawk™. A limitation of sUAS technology is its range and deployment in situations where sample points or targets of interest are widely separated. Examples are surveys of manatees (Trichechus sp.) at warm-water refugia or salmon (Oncorhynchus sp.) redd surveys in the Snake River, Idaho/Washington. The targets may be separated by scores of miles within a range of their 150 mile or greater extent and must be surveyed within a small temporal window. The sUAS might deliver very appropriate data but logistics obviate their use over such a large extent. The Nova 2.1 payload on a manned aircraft might deliver data that are far superior to ocular estimates of human observers, and also eliminate the need for trained observers in the manned aircraft. The photogrammetric solutions might vary from that of the Nova 2.1 because of the difference in the high-precision of programmed flight plans of the sUAS versus that of a human-piloted aircraft.
UF's aeronautical engineers produced drawings and constructed an aluminum box of aircraft standards to contain the Nova 2.1 payload. We worked with a local FAA Designated Engineering Representative to determine suitable attachment of the box to a Cessna 172M owned by our collaborator Avian Research And Conservation Institute (ARCI) . Finally, after nearly 2 years of effort, a Supplemental Type Certificate is approved for attaching the box to a step just forward of the cabin on the side of the airplane. This position was chosen to provide, first, an airworthy, safe attachment and second, a clear nadir view from the bottom and clear reception of satellite signals from above. The box was flight tested without the payload and position held without any perceptible vibration. Several test flights were conducted as low as 600'AGL over ibis and egret colonies, manatee winter congregations, and a round tail muskrat trap array. The technique holds great promise especially when used for transects. Although practice might improve flight line performance, creation of mosaics of a study area will be more precisely accomplished with UAS data which are more precisely overlapped at identical altitudes. Resolution obviously is enhanced at lower altitudes with the current 10mp payload. There also is promise in subsequent cameras having much higher resolution themselves or equipping the existing payload with different lenses. Testing and planning for specific research applications will continue.

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


Left: Seahorse Key Lighthouse viewed by Google Earth; Right: Seahorse Key Lighthouse captured by UF Nova 2.1

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

Principal Investigator: **Nancy Denslow**
Project Officer**: Franklin Percival**
Funding Agency: U.S. Geological Survey
Expected Completion: 12/31/2012 (RWO# 279, UF Project# 00103064)
Graduate Student: Candice Lavelle, Ph.D.
Postdoctoral Associates: Alvina Mehinto, Cristina Colli-Dula

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

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

1. Preparation of Gulf sturgeon sequencing data
2. Microarray analysis.
3. Verification of expression by Q-PCR
4. Reporting of the Results

PROGRESS:

Task 1: Obtain high quality RNA from Gulf Sturgeon and Atlantic Sturgeon blood and tissue samples. After honing our skills and getting suitable blood and tissue samples, we were able to get high quality RNA from the Atlantic Sturgeon tissues (liver and head kidney) and white blood cells and from the Gulf sturgeon white blood cells. Red blood cells did not result in a good RIN number for the total RNA analyzed by the Bioanalyzer, suggesting that total RNA from these cells was somewhat degraded. We were able to get RIN numbers in the low 6 range, suggesting that these samples could be used for Q-PCR down the line, but probably not for microarray analysis. So far, the samples that were received from Dr. Tillitt for the laboratory experiment, have been extracted for total RNA and the samples are stored at -80 C till needed for microarray analysis. We have still to decide on which Gulf Sturgeon samples to extract.

Task 2: To obtain a normalized cDNA library of Gulf Sturgeon and Atlantic Sturgeon. This part of the project was performed by staff at ICBR. For their first round, the ICBR staff made one normalized library using adapters that could be used both for the Illumina sequencer and the 454 sequencer. For Illumina, they barcoded the samples from Atlantic Sturgeon and from the Gulf Sturgeon and they were able to get high quality sequencing reads for about 8,000 contigs for each of the sturgeon. However, the 454 sequencing totally failed. Assuming that the problem was due to using the same adapter for the two sequencers, the ICBR staff remade the normalized library and used adaptors that were specific for the 454 sequencer. This time they used only one lane of the 454 to determine whether the libraries would sequence. However, again the sequencing failed.

After consultation with the ICBR staff, we decided to try making the libraries a third time. This time, the plan was to order a new kit and to check the library construction at every step. The sequences obtained from the Illumina sequencer will be useful to design specific primers for at least two genes, one that is expressed at a high level and one at a low concentration so that we can determine when the libraries are normalized. Dr. Denslow is in constant communication with the ICBR to monitor their progress.

Task 3: To annotate the Gulf Sturgeon and Atlantic Sturgeon gene sequences. This task is being undertaken by Dr. Fahong Liu at the ICBR. So far he has only annotated the sequences obtained from the Illumina sequencer. He compared the sequences to the original Shortnose Sturgeon sequences we obtained and annotated compared to that species. We have about 8,000 contigs with good annotations for Atlantic and for Gulf Sturgeon. Some of the sequences were identical with the Shortnose Sturgeon (as expected for highly conserved genes) and some were not. These gene sequences will be used to develop primer pairs for at least two genes, as described above, to follow the normalization. In addition, depending on further sequencing and microarray results, some of these sequences may be used to develop additional Q-PCR primer pairs for evaluation of specific biomarkers in relation to the oil spill.

Task 4: To design and use a microarray for Gulf/Atlantic Sturgeon. This task has not been completed as we are waiting for 454 sequences.

Task 5: Verification of expression by QPCR. This task has not been completed as we are waiting for 454 sequences

Task 6: Reporting of results. We have been in close communication with the laboratory of Dr. Don Tillitt. We shared the sequences (8,000 contigs for each, Atlantic Sturgeon and Gulf Sturgeon) with the Tillitt lab and are strategizing for how to go forward with the project. The final report will be delayed because the project has been delayed.

SUMMARY:

Initial studies by collaborators suggest that there is immune dysfunction in fish that were exposed to the oil from the Deep Water Horizon spill into the Gulf of Mexico. The Gulf Sturgeon are an endangered species and immune dysfunction is likely to result in major health issues for these sturgeons, possibly impacting them at the population level.

Optimal Management of Migratory Bird Habitat and Harvest

Principal Investigator: **Franklin Percival**
Co-PI: **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:
The research is to be conducted principally by a postdoctoral associate, but it has required 13 months to recruit a suitable candidate. The skillset desired is highly competitive, thus the protracted search. Although a candidate has now been identified, we are expecting additional delays because the person is not a U.S. citizen and requires a visa.

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.

Optimal Control Strategies for Invasive Exotics in South Florida

Principal Investigator: Franklin Percival
Co-PI: Fred Johnson
Funding Agency: U.S. Geological Survey
Expected Completion: 02/28/2013 (RWO: 273, 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:
The research is to be conducted principally by a postdoctoral associate, but it has required 13 months to recruit a suitable candidate. The skillset desired is highly competitive, thus the protracted search. Although a candidate has now been identified, we are expecting additional delays because the person is not a U.S. citizen and requires a visa.

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.

Alligator Capture Database

Principal Investigator: **Franklin Percival**
Co-PI: **Cameron Carter**
Funding Agency: Florida Fish & Wildlife Conservation Commission
Expected Completion: 06/30/2013 (UF Project# 00102800)

This project is working with FWC alligator research staff to develop a relational database designed to store current and historical alligator capture data. Parts of the project include appending historical alligator capture datasets into Microsoft Access and standardized field headings, developing metadata for the capture datasets, creating a master alligator capture dataset, create and design forms for data entry, and perform and develop data quality control procedures within the database. There are currently 34 datasets dating from 1975-2011 with a total of 37,264 entries to be included in the master database (Table 1). Once completed FWC alligator research staff will be able to use the database in the field for future alligator capture efforts, cross referencing the master database for recaptures, and standardize data collection protocols. The project is expected to be completed June 1, 2013.

Table 1. Historic alligator capture datasets that have been converted into Microsoft Access database files.

Name of historic dataset	File Type	First year of data	Last year of data	Number of records	Number of fields
NEWN7590.txt	text	1975	1988	276	15
NEWTAG16.txt	text	1975	1991	2861	16
OLNEW91.txt	text	1983	1991	423	17
PP_TEMP.txt	text	1975	1983	403	12
TAGGING1.txt	text	1975	1985	2838	13
TAGGING2.txt	text	1975	1988	2848	14
WOOD8191.txt	text	1981	1991	1476	17
APOPKA_NSRA2008-11.xlsx	excel database	2008	2011	508	17
OCPgator data.xlsx	excel database	2008	2008	18	17
OCPgator data_2.xlsx	excel database	2008	2008	19	16
RadioGatorData.xlsx	excel database	2008	2009	98	24
RadioGatorData_2.xlsx	excel database	2008	2008	46	12
CLUTCH_07.xlsx	excel database	2007	2007	1811	3
Stomach_Data (2).xlsx	excel database	2009	2009	21	14
Gross- ADULTFEMALE-2000.xlsx	excel database	2000	2000	28	12
2002_Capture_Data v2.xlsx	excel database	2002	2002	2341	25
2003_Capture_Data v2.xlsx	excel database	2003	2003	3459	34
alligator _recapture_thru2002.xlsx	excel database	1989	2002	14174	33
Gross data (2000-2002).xlsx	excel database	2000	2002	63	8
ORDWAY_capture data	excel database	2011	2011	28	17
cap92.xlsx	excel database	1992	1992	117	25
cap93.xlsx	excel database	1993	1993	305	24
cap94.xlsx	excel database	1994	1994	24	27
cap95.xlsx	excel database	1995	1995	637	27
cap97.xlsx	excel database	1997	1997	30	16
cap8991.xlsx	excel database	1987	1991	375	28
cap8992.xlsx	excel database	1987	1991	388	27
gators from 1997-1998.xlsx	excel database	1997	1998	224	13
Guillette 2002 Captures.xlsx	excel database	2001	2002	156	15
Juvenile cycle 1997-1999.xlsx	excel database	1997	1998	285	21
Juvenile cycle 1997-1999_2.xlsx	excel database	1997	1998	78	12
Percival stats2001.xlsx	excel database	2000	2001	16	16
Percival stats2001_2.xlsx	excel database	2000	2001	514	18
reprocap.xlsx	excel database	1987	1991	376	26

Climate Response and Fire History of Slash Pine on Blackbeard Island and Wassaw National Wildlife Refuge, Savannah Coastal Refuges Complex

Principal Investigator: **Leda Kobziar**
Project Officer: **Franklin Percival**
Co-Principal Investigators: David Kaplan, Chuck Hayes, Rob Wood
Funding Agency: USDI, USGS
Expected Completion: 11/31/2013 (RWO#278)
Personnel: Brenda Thomas, Kathryn King, James Camp, Michelle Bundy

The most extensive areas of maritime forest in the US are found along the Atlantic Coast of South Carolina and Georgia. Much of the original forest has fallen to development. Of the forest that is left, 65% is found in Georgia, and few ecological studies have been conducted in these forests due to their isolation. As a result, managers question what form management should take to conserve these forests, particularly regarding the use of prescribed fire and the appropriate management response to wildfire. Anthropogenic disturbances further complicate management considerations. Lowering of groundwater levels by aquifer withdrawal for industry and residential use in the Savannah, GA area has impacted wetlands on Blackbeard Island and Wassaw NWRs. The effects of this drawdown on the island ecosystems are as yet unknown, and coupled with sea level rise, resulting changes in island hydrology may influence vegetation and fuels structure and quality. This project seeks to provide a foundation for present-day management of the islands in the context of historical fire regimes, and present and future changes in island hydrology and vegetation.

OBJECTIVES:
1. Determine the historical fire regimes on Blackbeard Island and Wassaw NWRs, including fire return intervals and seasonality of fires prior to European settlement of the area.

2. Quantify the historical and present-day climate response of slash pine on Blackbeard Island and Wassaw NWRs.

3. Enumerate management recommendations in the context of historical fire regimes and climate response of slash pine, considering possible ecological impacts of climate change.

4. Establish baseline data for groundwater and salinity levels, and document the floristic composition of the plant community to determine impacts of altered hydrology associated with climate change/sea-level rise and anthropogenic activities.

PROGRESS:
Vegetation sampling was continued during the fall of 2012: research teams made three trips to the islands to continue collecting tree cores, sampling vegetation composition and coverage, and installing weather stations to monitor local climate. Data suggest 2-3 main tree cohorts on Blackbeard and Wassaw Islands: one established roughly 100 years before present, the next 40-60 years before present, and a younger cohort established around 20-30 years ago (Fig. 1). No fire scars were discovered for years prior to 1980, a surprising result suggesting either older trees did not record scars, fires were very low intensity and did not scar trees, or fires were historically less frequent. Impending analysis of growth patterns will help us determine the relationships between historical climate fluctuations, and to discern whether indicators of disturbance (fire) are present in growth release or recruitment patterns.

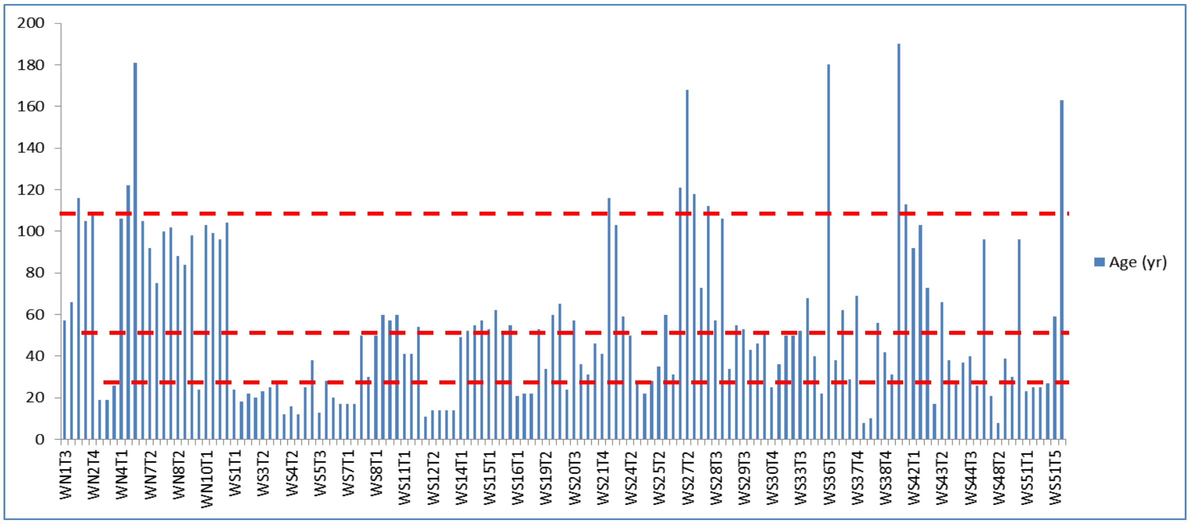
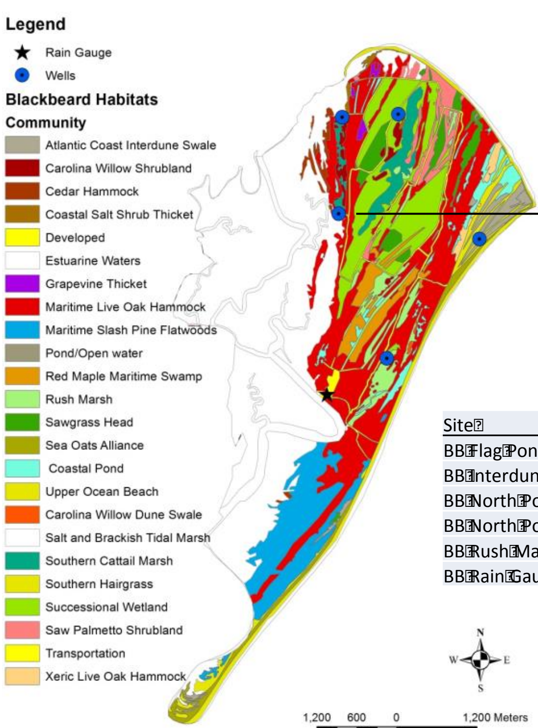


Figure 1. Example tree core ring widths for a single forest plot on Blackbeard Island. This example is representative of the two major tree cohorts found across the Island.

Also during this period, data from a network of monitoring wells installed in the spring and fall of 2012 was collected and preliminary analysis was completed. These data are being used on Wassaw and Blackbeard Islands to establish baseline data for shallow groundwater and salinity levels (Fig. 2). Wells were constructed of 1- and 2-inch PVC pipe, dug by hand using a bucket auger, and outfitted with Solinst “Edge” water level (pressure) loggers and Hobo U-24 electrical conductivity (EC) sensors. Additionally, one Solinst “Edge” barometric pressure logger was installed in a dry well on each island to correct for the effect of barometric pressure. A rain gauge was added to each island in October 2012. This report summarizes the first period of data from May through October 2012, which includes only water level data and synoptic EC data from Blackbeard Island.

Blackbeard Equipment Summary



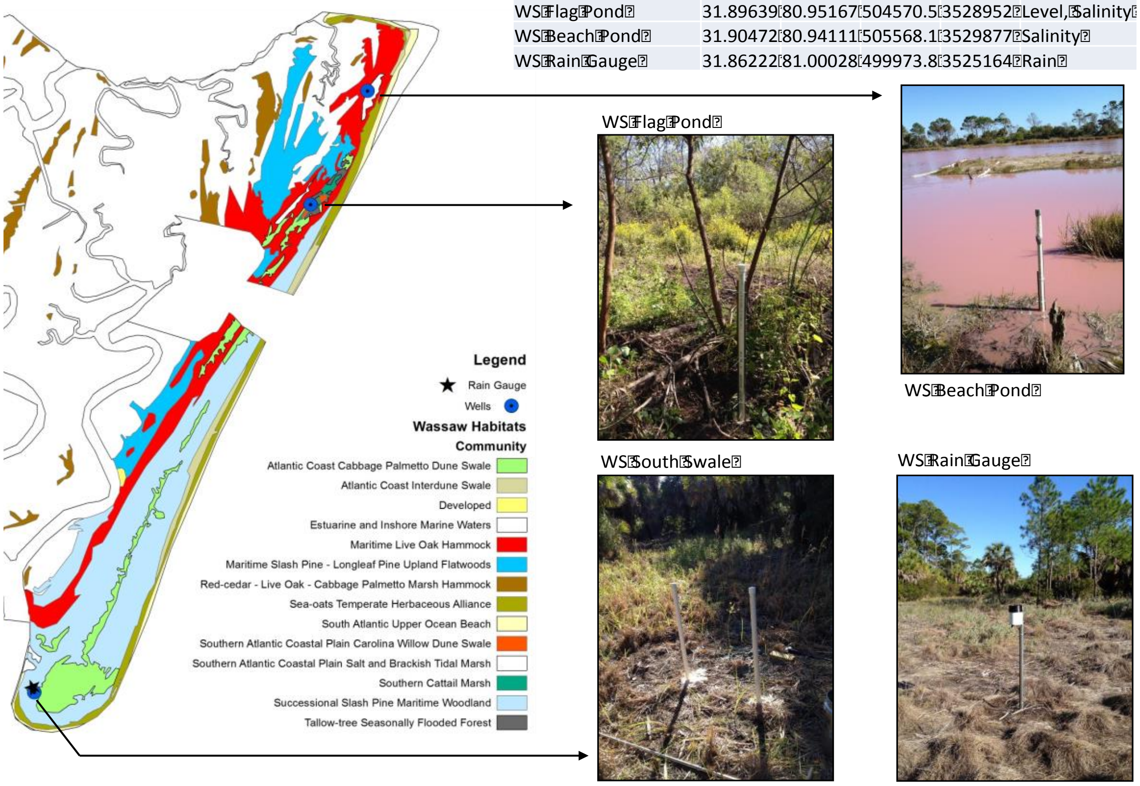
BB North Pond South

Fig. 2. Hydrological monitoring equipment installed on Wassaw and Blackbeard Islands.

Site	Lat	Lon	X	Y	Monitoring
BB Flag Pond	31.52772	81.19779	481222.9	3488106	Level, Salinity
BB Interdunal Wetland	31.51078	81.27833	482441.6	3486226	Level, Salinity
BB North Pond North	31.52731	81.20669	480377.1	3488062	Level, Salinity
BB North Pond South	31.51417	81.20722	480324.3	3486605	Level, Salinity
BB Rush Marsh	31.49453	81.19953	481050.9	3484427	Level
BB Rain Gauge	31.48963	81.20904	480146.8	3483886	Rain

Wassaw Equipment Summary

Site	Lat	Lon	X	Y	Monitoring
WS South Swale	31.86167	81.00028	499973.8	3525103	Level, Salinity
WS Flag Pond	31.89639	80.95167	504570.5	3528952	Level, Salinity
WS Beach Pond	31.90472	80.94111	505568.1	3529877	Salinity
WS Rain Gauge	31.86222	81.00028	499973.8	3525164	Rain



Data from Freshwater Areas

Wells were installed in three freshwater wetland/savanna areas on Blackbeard Island: a "successional wetland" in Flag Pond, a "rush marsh" in Tor Savanna, and an interdunal wetland approximately 200 m from the beach in the northeastern portion of the island (Fig. 1). At the Flag Pond well (Fig. 3), water level was consistently below the soil surface, even after heavy rains (which caused rapid rises in water level, but never inundated the surface). In late July the water level fell to its minimum level of 80 cm below the ground surface (bgs). High (temporal) resolution data revealed daytime declines in water level due to evapotranspiration (ET) and nighttime increases in water levels that suggest a general positive inflow of groundwater, either as inflow from shallow groundwater originating in the surrounding watershed, or possibly resulting from upward flow from a deeper aquifer layer. Salinity measured in the shallow groundwater at Flag Pond was 0.5 parts per thousand (ppt) on 5/23/2012 and 0.4 ppt on 10/24/2012.

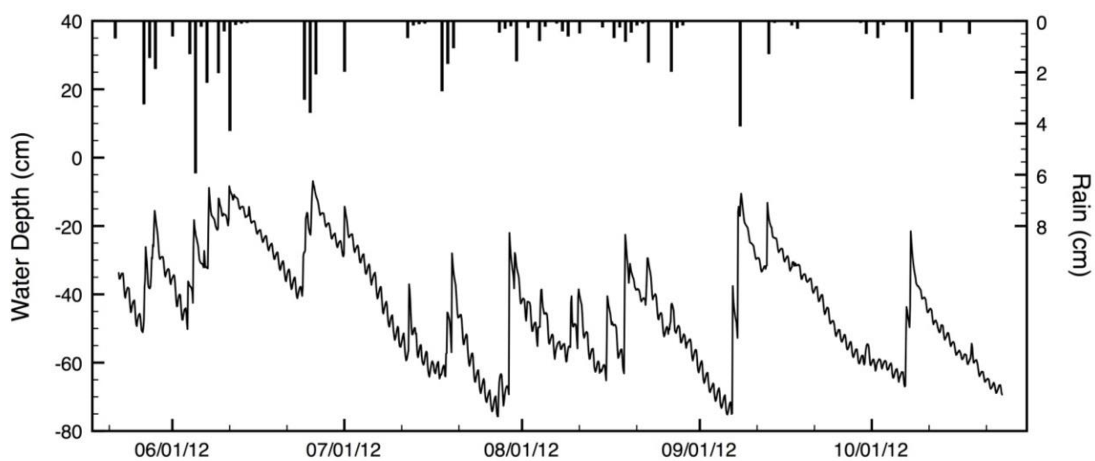


Fig. 3. Water depth measured at the Flag Pond well. Negative depths indicate depth below ground surface. Note diurnal variation in water level due to evapotranspiration (daytime drawdowns) and groundwater inflow (nighttime inflows). Rain data are from the monitoring station in Sapelo Island.

Data from the rush marsh well (Fig. 4) showed a similar pattern of ET-driven drawdowns and no surface water inundation, though the system was slightly drier, with a mid-summer drawdown of >100 cm bgs (lower limit of the monitoring well). Water level at this site had a slightly faster rate of drawdown than at Flag Pond, indicating higher ET rates and/or less groundwater inflow. Salinity measured in the shallow groundwater at the rush marsh site was 0.2 parts per thousand (ppt) on 5/23/2012 and was not measured on 10/24/2012 because the water level was below the well bottom. The data file from the interdunal wetland site was corrupted and has been sent to Solinst for recovery. Salinity in the shallow groundwater in the interdunal wetland was 0.2 parts per thousand (ppt) on both 5/23/2012 and 10/24/2012.

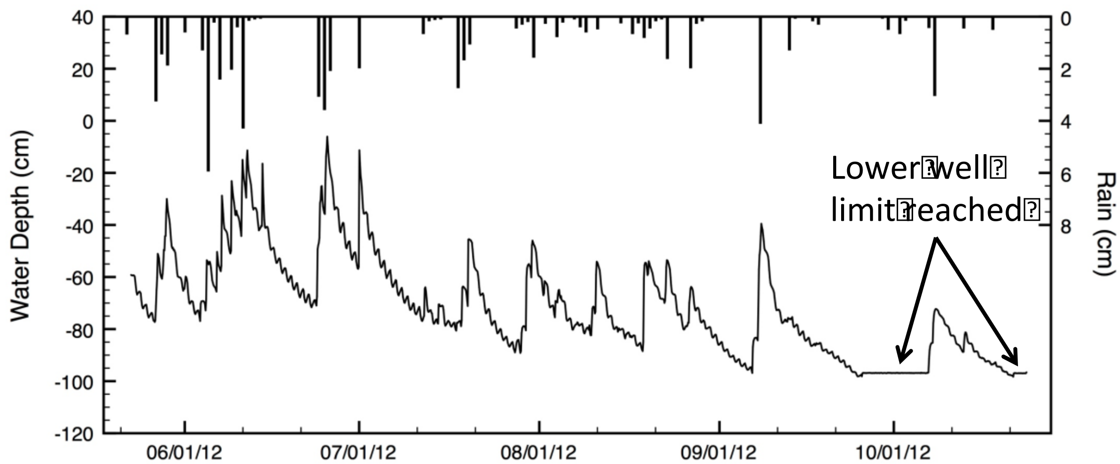


Fig. 4. Water depth measured at the rush marsh well. Negative depths indicate depth below ground surface. Rain data are from the monitoring station in Sapelo Island.

Data from Saltwater Areas

In May 2012, a well was installed in the northern end of North Pond (Fig. 2). Water level data from this well showed inconsistent tidal inundation (e.g., the site was not flooded for much of July). Overall, the site was inundated ~18% of the time and indicated a mix of diurnal and semidiurnal flooding cycles (perhaps due to inflow/outflow constriction at the levee breach). The maximum observed tidal range was ~70 cm. Even in this tidally affected location, nighttime increases in water levels when surface water tides were not present indicate that the area is receiving groundwater inflow. Salinity in the shallow groundwater in the northern end of North Pond was 31 ppt on 5/23/2012 and 24.3 ppt on 10/24/2012.

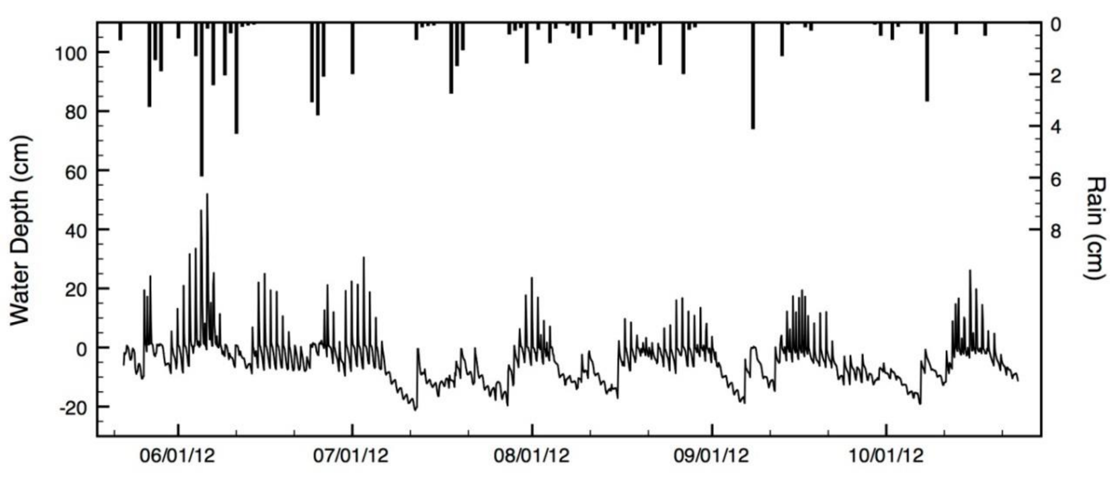


Fig. 5. Water depth measured at the northern end of North Pond, close to the breached levee. Negative depths indicate depth below ground surface. Note varying periods of tidal inundation and no tidal signal. Rain data are from the monitoring station in Sapelo Island.

SUMMARY:
High (temporal) resolution data revealed daytime declines in water level due to evapotranspiration (ET) and nighttime increases in water levels that suggest a general positive inflow of groundwater, either as inflow from shallow groundwater originating in the surrounding watershed, or possibly resulting from upward flow from a deeper aquifer layer. In the salt water wells, even in the tidally affected location, nighttime increases in water levels when surface water tides were not present, indicating that the area is receiving groundwater inflow. Monitoring of hydrology will continue and provide the basis for an integrated interpretation of the changing ecology of the islands.

Socio-cultural Constructions of Values and Attitudes Toward Wildlife and Nature; Attracting Underrepresented Groups to Wildlife Professions

Principal Investigator: **Susan Jacobson**
Project Officer(s): Ray Carthy
Funding Agency: USGS
Expected Completion: 6/30/2013 (RWO#280, PJ# 00101149)
Research Staff: Nia A. Haynes

The goal of this project is to complete a literature review and to conduct preliminary research on the association of culture and ethnicity with awareness, values, and attitudes toward the environment, wildlife, and natural resource professions. Our exploratory study will encompass a mixed methods approach including in-depth interviews and a quantitative survey of minority college students. Results will be disseminated through presentations at stakeholder meetings and an international conference, a manuscript submitted to a scholarly peer-reviewed journal, and a report to USGS/FWC and interested agencies and academic programs and with findings related to enhancing programs to increase minority recruitment in the wildlife and natural resources field. This project will provide partial funding for preliminary dissertation research by a PhD minority student at the University of Florida and expansion of her work will have relevance nationally for involving underrepresented populations in environmental fields.

OBJECTIVES:
The goal of this project is to complete a literature review and to conduct preliminary research on the association of culture and ethnicity with awareness, values, and attitudes toward the environment, wildlife, and natural resource professions. Our exploratory study will encompass a mixed methods approach including in-depth interviews and a quantitative survey of minority college students. Results will be disseminated through presentations at stakeholder meetings and an international conference, a manuscript submitted to a scholarly peer-reviewed journal, and a report to USGS/FWC and interested agencies and academic programs and with findings related to enhancing programs to increase minority recruitment in the wildlife and natural resources field. This project will provide partial funding for preliminary dissertation research by a PhD minority student at the University of Florida and expansion of her work will have relevance nationally for involving underrepresented populations in environmental fields.

PROGRESS:
A literature review has been completed and is currently being revised and edited for submission to the Wildlife Society Bulletin. Results were presented at the international conference, Human Dimensions of Wildlife: Pathways to Success Conference in Breckenridge, CO. Coordinators of programs within the Department of the Interior, including USGS, NPS, and USFWS have been contacted and a comprehensive list of outreach and diversity oriented human resource programs is being compiled. Interviews with wildlife ecology undergraduate students and a comparison group of non-wildlife students have been conducted to assess attitudes about wildlife and natural resource careers. Focus group meetings will be conducted in Spring 2013.

SUMMARY:
The goals of this project are to better understand cultural and ethnic difference in attitudes about wildlife and natural resource careers in order to better encourage recruitment and retention of underrepresented individuals into this career field. This study will broaden our understanding of the barriers and opportunities to minority recruitment and the resulting information will help agencies create a culture of diversity and inclusion within the career field.

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 the 2012 nesting season, 54 nests were laid on Eglin AFB-Cape San Blas property. Of the 54 nests deposited, we tagged turtles laying 29 (54%) of those nests and of those 29, 18 (62%) were new, untagged turtles. Although we observed a larger percentage of re-migrants in 2011, that pattern did not continue through 2012. In 2012, mean clutch size was 104 eggs. Mean incubation duration was 67 days. Only 4 nests laid in 2012 hatched and overall success of those nests was 54%. In addition to continuing our long-term mark-recapture and nest monitoring project, we partnered with the FDOT to document turtle movement along the north beach on Eglin property to assess impacts of beach and nearshore morphology on nest abundance and distribution. Results of that project can be found

in the associated abstract “The effects of shoreline armoring structures on nesting loggerhead turtles – a case study: SR 30E Stump Hole revetment, Gulf County, Florida”. We also partnered with the National Oceanographic and Atmospheric Association (NOAA) to remove debris from Eglin property to determine impacts of that debris on nest abundance and distribution. Debris was removed in December 2012 and results of the effects of that removal will be gathered during the 2013 turtle nesting season. Finally, in partnership with the US Fish and Wildlife Service, we are completing an assessment of trends in incubation length along the NW Florida coast including on Eglin AFB property. Results of that project will be completed in June 2013. Hatching data from 2012 indicated a slightly longer incubation length, as compared to the 18 year mean of 60 days (range 56-64).

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.

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: 3/31/2013
(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) ($p \leq 0.05$).

There was an increasing trend from west to east in mean sand and nest temperatures, accompanied by the expected negative correlation with incubation duration. Beach orientation may influence the sand temperatures, however a more likely explanation may be sand reflectance. Nutrient-rich sediments from the Apalachicola River may impinge on beaches to the east, creating darker sand, allowing for greater absorption of solar energy, and increasing sand temperatures. Westward movement of sediments from the river may be blocked by the Cape San Blas spit, allowing beaches west of the spit to remain lighter in color and maintain cooler temperatures and longer incubation rates. Sand reflectance, water table depth, sand characteristics, and weather data are currently being examined and analyzed to determine their effect on the incubation environment of loggerhead sea turtle nests in Northwest Florida.
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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.

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: 03/30/2013 (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. 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.

Project is completed. Draft final report has been submitted and will be finalized by September 1, 2013.

SUMMARY:
As coastlines change due to sea level rise and an increasing human presence, understanding how coastal species, such as marine turtles, respond to alterations in habitat is necessary for proper management and conservation. We used survey data from a major nesting beach in the northern Gulf of Mexico, where a revetment has been installed to assess spatiotemporal distribution of loggerhead emergences. Quadrat analysis indicates emergence patterns on this beach are not random and both nesting and non-nesting emergences were clustered immediately adjacent to the revetment and at other eroding sites along the beach. The large number of nest sites immediately south of the road revetment appears to account for the number of nests that have been displaced by the placement of the road. Piecewise linear regression with breakpoint, a form of segmented regression in which the dependent variable is partitioned into intervals at user defined breakpoints, was used to determine the relationship between nest location and wave height, time-averaged current velocities, depth at 100 m offshore and historical shoreline change. Alongshore variation in nesting changed in response to these variables, however, the relationship to the oceanographic and geomorphological variables differed above and below the threshold. The primary determinant of local nesting patterns around Cape San Blas appears to be related to the time-averaged regional current. The use of this technique in assessing nest distribution provides managers with a useful tool for predicting nest counts on other beaches.

St. Joseph Peninsula Beach Restoration

Principal Investigator: **Raymond R. Carthy**
Co-PI: Margaret Lamont
Funding Agency: MRD Associates
Expected Completion: 3/31/2013 (UF PJ# 00096816)
Research Personnel: Jessica McKenzie, Brail Stephens, Seth Farris, Caitlin Hackett

Human activity on nesting beaches increasingly impacts sea turtles and threatens to degrade their nesting habitat (Iocco 1998). Reduced availability and suitability of nesting habitat due to coastal development, beach modification, and erosion can adversely affect turtle populations (Hopkins and Richardson 1984). One method of addressing these problems is beach nourishment. Beach nourishment is the placement of beach fill as an engineering solution to erosion (Crain et al. 1995). Beach fill can be obtained from inland sources; estuaries, lagoons, or inlets on the backside of a beach; sandy shoals in navigation channels; nearshore ocean waters; or offshore ocean waters (Green 2002). The fill is placed on a beach and then graded to the desired profile. The primary goals of beach nourishment are to increase shoreline stabilization, protect beachfront property, increase recreational areas, and restore habitat (Rumbold et al. 2001). However, it can potentially have adverse effects by disrupting existing biological communities in the subaerial, intertidal, and shallow subtidal zones of beaches if not conducted and monitored properly (NRC 1995).

Beach nourishment has great potential to help threatened and endangered sea turtle populations by providing increased or improved nesting habitat that would otherwise be unavailable, especially in areas where beaches have eroded to the point where little nesting habitat was available prior to the nourishment (Ernest and Martin 1999). Crain et al. (1995) noted that turtle crawl and nesting numbers often increase after nourishment. While the quantity of nesting habitat is not a problem, the quality of beach habitat may be altered in ways that could adversely affect turtle nesting (Crain et al. 1995). Nourishment can alter a beach's sand density, compaction, shear resistance, moisture content, slope, sand color, grain size, grain shape, sand mineral content, and gas exchange (Nelson and Dickerson 1988a, Crain et al. 1995, and NRC 1995). Previous studies have found nourishment increased sand compaction (Raymond 1984, Ryder 1993, Steinitz et al. 1998, Ernest and Martin 1999, and Scianna 2002), moisture content (Ackermann 1991, Ackermann et al. 1992, Broadwell 1991, Ernest and Martin 1999, Herren 1999, and Parkinson et al. 1994), and sand temperature (Ackermann et al. 1992, Ernest and Martin 1999, Mihnovets 2003, and Mihnovets and Godfrey 2004) and altered grain size (Steinitz et al. 1998, Ernest and Martin 1999, and Herren 1999) and sand color (Mihnovets 2003, Mihnovets and Godfrey 2004). Therefore, nourishment projects conducted along sea turtle nesting beaches typically require long-term monitoring to document potential impacts.

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 2012 nesting season, 54 nests were laid on Eglin AFB-Cape San Blas property and 227 nests were deposited on the nourished beaches of the St. Joseph Peninsula, Florida. We observed turtles during 215 (77%) of those 281 nesting events. Those 215 nesting events were conducted by 97 individual turtles. Of those 97 turtles, 27% were neophyte nesters and 73% were returns. Of the 73% returns, 37% were re-migrants from previous nesting seasons and 36% were returns from within the 2012 nesting season (inter-nesters). Although we observed a large proportion of remigrants during the 2011 nesting season, that pattern was not evident this year. Continuing our saturation tagging project through the 2013 nesting season will help better understand these long-term patterns.

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.

Reassessing the status of the Endangered Florida Salt Marsh Vole – Phase 1

An interagency meeting to discuss vole habitat and camera traps

Principal Investigator: Robert McCleery
Co-PI: Christa Zweig
Personnel: Melissa Desa, Rod Hunt, Danielle Sims
Funding Agency: U.S. Fish and Wildlife Service, CESU
Expected Completion: 09/30/2013 (UF Project# 00105158)

The federally endangered Florida salt marsh vole is possibly the least understood endangered mammal in North America. The lack of information on the vole greatly constrains managers' abilities to conserve this endangered species. The Florida salt marsh vole is known from only three sites in Levy County, Florida. Since 1979, when this subspecies was discovered, only 43 individuals have been captured. This is mostly from the type location in the Waccasassa Bay area, 3 from Raleigh Island, and 2 from Long Cabbage Key in the Lower Suwannee and Cedar Keys National Wildlife Refuge (LSNWR). The LSNWR captures are within 5 miles of the original capture site, suggesting that the vole may persist throughout the salt marshes of central Florida's gulf coast. Other than captures at these three sites, we know nothing about the species' distribution throughout the salt marshes of the Big Bend, particularly LSNWR, nor do we understand vole habitat use, population dynamics, or response to management. Our ability to study the species has been hindered by the accessibility of the habitat, the vole's patchy distribution, and adequate trapping techniques. Nonetheless, recent successes by the USGS and the University of Florida have shown that it is possible to conduct meaningful research on the voles and significantly increase our knowledge of this rare species (Figure 1). Our intent is to provide missing life history information and determine the extent of the vole along the Big Bend, all of which could lead to reassessing the status of the vole. We will monitor areas of vole habitat that have been burned in the recent past to document the effect of fire as a potential management tool for the vole. We also have the ability to concurrently monitor for the Gulf salt marsh mink, a rare species that has only been identified in the Big Bend area by road kill and few other sightings. A mink was recently captured in vole bucket camera traps indicating another opportunity should traps baited specifically for mink prove useful (Figure 2). The mink is of particular regional interest as a mammal species of greatest conservation need for the Florida Fish and Wildlife Conservation Commission. Mink are indicative of excellent marsh habitat, water quality, and undisturbed areas. This is an excellent opportunity to monitor for two important marsh species, and will provide LSNWR leadership the information they need to manage for Florida salt marsh voles and mink currently and in the face of sea level rise-related changes to the refuge.

OBJECTIVES:
These objectives address two of the five management goals for LSNWR: to expand scientifically based monitoring and research to support management decisions regarding wildlife habitat and populations; and to restore, conserve and enhance the natural abundance, and ecological function of refuge habitat, with an emphasis on managing habitat to benefit T&E species. These also address several of the USFWS Vole Recovery Plan objectives.

1) Determine the possible extent of the population within LSNWR. We will determine the distribution of potential habitat using remote sensing and habitat data from a USGS team's recent work. Sites will be trapped for presence of voles.
2) Monitor the known populations within LSNWR: The number of failed attempts to detect voles leads us to believe that, like many rodent populations, voles fluctuate both seasonally and annually. To better understand these dynamics and the factors influencing them, we will establish a long term monitoring grids on Long Cabbage Key and two other sites that will be trapped 4 times a year for 5 nights. Understanding the population's normal fluctuation will allow us to better understand how voles respond to management actions and assist us in focusing subsequent research efforts.

3) Determine extent of vole habitat preference: We know that voles are isolated in Distichlis/Spartina patches of habitat throughout the salt marsh, but voles in other states have been detected in different vegetative communities within the marsh. Thus, we are uncertain as to the extent of vole habitat preference and the factors limiting their distribution in the marsh.
Evaluate the potential to monitor for the Gulf salt marsh mink with camera traps, another rare species that is indicative of good habitat and water quality

PROGRESS:
Camera trapping began in December 2012 and continued until March 2013
Live trapping for demographic data was completed in March/April 2013
Trapping for telemetry and telemetry will begin in April 2013

Photo of 3 endangered Florida salt marsh voles taken by our unique camera traps

Marsh Rabbit Translocation to Everglades National Park

Principal Investigator: **Robert Allen McCleery**
Co-Principal Investigators: Kristen Hart, Robert Reed
Funding Agencies: U.S. Geological Survey
Expected Completion: 08/31/2014 (RWO#'s 282, 281)
Research Staff: Elizabeth Dancer, Charlotte Robinson
Graduate Students: Adia Sovie, Edward J. Larravee

Marsh rabbits (Sylvilagus palustris) were historically one of the most obvious components of the mammalian fauna of Everglades National Park (ENP), especially because unlike most of the park's mammals, rabbits are largely diurnal and make extensive use of the same habitat edges frequented by humans (Dorcas et al 2011). Despite their historical abundance, marsh rabbits have largely vanished from ENP over the last decade (Dorcas et al 2011). Experienced observers reported seeing few or no rabbits in areas in which they were formerly abundant, and recent surveys of road-killed mammals in ENP have yielded no rabbits (Dorcas et al.2011). One promising hypothesis is that predation by the invasive Burmese python (Python molurus bivittatus) has contributed to the marsh rabbit's apparently drastic decline. To test this hypothesis we have translocated marsh rabbits to ENP and control site sites from areas outside the park boundaries. We will compare differences in survival rates and cause specific mortality among the sites upon the completion of field work. Preliminary result show python predation of rabbits only from the southern portion of ENP and a lack of mammalian predations on rabbits from both sites in ENP.

OBJECTIVES:
1) Determine if there are difference in the rates of survival and cause of mortality among released and translocated populations of marsh rabbits.

2) Determine if python predation is reducing survival rates of rabbits in ENP

PROGRESS:
We released rabbits on two sites in Everglades National Park, the Coastal Prairie Trail (n = 12) near Flamingo and the Coe Visitor Center (n = 11). Additionally, we released rabbits (n = 13) at the Loxahatchee National Wildlife Refuge, a site similar to the Everglades but with a healthy marsh rabbit population and no confirmed python sightings. Finally, we are monitoring 23 captured and released marsh rabbits that at Fakahatchee Strand State Preserve. This “control” population serves to evaluate the population dynamics of a healthy marsh rabbit population in the absence of pythons.

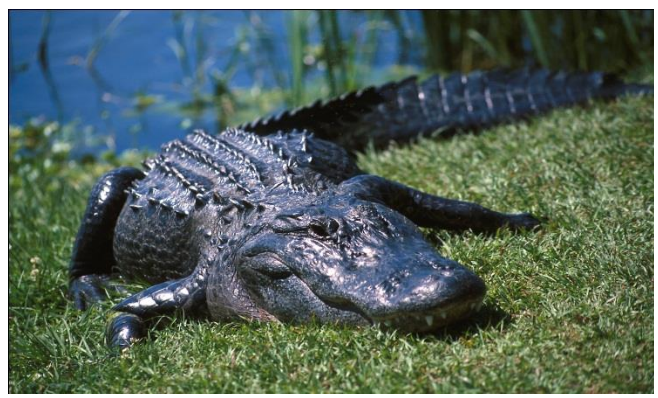
At ENP we have recorded ten mortalities and 7 predations (python = 2, avian = 3, unknown = 2) and 3 deaths from unknown causes. At Loxahatchee National Wildlife Refuge there have been eleven mortalities from predation (mammal = 3, avian = 2, alligator = 4, unknown = 2). Meanwhile, at the capture and release population in Fakahatchee Strand State Preserve we have recoreded 10 mortalities, (mammal = 4, avian = 3, unknown = 3). We will calculate difference in cause specific mortalities at the end of the study but the observed python predations appear to support the hypothesis that pythons may have contributed to the loss of rabbits in the ENP. Equally notable is the lack of mammalian predation in ENP that appears common in Fakahatchee and Loxahatchee. These preliminary findings support the recent work suggesting mammal populations in the ENP are greatly reduced (Dorcas et al 2011). Furthermore, it suggests that a lack of mammalian predators in ENP may be leading to cascading effect throughout the food chain.

We will capture and translocate our final 8 rabbits to ENP early next year. Additionally, we will continue to track 20 rabbits that will be maintained at Fakahatchee Strand State Park.

The next phase of the project will focus on developing an Everglades wide marsh rabbit occupancy model, investigating the impact of excluding marsh rabbits from a grassland ecosystem, and evaluating marsh rabbit habitat selection on multiple scales.

SUMMARY:
This project evaluates the cause of dramatic declines in mammalian fauna in the grater Everglades and aims to determine if invasive pythons are responsible.


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 76 (39 female and 37 male) alligators were captured in the spring at 5 areas (A.R.M. Loxahatchee National Wildlife Refuge, Big Cypress National Preserve, and 3 areas in Everglades National Park). Of those captured, 58 were new individuals and 18 were recaptured individuals. Captured alligators ranged from 120.0 cm to 275.6 cm. A total of 74 (31 female and 43 male) alligators were captured in the fall. Of those captured, 57 were new individuals and 17 were recaptured individuals. Captured alligators ranged from 126.7 cm to 282.9 cm.
Alligator Surveys: Spring alligator surveys were conducted in 4 marsh and 1 estuary areas. Alligator encounter rates ranged from 0.0/km to 5.2/km in the marsh/estuary. Fall alligator surveys were conducted in 4 marsh and 1 estuary areas. Alligator encounter rates ranged from 0.0/km to 4.5/km.

Alligator Hole Occupancy: Not conducted in 2012.

Crocodile Surveys: Surveys performed from Biscayne Bay and Key Largo west along most of the accessible coastal and estuarine shoreline to Cape Sable in ENP resulted in 139 crocodile observations, 28 alligator observations and

130 indistinguishable eyeshines (Figure 2). Seventy-eight captures were made of crocodiles, with 40 being recaptures. Personnel at TP and FWC originally marked seven, and the University of Florida originally marked the remaining 33.

Crocodile Nesting: Ninety five confirmed nests were located during the 2012 nesting season during University of Florida surveys, 89 within ENP, one depredated nest was located at Chapman Field in Miami, one failed nest just outside Matheson Hammock County Park, one successful nest located in Lower Matecumbe and 3 successful nests located at the Crocodile Lake National Wildlife Refuge. For nests whose fate was known, fifty-eight percent (55) were successful, 42% (40) were depredated by raccoons or failed for unknown reasons. A total of 343 hatchlings were captured, 336 from nests within ENP

SUMMARY:

Hydrology influences alligator encounter rates, 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: Merill Rudd

We are developing robust analytical techniques to evaluate the information from the acoustic array and utilize the new information to update the stock assessment and recovery plan for this species. We chose a multistate model for analysis due to its ability to marine and river-specific survival rates, transition probabilities, and detection probabilities (Schaub et al. 2004, Nichols and Kendall 1995).

A variety of life-history, feeding ecology, movement, genetics, and population viability studies have 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 provide a baseline of information about basic Gulf sturgeon life history attributes and relative snapshots of the status of Gulf sturgeon stocks in individual rivers. Though significant advances have been made in the synthesis of information for Gulf sturgeon, the 2009 assessment (Pine and Martell 2009) identified large uncertainty in natural mortality rate estimates from life-history characteristics and traditional passive (PIT) tagging programs. This uncertainty propagates through the assessment and leads to divergent predicted population trajectories and current stock status. Pine and Martell (2009) and the gulf sturgeon working group identified the resolution of these natural mortality and movement rates as high priority.

To address this uncertainty, in 2009 NMFS launched a large-scale cooperative acoustic telemetry tagging program, with the goal of tagging 20 individual sturgeon in five core rivers across the Gulf of Mexico (GOM) with long-life (5-year) acoustic tags. A large network of acoustic receivers was deployed in rivers of key management interest throughout the GOM including critical habitat rivers Suwannee, Apalachicola, Choctawhatchee, Yellow, Escambia, Pascagoula, and Pearl rivers as well as the Ochlockonee and Blackwater rivers. Rivermouth receiver arrays monitor the movements of these tagged individuals into and out of their river habitats in order to improve estimates of exchange rates between management units and current estimates of natural mortality rates. This array has been tracking acoustically tagged Gulf sturgeon since fall 2010.

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:

Significant progress has been made during the first year of this project. Telemetry information for 2010 and 2011 tag deployment has been entered and detections from Fall 2010 through Summer 2012 have been obtained from the National Marine Fisheries Service, U.S. Fish and Wildlife Service, and other collaborating academic institutions. A simulation evaluation framework has been developed to assess the appropriate model structure in Program MARK to assess mortality and movement rates with the current sampling design. With the chosen multistate modeling structure, we performed 1000 iterations of simulated Gulf sturgeon population dynamics to assess precision of key parameter estimates with the expected number of tags to be deployed and time period of the current program. We ran the first two and a half years' worth of rivermouth detection data through the same multistate modeling structure to obtain preliminary marine and river-specific survival rate estimates, detection probability, and transition probabilities from natal (tagging) rivers.

The stock reduction analysis used to assess Gulf sturgeon status has been revised to allow for population assessment at the level of spawning river. We have begun editing the age-structured mark-recapture model used in Pine and Martell (2009) to include the updated tagging information across the GOM since 2007 and the updated mortality rates from the multistate modeling framework. Three presentations outlining the preliminary status of the project were given to the Gulf sturgeon working group at the annual meeting in November 2011. At a Gulf sturgeon monitoring meeting in May 2012, we gave three presentations regarding updates to the stock reduction analysis, developments and applications for the multistate modeling framework, and methods of using the new database to estimate population growth. Two presentations were given at the annual national meeting of the American Fisheries Society presenting our unique sampling design and multistate modeling framework to other sturgeon and fish population dynamics researchers throughout the country

SUMMARY:

Resolving the uncertainty in Gulf sturgeon natural mortality and movement rates between river systems within the Gulf of Mexico is critical for assessing the status and setting recovery targets for this ESA-listed threatened species. The resulting analytical framework is an interesting application of large-scale acoustic telemetry relevant to fish and wildlife metapopulations and breeding site fidelity.

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: 05/31/2013 (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.

Vegetation and elevation monitoring for global climate change background data in Lower Suwannee National Wildlife Refuge

The endangered Florida salt marsh vole (*Microtus pennyslvanicus 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. pennyslvanicus*, 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.

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
Date of Completion: *0*3/31/2012 (RWO 264)
Research Staff: John Simon, Chris Winchester, Brittany Burtner, Louise Venne, Ross Tsai, Jason Fidorra

This work is a continuation 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 monitors 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:
Nesting effort by all wading bird species combined was significantly higher than in 2010, increasing by 42%. (12,432 nests observed in 2010) but considerably lower than either the average of the preceding five (30, 416; 32% lower) and ten years (34,038; 39% lower). While rapidly drying conditions provided foraging conditions that allowed the birds to initiate, drying may have been too rapid to generate and attract large numbers of nesting birds. White Ibis nest starts (n=13,379) were 23% and 31% lower than the five (n=17,532) and ten-year (19,431) averages respectively. Great Egret nest starts in 2011 (n= 5372) were very similar to the five year average (n=5361), but down 11% from the ten year average (n=6094). Wood Stork nest starts were 42% and 22% higher than five (n=330) and ten (n=386) year averages, while Roseate Spoonbill nest starts were 315% and 600% higher than five (n=41) and ten(n=24) year averages.
The average number of LBHE and TCHE observed in 2005 – 2011 was reduced by 76% and 53% by comparison with 1996 – 2004 averages. This pattern could be the result of a general reduction in nesting by these species throughout the Everglades, or it could indicate that these species are nesting elsewhere in the system in recent years. In any case, this trend should serve as an alarm for potential widespread declines of these two state-listed species. During ground surveys, we also noted that the marsh surrounding a number of colonies of small herons experienced drying, to the point that raccoons consistently were able to access the areas and cause heavy nest losses (Burtner 2011). This was evidenced by feathers of nestlings in raccoon scat, high nest loss/abandonment, and large numbers of partially eaten chick carcasses. It seems likely that nest success was generally lower in the northernmost of the colonies which dried first. Since we could only measure nest success in colonies that we could reach with airboats, we therefore believe our nest success estimates for Tricolored Herons, Little Blue Herons, and Great Egrets may be biased high for the WCAs.
Perhaps the largest change and biggest surprise in wading bird nesting community in 2011 was a large increase in numbers of Roseate Spoonbills nesting in the WCAs. While there have been regular nestings of 20 – 60 pairs in

Alley North for over 10 years, we found over 160 pairs in 6th Bridge colony in February. These birds must have largely come from colonies in Florida Bay, where the nesting totals were considerably reduced in 2011. Spoonbills were largely successful at 6th Bridge, and it is unclear why they may have moved to the WCAs in such large numbers this year. Spoonbills were first recorded nesting in the WCAs in recent history in 1992 – another year in which water levels fell rapidly. Perhaps spoonbills are particularly attracted to sudden pulses of food during these conditions. Food availability indices in Florida Bay were reported to be favorable for nesting in winter 2010/11, so it seems unlikely that they had moved because of poor foraging there.
Forty-three percent of wood stork nests monitored were successful in the Tamiami West colony, while all stork nests in the Jet Port South colony failed due to abandonment. It is unclear why the storks abandoned at Jetport, though food sources on the west side of the WCAS may have dried up earlier than on the east side, based solely on elevation gradients. If storks nesting in freshwater Everglades (ENP and WCAs) are tallied together (870 nests), 350 were known to have failed at Jetport South, and 228 of those at Tamiami are estimated to have failed. This indicates that nearly 70% of all the stork nests in freshwater marshes failed in 2011. Nest success at Tamiami may also give an overly optimistic picture, since we only estimated success through 65 days of nesting. A trip into the colony after young had left the nest but had not fledged (need date) found appreciable numbers of dead young and scavenged carcasses in and near nests. So the numbers of chicks actually fledged from any of the freshwater colonies was almost certainly very low. This suggests that the 2011 season was only marginally successful for storks, with about the same number of nest starts as the ten-year average, but poorer nest success than usual.

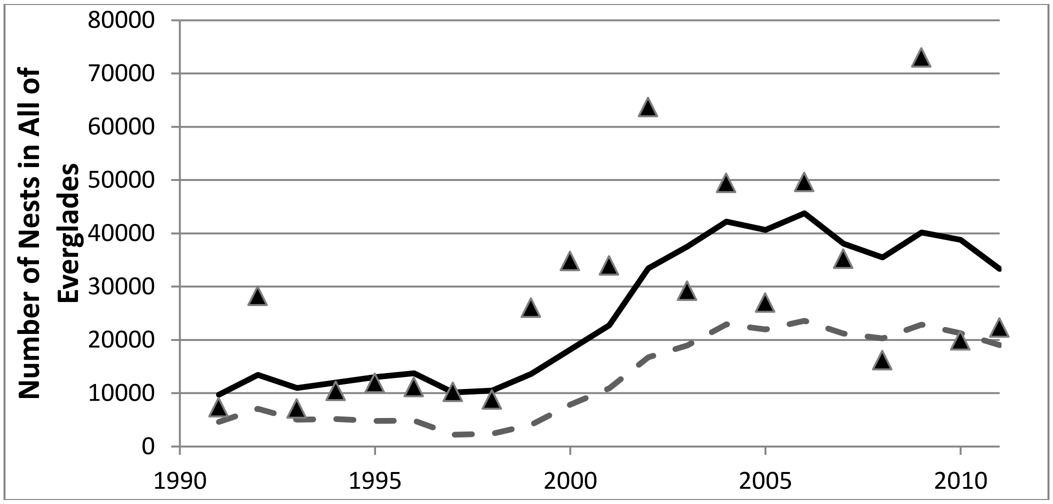
SUMMARY:
2011 showed either no improvement or no change in the four key parameters that are monitored for signs of response to restored conditions (Frederick et al. 2008).

Change in timing of Wood Stork nesting
Stork initiation occured later in 2011 than any other season since 1998, occuring in early March. Given the rapid and uninterrupted drying pattern that prevailed throughout the nesting season beginning in September 2010, it seems unlikely that food was not being made available to storks. Since the drying pattern occurred following a relatively long period of high water and long hydroperiod (Summer 2009 through September 2010), it seems likely that production of prey animals may have been good prior to the 2011 nesting season. We suggest that initiation of nesting may have been delayed due to the very cold temperatures of December, January and February . Cold water temperatures are known to have strong effects upon the behavior of Everglades aquatic fauna, in general making them much less available to birds (Frederick and Loftus 1993)

Proportion of Storks + Ibises to Great Egrets
A high ratio of tactile foragers (storks + ibises) to sight foragers (Great Egrets) is thought to be a characteristic of the predrainage Everglades, since tactile foragers apparently do better under conditions of very high prey availability. The ratio during the 1930s was thought to be over 30. The ratio in 2011 was 2.65, which is low even by comparison with recent years .

Interval between exceptional ibis nesting events
During the 1930’s, exceptionally large ibis nestings (70th percentile of records during the period) occurred once every two to three years. This was thought to have been a response to the relative frequency of exceptional years for feeding when large pulses of prey animals were produced and made available. This measure has improved markedly in recent years, and while both 2007 and 2008 were non-exceptional, 2009 was definitely exceptionally large. The 2011 season however has pushed the interval up to 2 years, and the running average remains below 2. This still compares favorably with the 1930 – 1940 period.

In 2011 the proportion of nesting birds found in the coastal region of the mainland peninsula decreased to 14% of the total. This is the lowest percentile over the last three seasons, below the five-year average of 18%, but consistent with the ten-year average of 13%. The proportion in the coastal zone in 2011 remained well below the 70 – 90% thought to have nested there in the predrainage system



Numbers of wading bird nests in all areas (WCA 1,2, 3 & ENP), 1991 - 2011, showing totals of all species (triangles), 5-year running average of totals (dark line), and 5-year running average of White Ibis nests (dashed line).

Resource use by Florida manatees in the northern Gulf of Mexico

Principal Investigator: Robert Fletcher
Funding Agencies: USGS
Expected Completion: 8/31/13 (RWO 274, UF#96834)
Graduate Student: Catherine Haase

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

OBJECTIVES:

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

PROGRESS:
A Ph.D. student was selected and completed her first semester. She has started background research on manatee thermal physiology and habitat use, and is in the process of developing methodology to begin analyzing the available data in accordance to our objectives

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SUMMARY:

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

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Determination of Population Diversity in the Florida Endangered Orchid Cytopodium punctatum

Figure 1 Flower of *Cyrtopodium punctatum*, cigar orchid.

Principal Investigator: Michael E. Kane
Funding Agencies: U.S. Department of Interior, USGS
Date of Completion: 9/30/2012 (RWO 251, UF#77491)
Research Staff:Timothy Johnson, Philip Kauth, Nancy Phiman, JJ Sadler

Cytopodium 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:

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. Intepret results with respect to development of a ecologically-sound re-introduction program for *C. punctatum.*

PROGRESS:

We were able to isolate high quality DNA preps from leaf tissue of Cyrtopodium punctatum using the DNeasy Plant Mini Kit. However, it is interesting to note that this is in contrast to the significant difficulties that we encountered obtaining purified DNA preps to conduct population diversity studies with the terrestrial orchid species Bletia purpurea and Calopogon tuberosus which also occur at the FPNW. The reasons for these differences in ease of recovery of high quality DNA are unclear. Nevertheless, for C. punctatum we were then able to successfully generate the required allelic database. These data are being used to complete final analyses of the genetic differences within and between the two small populations. Since this study was initiated, the majority of the C. punctatum plants sampled are in rapid decline due to changes in perhaps hydrological conditions and certainly significantly increased canopy shading. Within several years all exisitng plants may be lost. During completion of our pollenation biology study (Dutra 2009b), a large volume of seed was collected and is being stored at lower temperature at the University of Florida. The availability of a Cyrtopodium seed culture protocol (Fig 2.) developed in our laboratory allows us to generate plants from these declining popluations for reintroduction. These plants are currently being propagated. The final genetic analysis of the declining population generated from the current study combined with our previous pollenation biology study we provide insight into the level of genetic diversity of these fragile populations. A follow-up examination of the genetic diversity between the seed donor plants (this study) and seedlings would provide a more in-depth understanding of the consequence of restricted gene flow in isolated populations.

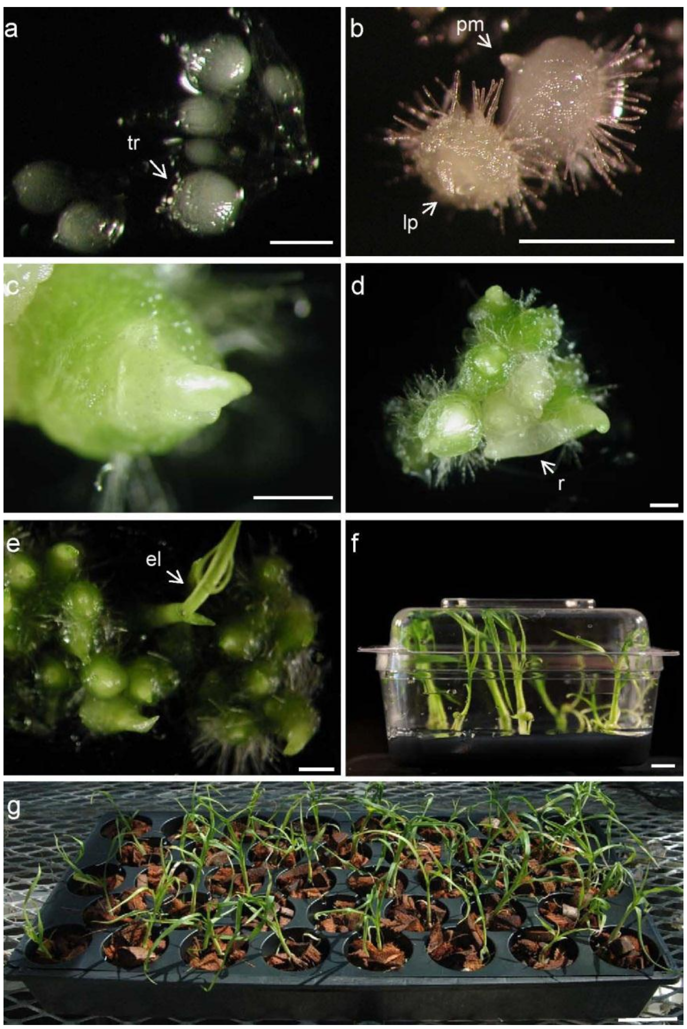

Figure 2 Asymbiotic seed culture of *Cyrtopodium punctatum*

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.

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

The ecology & reproductive biology of the native FL orchid species, 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 on-slaught 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.

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.

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 involves 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. To meet broad Objective 1, we have been conducting experiments to assess how behavior of mice (i.e., foraging) is influenced by risk perceived, and thus movement by, beach mice. We measure perceived risk using depletable foraging patches (GUD trays). Trays comprised covered plastic sandwich trays baited with 5 g of dried millet seeds mixed evenly into 3 l of sifted beach sand. Trays are elevated to prevent access of non-target animals, and wooden dowels are placed for mice to access trays. To determine GUDs, seeds are sifted from trays every 1 or 2 days, depending on the protocol for a particular experiment, and the average weight of seeds from 3 separate collections is calculated. Trays are rebaited after each collection. Field work is centered on the full and/or new moon, depending on the research questions.

In Experiment 1 (2010-2011 season), our objective was to determine 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. We compared the influence of fox, owl, and cat cues in two microhabitats, open sand and vegetated. Control aural and scent cues were also tested. Only the owl (Bubo virginianus) cue negatively influenced foraging by mice, and only in the open microhabitat.

In Experiment 2 (2011), our objective was to determine whether landscape structure influenced perceived risk under ambient and heightened risk. We compared foraging in experimental connected and unconnected vegetation patches of different sizes (1 m2 & 2.5 m2) treated with artificial light (indirect cue) and a predator cue identified in Experiment 1 as important (direct cue). (See Progress Statement)

In Experiment 3 (2011), our objective was to determine how foraging and amount of area used by mice over a broader spatial scale (1 ha landscapes) are influenced by landscape characteristics and risk. We measured risk (i.e., GUDs) at multiple points in 2 landscapes with (owl cue as determined from Experiment 1) and 2 without (control) heightened risk conditions. (Analysis in progress)

In Experiment 4 (2012), our objective was to distinguish more clearly the influence of patch size, connectedness, and distance between a source and target patch on movement between and risk perceived by mice in these patches. We assessed responses in larger patch sizes and greater distances between patches than those tested in Experiment 2.

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

After we proposed work to address Objective 2 and before support was granted, a high-effort trapping and monitoring effort on Perdido Key was conducted by the Florida Fish and Wildlife Conservation Commission. Also during this time, new evidence on the genetics of Perdido Key and Santa Rosa Beach mice emerged showing genetic exchange is occurring along these barrier islands. Results from both studies suggest berms are being used by beach mice. However, because such berms are at risk of being flattened by severe weather, they do not represent permanent solutions for creating habitat connectivity. We therefore modified Objective 2 to evaluate whether newly restored (planted) sites—which are more likely to persist through severe weather—facilitate movement for mice. In Experiment 5 (2012), we compared use in naturally vegetated, open sand, and restoration sites.

Study Area: 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:

Objective 1:

Experiment 2: We completed processing data collected from broomsedge plots that had not been included in results presented previously. In this study we assessed how patch size (1 m^2 vs. 2.5 m^2), connectedness (presence of a broomsedge corridor), and treatments that increased risk (owl, artificial lights, owl + lights) influenced foraging by mice. Results using data from all study plots (n=15) show mice perceived greater risk (less foraging, higher GUDs, Figure 1) in treatments with artificial lights than in plots with only the owl treatment or the control. Patch size and connectedness did not appear to influence mouse activity, suggesting the two patch sizes may have been perceived similarly by mice, and that the distance between the patches was short enough that mice did not perceive heightened risk associated with crossing with or without a corridor. Results from mixed models (Type 3 tests) support this observation, with mean GUDs differing by treatment (F: 6.07; Pr > F = 0.001), but not by patch size or connectedness.

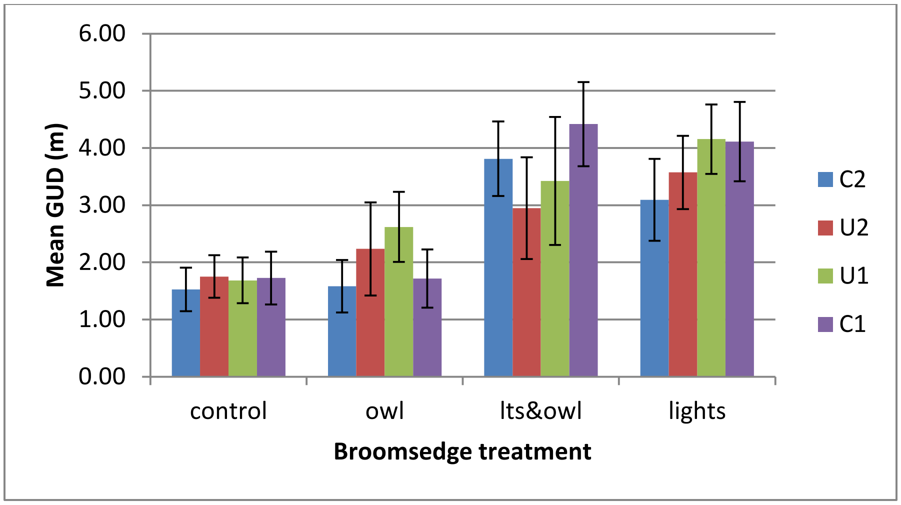

Figure 1: Mean Giving up Densities (GUD) in foraging trays in experimental vegetation plots with different patch sizes and connectedness, and under predator and/or lighting treatments. Trays were originally baited with 5 g of millet seeds. Lower GUDs (fewer seeds left in tray by mice) correspond to lower perceived predation risk. C = connected; U = unconnected; 1 = 1 m^2 patch; 2 = 2.5 m^2 patch. Standard error bars are shown.

Experiment 4: Because results from Experiment 2 regarding patch size and distance were equivocal, we have been conducting another experiment (June-Aug 2012; Dec 2012-Jan 2013) to assess the influence of a larger experimental patch size and wider distance on perceived risk. We identified open sand areas at least 25 m in diameter and bordered by a source dune with evidence of regular use by mice or presence an active burrow. Sites were randomly selected to be 10 m (n=14) or 20 m (n=14) from the source dune. In each site we installed a 5 x 5 m patch of broomsedge and placed a GUD tray at the center. We are comparing GUDs over 3 nights each when patches were either connected or not connected to the source patch with a narrow corridor of broomsedge. Order of corridor treatment (1st or 2nd 3 nights) is randomly assigned. Data are collected for each point during both full- and new-moon sampling sessions to identify how moonlight influences foraging behavior.

Preliminary results from data collected between June-August (10 sites per distance) show GUDs in general were higher (i.e., perceived risk was higher) during the full vs. the new moon (Figure 2). Whether patches were connected or not did not influence GUDs at different distances during the full moon (10 m: $t = -1.97$, $P > t = 0.08$; 20 m: $t = -1.59$, $P > t = 0.15$). During the new moon, mice foraged less in the unconnected than connected plots when 20 m separated the source and target patches ($t = 2.71$, $P > t = 0.02$). These results suggest corridors may facilitate movement when ambient light is low (i.e., new moon) and when distance between patches is >10 m, but the high perceived risk associated with moonlight may override the potential safety provided for movement by a corridor when ambient light is brightest (i.e., peak full moon). Data collecion is ongoing at additional plots.

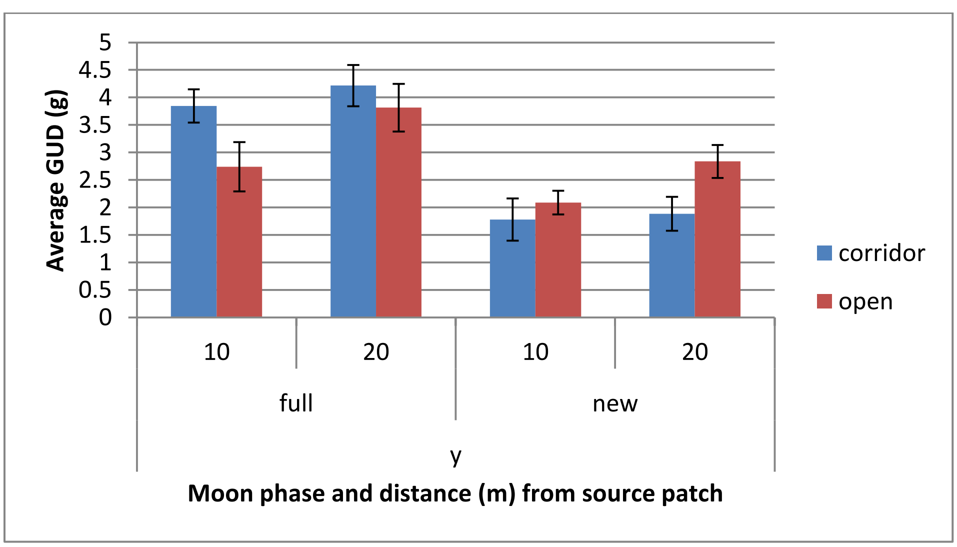

Figure 2. Average giving up density (GUD, g) in experimental vegetation (broomsedge) patches in two treatments at two distances (10 v. 20 m) from a natural source patch for mice, measured during full and new moon phases. During the “open” treatments there was an open sand gap between broomsedge and source patches. Standard error bars are shown.

Objective 2:

Experiment 5: We used tracking tubes to assess whether restoration sites might facilitate movement by beach mice. At each of 4 sites, we installed one linear 6-tube transect (9 or 10 m spacing) in each of three treatments, 1) open gap; 2) naturally vegetated dune; and 3) restoration plots. Treatments were selected based on relative proximity to restoration plots. Restoration plots (~6 x 60 m) spanning open sand gaps on Perdido Key were installed as part of a separate study on regeneration success of coastal dune plants. 5-night trapping sessions were centered on the full or new moon. Two full and two new moon trapping sessions were conducted. Presence of mouse tracks in tubes was assessed each morning of the trapping session.

Preliminary results show tubes in the natural vegetation treatments were visited more often than those in other treatments during both the full and new moon phases (Figure 3), and restoration plots were visited more than open sites. In both the open and restoration treatments, the effect of moon phase appeared to be strong, with mice visiting fewer tubes during the full v. the new moon sessions. These results suggest both naturally vegetated dunes and restoration plots installed in open sand (e.g., storm damaged) areas may facilitate movement by mice. We are currently evaluating whether habitat characteristics (e.g., species composition & plant height) may explain differences in responses between these habitat types.

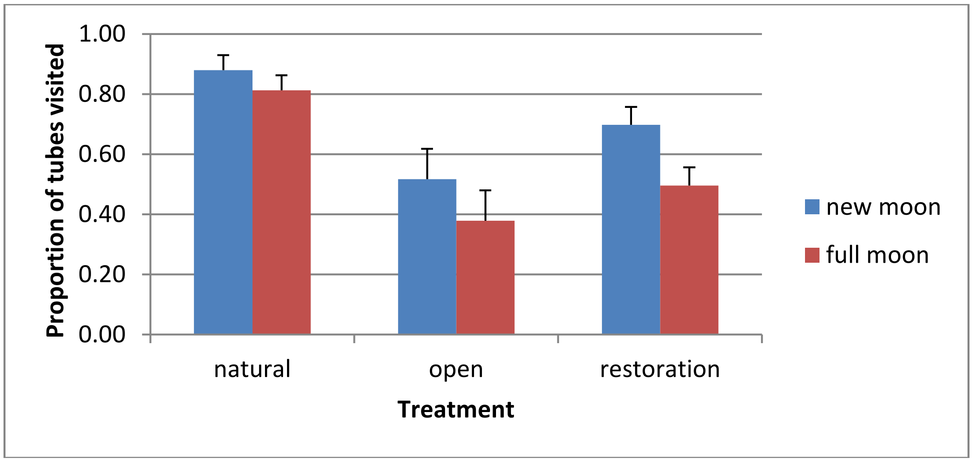

Figure 3. Average proportion of tracking tubes visited by Perdido Key beach mice in three treatments during new and full moon phases. +1 Standard error bars are shown.

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.

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: 12/31/2012 (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.
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
4) Identify and extrapolate key remote indicators of declining ridge-slough landscape condition.

PROGRESS:

Task 1 – Soil Respiration: The Everglades is a peatland, and as such the balance of carbon between the soil and the atmosphere is critically important. We investigated how local and regional variation in hydrology controls soil carbon efflux (respiration) in the ridge-slough landscape. Integrated soil and water column CO2 evolution was measured from January 2009 through June 2011 at sampling blocks spanning a hydrologic gradient from drained to impounded which includes the best conserved portion of the characteristic landscape pattern. Respiration was predicted based on hydrologic attributes (water depth) and other environmental covariates (water temperature, pH, and community type). Water table depth explained over 50% of the variance in instantaneous soil respiration; temperature was a poor predictor, both alone and in combination with water depth. Extrapolating the best-fit model to recent hydrologic conditions at each of the locations allowed an investigation into our central hypothesis that hydrology controls soil respiration rates in ridge and slough landscape patches. Estimated respiration rates for mean elevations in ridges and sloughs ranged from a maximum of 825 gCO2-C m2 yr-1 on ridges in 2011 (drained portions of the landscape) to a minimum of 370 gCO2-C m2 yr-1 in ridges (impounded portions of the landscape) in 2010, with generally higher estimates for ridges and lower estimates for sloughs. The large difference in estimated soil respiration rates between years was due to significant interannual hydrologic variability. Long-term estimated average annual respiration (2000-2011) suggests differences between ridges and sloughs is far in the hydrologically conserved compared to drained and impounded areas. Our results indicate hydrologic modifications have altered soil carbon cycling in the region.

Task 2 – Net Ecosystem Production: The importance of net ecosystem exchange (NEE) or carbon (C) as a function of water management and ecological condition is of paramount importance to Everglades restoration in that it encapsulates the peat accretion process, and the ecological and hydrological controls on that process. We used chamber methods to monitor NEE in ridges and sloughs spanning a gradient of hydrologic modification in Water Conservation Area 3. Over one year of bi-monthly measurements at 8 locations in each of 4 landscape blocks we observed significant differences in NEE, GPP and Reco between ridge and slough, and across blocks. While there was strong diel variation in NEE, the expected seasonal patterns in NEE were not observed, possibly because the area experienced a mild winter and prolonged inundation that lasted throughout the study period. Despite substantial hydrologic modification to the Everglades, the central portion of the ridge-slough landscape has a carbon accretion potential with declines in that potential with lowered water levels. Carbon fluxes differ seasonally, and the rate for all carbon fluxes in ridges is related to sawgrass density. As expected, the potential for carbon accretion is substantially higher on ridges than sloughs. In order for ridges to have equivalent net carbon balances to sloughs requires a loss of carbon from sloughs that is not covered by this study, but does suggest that exogenous carbon inputs to maintain ridge elevations may not be necessary to maintain ridge and slough soil elevation differences.

Task 3 – Phosphorus Enrichment Patterns in Ridges

A -Deep Core Measurements of P Concentrations: The objective of this work was designed to aid in better understanding the mechanisms that create regional heterogeneity in P concentrations; this work also builds on previous MAP/RECOVER monitoring efforts. The redistribution of P is a critical process in primary production in the Greater Everglades; the most charismatic example is the dramatic enrichment of P on tree islands (Wetzel et al. 2009), but less dramatic though potentially equally important redistributive processes enrich P on ridges. Because of the general importance of P in this oligotrophic landscape, it is important to better understand the redistributive mechanisms and consequences; the coupling to the C balance objective is intentional in that we view these processes as coupled. Among the elements of field work required for this objective are 1) measurements of soil P spatially and with depth in ridges and sloughs spanning the full range of hydrologic modification, and 2) detailed measurements of hydraulic gradients between ridges and sloughs that are thought to be required if lateral translocation (e.g., due to evaporative gradients when ridges are dry and sloughs wet) of P is the underlying mechanism.

B - Hydrologic Transport of P from Ridges to Sloughs: One of the mechanisms proposed for creating the landscape pattern in the ridge-slough landscape is the translocation of P from source areas (sloughs) to evaporative sinks (ridges), with attendant consequences on primary production. This mechanism is strongly supported by the observation that soil total P in ridges is higher than in sloughs, and that this difference is lost as landscape vertical differentiation is lost. This would suggest that the mechanism that sustains TP variation between ridges and sloughs occurs primarily in settings where ridges retain their 20 cm elevation difference from the adjacent sloughs. The most likely explanation for this difference is that transpiration from ridges, particularly during periods when the ridge is dry but the adjacent slough is wet, leads to an evaporative hydraulic gradient that draw water and solutes from sloughs into ridges. We deployed paired wells, one in a ridge and another in the adjacent slough (ca. 100 m apart) in areas where vertical differentiation is conserved and another where it is largely degraded. The study period included the entire range of hydrologic conditions from the entire landscape being inundated to ridges dry but sloughs wet, to a prolonged period when both were dry, and then back. Over that time, water level differences between the ridges and sloughs were consistently small; in short, water levels varied in lockstep during most of the deployment, even during the period when ridges were dry but sloughs wet. However, because of differences in specific yield between soil and open water, this lockstep behavior actually implies significant lateral transport from sloughs to ridges. We estimated that flux, and point out that it occurs preferentially on large ridges, potentially providing a mechanism to explain the power function distribution of ridge sizes (which indicates that large ridges grow more quickly than smaller ridges). We also estimated ET from both ridges and sloughs using the White Method.

Task 4 – Modeling the Hydrologic Effects of Pattern
A - Numerical Simulation Modeling - Identifying the mechanisms that drive development of self-organized patterned landscapes is essential for guiding ecosystem management and restoration. In this work, we modeled flow through real and geostatistically simulated landscapes to test the hypothesis that feedbacks between patch anisotropy and hydroperiod may be sufficient to explain development of the flow-parallel ridge-slough mosaic of the Everglades (Florida, USA). Results show patch anisotropy to be a strong predictor of hydroperiod, with ecologically significant increases in flooding duration (>40 days/year) in isotropic landscapes compared with areas of the Everglades with the best-conserved anisotropic patterning. Notably, hydroperiod differences among landscapes were largest in dry years, suggesting that low flow periods may be most influential in landscape pattern development, contrary to alternative models of pattern formation. This study demonstrates the potential for coupled feedbacks between landscape geometry and hydrology to drive anisotropic pattern formation via inundation frequency without requiring velocity-driven erosion and redistribution of particulates.

B - Analytical Modeling: Regular landscape patterning arises from spatially-dependent feedbacks, and can undergo catastrophic loss in response to changing landscape drivers. The central Everglades (Florida, USA) historically exhibited regular, linear, flow-parallel orientation of high-elevation sawgrass ridges and low-elevation sloughs that has degraded due to hydrologic modification. In this study, we use a meta-ecosystem approach to model a mechanism for the establishment, persistence, and loss of this landscape. The discharge competence (or self-organizing canal) hypothesis assumes non-linear relationships between peat accretion and water depth, and describes flow-dependent feedbacks of microtopography on water depth. Closed-form model solutions demonstrate that 1) this mechanism can produce spontaneous divergence of local elevation; 2) divergent and homogenous states can exhibit global bi-stability; and 3) feedbacks that produce divergence act anisotropically. Thus, discharge competence and non-linear peat accretion dynamics may explain the establishment, persistence, and loss of landscape pattern, even in the absence of other spatial feedbacks. The potential for global bi-stability suggests that hydrologic restoration may not re-initiate spontaneous pattern establishment, particularly where distinct soil elevation modes have been lost. Restoration efforts should focus on preserving relict patterned landscapes via maintenance of historic hydroperiods. This study illustrates the value of simple meta-ecosystem models for investigation of spatial processes.

Task 5 – Ridge-Slough Pattern Metrics: The degradation of the ridge-slough landscape is most evident in the loss of vertical differentiation between ridges and sloughs, a phenomenon that appears to precede broad-scale changes in first-order vegetation patterning. Here we explore a variety of pattern metrics that were designed to provide early warning indication of ridge-slough landscape degradation, and that are more firmly rooted in the hydraulic foundation of landscape patterning. Among the key metrics are the size class distribution of ridges, which uniformly follows a power function that is largely incongruous with a regular pattern (i.e., with a fixed wavelength), and a metric that describes the flow-friction (i.e., a proxy for flow impedence through the landscape). We explore these and other metrics using 13 new high resolution vegetation maps from the remaining portion of the Everglades landscape with ridge-slough patterning. We conclude that while metrics like length-to-width ratio and ridge prevalence are intuitive, they fail to capture integral hydrologic features of the landscape. Moreover, we observe that patch geometry measurements (aspect ratio and orientation) are strongly size dependent, suggesting that larger patches are more elongated and more closely oriented with flow than small patches. This finding has potentially important implications for discerning the mechanisms of landscape formation and maintenance.

Task 6 – Ridge Senescence: The process of ridge senescence, wherein spontaneous and potentially widespread die-off of the sawgrass on ridges occurs, is a phenomenon that is poorly described in the literature, and poorly understood. It has significant implications for the C accretion budget of ridges since the period between senescence and recovery can be several years, during which respiratory losses are sustained or even enhanced, while primary production is severely reduced. We sought to understand the prevalence and causal mechanisms of ridge senescence along a gradient of hydrologic modification in the Central Everglades. We used aerial images and a photo-interpretation protocol to discern the location, extent, and type of senescence, and explored hydrologic drivers thereof. While we observed strong evidence that the ridge senescence phenomenon is widespread (ca. 50% of ridges showed some form of senescence in one synoptic survey) and under hydrologic control (prevelence responds to mean inundation depth during the preceding dry season), the specific management goals that would enhance or reduce this phenomenon remain obscured by conflicting evidence. Further work, particularly during drought periods is needed to establish a better mechanistic understanding of this important marsh succession process.

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.

Assessing juvenile fish responses to water releases from Glen Canyon dam

Principal Investigator: **Bill Pine**
Funding Agency: USGS
Expected Completion: 08/15/2013 (RWO#283)
Graduate Student(s): Michael Dodrill

This project is part of a comprehensive effort between DOI, state, tribal, and academic researchers to assess how different riverine flow operations from Glen Canyon Dam effect fish resources in lower Colorado River basin. In this project we are assessing two things (1) how juvenile rainbow trout hatch date distribution and growth changes under different flow regimes and (2) estimating juvenile native fish density in different habitat types and relate this to different types of habitat available.

OBJECTIVES:
Evaluate the relationship between river flows and rainbow trout growth rate. Assess the relationships between juvenile native fish density and habitat types and link these estimates to a habitat model.

PROGRESS:
We are continuing to estimate growth of rainbow trout samples and have completed processing about 60% of the samples. We are still working on approaches to estimate the density of juvenile native fish in different habitat types. We have two different prototype models working for the juvenile habitat estimation and are working to determine which model is less biased using simulated data.

SUMMARY:
We are assessing how experimental water releases from Glen Canyon Dam change the spawning window and growth rate for rainbow trout in the Lees Ferry Reach of the Colorado River. We are also working to better understand native fish density in the Little Colorado River reach of the Colorado River in different habitat types.

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:
A functional Decision Tool that can be used by refuges to guide long term RCG control: the development of the Decision Tool rests on our determination of the effect of broadcast seeding. This effect alters the outcome of the glyphosate application, the transition probabilities associated with several management actions, and the potential stratification of transition probabilities. Once this effect is determined, a manual for overall coordination of data entry, updated Decision Tool use, and the model will be provided.

Long term RCG management recommendations for each refuge: Consistent with the DOI's policy on adaptive management, we recommend refuges simply follow the updated policies generated by the decision tool. These recommendations will be further refined through the use of the Decision Tool and by interactions with participants. Recommendations for future AM projects: Recommendations to FWS regarding the transition to the operational phase of RCGAM have begun in the form of discussions between the Science Team and the Biological Monitoring Team from FWS. Meetings are planned for the next few months to develop formal recommendations specific to RCGAM and for future AM projects in general.

Protocols for data collection suitable for long term monitoring: Determination of these protocols rests on the effect of broadcast seeding. After completion of the 2011 field season, we can provide long term protocols. These protocols will be developed with participant guidance on the level of effort and intensity that are reasonable within refuge capabilities.

At least two publications in a peer-reviewed journal that describe major results and recommendations from the study: Several publications have resulted from this work, and one peer reviewed publication has published. Other publications are in progress or planned.

SUMMARY:
Invasive species present a challenge to the efforts of the National Wildlife Refuge System (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 invaded 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 has been developed. Through AM, the goal of this project was 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. 2009).
The Reed Canary Grass Adaptive Management (RCGAM) Project was initiated in 2007 and the setup/research phase of this project will continue until October 2011. The project involves NWRS participants from 10 refuges in two regions (Regions 3 and 6) and a science team with representatives from USGS, University of Florida, University of Minnesota, and Lincoln Park Zoo. The central premise of the RCGAM project is to assure that efforts to control reed canary grass are well-informed and are improved upon over time through the use of predictive models and a structured monitoring design that provides data to support or challenge the models. There is considerable uncertainty regarding RCG management outcomes, therefore this approach provides an opportunity for learning.

The Science Team and NWRS participants identified objectives, designed treatment and monitoring protocols, and agreed on experiments that will improve decision-making for management but will also contribute to furthering ecological knowledge. These experiments address conversion of RCG dominated meadows and forests, and are characterized by three commonly encountered scenarios: 1) a wet meadow partly invaded by RCG with substantial wet meadow native species cover, 2) a heavily RCG invaded meadow with little wet meadow native species remaining, and 3) a formerly forested, now RCG dominated area adjacent to an intact floodplain forest. Management actions consisted of applications of the broad spectrum herbicide glyphosate, applications of the graminoid-specific herbicide fluazifop (Fusilade), and broadcast seeding native species.

A state and transition model was developed as the basis for a Decision Tool that links observed current states and management actions to outcomes of these actions. The Decision Tool was developed using a Microsoft Access database and Microsoft SharePoint software, and is based on an annual cycle of management implementation, monitoring, and decision-making. With each round of data collection, predictive models supporting the Decision Tool are adaptively updated with learning that occurred during that round of management. Administering the Decision Tool during a long-term implementation phase will require centralized coordination, and can proceed under a narrower scope for data collection with simpler protocols. The effect of broadcast seeding cannot be estimated until after the 2011 field season, therefore final deliverables for this project will be provided in a report issued in February 2012.

COMPLETED PROJECTS of Florida Unit….

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

35. Production, Sterility, & Food Habits of Bighead Carp. PI: J.V. Shireman;
Completion Date: July 1987

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

53. Effects of the Modified Water Delivery Program on Nest Site Selection & Nesting Success of Snail Kites in Water Conservation Area 3A (RWO40). PI: M.w. Collopy, s. Beissinger; Personnel: R. 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 Nati'l Park (RWO50). PI: F.J. Mazzotti; Completion Date: April 1989

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

86. Workshop in Florida Manatee (*Trichechus Mantus*) Population Biology (RWO88) PI: T.J. O'Shea, H.F. Percival; Personnel: B.B. Ackerman; Completed: October 1993

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

102. Sea Turtle Populations in The Eastern Gulf of Mexico: Biology, Distribution & Population Structure (RWO77) PI: K.A. Bjordnal, A.B. Bolten; Personnel: J.R. 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. Silviera, W. Bryant; Competed: September 1995

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

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

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

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

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

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

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

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

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

119. Development of an Ecologically Stable Cost Efficient Biological Water Treatment system & Technology 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 Beauchair. PI: H.F. Percival; Personnel: C.L. Abercrombie, A.R. Woodword, K.G. Rice; Completion Date: July 1995

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

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

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

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

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

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

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

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

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

135. Necropsies of Ill and Dying Desert Tortoises From California and Elsewhere in The Southwestern United States (RWO131) PI: B.L. Homer; Personnel: E.R. Jacobson, K.H. Berry; Completed:March 1996

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

138. Interactions Among Cavity Dependent Species in Longleaf Pine Forests: The Roles of Snags and

Red-Cockaded Woodpecker Cavities (RWO143) PI: J.D. Harris; Personnel: R. Costa, J.J. Kappes, Jr.; Completion Date: August 1996

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

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

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

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

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

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

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

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

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

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

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

150. Captive Propagation & Experimental Reintroduction of 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 Herpersvirus Associated with Green Turtle Fibropapillomatossis: Phase I Virus Isolation & Transmission (RWO161) PI: P.A. Klein; Completion Date: June 1998

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

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

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

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

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

165. Demographics, Genetic Relationships & Impacts From Rd Imported Fire Ants on The Florida 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 Crocodilian Growth Development and Fertility (RWO 154b) PI: P.T. Cardielhac; Completion Date: December 1999

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

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

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

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

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

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

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

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

186. Dry Down Tolerance of Florida Apple Snail (*Pomacea Paludosa*): Effects of Age and Season (RWO 182) PI: H.F. Percival, P.C. Darby, Z.C. Welch; Completion Date: August 2000

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

202. Ecological Inventory of Moody Air Force Base and Surrounding Properties (Z 039) PI: R.R. Carthy; Personnel: C.J. Gregory; Completion Date: March 2003

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

264. Science Fellowship for Assessment of Coastal Habitats and Listed Species. PI: Raymond R. Carthy Co-PI: M. Lamont. Completion Date: April 2009.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

288. Directing Succession Through Adaptive Management in National Wildlife Refuges: Reed Canary Grass Control and Transition to Wetland Forests and Meadows. PI: C. Reinhart-Adams. Co-PI: S. Gatowitsch, E. Lonsdorf, F. Percival. Completion Date: April 2011.

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

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

291. Management of Functionally Connected Dune Habitat for Endangered Beach Mice on Fragmented Landscapes. PI: L. Branch. Co-PI: D. Miller, M. Stoddard. Completion Date: December 2012.

292. Genomic Analysis of Peripheral Blood Cells from Sturgeon Exposed to Oil and Oil-Related Chemicals. PI: N. Denslow. Completion Date: December 2012.

Publications 2012

Bowling, A. W., J. Martin, and W. M. Kitchens. 2012. Evaluating the effect of changes in habitat conditions on movement of juvenile snail kites. Ibis 154:554-565 .

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Presentations 2012

Percival, H.F., M.A. Burgess, P.J. Ifju, S.E. Smith, B.A. Dewitt, B.S. Evers, J.H. Perry, T.J. Rambo, T.M. Reed, P.C. Frederick, H.Y. Rodriguez-Asilis, and D.A. Wolfe. Unmanned aircraft system for ecological research and monitoring. Invited seminar. CSU Unmanned Aerial System Symposium. Colorado State University. Ft. Collins, CO. 20-21 March 2012

Percival, H.F., M.A. Burgess, P.J. Ifju, S.E. Smith, B.A. Dewitt, B.S. Evers, J.H. Perry, T.J. Rambo, T.M. Reed, P.C. Frederick, H.Y. Rodriguez-Asilis, and D.A. Wolfe. Unmanned aerial system for ecological research and monitoring. Invited seminar. University of Florida Center for Remote Sensing. Spring Seminar Series. Gainesville, Florida. January 20, 2012.

Kitchens, W., C. Cattau, and Z. Welch. 2012. Refugia in a Novel Ecosystem: Everglades Snail Kite in Florida. 9th INTECOL International Wetlands Conference. Conference. Orlando, FL. June 6, 2012.

DeSa, M., R. Hunt, C. Zweig, H.F. Percival and W.M. Kitchens. A novel method for camera trapping small mammals in irregularly flooded marsh environments. 9th INTECOL International Wetlands Conference. Conference. Orlando, FL. June 6, 2012.
Olbert, J. and W. Kitchens. 2012. Determining Reasons of Nesting Failure and Brood Reduction of Snail Kite (Rostrhamus sociabilis plumbeus) Nests on Lake Tohopekaliga, FL. Poster presented at: North American Ornithological Conference. Vancouver, British Columbia, Canada. August 2012.

Pias. K. and W. Kitchens. 2012. An Artificial Platform to Help Snail Kites (Rostrhamus sociabilis plumbeus) Handle an Introduced Prey Species. Poster presented at: North American Ornithological Conference. Vancouver, British Columbia, Canada. August 2012.

Pias. K. and W. Kitchens. 2012. Relationships Between the Foraging Rates and Home Range Structure and Composition of Breeding Snail Kites (Rostrhamus sociabilis plumbeus) on Lake Tohopekaliga in Florida . Poster presented at: North American Ornithological Conference. Vancouver, British Columbia, Canada. August 2012.

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