Invasive Exotic Animals

Everglades National Park
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Everglades National Park is an active member of the Everglades Cooperative Invasive Species Management Area (E-CISMA), a formal partnership of federal, state, and local government agencies, individuals and groups that manage invasive species. To date a draft ***Early Detection and Rapid Response Plan*** has been developed.

Everglades National Park has thus far concentrated most effort on the Burmese python, through research on ***Movements and Habitat Use of Burmese Pythons*** (USGS, UF, SFWMD, and Davidson College), ***Developing Effective Traps for Pythons*** (USGS, USFWS, UF, SFWMD, and Davidson College), the development of an ***Invasive Species Risk Assessment*** (USGS, USFWS). We also have an active program with "designated agents" for removal of pythons from public lands.

We are working with the USFWS and the USGS to establish a federally funded ***Everglades Ecosystem Invasive Animal Rapid Response Team***. This team would provide field operations and science support, and educational and outreach efforts. The success of this effort will depend on having agency staff fully dedicated to it, with commensurate operational and research funding.

Florida Atlantic University

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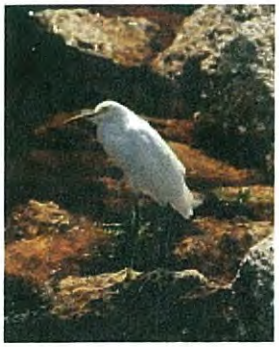
While FAU does not have a formal Invasive Exotic Animal Plan/Program, it does as part of it's Environmental Sciences Program's Greater Everglades Research Initiative (GERI) identify the topic of invasive species research as one of four high research priorities(www.science.fau.edu/biology/envirosci/conceptualmodel.html) and there are several FAU researchers with expertise invasive species biology who have current and planned projects in this area. We have faculty with expertise in mathematical modeling applied to biological invasions whose research ranges from individual-level behavior and life history variation to population dynamics, food web impacts, and control of invasive species.Some examples of invasive exotic animal projects include; Documentation and implementation of a model of action for the eradication of the Sacred Ibis with federal, state, and private agencies that make up the Everglades Cooperative Invasive Species Management Area (ECISMA) and supportfrom bird advocacy groups like FL Audubon; Burmese Pythons, which in ENP have consumed 23 species of birds, including four Species of Special Concern and one Endangered Species. The risk to other bird species is unknown. Dr.Gawlik, in collaboration with other FAU faculty involved in GERI as well as UF faculty, submitted one proposal for a project that will quantify the risk of predation by the Burmese Pythons on the avifauna of Everglades National Park and a second proposal on the development of a python camera for studying the animal's movements. Proposals are currently in review; As part of CERP Monitoring and Assessment Plan, several FAU labs are sampling aquatic fauna in drying pools in the marsh during the dry season across the entire Everglades landscape as an assessment of wading bird food availability, crayfish population dynamics, and linkages to hydrologic patterns. An indirect consequence of these fauna sampling designs, is that these samples document the spatial distribution of invasive aquatic fauna in the Everglades. With collaborations of colleagues at FIU, they have the potential to assess the expansion of various species following disturbances like droughts and floods. FAU faculty also have proposals out to investigate invasive aquatic apple snails (*Pomacea spp.*) working with scientists at Everglades National Park.



FAU

FLORIDA ATLANTIC UNIVERSITY

Greater Everglades Research Initiative White Paper

Prepared By: John Baldwin, Camille Coley, Dale Gawlik, Dennis Hanisak, Bill Louda, Dianne Owen, Gary Perry, Ed Proffit, Charles Roberts, JaapVos

March 2009

Introduction

Environmental Sciences faculty at several institutions in South Florida are heavily involved in the large scale restoration and management of the ecosystem. Through an applied multi-disciplinary approach that focuses on water and human-caused problems, their expertise is sharpened by working in a setting where urban panning must be conducive to large-scale restoration and management of natural areas. South Florida's vast sensitive wetlands are directly adjacent to a large and burgeoning human population that is dependent on the same resources. Thus, South Florida is encountering sooner than most other areas in the U.S., unprecedented challenges in balancing human and environmental water needs.

Vision

The vision for restoring the Everglades from the Greater Everglades Research Initiative prospective is to develop the tools and provide the expertise to guide sustainable human activities in South Florida, and to recover a natural system with the ecological functions, and a diversity and abundance of species that characterized the historical greater Everglades region. The restored ecosystem should be in an altered form and smaller than the pre-drainage system yet still retain the essential characteristics of the historic "River of Grass."Successful restoration will be achieved when the new system no longer acts like a set of managed, disconnected wetlands but rather reestablishes the defining characteristics and connectivity of a natural Everglades system.

Emerging Issues

Anthropogenic Stressors

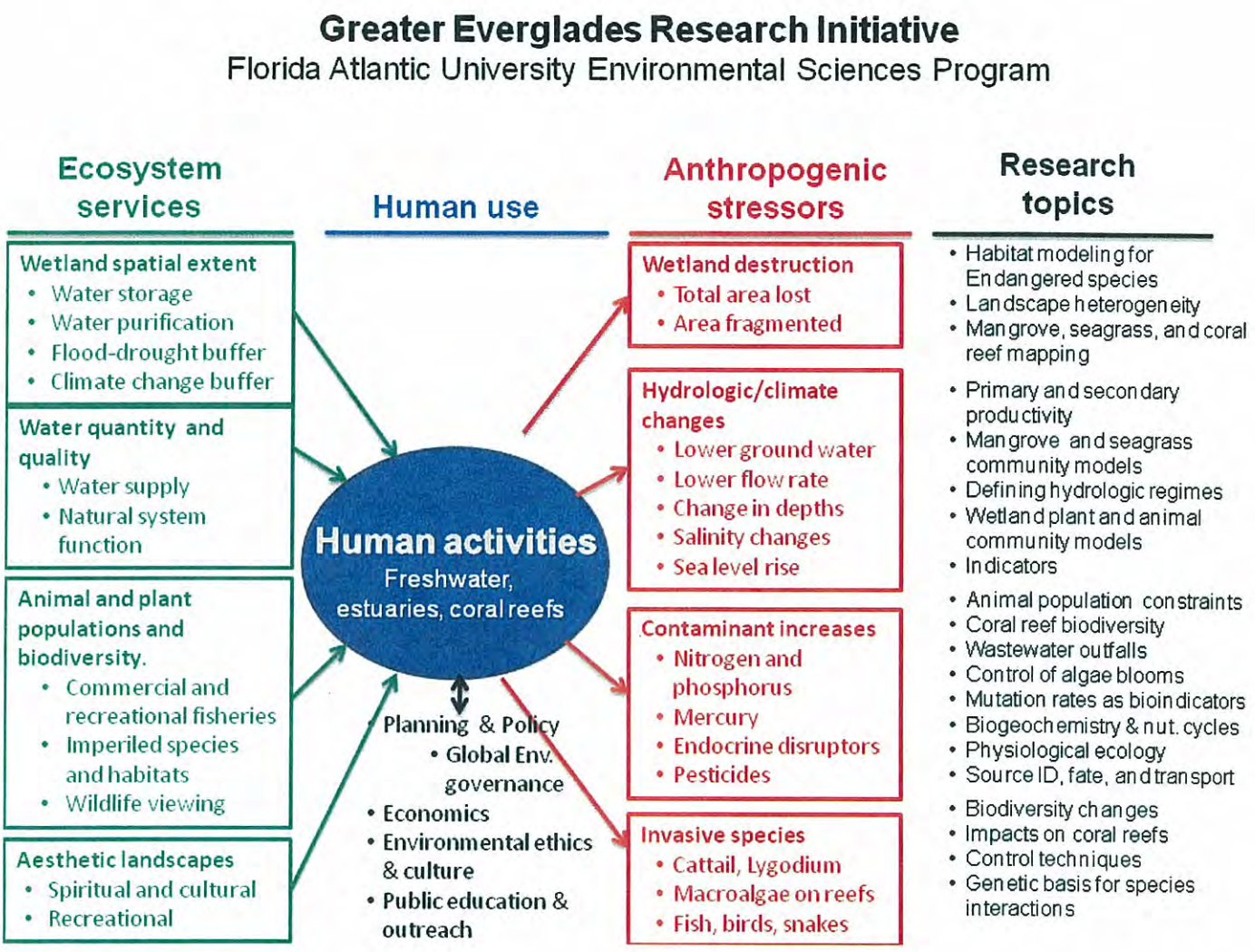
The Greater Everglades Initiative is organized around four human-caused stressors to the environment – wetland destruction, hydrologic/climate changes, contaminant increases and invasive species issues. In our model, humans are viewed as an integral part of ecosystems rather than as separate from them. Humans use ecosystems in different ways and for different purposes. Our decisions are guided by ethics, culture and economics. Research aimed at understanding these factors can help to resolve environmental conflicts and lead to a more effective and efficient implementation of conservation projects and resource management decisions.

Ecosystem Services

Reversing the decline of the Everglades is important to Florida Atlantic University, its partners, the entire South Florida population, and the nation. Defining values relative to humans leads to good management decision and the long-term stability of the Greater Everglades. The ecosystem services include:

- Wetland spatial extent (water storage, water purification, flood-drought buffer, climate change buffer)
- Water quantity and quality

- Animal and plant populations and biodiversity
- Aesthetic landscapes (spiritual, cultural and recreational)



Key Faculty Areas of Expertise

Environmental Sciences Faculty are drawn from a wide range of academic units at FAU including all departments in the Charles E. Schmidt College of Science, the School of Urban and Regional Planning, and the FAU Center for Environmental Studies. Faculty have strong research expertise with: (1) aquatic animals, like sea turtles, wading birds, fish, and crayfish, (2) aquatic systems like freshwater marshes, mangroves, sea grass, and coral reefs, and (3) wetland ecosystem restoration techniques. A few of the specific research topics include:

- Habitat modeling for Endangered species
- Landscape changes
- Mangrove, seagrass, and coral reef mapping
- Primary and secondary productivity

- Mangrove andseagrass community models
- Defining hydrologic regimes
- Wetland plant and animal community models
- Indicators
- Animal population constraints
- Coral reef biodiversity
- Wastewater outfalls
- Control of algae blooms
- Mutation rates as bioindicators
- Biogeochemistry and nutrient cycles
- Physiological ecology
- Biodiversity changes
- Impacts on coral reefs

In addition to the research questions above faculty are also engaged in studies involving planning and policy, economics, environmental ethics and culture, and public education & outreach.

Key FAU Facilities

- Botanical research and teaching Green House (Davie Campus)
- Joint-Use Facility Davie Campus (under construction)
- Harbor Branch Oceanographic Institution at FAU
- Gumbo Limbo Environmental Complex
- Riverwoods Field Laboratory
- Pine Jog Environmental Education Center

Other Collaborations

FAU Faculty work closely with colleagues at the University of Florida and the U. S. Geological Survey that is co-located on FAU's Davie campus. Faculty also enjoy partnerships with their colleagues at Florida International University, the National Audubon Society and the Smithsonian Institute.

Key Agency Partners

Everglades National Park
The A.R.M. Loxahatchee National Wildlife Refuge
South Florida Water Management District
U.S. Geological Survey (Davie, Florida)
U.S. Army Corps of Engineers
Florida Fish and Wildlife Conservation Commission

Projects under the Greater Everglades Research Initiative

FAU Everglades Fellowship Initiative

The Environmental Sciences Program and Everglades National Park have recently initiative the FAU Everglades Fellowship Program. The partnership is designed to

create a pool of new scientists that can potentially move into the U.S. Department of Interior workforce in South Florida while also supporting short projects that address specific science and management questions related to Everglades restoration. This program will also foster stronger collaborations between FAU faculty and National Park Service staff that will likely lead to more scientific discoveries in the future.

South Florida Water Management District Internship Program

Two internship opportunities at South Florida Water Management District are being offered to FAU students on a rotational basis though the FAU Environmental Sciences Program. These positions provide students with valuable experience in environmental sciences, conservation, ecology, and resource management in South Florida while the students earn academic credits. In some cases an internship may lead to a job. In other cases it may spark a new interest and lead to further academic studies. The Environmental Sciences Program promotes internships for its students because internships are a form of experiential learning, where students learn by doing an activity. South Florida is rich in institutions involved in resource management and research so it is an ideal place to have students engaged as part of their academic studies, in experiential learning.

Scientific facilitation and education

The Environmental Sciences Program in cooperation with the U.S. Geological Survey and the South Florida Water Management District, the Charles E. Schmidt College of Science, FAU Department of Biological Sciences, FAU Department of Geosciences, and the FAU Center for Environmental Studies hosted a series of science collaboration workshops, technical training workshops and educational seminars that were open to entire the scientific community of South Florida. The collaboration workshops brought together teams of Everglades scientists from a variety of agencies and universities to work together to solve management conflicts related to climate change, biologically sensitive tree islands, and progress on the overall restoration effort. Technical training workshops provided intensive training in the latest statistical techniques that so that the strongest science can be applied to management decisions. The educational seminar series occurs during one semester per year and exposes the audience to cutting edge research and management from around the country. Collectively, these efforts have greatly enriched the flow of reliable knowledge to the scientific community of South Florida.

Sample of Research Projects

- Distilling Complex Ecological Research into Simple Habitat Models: Predictive tools for Wetland Ecosystem Restoration and Management. Funded by the U.S. Geological Survey and U.S. Fish and Wildlife Service.

- The Linkage Among Hydrology, Prey Populations, and Wading Bird Populations in the Florida Everglades. Funded by the South Florida Water Management District 2004-2009.

- The Potential Effect of Regional-scale Hydrological Changes on Tree Island Spatial Extent and Plant Species Composition in the Florida Everglades, USA: Implications for Restoration., Funded by SFWMD

- Validation and Ecosystem Applications of the EDEN Water-surface Model for the Florida Everglades. . Funded by USGS.

- Landscape Model of Ridge and Slough Topography: Integration of Hydrology and Biological Processes. Funded by National Park Service.

- The Rapid Spread of*Lygodiummicrophyllum* in the Central Everglades. Funded by the Florida Fish and Wildlife Conservation Commission.

- The Effect of Hydrology on the Growth of the Crayfish Species *Procambarusalleni* and *P. fallax*: Two Keystone Species in the Florida Everglades.Funded by the South Florida Water Management District.

- Bioindicators of Hydropattern and Nutrient Levels in Forested Wetlands of the Big Cypress region. Funded by Seminole Tribe.

- Photosynthetic Pigment Analysis Core for Monitoring Microalgal Community Dynamics in Response to Water Quality.

Conclusion

As an academic institution it is our responsibility to prepare students for a professional career or advance degrees in Environmental Sciences. As a South Florida institution situated directly adjacent to the fragile Everglades ecosystem, it is also important to provide our students and community with sound information and informed views of the environmental situations and challenges facing the South Florida region. It is particularly important for the University to prepare the next workforce for our key partners in environmental science. Our key partners will require students who possess a robust foundation of environmental knowledge and are well rounded enough to enter the workforce as researchers, managers, regulators and to head non-governmental organizations.

FWC Exotic Species Management

FWC Point –of-Contact: Scott Hardin, Section Leader, Exotic Species Coordination
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Over the last three years FWC has coordinated with the Dept of the Interior to eradicate the Gambian pouch rat and has a separate management action ongoing to address the purple swamp hen. In 2007, the FWC began holding Pet Amnesty events throughout the state to provide the opportunity for people to surrender their nonnative pets free of charge with no penalties. Nonnative reptiles, amphibians, birds, fish, mammals and invertebrates are accepted at Amnesty Day events. Domestic pets, such as dogs, cats or ferrets, are not accepted.

Another goal of the program is to foster responsible pet ownership. Current exotic pet owners and anyone interested in acquiring a nonnative pet can come and talk to experts to learn more about that animal's needs. Amnesty day events are free and open to the public. Low cost microchipping is offered at many Amnesty Day events.

U.S. Fish and Wildlife Service Actions

Contact: Art Roybal
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1. Constrictor Snake Risk Assessment

The Fish and Wildlife Service jointly funded with Everglades National Park "An Invasive Species Risk Assessment for Giant Constrictor Snakes: Possible Ecological and Economic Impact to Florida, especially Everglades National Park, and Potential Distributional Limits in the Continental United States." The work, which is being competed by the U.S. Geological Survey (USGS), will: 1) conduct comprehensive literature reviews to compile available information for each species individually (Python molurus, Python reticulatus, Python sebae, Python natalensis, Boa constrictor, Eunectes murinus, Eunectes deschauenseei, Eunectes beniensis, and Eunectes notaeus; the latter three species will be considered due to similarity of appearance to Eunectes murinus, following the taxonomy of Dirksen 2002), 2) delineate localities that have climate similar to the native range sites already occupied, using a climate-matching model based on native-range specimen records and available climate data from sources such as the World Climate online database, 3) use published habitat information to estimate which U.S. habitats are potentially inhabitable by each species, 4) use existing dietary information to project which prey species are likely to be impacted by each species, and 5) discuss other considerations (such as population density achievable, mode of reproduction, physiology, pathogens, prevalence in the live animal trade, etc) that bear on the risk associated with potential establishment, spread, and ecological impacts in the U.S. of these nine snake species.

2. Developing Effective Python Traps and Preventing Expansion into the Florida Keys

The Fish and Wildlife Service has also funded an agreement with the USGS to develop effective trapping techniques for the Burmese python, with a focus on stopping their spread into the Florida Keys. The python is native to South and Southeast Asia, and is very popular in the international live animal trade. A burgeoning invasive population of these snakes, likely originating from released pets, is now present and expanding in the greater Everglades ecosystem. This population has already moved well beyond the boundaries of National Park Service (NPS) lands. The recent discovery of a python on Key Largo containing two ESA-listed Key Largo woodrats implies that the python is able to cross saltwater or causeways, and may threaten to colonize the rest of the Florida Keys. While the existence of high-density populations of a large-bodied invasive predator is of obvious conservation concern, little progress has been made towards development of appropriate control tools for pythons. This partnership includes a multi-faceted effort to detect and control a population or incipient population of pythons on Key Largo. Several types of experimental traps are being used. Trapping efforts are being augmented with extensive visual surveys in all accessible habitats and other detection methods as opportunity arises.

3. Facilitating Multi-Stakeholder Workshops to Address the Python Threat

The Fish and Wildlife Service has helped to facilitate workshops with different organizations that are addressing the threat posed by pythons. Preliminary coordination among interagency partners has initiated basic biological studies, some monitoring of the occurrence and spread of pythons, evaluation of trapping techniques, and opportunistic removal of snakes within Everglades National Park and the Florida Keys. The workshops identified actions underway and needed to help prevent range expansion, potentially eradicate pythons in certain locations, and reduce python numbers.

ARM Loxahatchee National Wildlife Refuge

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Invasive Exotic Animal Plan: prepare an intergovernmental plan that will identify key species and actions necessary to help control invasive exotic animals.

- Lox is aggressively tackling invasive exotic plants with a dedicated program
- Lox has strong interest in invasive exotic animals - although no dedicated resources - and supports concept of intergovernmental plans
- Lox does not have any confirmed sightings of pythons, but has problems with iguanas; limited sacred ibis sitings; exotic fish in canal (Lox recently conducted canal fish survey)

Miami-Dade County

Miami-Dade County Department of Environmental Resources Management (DERM) and Park and Recreation Department (PRD) manage approximately 20,000 acres of publicly-owned environmentally sensitive lands, including wetlands, pine rocklands, and hardwood hammocks. Management activities in these natural areas focus on invasive exotic vegetation, but also include efforts to reduce or eradicate non-native animal species, particularly iguanas, monitor lizards and feral cats. Although there is not a countywide exotic animal plan at this time, management occurs on the public parcels on a site-by-site basis, and is overseen by the Environmentally Endangered Lands Program in DERM and implemented largely by the Natural Areas Management division in PRD.

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South Florida Water Management District
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Email: tteets@sfwmd.gov/jwarner@sfwmd.gov

Invasive Exotic Animal Plan: prepare an intergovernmental plan that will identify key species and actions necessary to help control invasive exotic animals.

Project Paragraph: SFWMD invasive species biologists have participated on the Florida Invasive Animal Task Team (FIATT) since the team's creation in 2004 and have had an active role in preparing the FIATT priority invasive animal list.
As a major land management agency, the SFWMD has been, and plans to continue to be, active in the various issues regarding invasive animals in south Florida's ecosystems. The SFWMD has played an active role in monitoring and control efforts for Burmese pythons and purple swamphens, has promoted legislative and policy initiatives on various invasive animal regulatory issues, and has provided funding for research related to numerous species including the Burmese python, bromeliad weevil and lobate lac scale.

The need for an interagency invasive animal plan was discussed at recent FIATT meetings, although there was no consensus on a plan of action. If an interagency plan is deemed necessary, the SFWMD is willing to participate in its development. However, the SFWMD believes this effort is best lead by State and Federal wildlife agency staff.

USDA-NRCS
Bill Reck

Invasive Exotic Animal Plan

NRCS has focused essentially only upon plant concerns related to invasive species, and not animals as of yet. NRCS recognizes the animal component is an ever expanding issue, especially in Florida and the Everglades Region. NRCS will be meeting with the Florida Fish & Wildlife Commission to elevate the development of a invasive animal "target list" and some recommended procedures that our conservation planners should follow with our clients.

Ongoing: Greg Hendricks, State Resource Conservationist, NRCS, (352) 338-9543, Greg.Hendricks@fl.usda.gov

USGS work with Invasive Exotic Animals in the Everglades

USGS / FISC 2008-2009 Research Overview
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brosen@usgs.gov

The core strengths of USGS Florida Integrated Science Center (FISC) in Everglades invasive species research and management support include data management, early detection, environmental tolerances, and ecology of invasive exotic animals. **Data management:** The USGS's Nonindigenous Aquatic Species (NAS) online database (which receives over 26,000 requests a day) tracks the distribution of introduced aquatic organisms nationwide, including substantial data on invasive species in the Everglades. USGS scientists respond daily to requests from managers for data, maps, graphs, photos, and questions regarding exotics and continue to update the database (over 7,500 new locations added last year). For invasive pythons, a USGS-FISC partnership with NPS, UF, USGS-Ft. Collins and others is providing managers with up-to-date information on the species' distribution and biology. **Early Detection:** The NAS Alert System provides users with the ability to register for alerts based on geographic or taxonomic criteria. We also are partnering with REEF (a non-profit organization), allowing USGS scientists to develope early detection and rapid response (ED/RR) plans to assist National Park units (including Biscayne and Everglades National Parks) with rapid removal of lionfish. The group's accomplishments in the last year include 39 verified sightings of non-native marine fish, removal of five of the first six lionfish in the Florida Keys, and removal of a new species of non-native fish. **Environmental Tolerance:** Recent programs in USGS-FISC have begun investigating environmental tolerances of aquatic invasive species, including the effects of saltwater and temperature on distribution and survival. This research, conducted in partnership with NPS and SFWMD, provides information on factors that control the spread of invasive species under changing conditions (whether from restoration or climate change/sea level rise). Together, USGS complementary research efforts help support manager's needs to detect invasives, remove them, develop strategies for their control, and prevent their spread under changing conditions. **Applied Ecology:** USGS-FISC has a decades-long record of research on the ecology of invasive aquatic species. A new partnership between USGS-FISC and NPS, UF, USGS-Ft. Collins and others is now investigating invasive pythons in the Everglades in order to work with managers to develop traps and other control measures.

USGS Invasive Species Research

Contact: Stephanie Romañach
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Email: sromanach@usgs.gov

- **USGS-NPS Collaboration on Mercury/Methylmercury Bioaccumulation in Pythons**

  David Krabbenhoft (USGS) and Skip Snow (NPS)

  - First known mercury and methylmercury bioaccumulation data for pythons
  - ~80% of the mercury body burden in the pythons was in the methylated form
  - Mean concentration (3.6 ppm) is greatly elevated over Everglades fish (and alligators), for which there are consumption advisories
  - One possible Python control strategy is to issue a bounty; however, such high mercury and methylmercury levels would warrant concern for consumption by possible python hunters

- **Movements, habitat use, diet, thermal biology, and trapping of Burmese pythons in the southern Everglades**

  Kristen Hart, Ken Rice, Gordon Rodda, Robert Reed (USGS); Frank Mazzotti and Mike Cherkiss (University of Florida); and Skip Snow (NPS)

  Problem: Invasive Exotic Reptile
  - preys on species of great conservation concern (e.g., endangered Key Largo woodrat)
  - likely competes with native animals for prey
  - competes with native animals (e.g., federally threatened eastern indigo snake) for critical and limited microhabitat features (i.e., burrows, cavities, solution holes, tip ups, dry ground)
  - may spread diseases, such as Inclusion Body Disease (IBD) to natives
  - presents human (visitor) safety concerns (e.g., road collisions)

  Methods currently used:
  - Radiotelemetry to determine habitat utilization patterns
  - Gut content analysis to determine diet, impact on native species
  - Thermal biology (implanted temperature loggers) to determine daily activity patterns and energetics
  - Trap development to determine whether trapping would work in areas of the Everglades where we'd like to protect key resources (e.g., around a wood stork colony)

NOAA Fisheries Southeast Fisheries Science Center, Miami

Summary of Exotic Species Activities

by
Tom Jackson

July 14, 2009

Since 2007 the SEFSC exotic species activities included 1) representation on governmental boards, 2) research, 3) dissemination, and 4) outreach on exotic species. Tom Jackson serves on Florida Invasive Animal Task Team (FIATT) and Gulf and South Atlantic Regional Panel (GSARP), addressing exotic species monitoring, future criteria for evaluation, pathways and prevention, and species natural histories. He contributed to the documentation that enabled FIATT to add the Lionfish as a species of concern (after seven years of effort). Tom has been a seated member of GSARP since 2004. In 2008 he collected and contributed to the list of member-states statutes concerning exotic aquatic (animal) species and presented and shared that material in a meeting in Savannah, Georgia in late 2008. He attended and contributed to the first exotic marine fishes workshop in Marathon, Florida in July 2008. He is in a number of identification cadres and often identifies species images for other agencies and groups, and provides appropriate follow-up contacts.

Tom reviews exotic species publications research proposals, assists a graduate student at the University of Miami (RSMAS) on her Lionfish thesis, and captured five of the eight lionfish captured in the Bahamas and presented to the NOAA research group in Beaufort, NC. From his contacts he has acquired numerous Lionfish sightings from central eastern Florida, Haiti, Bahamas, and recently Miami, and has contributed them to USGS NAS, the site being used to monitor the spread of exotic species. Also by means of contacts, he provided the first of multiple sightings of an exotic Pacific shark, the brownbanded bamboo shark (*Chiloscyllium punctatum*), off of West Palm Beach - another ornamental species. He has stressed that another shark species, the wobegong (*Orectolobus sp* unidentified at sale), is likely to be seen soon off our subtropical shores because he has been seeing many young ones for sale in local pet shops for years. These likely are destined for release due to their expected increase in size, and they are known to bite lobster divers in Australia.

Tom disseminates exotic species information important to fisheries and natural resources ranging from species reports received from personal contacts to accounts from exotic species meetings. His exotic species outreach has ranged from general lectures to high school groups and research groups to answering Lionfish questions in newspaper articles and local television news interviews. Most recently Tom contributed to exotic species discussions in Florida on "Life After Humans-Invaders", currently on the History Channel. He is constantly involved with exotic species outreach activities. His experiences with exotic animals suggest that released ornamental species, once observed, should, without delay, be seriously evaluated with respect to their continued sale in areas adjacent to their release.