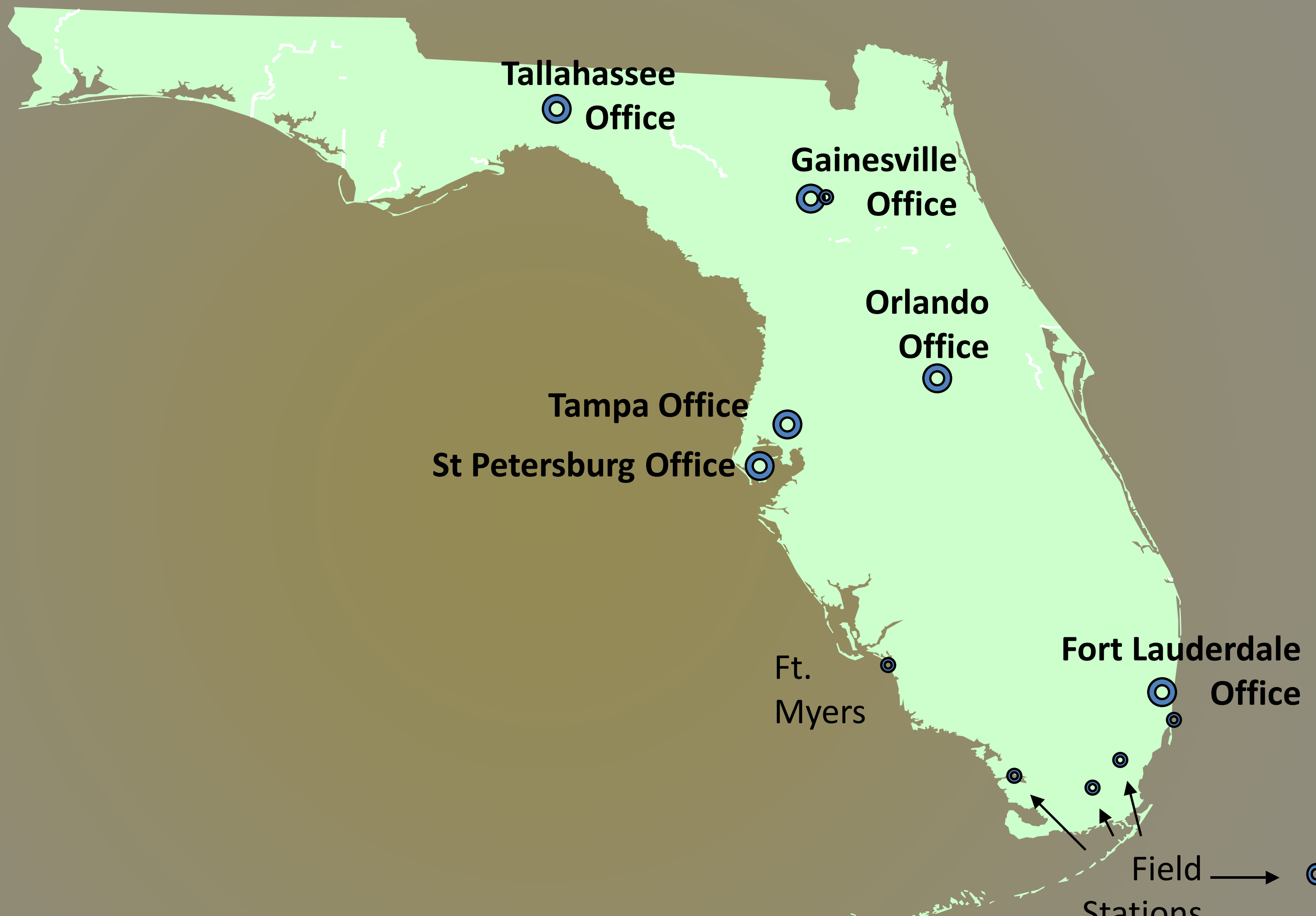
Florida Science Program

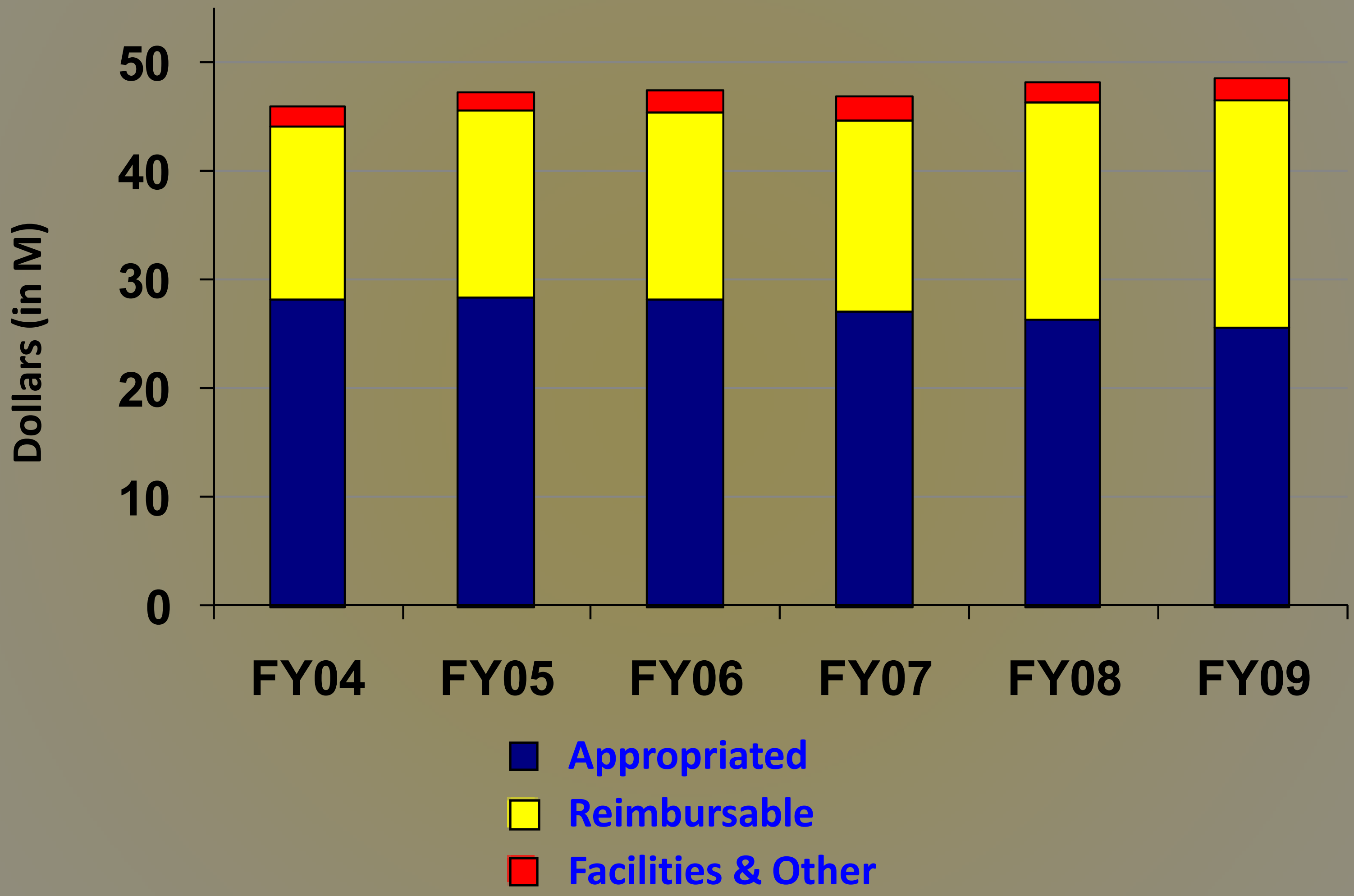
Barry H. Rosen, Ph. D.
Biologist

U.S. Department of the Interior
U.S. Geological Survey

USGS Locations

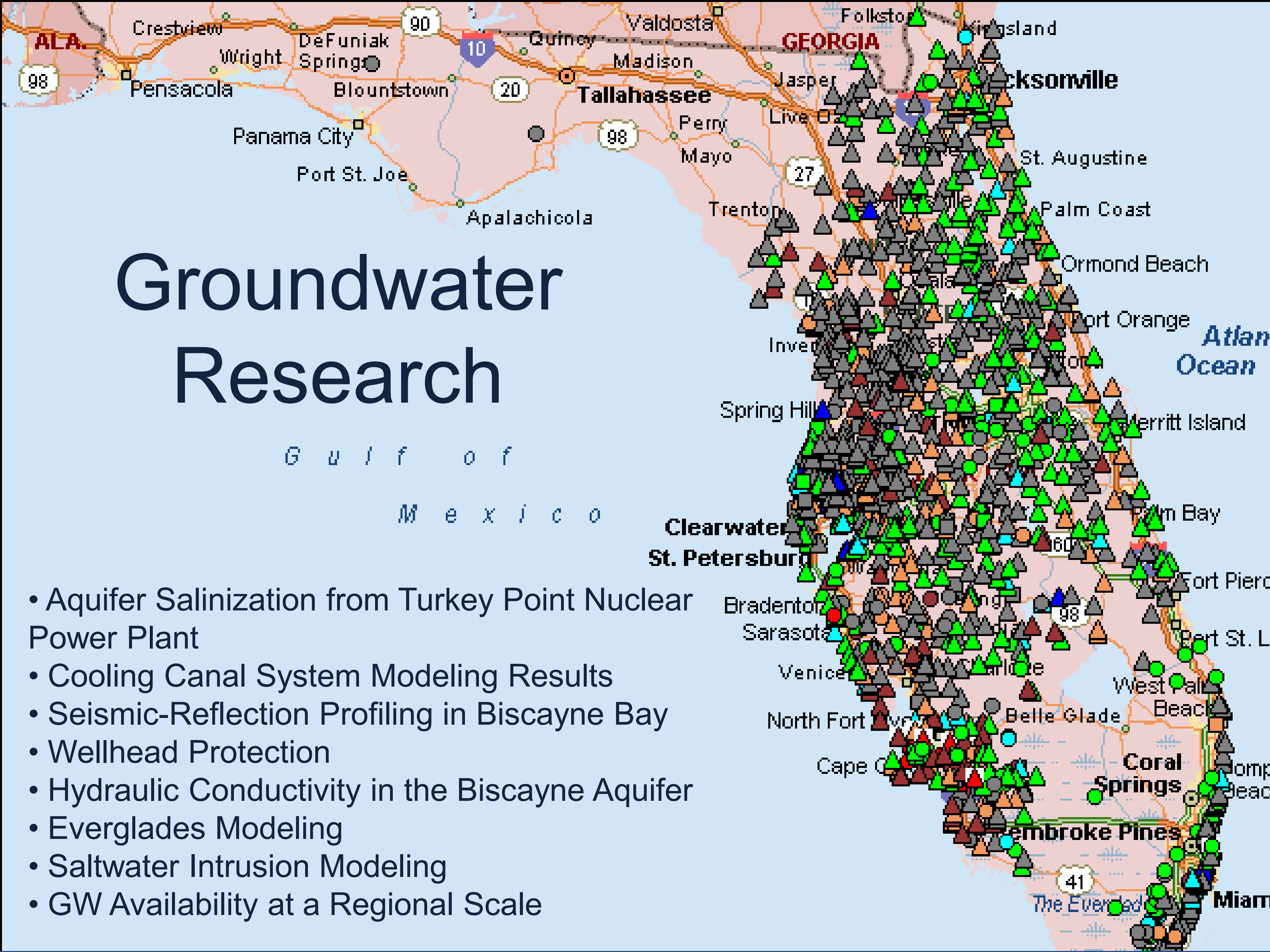


Total Funding – All Funding Sources



Groundwater Research

- Aquifer Salinization from Turkey Point Nuclear Power Plant
- Cooling Canal System Modeling Results
- Seismic-Reflection Profiling in Biscayne Bay
- Wellhead Protection
- Hydraulic Conductivity in the Biscayne Aquifer
- Everglades Modeling
- Saltwater Intrusion Modeling
- GW Availability at a Regional Scale



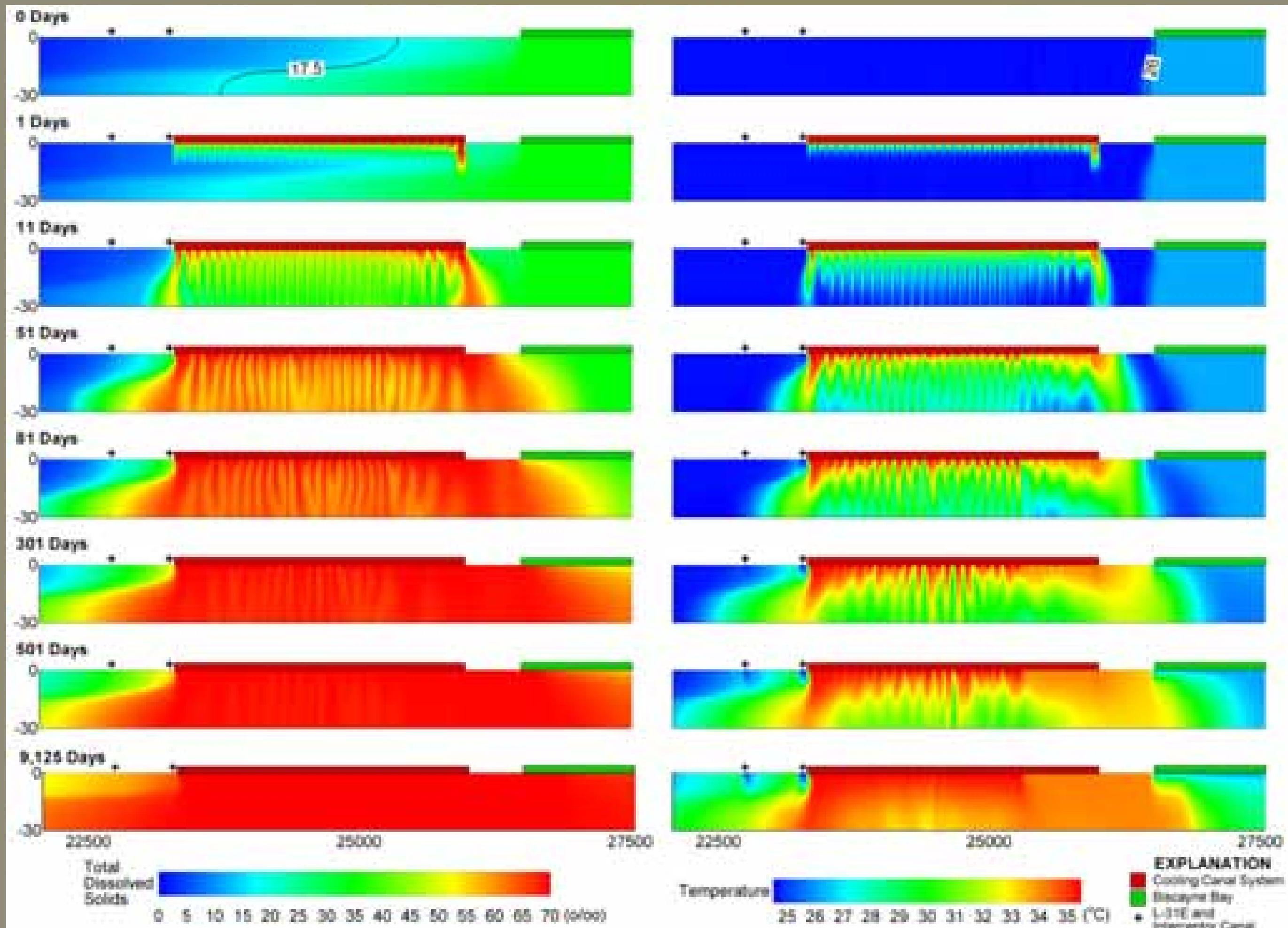
Aquifer Salinization from Turkey Point Nuclear Power Plant

ISSUE: Salinization in Cooling Canals

Effect of hypersaline cooling canals on aquifer salinization

Introduction

Cooling Canal System Modeling Results

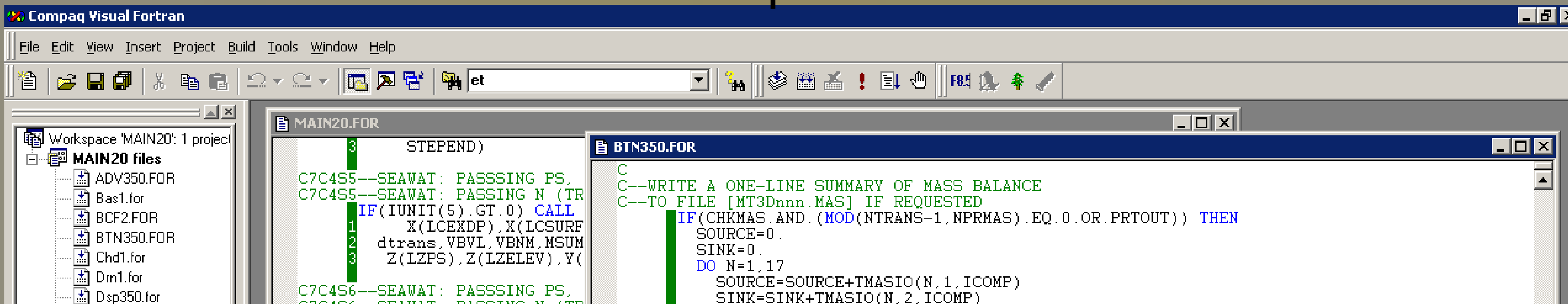


Salinity

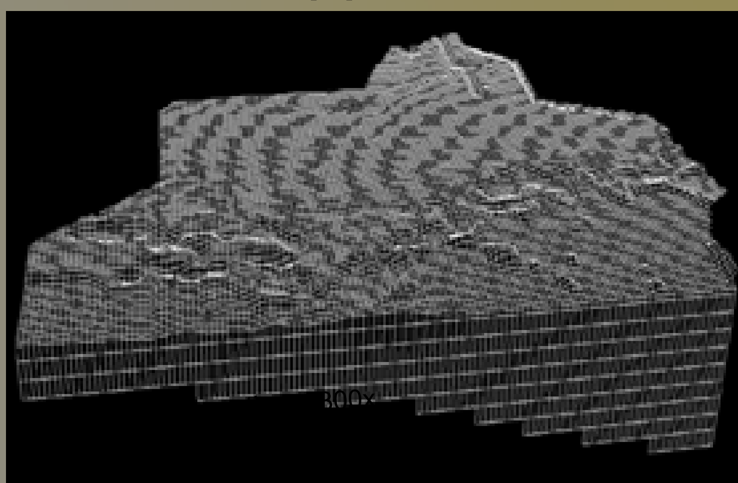
Temperature

Saltwater Intrusion Modeling

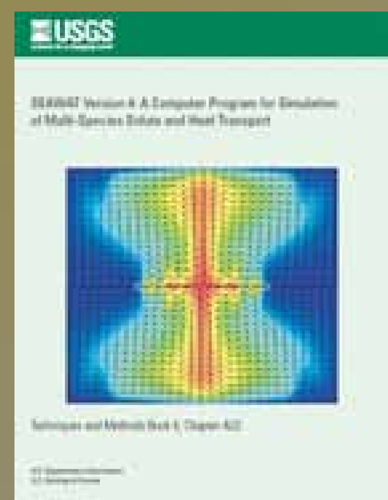
Code and Method Development



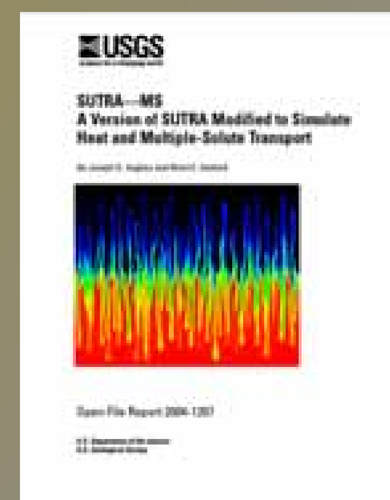
Model Application



SEAWAT



SUTRA-MS



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Wellhead Protection

ISSUE: Managing municipal water supply protection, ecosystem needs, and mineral resources

STUDY: Wellhead protection in the Everglades Lake Belt mining district

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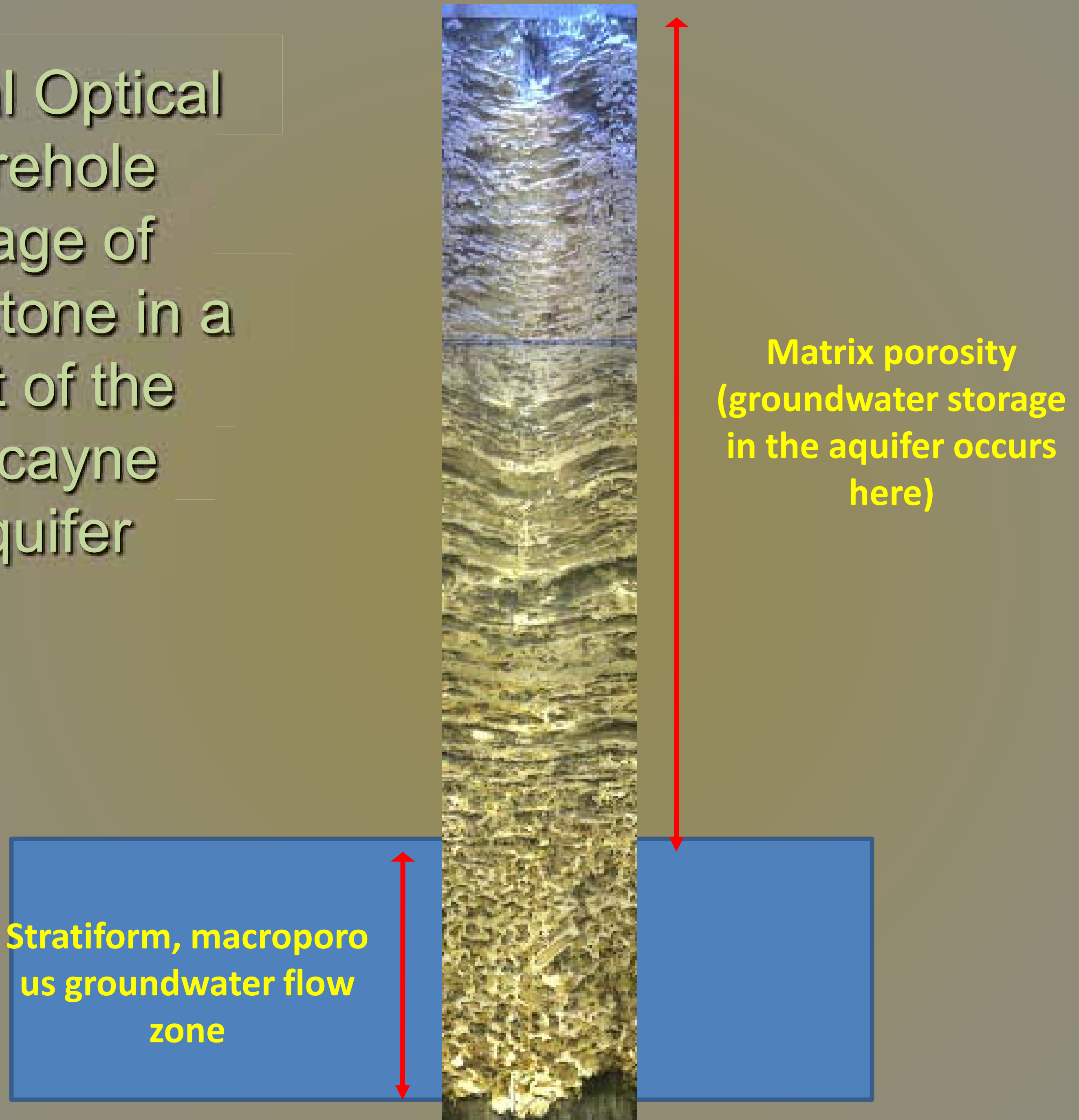
Digital Optical Borehole Image of Limestone in a Part of the Biscayne Aquifer



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HIGH-RESOLUTION CT SCANNING

Macroporous limestone from Biscayne aquifer

CT scan slice from High Resolution X-ray

Stacking of slices

Computer rendering of CT-scan

Virtual core cut from computer rendered sample

Epoxy model

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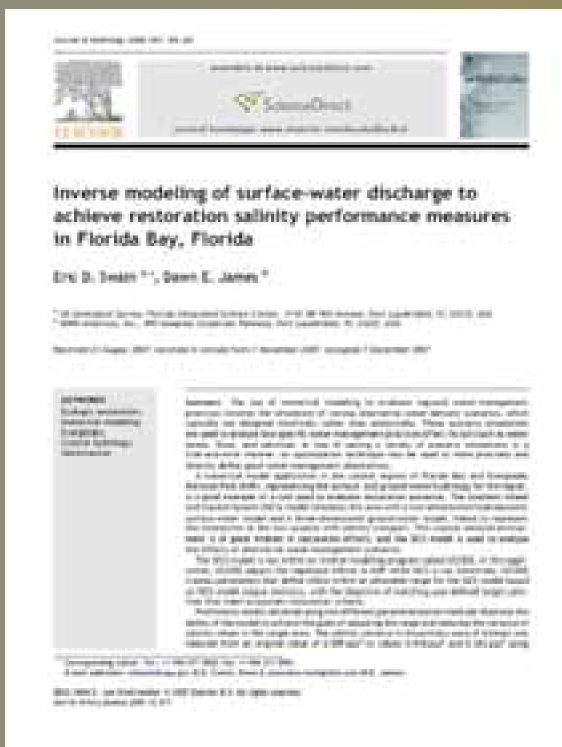
Cunningham et al (2009)

Everglades Modeling

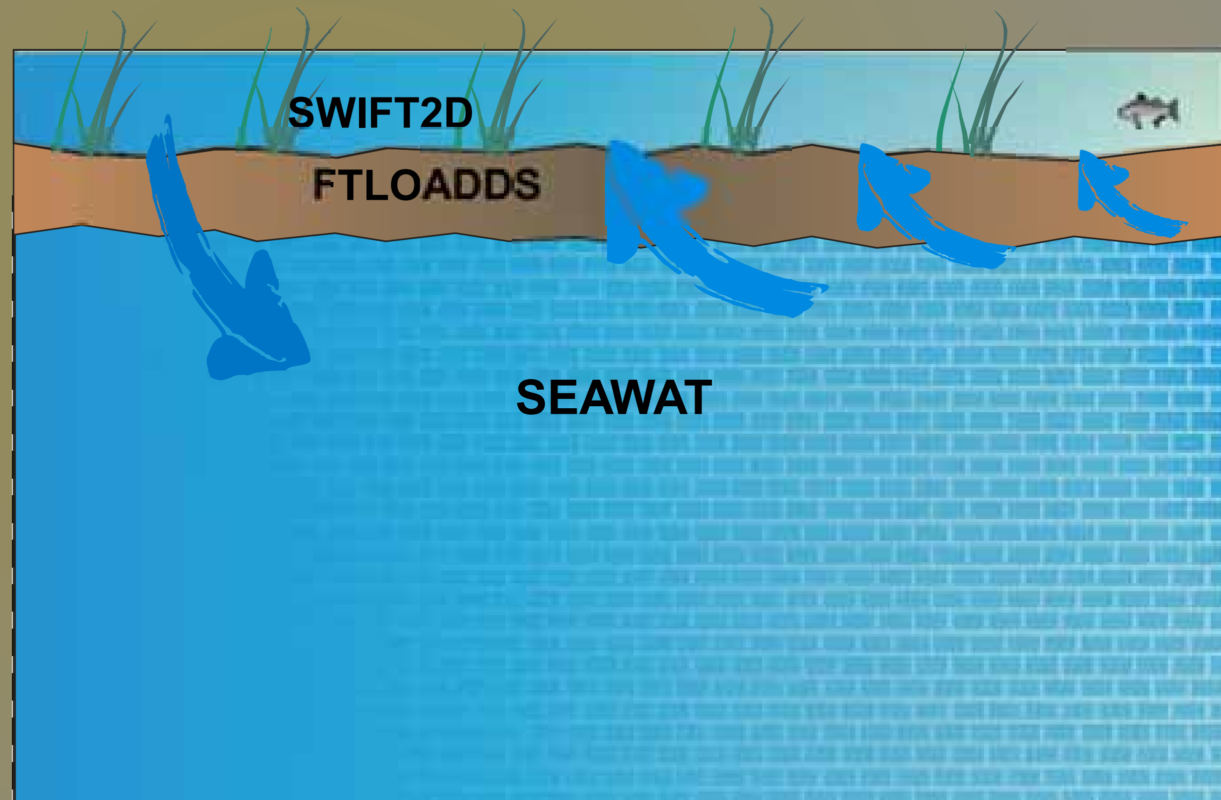
Model connectivity between overland (SWIFT2D) flows and underlying groundwater (SEWAT) makes it possible to ask system-wide questions



ScienceDirect

Inverse modeling of surface-water discharge to achieve restoration salinity performance measures in Florida Bay, Florida

Eric D. Swain, Dawn E. James



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Coastal Systems & Inland Waters

- Ecology and Hydrology of Springs
- Wetland Hydrology and Dynamics
- Inundation Mapping
- South Florida Coastal Hydrology Monitoring
- Manatee & Hydrologic Modeling
- Coral Reef Ecosystem Studies (CREST)
- Coral Pathogens in Dry Tortugas Park
- Everglades Depth Estimation Network

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Photo: H. Means

Ecology & Hydrology of Florida Springs

H. Means

ISSUE: State agencies need to understand how eutrophication and ecological changes relate to discharge from groundwater withdrawal and droughts to establish Minimum Flows and Levels (MFL's)

STUDIES: Evaluated hydrology and characterized aquatic communities to develop appropriate bioindicators for long-term monitoring:

- Determine aerial extent of springsheds
- Examine land-use changes
- Age dating of groundwater to determine source & aquifer residence time
- Analyze discharge & water quality
- Baseline data on aquatic communities, with emphasis on benthic macroinvertebrates & fishes
- Metrics / indices to evaluate status & condition of aquatic fauna

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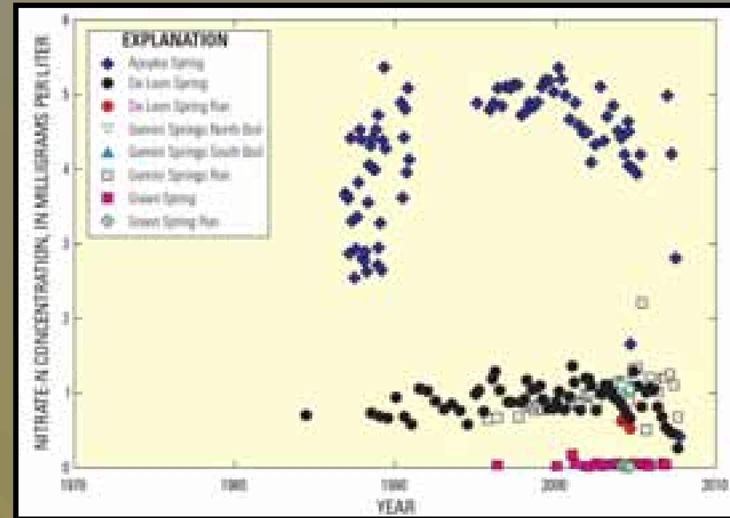
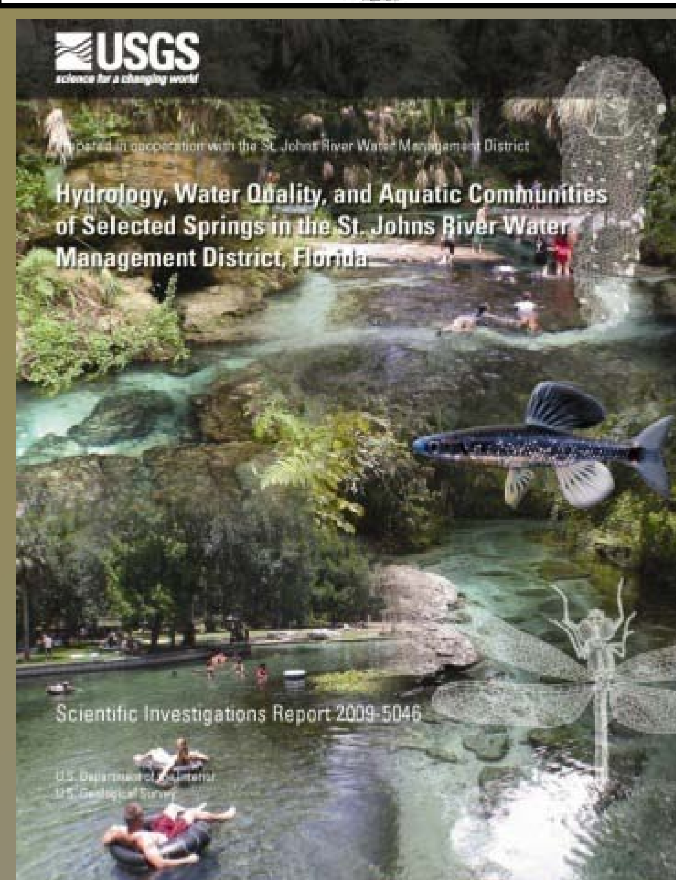
S.J. Walsh

Results and Products

- Analyzed historic data on discharge and water chemistry
- Baseline faunal inventory
- Concurrent physicochemical data, new discharge measurements
- Community characteristics used to define impaired waters
- Interpret relationships between the physical environment and the biological communities for 12 springs in northcentral Florida





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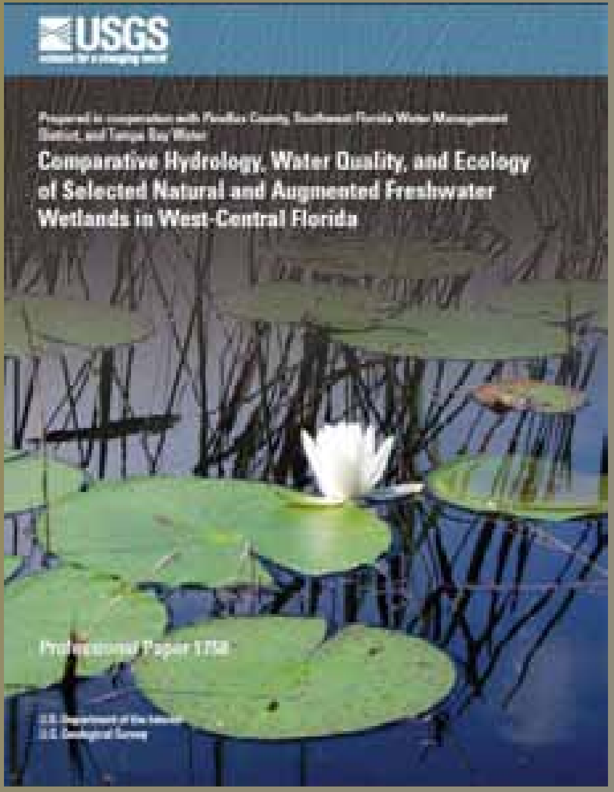
Wetland Hydrology and Dynamics

ISSUE

- Central Florida wetland dynamics affect availability of drinking water for populated regions of Florida

STUDIES

- Comparative Hydrology, Water Quality, and Ecology of Selected Natural and Augmented Freshwater Wetlands in West-Central Florida
- Factors Limiting Hydrologic Recovery of Wetlands in Northern Tampa Bay Area
- Water Budgets over a Decade of Climate Extremes in Central Florida Lakes
- Florida Evapotranspiration Network in West-Central Florida
- Interaction of Ground Water with Lake Panasoffkee, West-Central Florida



Professional Paper

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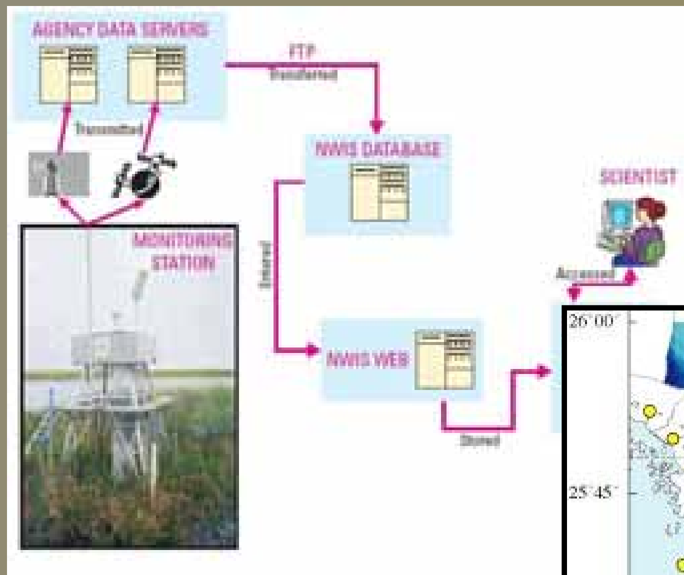
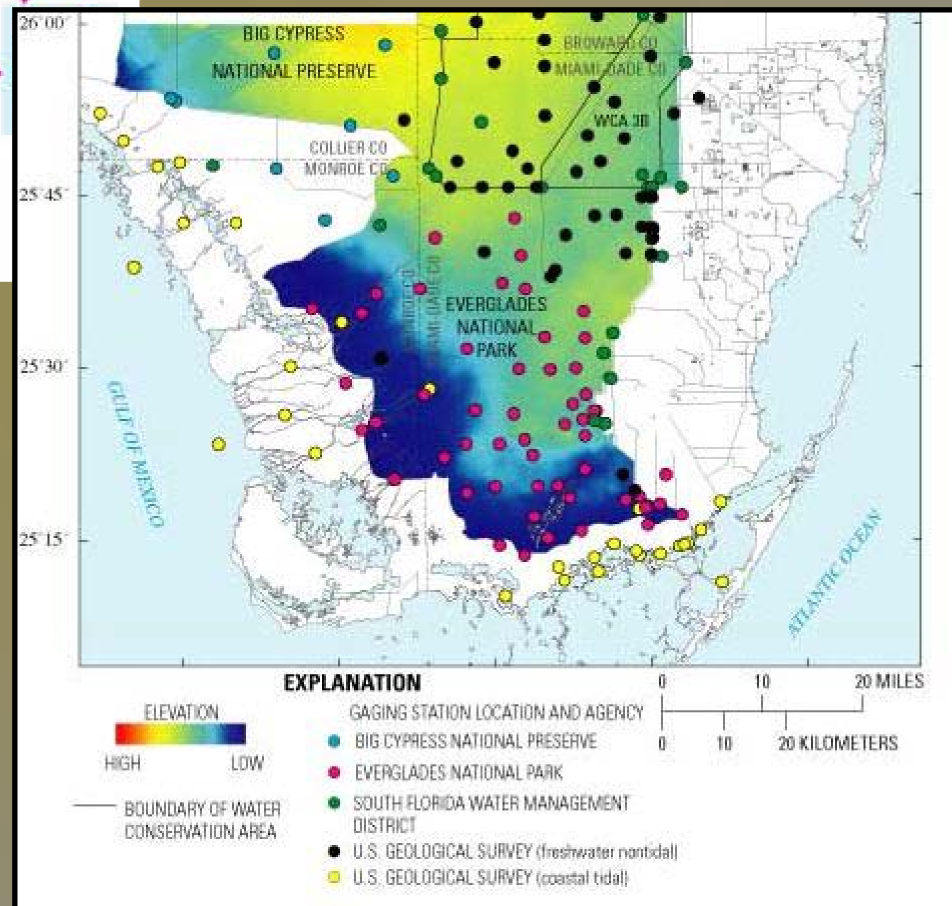
Everglades Depth Estimation Network



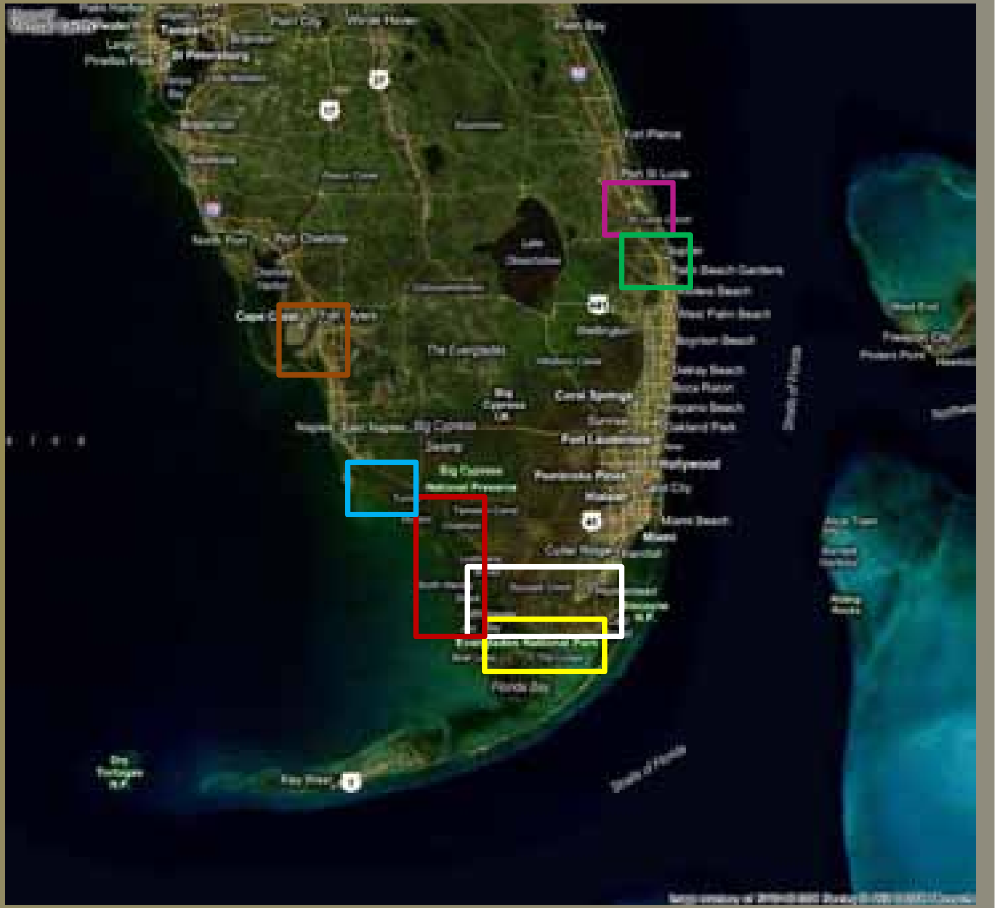


USACE, NPS, FWS, SFWMD

South Florida Coastal Hydrology Program

ISSUES: Operate and maintain hydrologic and water quality data collection platforms (DCPs) in support of restoration and TMDL projects.

STUDY: Monitor flow, wetland velocities, salinity, temperature, continuous water level in NAVD '88, and water chemistry for total and dissolved nutrients.



- St. Lucie River Estuary
- Loxahatchee River Estuary
- Caloosahatchee River
- Ten Thousand Islands / Tamiami Trail
- SW Coast of ENP
- Coastal Gradients
- Florida Bay

USACE, USGS PES program, NPS CESI program, SFWMD, FDEP

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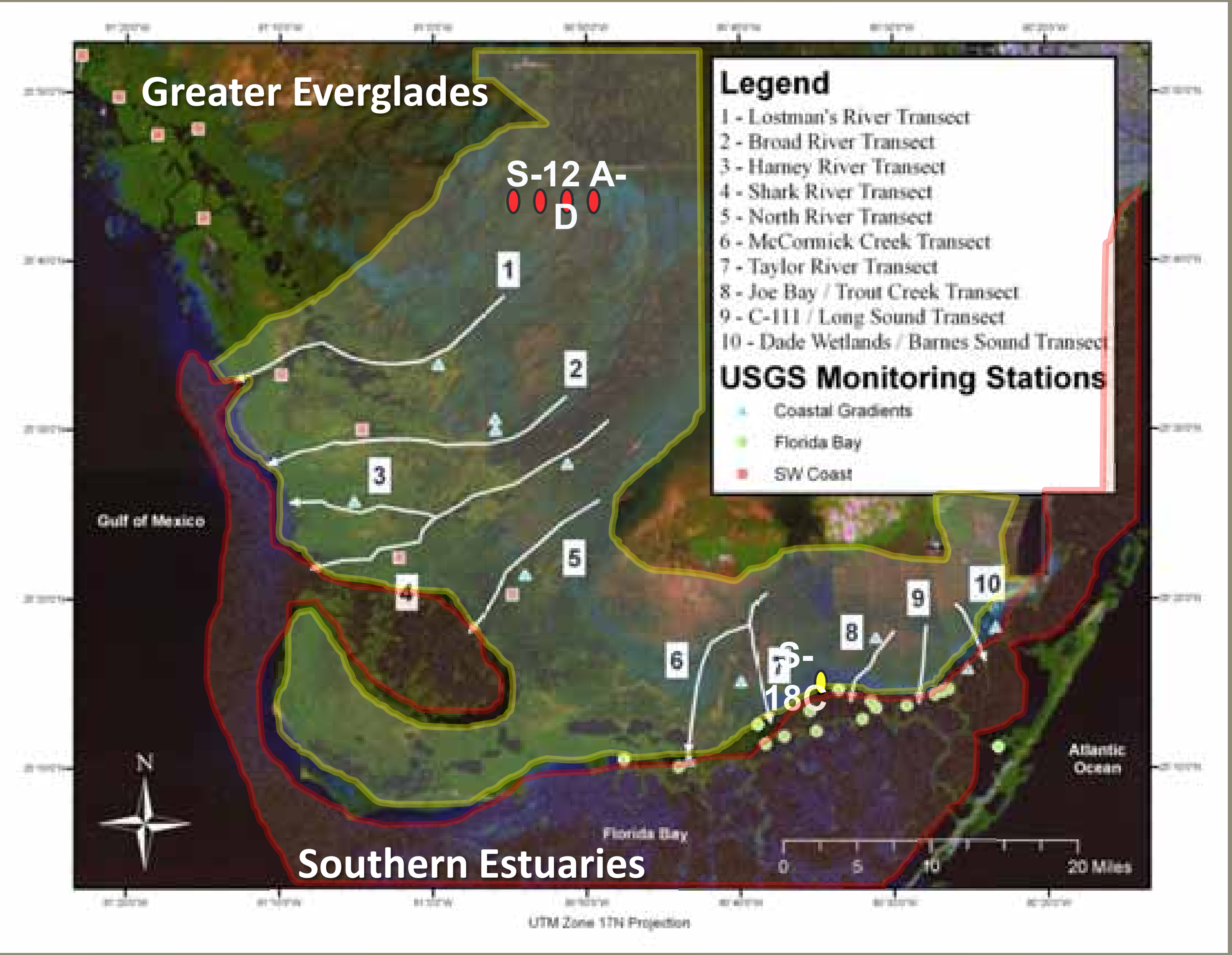
USGS Hydrologic Monitoring Network



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Manatee & Hydrologic Modeling

ISSUE: Manatees need warm water refugia for winter survival. Picayune strand restoration required analysis of impacts to the estuary and endangered species.

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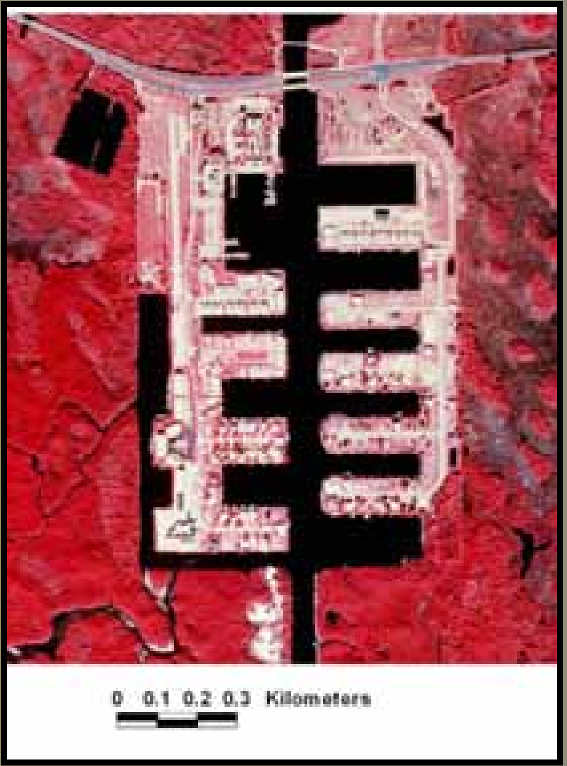
Manatee & Hydrologic Modeling

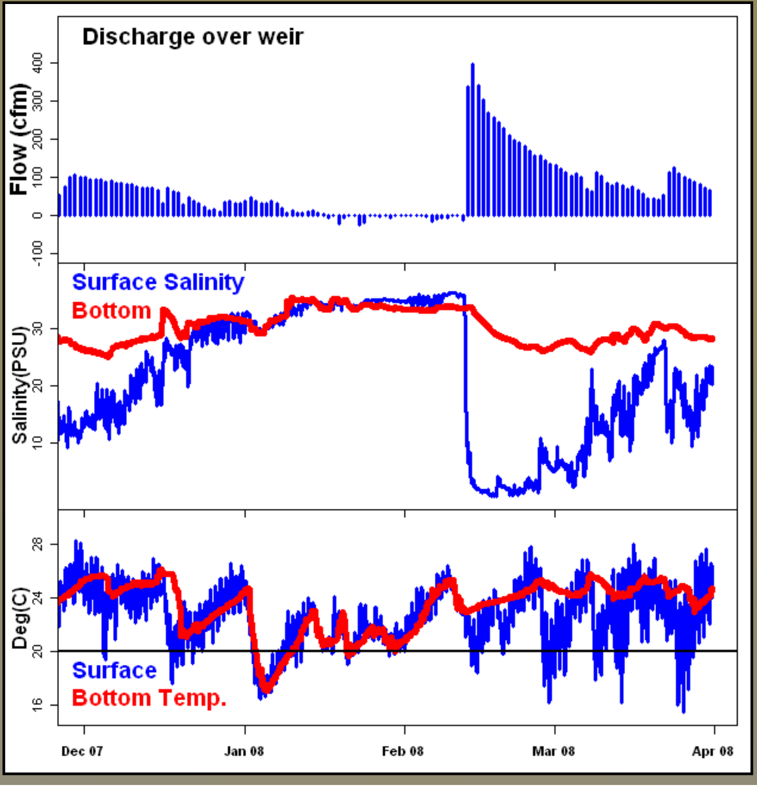
•Port of the Islands is largest passive thermal refugia for manatees in Florida
• Counts regularly greater than 100 manatees, up to 250+ animals
• Freshwater discharge maintains halocline
• Halocline maintains warm water on bottom

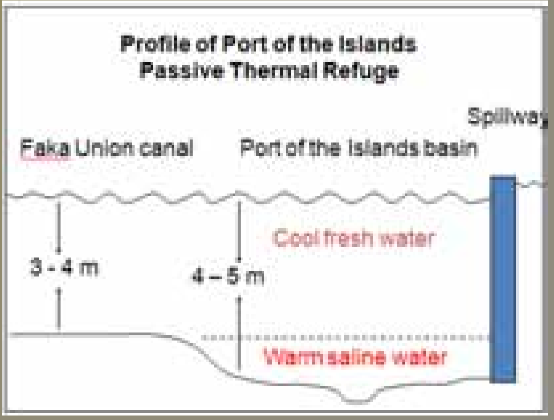


Freshwater discharge

Salinity stratification (halocline)

Thermal inversion (20 C threshold)





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Coral Reef Ecosystem Studies Project (CREST)

ISSUES

- Process /monitoring to assess health of shallow water reef environments
- Dry Tortugas, Virgin Islands, Biscayne National Parks, and FL Keys National Marine Sanctuary
- Improve understanding and information for forecasting changes & guiding management

CREST – Investigating Five Themes

❶ **Coral Disease:** Major cause of reef degradation and mortality

❷ **Benthic Habitat and Monitoring:** Map critical habitat and users

❸ **Climate and Sea Level:** Natural history of corals and response to climate change

❹ **Biogenic Calcification:** Modern calcification rates in key corals

❺ **Community Calcification and Metabolism:** Community level calcification monitoring and experiments

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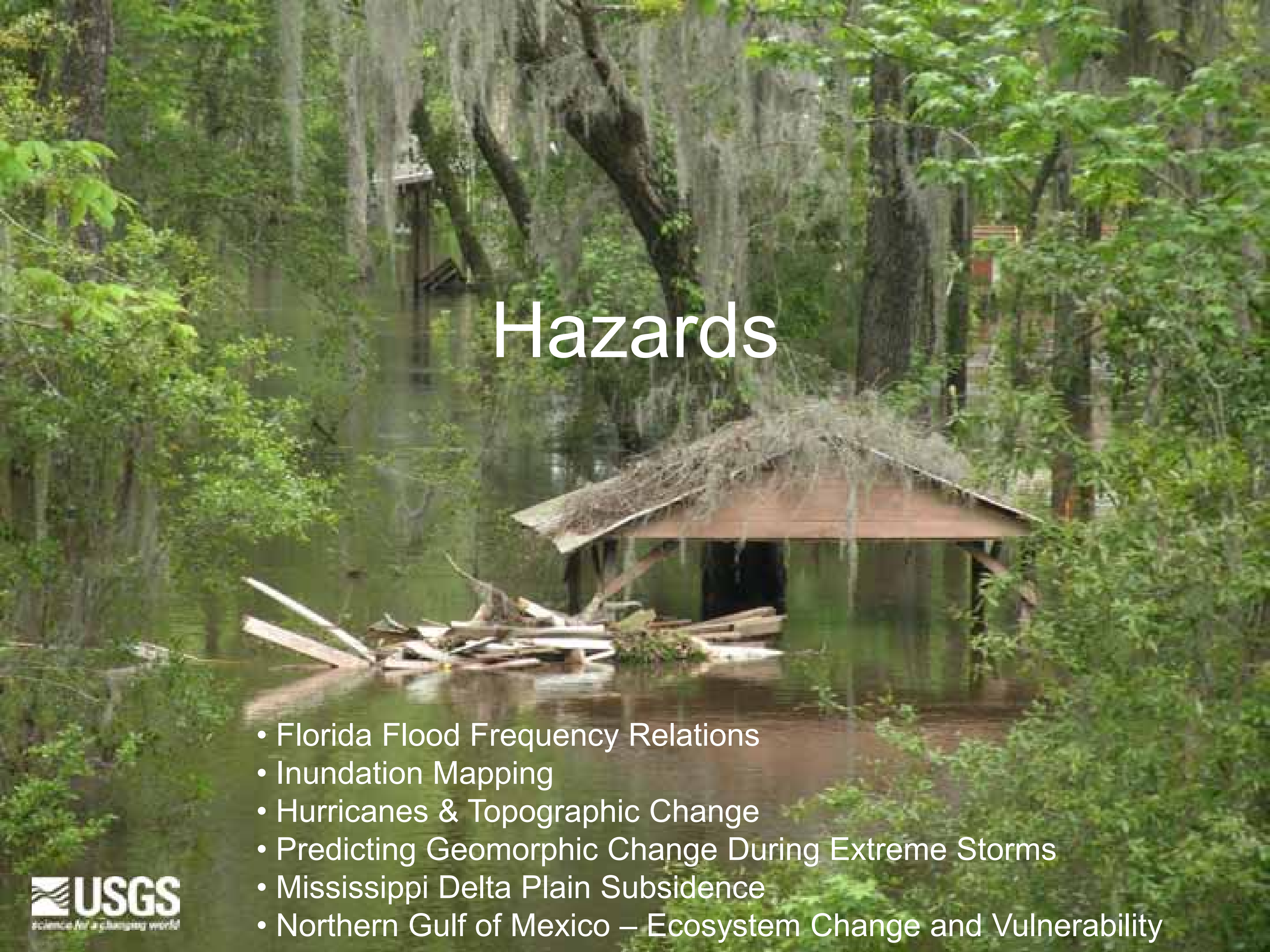

Hazards

- Florida Flood Frequency Relations
- Inundation Mapping
- Hurricanes & Topographic Change
- Predicting Geomorphic Change During Extreme Storms
- Mississippi Delta Plain Subsidence
- Northern Gulf of Mexico – Ecosystem Change and Vulnerability

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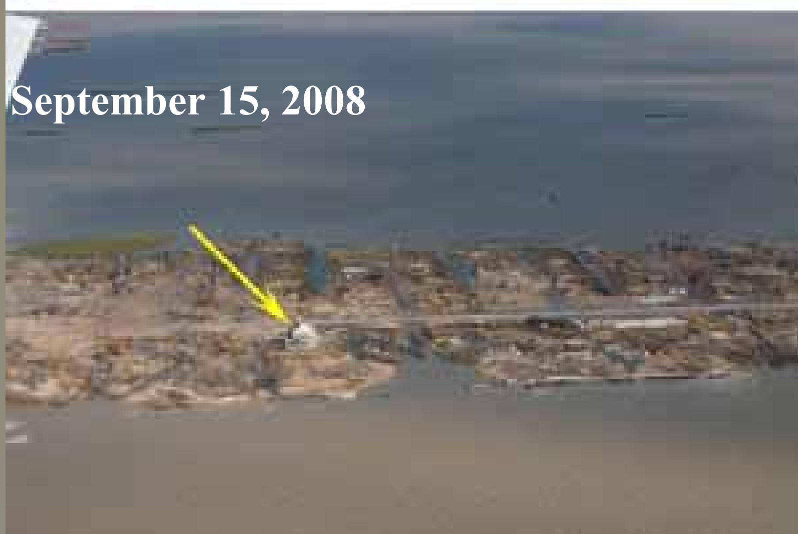
Hurricanes and Topographic Change

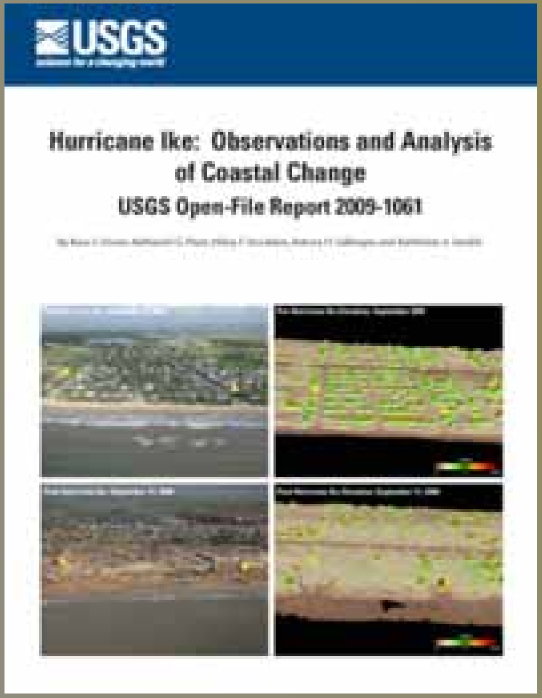


Hurricane Ike, Gilchrist, TX

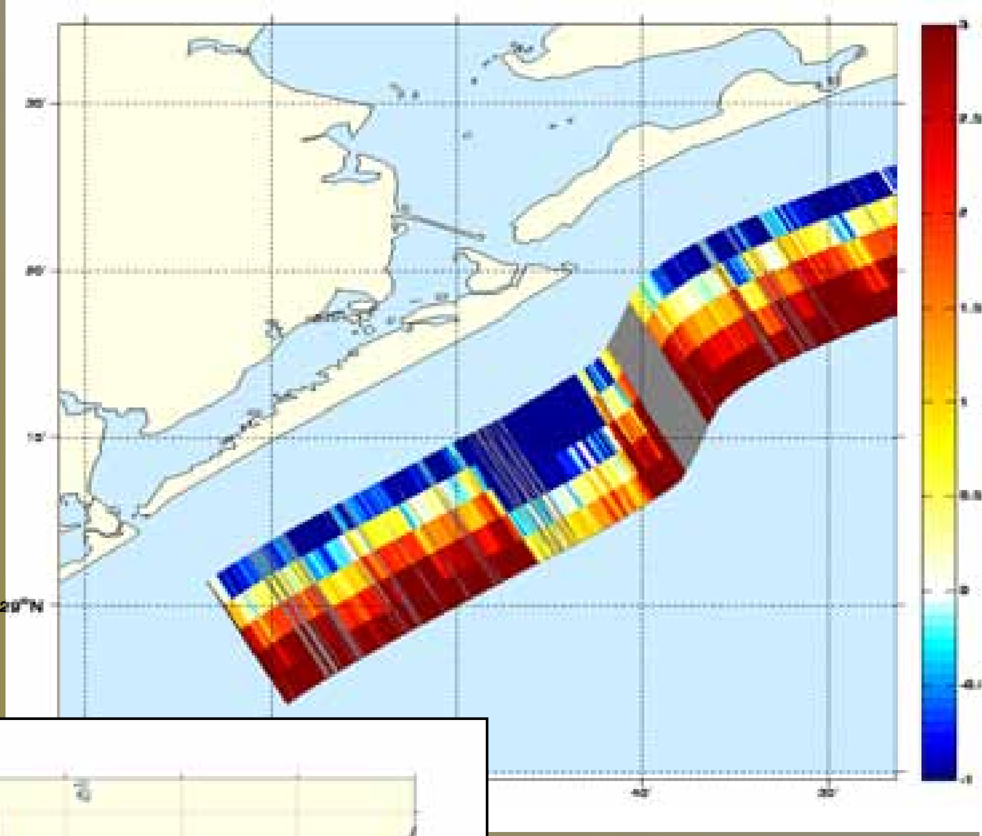
Topographic change (LIDAR)

Storm reports

- Specific storm reports and season summary
- Released every year in early April at the National Hurricane Conference


USGS

Hurricane Ike: Observations and Analysis of Coastal Change
USGS Open-File Report 2009-1061



Hurricane Ike Landfall: Sept 13, 2008

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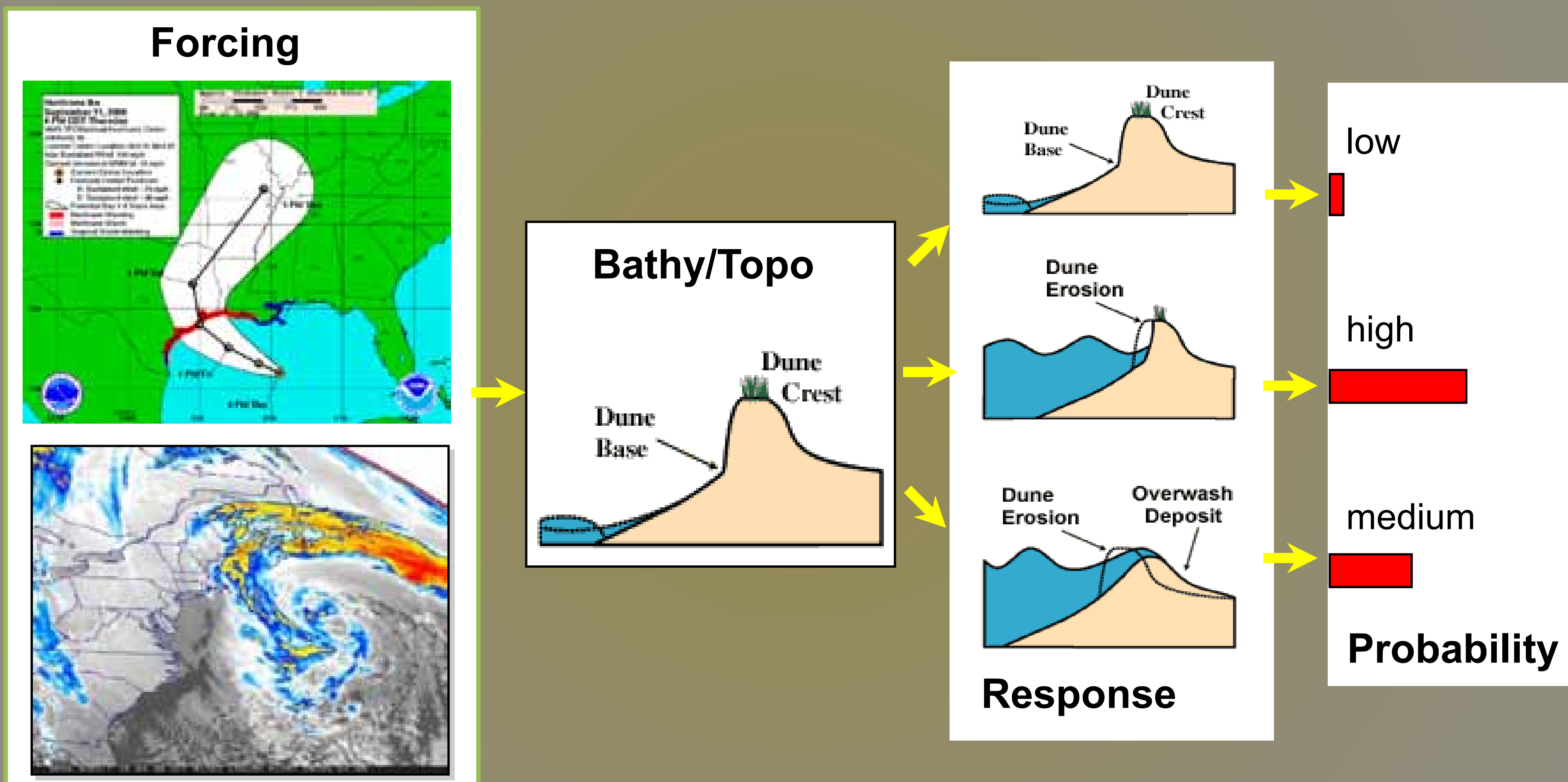
Predicting Geomorphic Change During Extreme Storms



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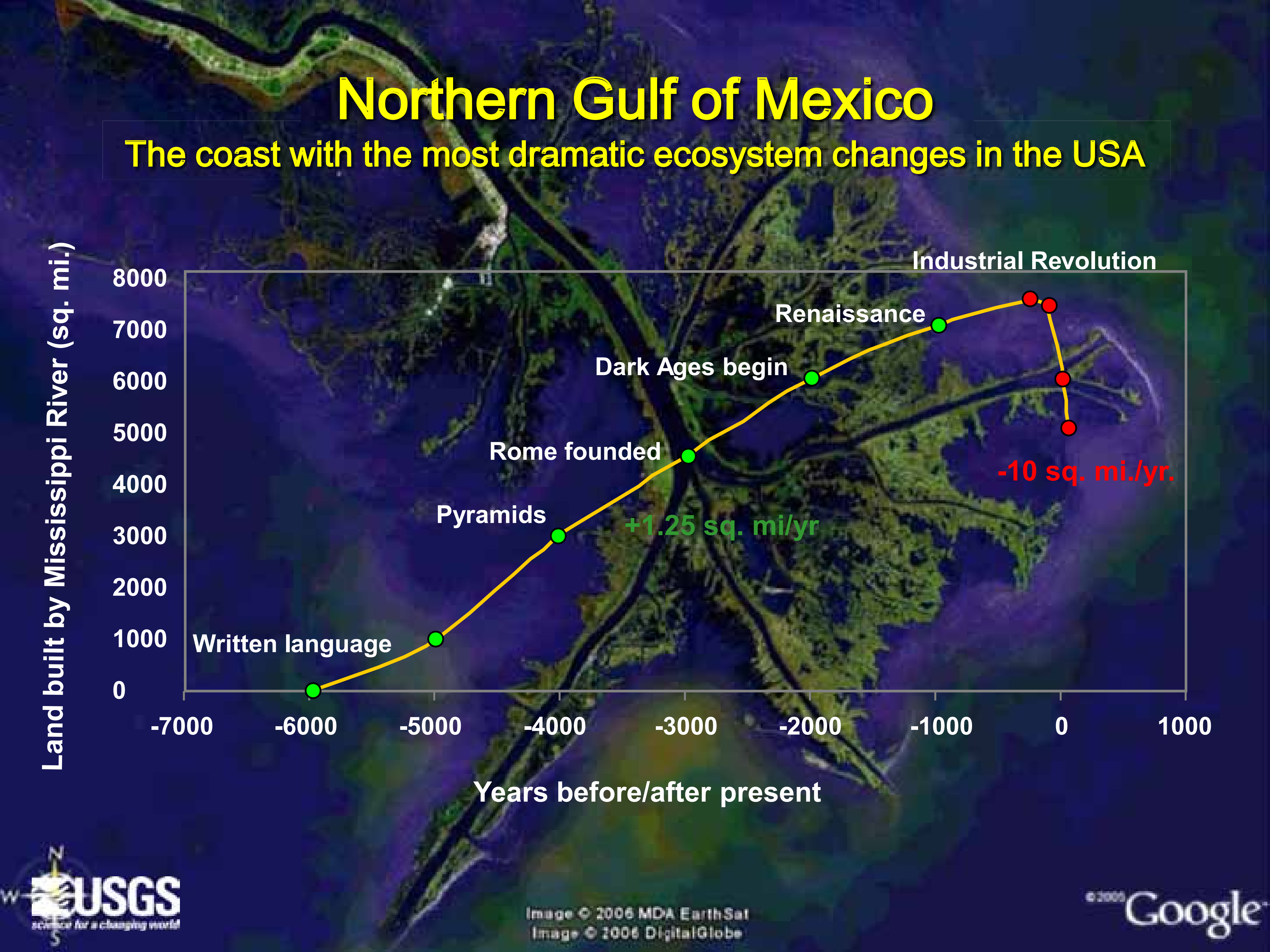
Northern Gulf of Mexico
The coast with the most dramatic ecosystem changes in the USA
Land built by Missisippi River (sq. mi.)
8000
7000
6000
5000
4000
3000
2000
1000
0
-7000
-6000
-5000
-4000
-3000
-2000
-1000
0
1000
Years before/after present
Written language
Pyramids
Rome founded
Dark Ages begin
Renaissance
Industrial Revolution
+1.25 sq. mi/yr
-10 sq. mi./yr.
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Image © 2006 MDA EarthSat
Image © 2006 DigitalGlobe
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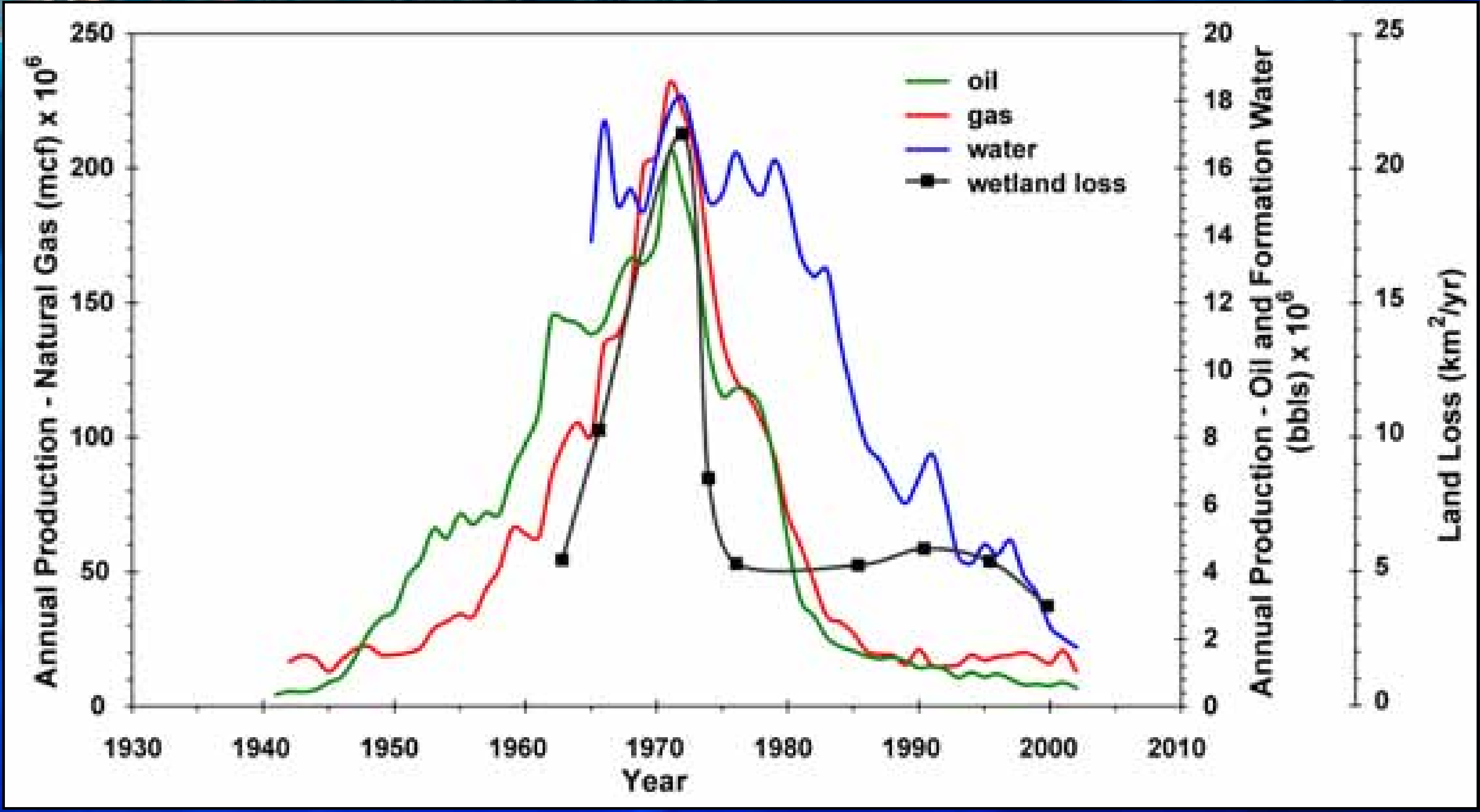
Subsidence

Mississippi Delta Plain (south Louisiana)
Subsurface Fluid Production vs. Wetland Loss



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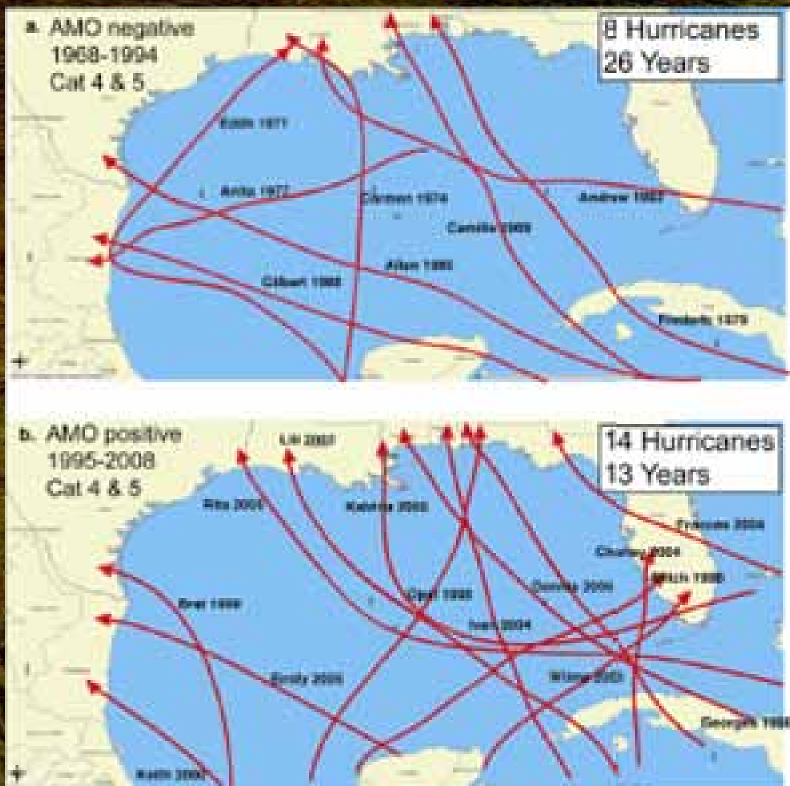
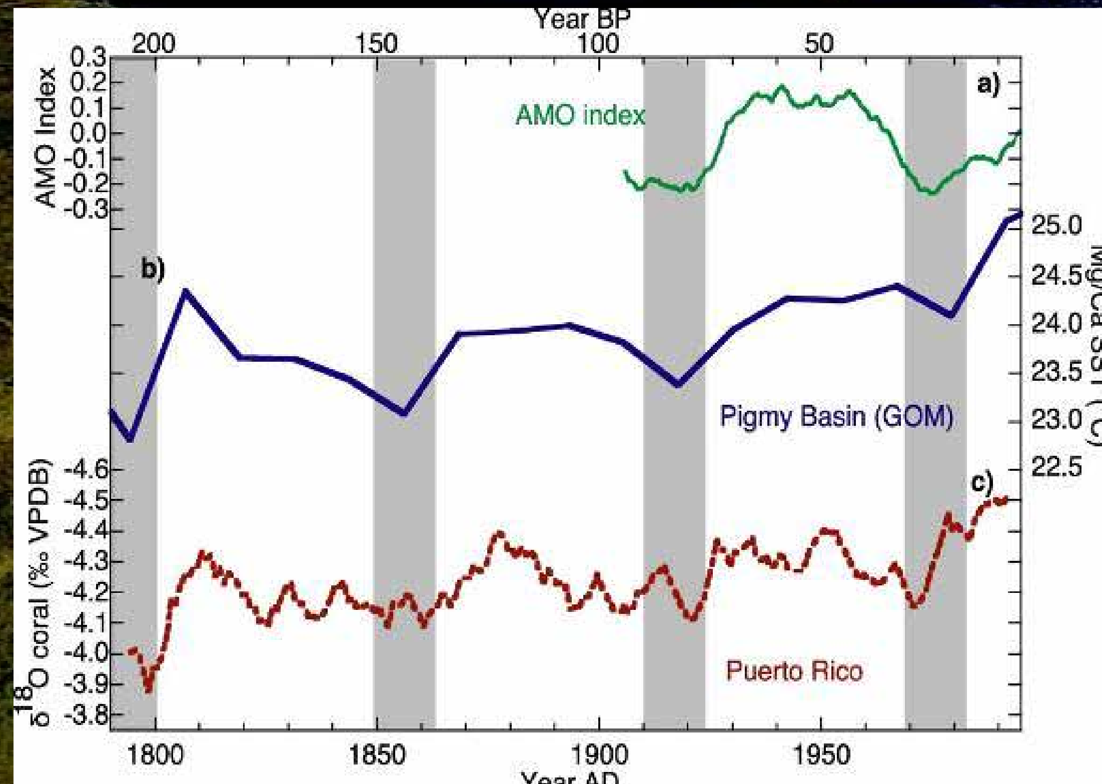
Reconstruct Holocene Geologic Stratigraphy, Paleoenvironments, & Climate – from eastern Louisiana to western Florida

Evidence of Multidecadal Climate Variability from a Gulf of Mexico Sea Surface Temperature (SST) Proxy Record





Contaminant Research

- Watershed-scale Mercury Studies
- Impact of Mosquito Control on Butterfly Species
- Pesticides in Central Florida Lakes

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Mercury Research Activities

- ISSUE (1): National-scale mercury studies
  - 1998-2005: National survey of mercury in bed sediment, water, fish at >200 sites across the US (*in press*)
  - 2002-2006: Process-based studies of the relative importance of mercury source, methylation, trophic dynamics in Oregon, Wisconsin, Florida (*ES&T, April 15, 2009, 43:8*)
  - Current activity: USGS Circular, "Mercury in aquatic ecosystems across the United States — A summary of selected studies by the U.S. Geological Survey"

Collaboration with NRP

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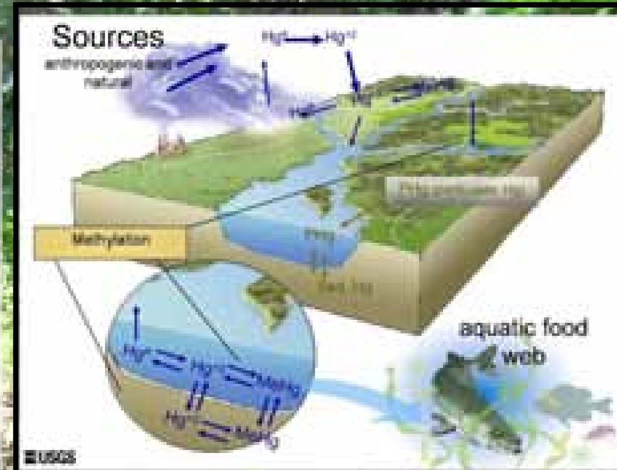
Mercury Research Activities

- Issue (2): Watershed-scale mercury studies
  - (2006-ongoing) Watershed modeling
  - (2006-ongoing) Compare/contrast characteristics in New York & South Carolina headwater streams related to mercury accumulation in aquatic biota
  - Current activity
    - Spring FY2010 Field Work scheduled
    - Synthesis: Mercury speciation, bioavailability, Bioacumulation factors, Biomagnification rates



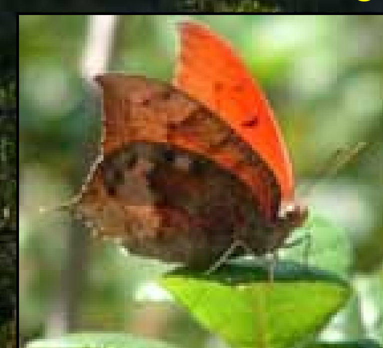
Collaboration with NRP & EPA

Impact of Mosquito Control on Resident Butterfly Species

ISSUE: Balancing mosquito control operations with efforts to conserve two butterfly species (Bartram's hairstreak and Florida leafwing) that are candidates for listing under ESA.

Plane spraying mosquito control pesticide over the National Key Deer Wildlife Refuge (Big Pine Key, FL)

Florida leafwing



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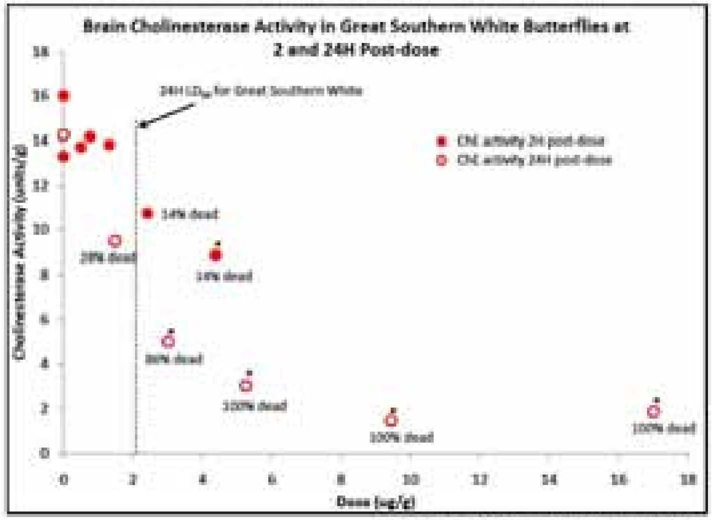
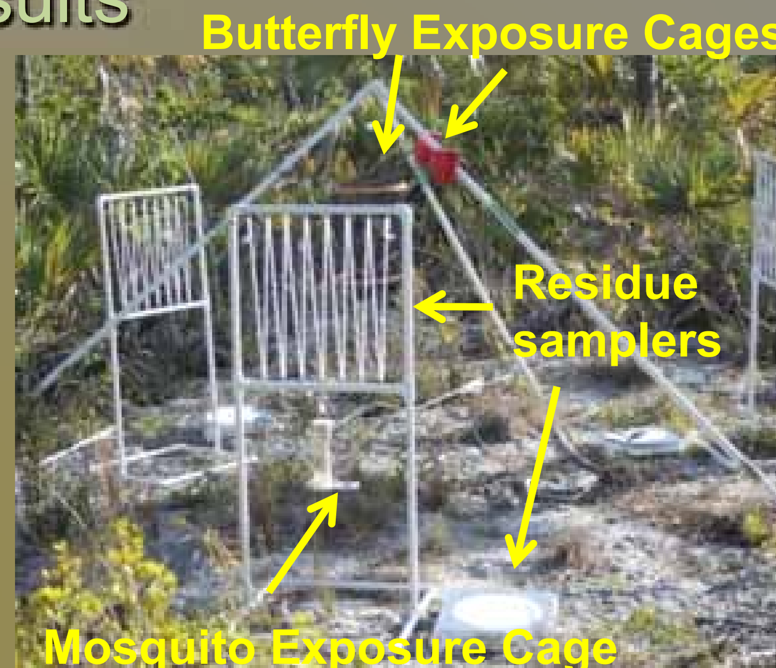
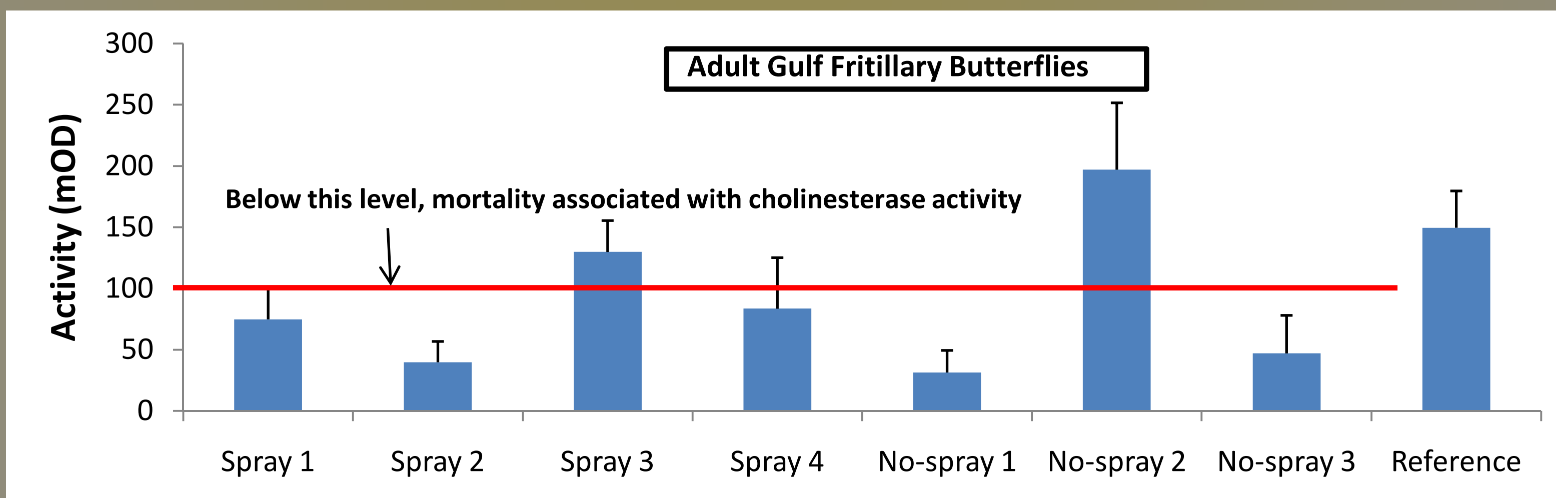
Initial Results

Figure 4



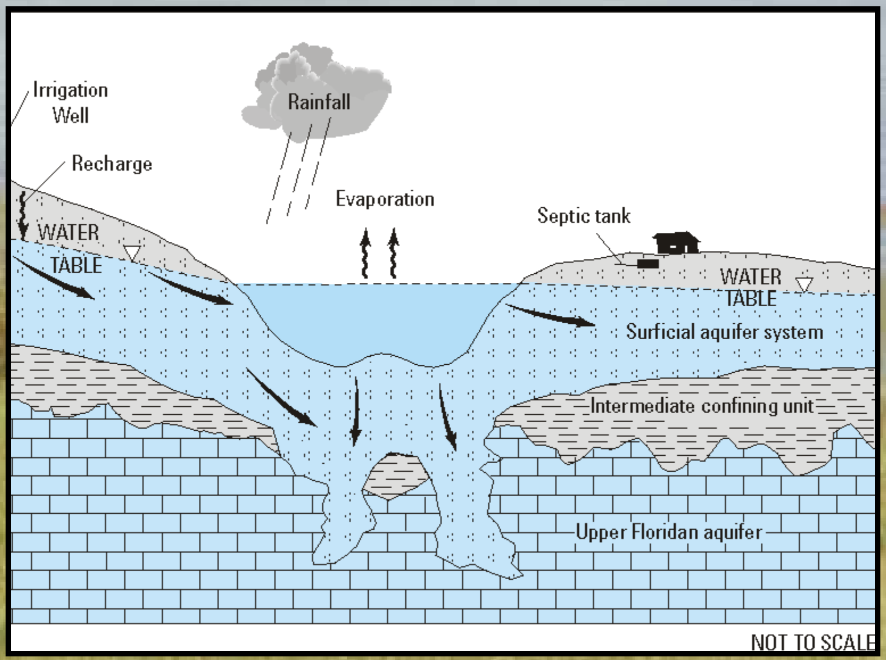
* Significantly different from control (α=0.05)

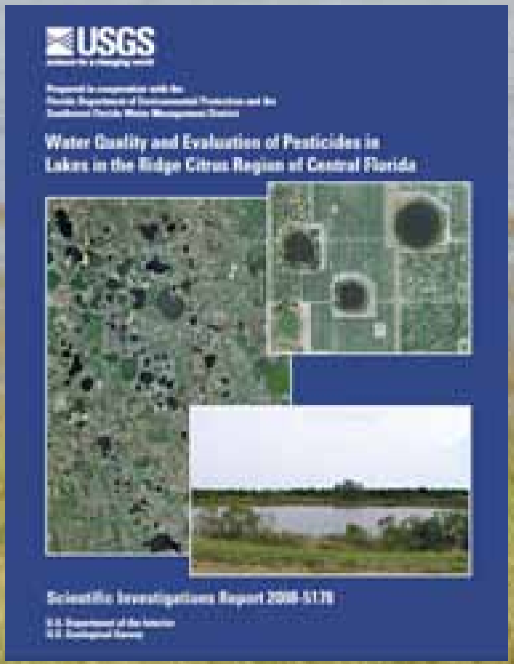




Water Quality and Evaluation of Pesticides in Lakes in the Ridge Citrus Region

ISSUE: Regional reconnaissance of current use pesticides





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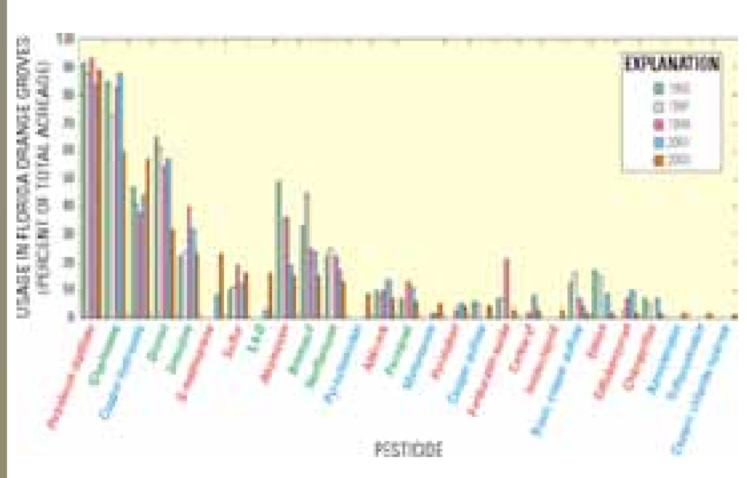
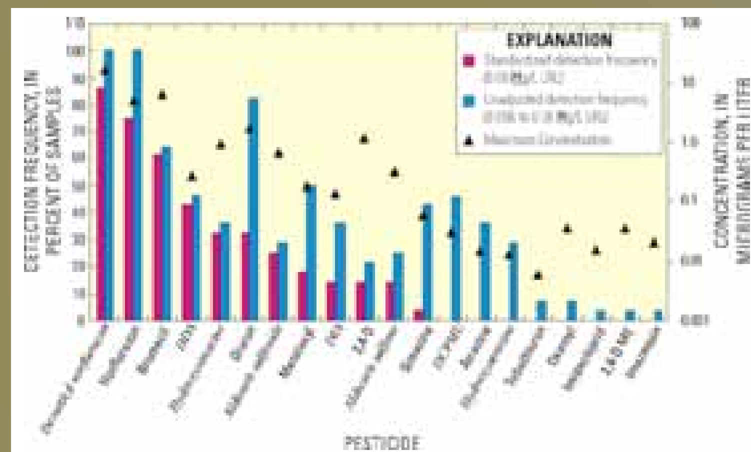
Water Quality and Evaluation of Pesticides in Lakes in the Ridge Citrus Region

RESULTS

Pesticides applied in Florida orange groves

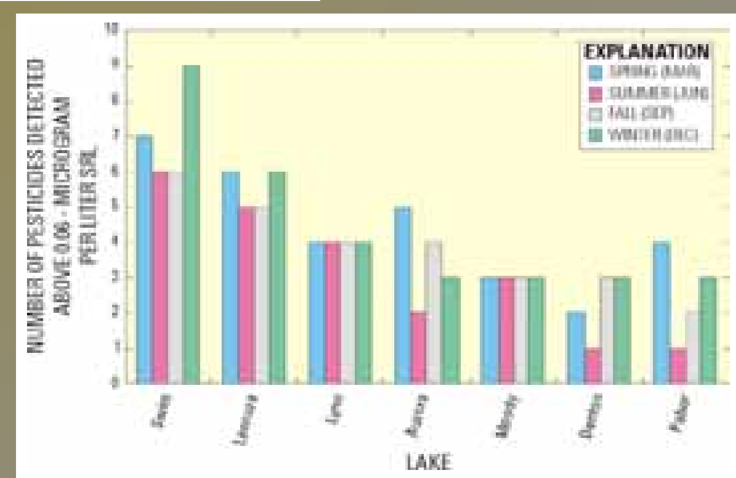


Frequency of pesticides & degradates in samples from 7 lakes



2, 4-D
Diuron
Simazine
Atrazine
Etc.

Lakes have the pesticides all year round, and some at significant concentrations



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Species Studies / Adaptive Management
• Non-Indigenous Aquatic Species National Database
• Invasive Species Effects & Interactions
• Non-native Marine Fishes Early Detection & Rapid Response
• Invasive Burmese Pythons in Everglades National Park
• Dry Tortugas Marine Turtles
• Strategic Habitat Conservation for the Florida Scrub-Jay
• Data For Sturgeon Management
• Manatee Health Assessments & Genetic Analysis
• Imperiled Freshwater Organisms of North America
• Joint Ecosystem Modeling (JEM)
• *Bacillus anthracis* in North American Soils
• Asian Dust Microbe Transport
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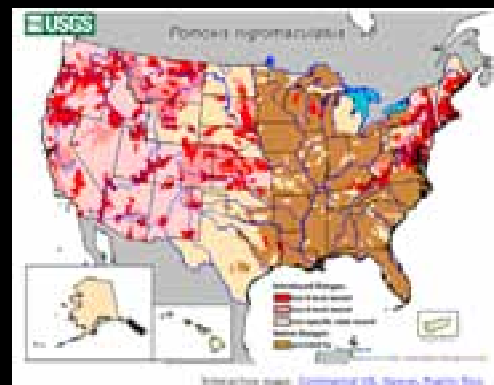
Non-Indigenous Aquatic Species (NAS) National Database

Averaging 55,000 hits/day (last 6 mos)

ALERTS

Hundreds of people are registered to receive alerts of an introduced species in a new location.

INTERACTIVE MAPS

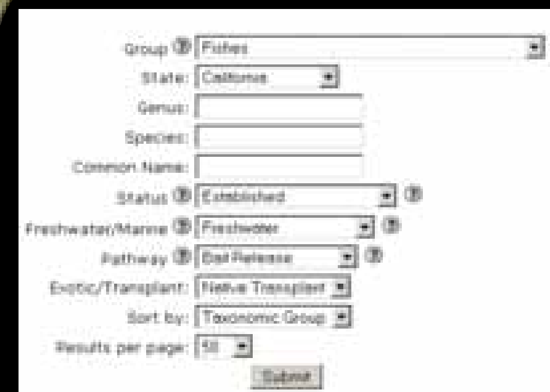


Real-time

Generated with ArcIMS

User can zoom in, identify points, add layers

ADVANCED QUERIES



Group:	Fishes
State:	California
Genus:	
Species:	
Common Name:	
Status:	Established
Freshwater/Marine:	Freshwater
Pathway:	Bait Release
Exotic/Transplant:	Native Transplant
Sort by:	Taxonomic Group
Results per page:	50

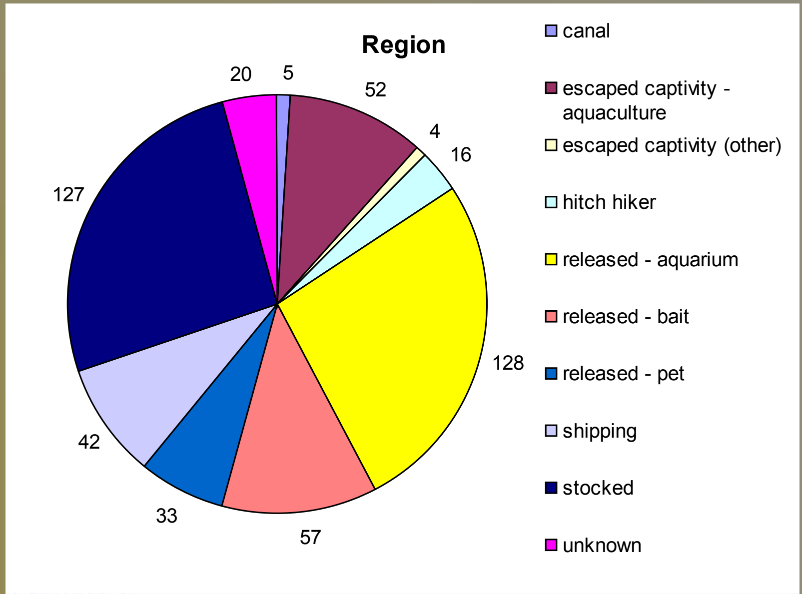
Submit

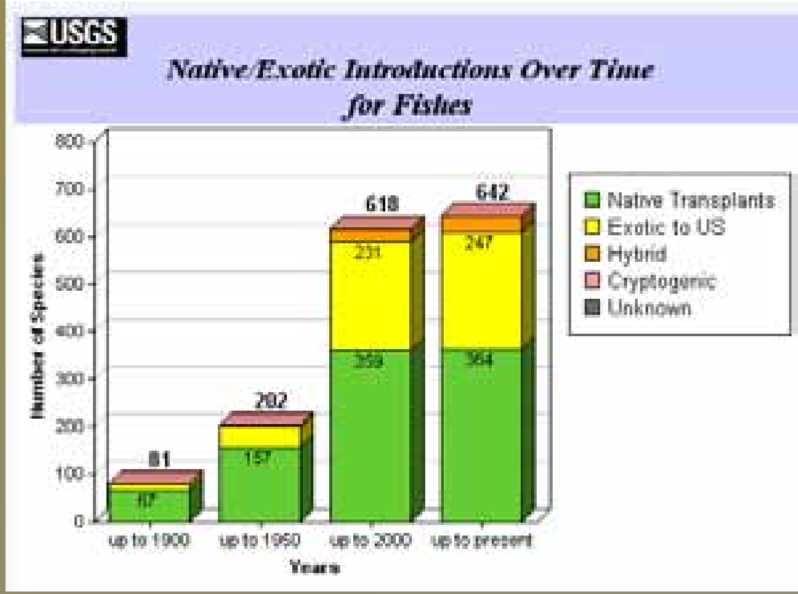
Advanced queries and access to more data

NAS National Database

The NAS database provides:

- Nationwide distribution of introduced aquatic species
- Interactive distribution maps (served in ArcIMS)
- Real-time data queries
- Species lists for regions or taxonomic groups
- Collection/Specimen information
- Species fact sheets
- Summary graphs





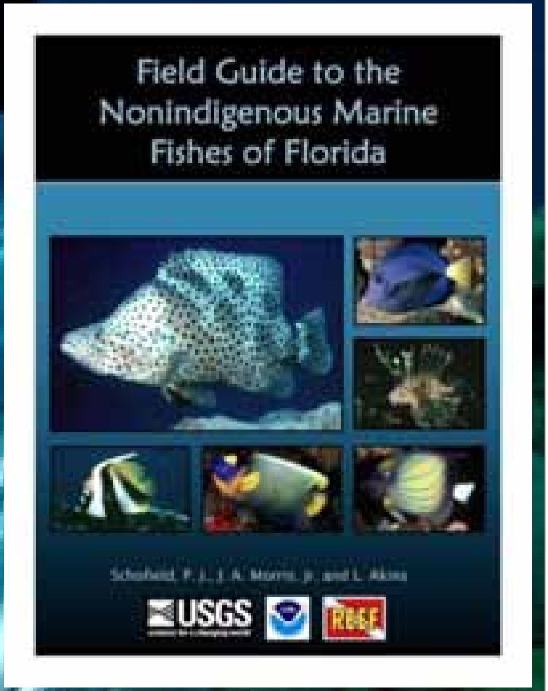
Invasive Species Effects & Interactions

Photo by J. P. Reid/USGS

Armored catfish, an invasive from South America, grazing algae and epibiota on Florida manatees.

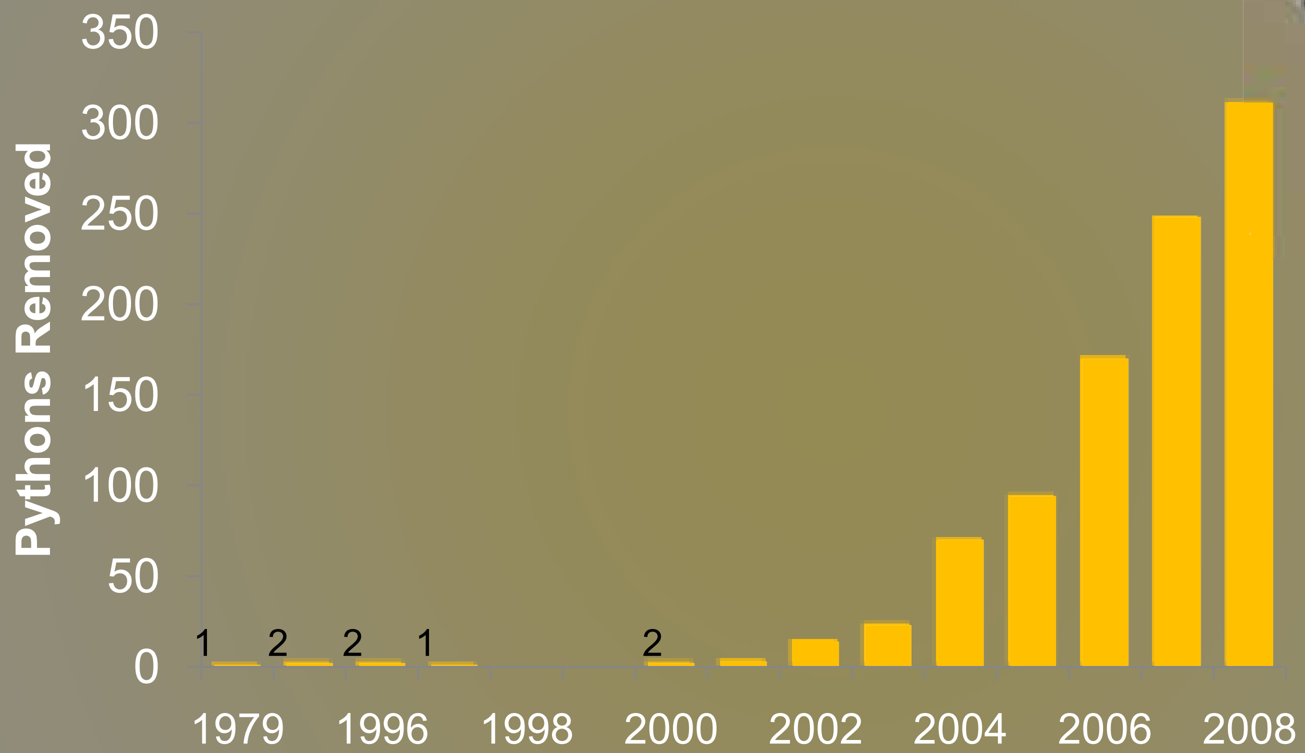
Non-native Marine Fishes in South Florida:

Early Detection and Rapid Response



USGS, REEF, NOAA

Invasive Burmese Pythons in Everglades National Park



Collaborators:
National Park Service: Skip Snow
University of Florida: Frank Mazzotti, Mike Cherkiss
USGS: Kristen Hart, Gordon Rodda, Bob Reed, Pam Schofield, Amanda Demopoulos, Maggie Kellogg
Davidson College: Mike Dorcas
UGA-SREL: J.D. Willson, Whit Gibbons

Research

ECOLOGY:

Diet - Gut content analysis

Spatial Ecology & Movements – Satellite and GPS Radiotelemetry

Population ecology – Genetics, isotopes

TOLERANCES

Thermal Biology -

Implant data loggers

Salinity tolerance

Climate tolerance

IMPACTS

CONTROL

Trapping

Trap development

Trap trials

RISK ASSESSMENT

Climate matching

Predicting new invaders

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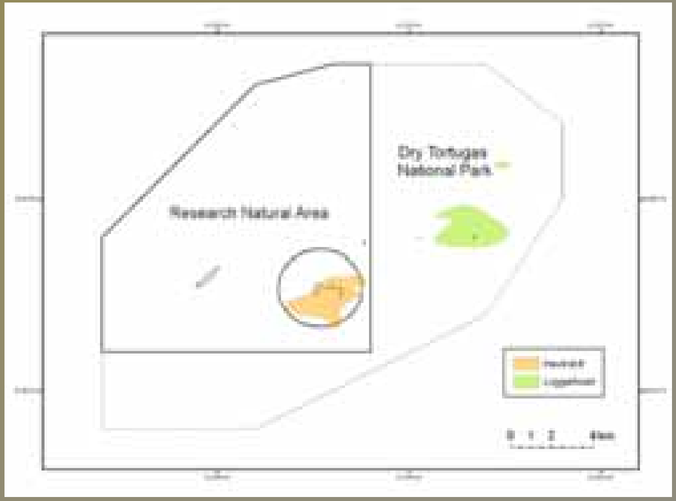
Dry Tortugas Marine Turtles

ISSUE:
Use of marine protected areas by Loggerheads (T), Green turtles, and Hawksbills (E)

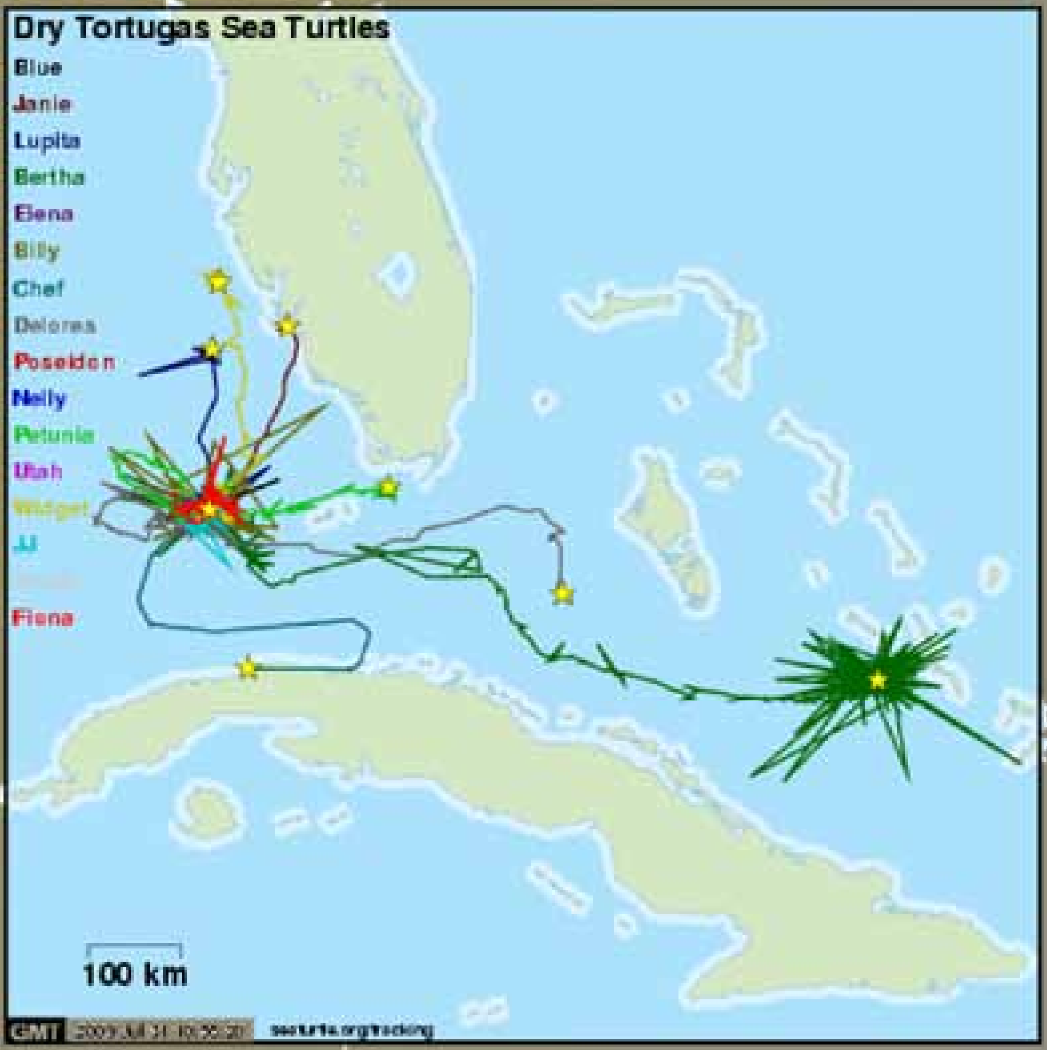
- *Satellite and acoustic telemetry methods*
- *Genetics, diet, growth, survival information*

STUDY:
Initial results indicate preferred habitat of sea turtles in Dry Tortugas National Park is outside of Research Natural Area (no take area)



Dry Tortugas Marine Turtles

Turtles are highly mobile, some travel as far as Cuba and the Bahamas



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Strategic Habitat Conservation for the Florida Scrub-Jay

ISSUES:

- Maximize number of scrub-jay breeding pairs
- Increase proportion of medium-height scrub with adequate open areas

MANAGEMENT ACTIONS:

1) Do nothing
2) Only burn
3) Plow open areas + burn
4) Only plow open areas

USGS, Merritt Island NWR, Kennedy Space Center

Data For Sturgeon Management

PRODUCTS: USGS Mark-recapture and tagging studies since 1986 have provided data on:

- Population dynamics
- Life history (such as fall spawning)
- Correlations between population and environmental conditions
- Location of winter habitats
- Inter-river transfers

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Manatee Health Assessments

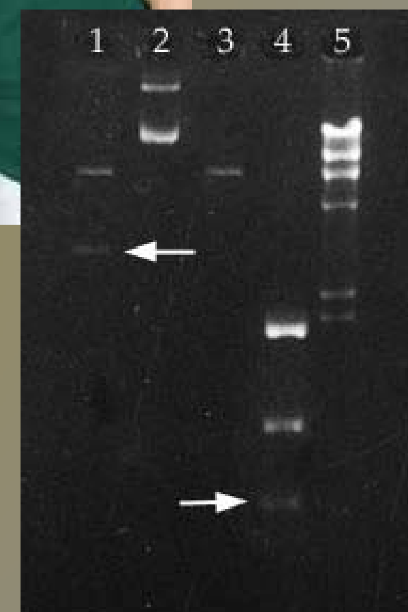
ISSUE: Clinical data needed to support management of manatees and provide baseline data for assessing manatee health in public management and improve data available for private care such as aquaria

STUDY: USGS manatee health assessments provide baseline clinical data

Manatee Genetic Analysis

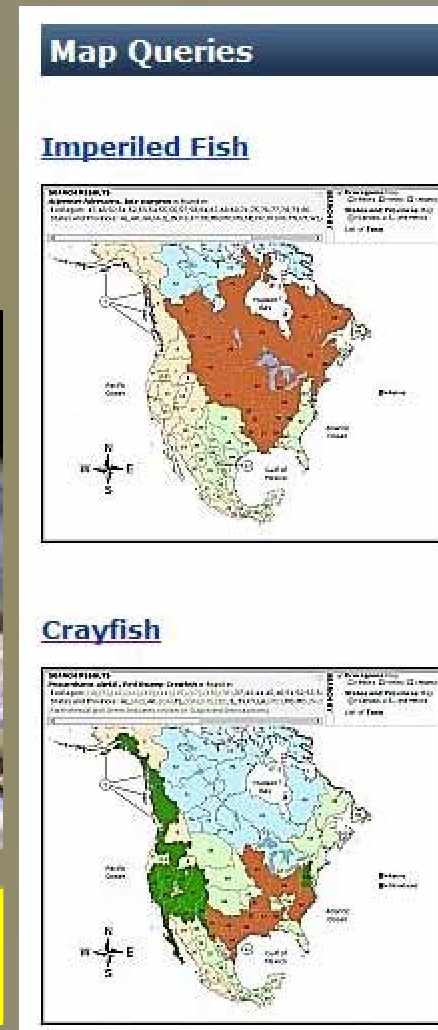
Scientists collect tissue samples from wild manatees, such as this “cookie” from the tail margin, for genetic analysis

USGS biologists prepare manatee genetic samples for analysis



Imperiled Freshwater Organisms of North America

Website co-hosted with American Fisheries Society



<u>Current pages:</u>
- Imperiled Fish
- Crayfish (new this year)

<u>Future pages:</u>
- Mussel
- Snail

Used by state and federal agencies, researchers, NGOs, and the public.

http://fisc.er.usgs.gov/afs/

Sea-level Rise

- Surface Elevation Change in Wetlands of Southwest Coastal Everglades
- Tree Mortality & Elevation
- Surfacewater & Sea Level Rise Dynamics
- Impacts of Climate Change on Coastal Habitats and Species in the Everglades
- Integrating Geology, Hydrology, and Biology of Sea-level Rise Vulnerability into a Decision-support Framework
- Predictions of Geo-bio-hydro-climate Response to Sea-level Rise
- Climate Change Effects on Evapotranspiration
- Evapotranspiration & Carbon Network
- Florida Shelf – Ocean Acidification
- Saltwater Intrusion Sensitivity Analysis

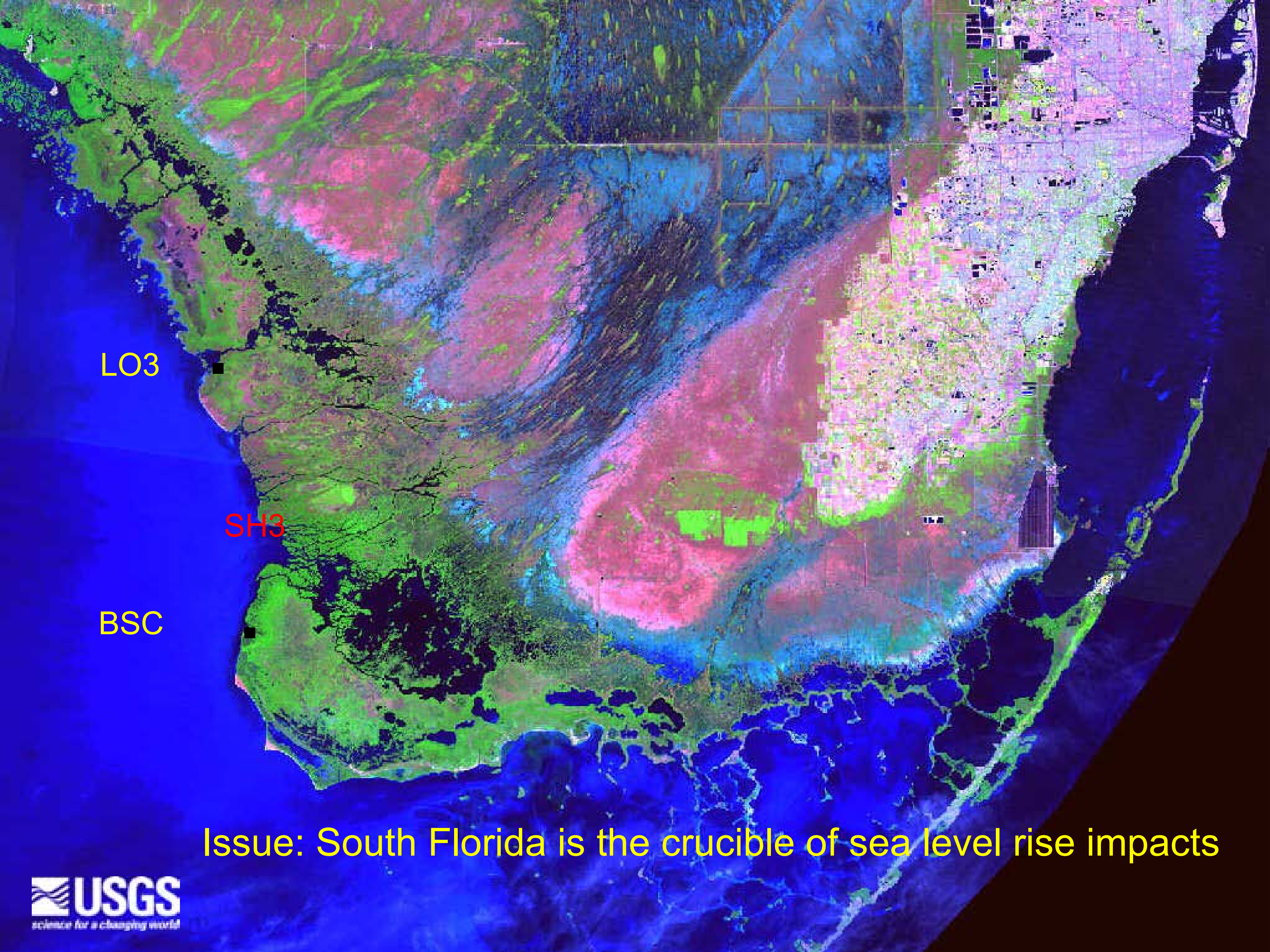
Located at the southern tip of the Florida peninsula, the County is only feet and inches above sea level, resting on porous limestone rock, surrounded by ocean waters and a "river of grass," the world famous Everglades. Any slight increase in the sea level will have a devastating impact on Miami-Dade County.

Climate Change
Preparing for the Impacts

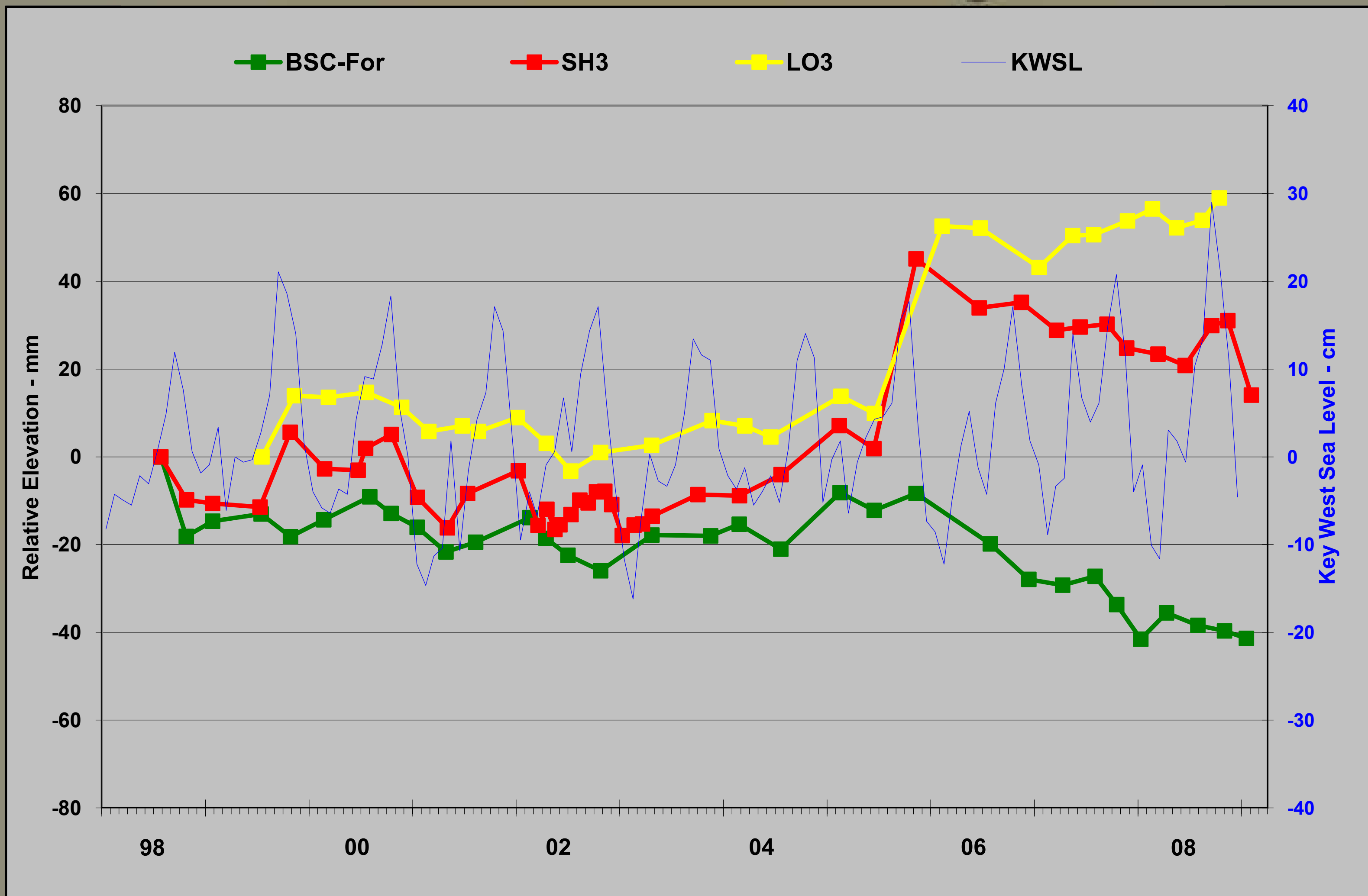
MIAMI-DADE COUNTY

Located at the southern tip of the Florida peninsula, the County is only feet and inches above sea level, resting on porous limestone rock, surrounded by ocean waters and a "river of grass," the world famous Everglades. Any slight increase in the sea level will have a devastating impact on Miami-Dade County.

America's Most Vulnerable Community


LO3
SH3
BSC
Issue: South Florida is the crucible of sea level rise impacts

Surface Elevation Change in Wetlands of Southwest Coastal Everglades



Freshwater inflow, disturbance & sea-level rise: a decade of change

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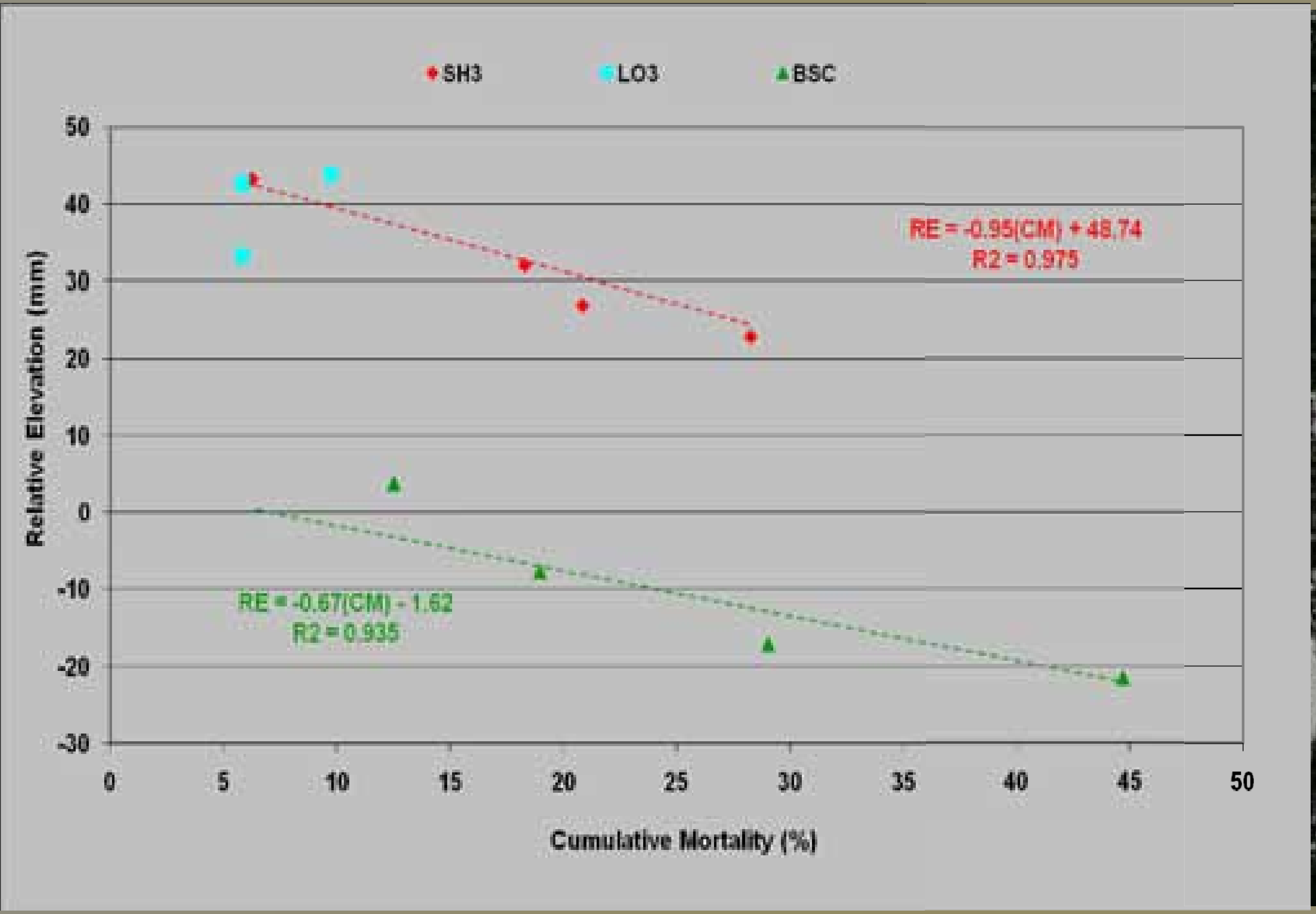
Tree Mortality & Elevation



Delayed mortality as elevation decreases - initial survivors die months to years later

Smith, T.J., III et al. 2009 Cumulative impacts of hurricanes on Florida mangrove ecosystems: sediment deposition, storm surges and vegetation. Wetlands 29: 24-34.

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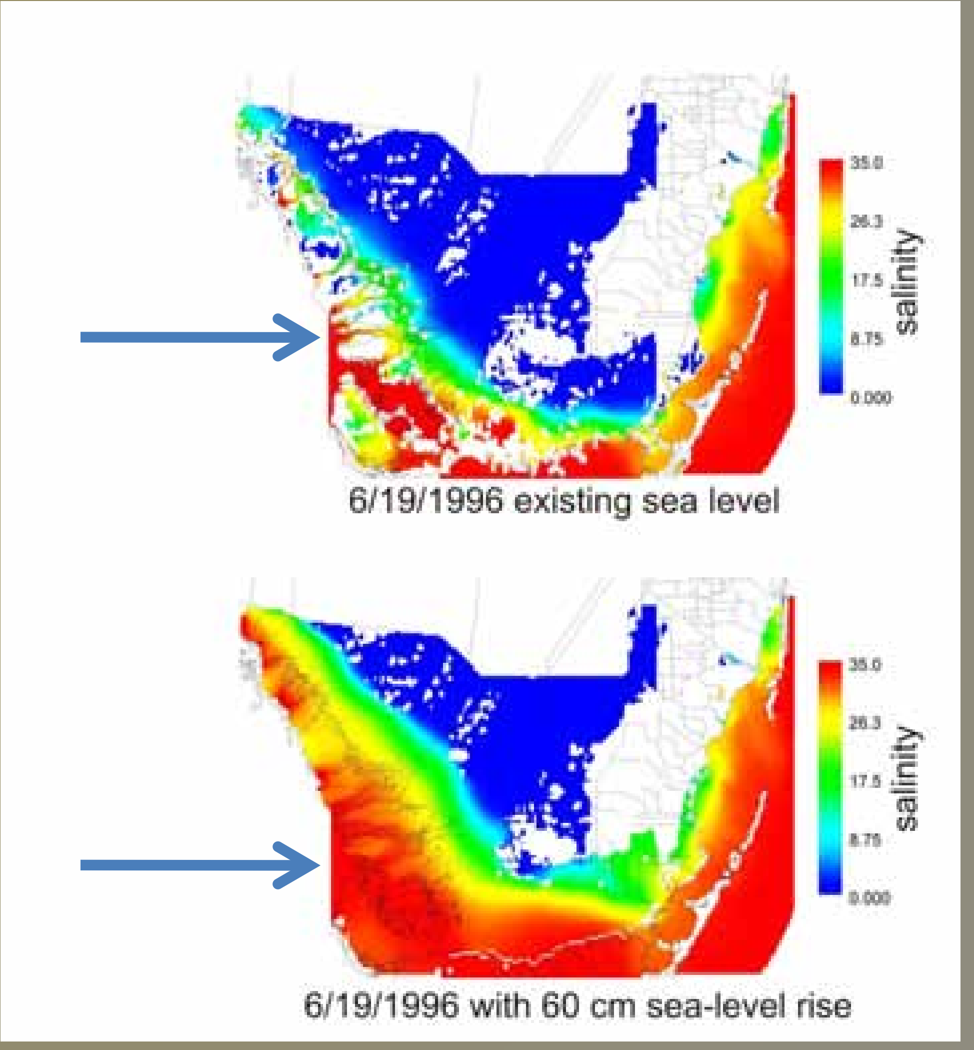
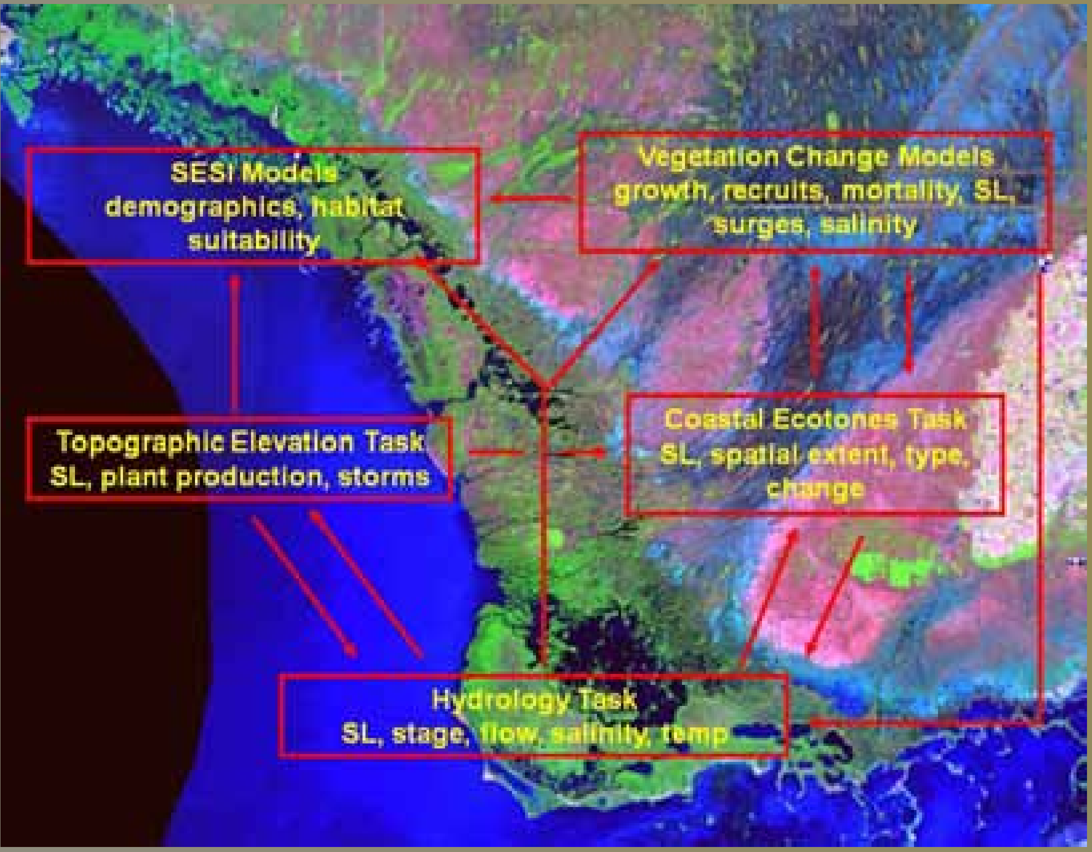
Surfacewater & Sea Level Rise Dynamics

- Inundation and salinity values are interactive with ecologic and landscape change
- FTLOADDS model results show this dynamic



Impacts of Climate Change on Coastal Habitats and Species in the Everglades



Integrated Modeling Approach:

- Enhance existing hydrology model to hindcast SLR and historic vegetation change
- Add land elevation change
- Add mechanistic models of vegetation change
- Add hurricane disturbance
- Assess habitat suitability for focal species
- **Develop predictive capability for SLR under restoration and management scenarios**

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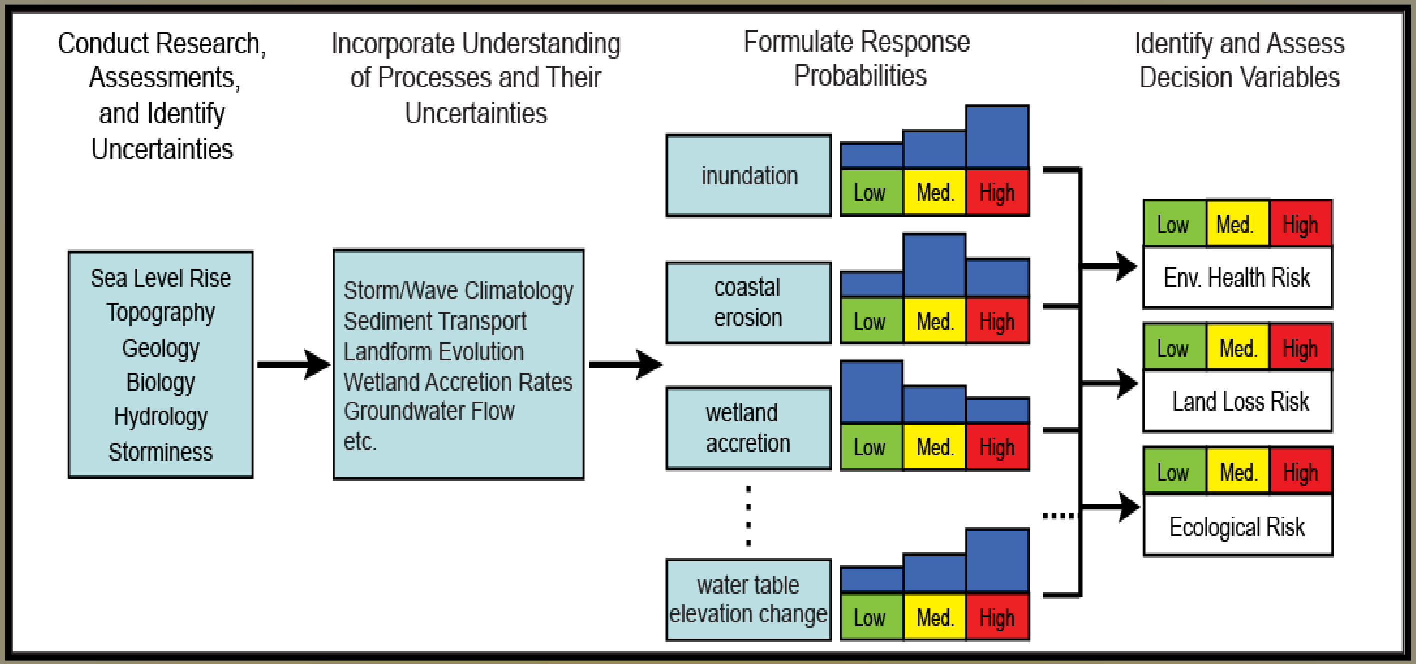
Integrating geology, hydrology, and biology of sea-level rise vulnerability into a decision-support framework



- Collect coastal vulnerability results and link to sea-level rise (SLR)
- Spatial variation in modern SLR is proxy for future SLR
- **Bayesian network** produces probabilistic forecast
- Coastal vulnerability data used to forecast shoreline erosion

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Predictions of geo-bio-hydro-climate response to sea-level rise

- Develop robust Decision Support System (DSS)
  - Update knowledge (and uncertainty) of present system state
  - Provide probabilistic prediction of future state
- Develop scientific SLR integration system
  - Update knowledge of present system interactions
  - Show nature/knowledge of interactions between system components
  - Show impact of increased knowledge (reduced uncertainty)

Temperature, Salinity, Velocity, Dissolved Oxygen, Rainfall, Water Depth

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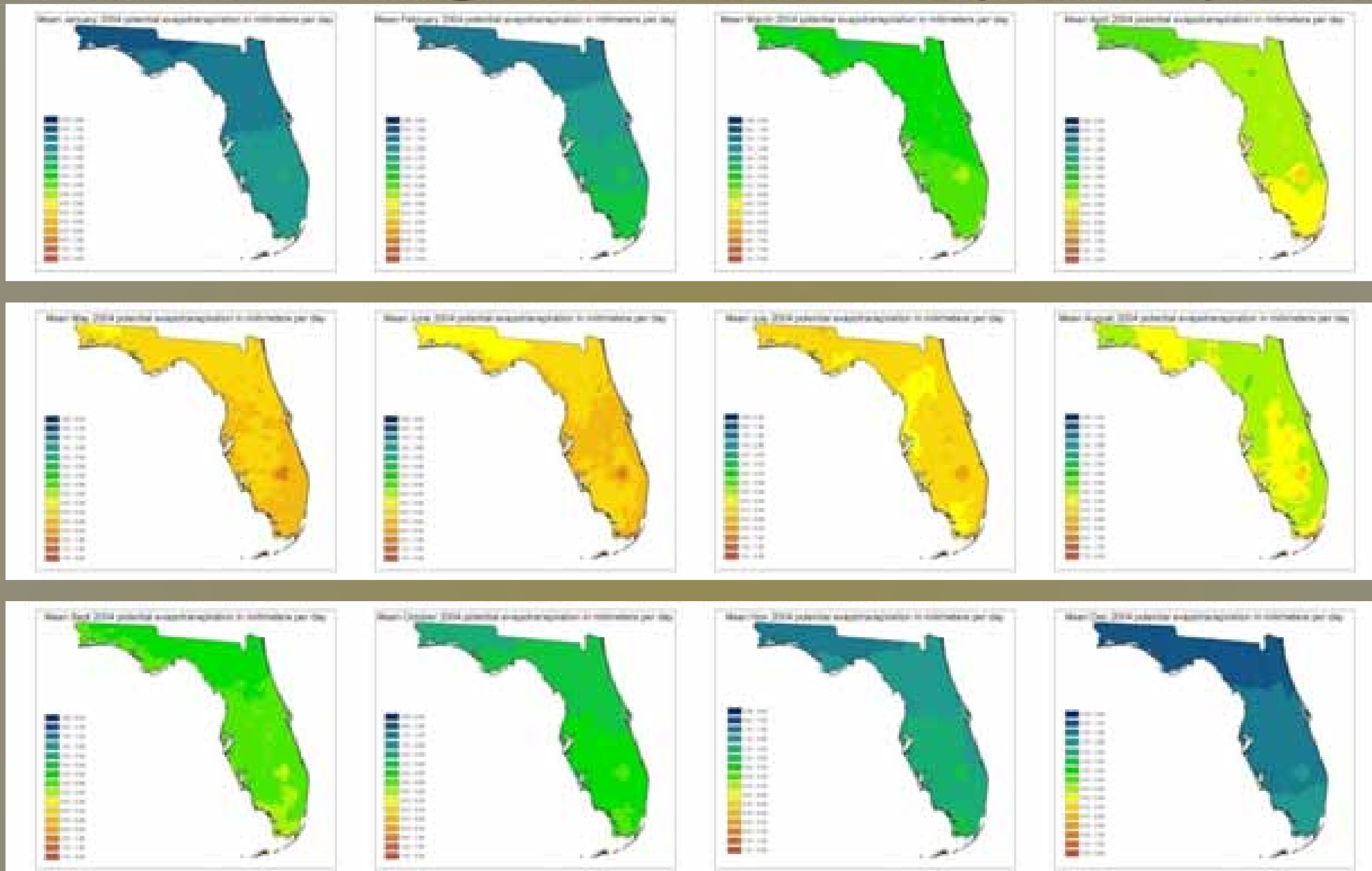
Climate Change Effects on Evapotranspiration



Mean monthly 2004 potential evapotranspiration (mm / day)

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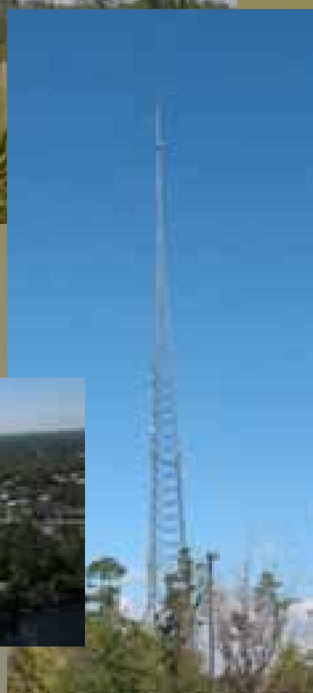
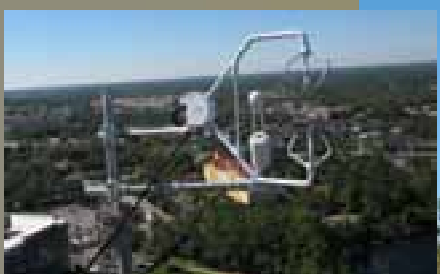
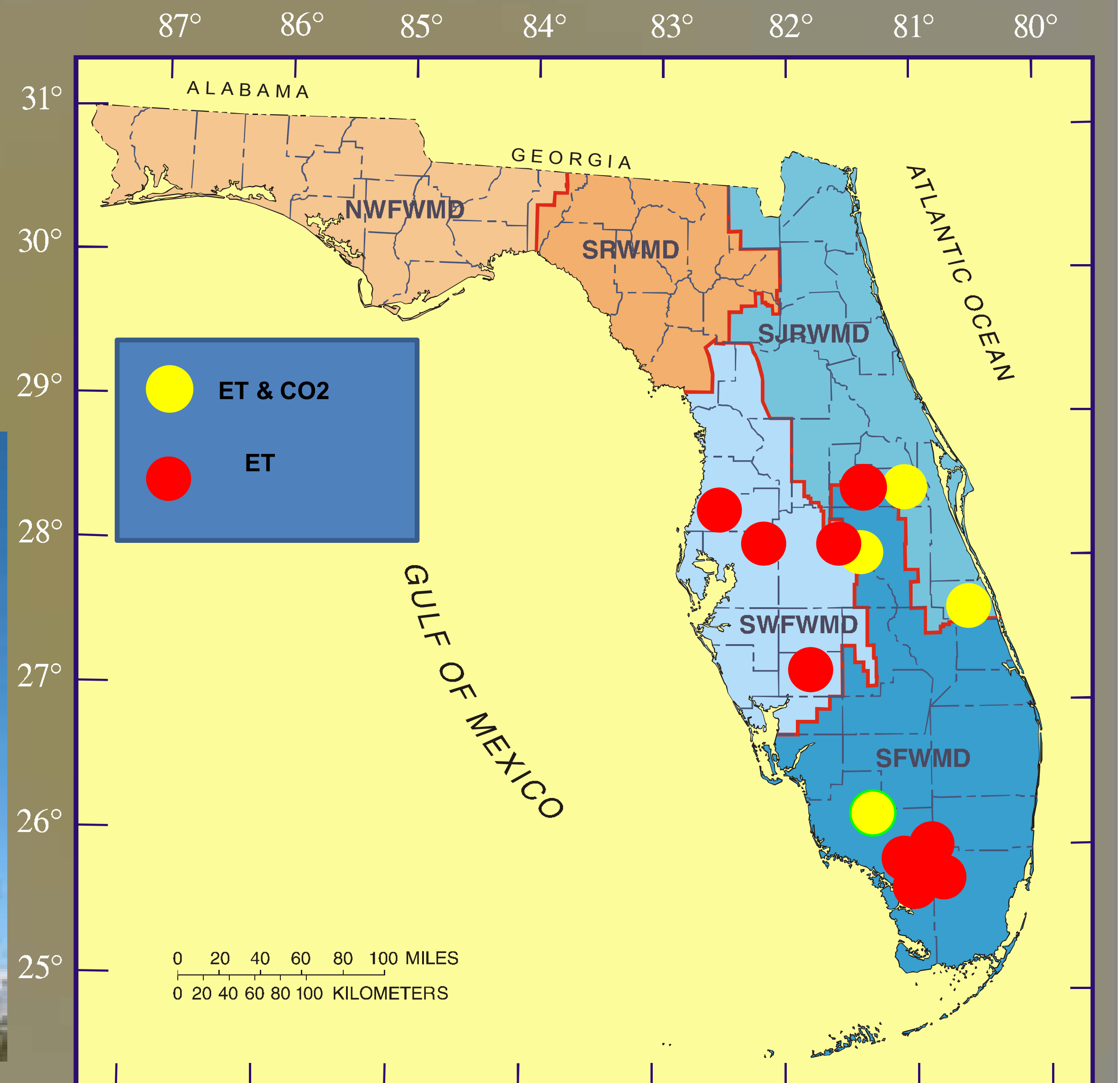
Evapotranspiration & Carbon Network

ET station (WRWX, Polk County)



Urban station
(with UCF Biology
Department)





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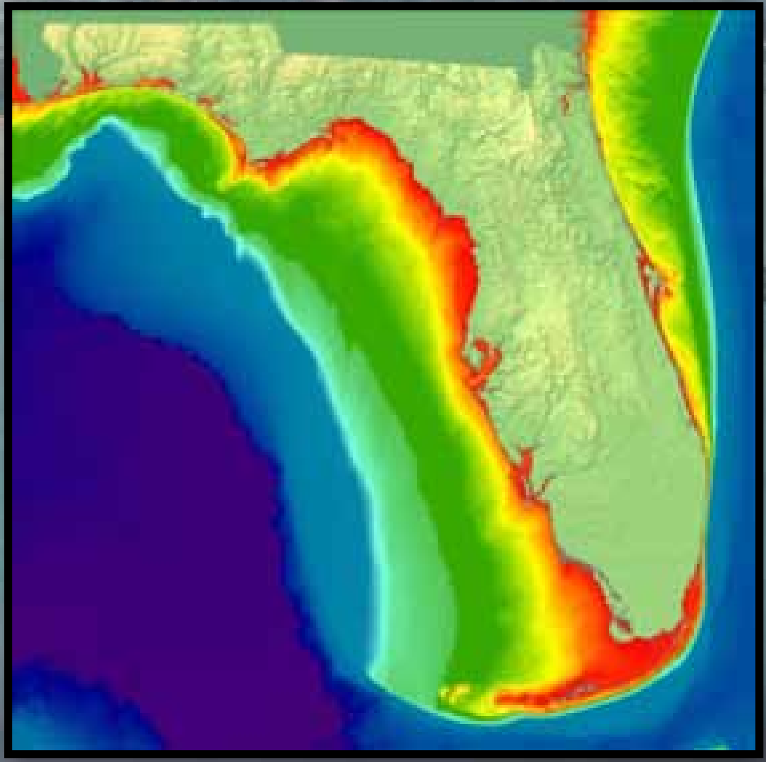
Florida Shelf – Ocean Acidification

ISSUE: Sustainability of ecosystems under changing environmental conditions

Integrated approach to understanding impacts of ocean acidification & carbon budget of shelf:

- Calcifying species & response to changing pCO_2
- Critical thresholds & impacts for species
- Map regional pCO_2 and saturation for shelf to link to habitat characteristics
- Use historic pH trends to predict future responses



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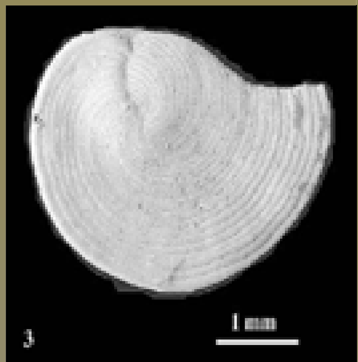
Calcifying Organism Response: lab and field process studies

- Complement historic data
- Indicate how calcium carbonate producing organisms on the shelf respond to pH decreases (pCO2 increases) over time



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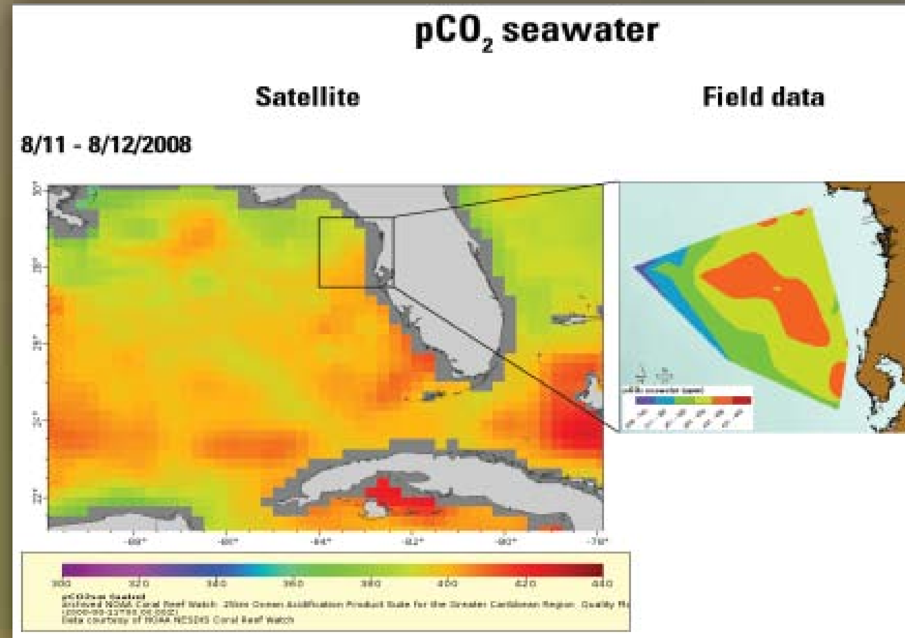
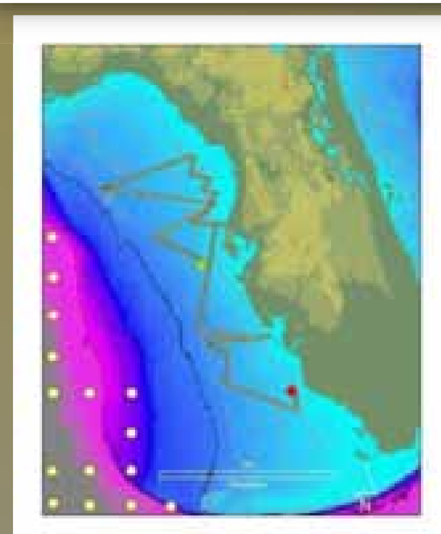
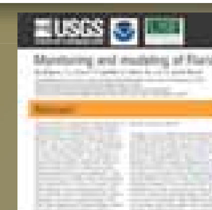
Linking Regional Coastal pCO2 to habitat

Flow thru system collects pCO2, DIC, pH, total carbon







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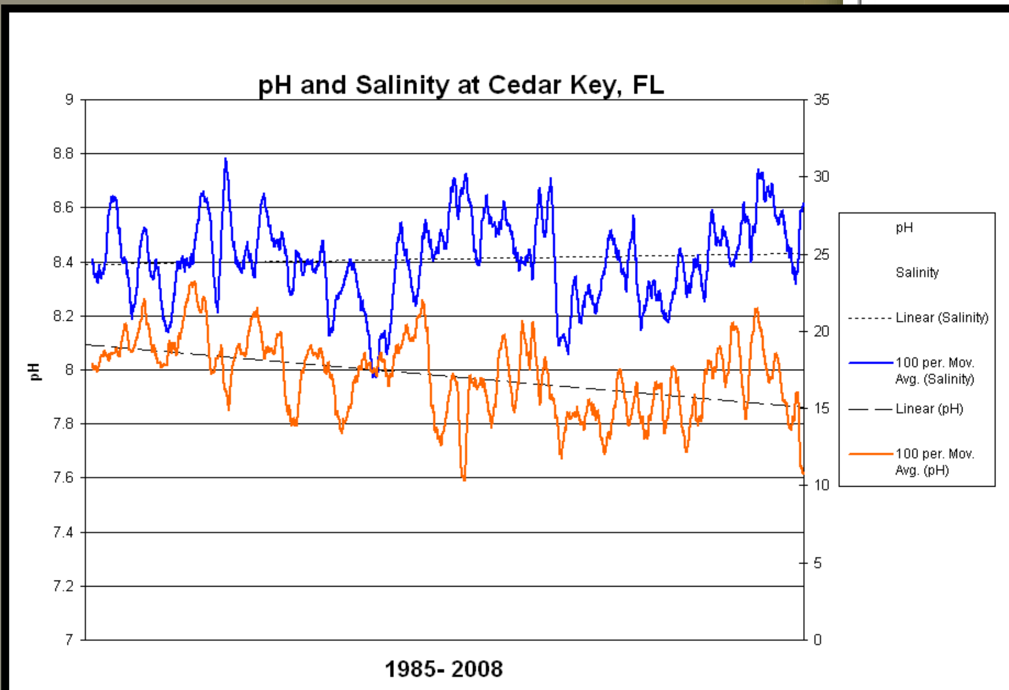
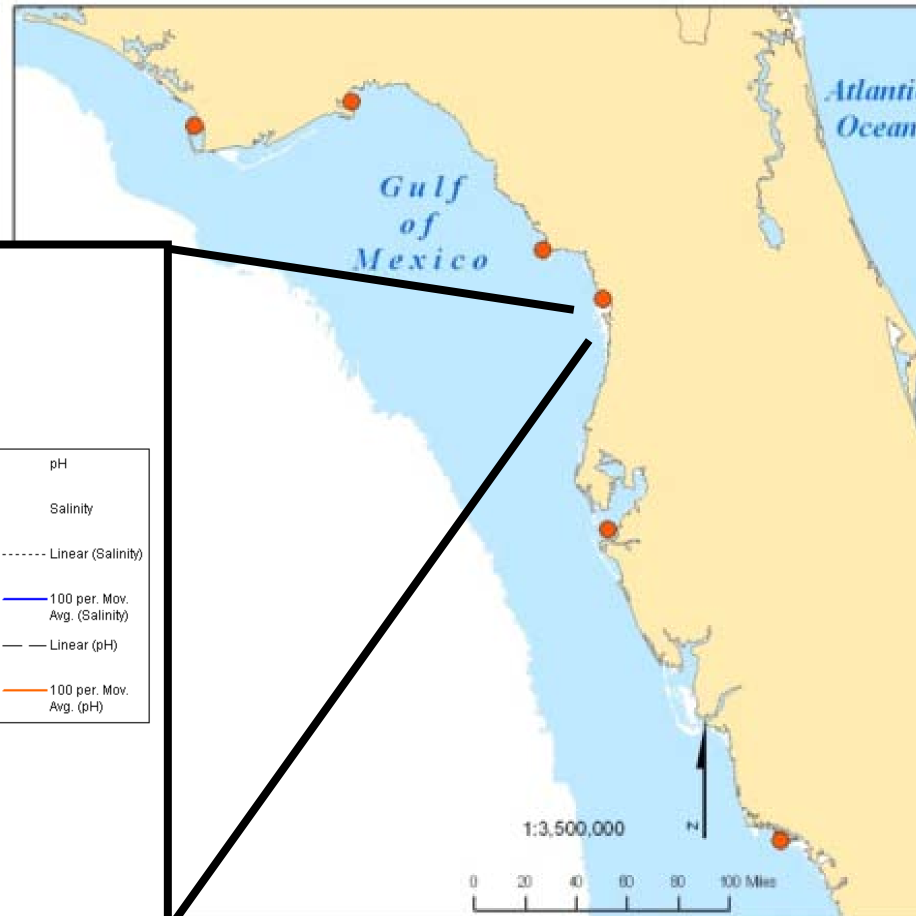
Historic Coastal pH and Salinity in Florida Shellfish Beds

Florida's west coast shows decrease in pH since 1980s





Select Water Quality Sites

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Seminole Tribe of Florida

Counties

Volusia, Highlands, Lee, St. Lucie, Broward, Lake
Hillsborough, Manatee, Pinellas, Okaloosa, Orange
Sarasota, Miami-Dade, Santa Rosa, Seminole, Walton

Cities

Bradenton, North Port, Sarasota,
Tampa, Jacksonville, Cape Coral, Boca Raton
Hollywood, Cocoa, Hallandale Beach, Sanibel

Authorities

Peace River Manasota Regional Water Supply
Jacksonville Electric, Florida Keys Aqueduct ,
Reedy Creek Improvement District
Water Tampa Bay Water

Universities, other Science Centers

st.petersburg
www.stpete.org

TAMPA BAY Estuary Program

TAMPA BAY WATCH
Restoring the Bay Every Day

CLEARWATER MARINE AQUARIUM

ECKERD COLLEGE

THE UNIVERSITY of NEW ORLEANS

Rookery Bay
National Estuarine Research Reserve

MANATEE COUNTY FLORIDA

TAMPA BAY WATER
Supplying Water To The Region

CITY OF SARASOTA

GULF OF MEXICO PROGRAM

CENTER FOR OCEAN TECHNOLOGY

COLLEGE OF MARINE SCIENCE

EARTH FORCE

THE PIER AQUARIUM
Community Marine Education

BROOKER CREEK PRESERVE
Our Wildest Place
A Pinellas County Government Program

WEEDON ISLAND PRESERVE
A Pinellas County Government Program

Pinellas County

MOTE MARINE LABORATORY

MOSI

FIU
FLORIDA INTERNATIONAL UNIVERSITY

KML
Keys Marine Lab, Florida Keys

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Hillsborough County Florida

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