

FWRI Water Resource Monitoring Programs

Paul Carlson Jr., Ph.D - presenter

Amber Whittle, Ph.D. – presentation compiler



EPA National Coastal Condition Assessment (NCCA)



National Aquatic Resource Surveys

- Comprehensive assessment of national water quality
- Key questions
 - Extent of waters supporting healthy ecosystems
 - Extent of waters affected by stressors / water quality problems
- Report resource condition at regional and national scales
- Promote state / tribal monitoring efforts
 - Sampling often conducted by states
 - Promotes collaboration and consistency among states



5 Year Rotating Schedule for Field Work

2007 - Lakes

2008 - Rivers

2009 - Streams

2010 - Coastal

2011 - Wetlands



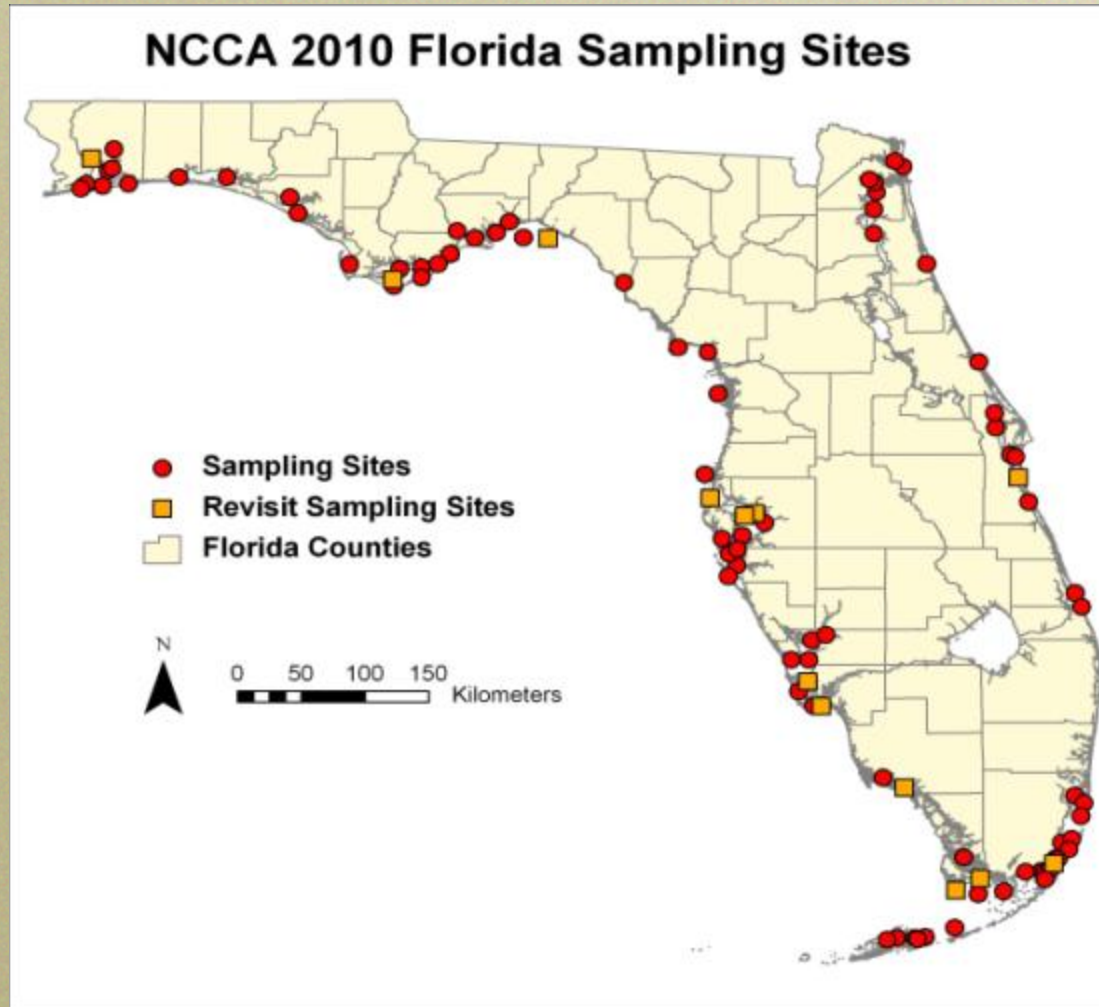
NCCA Project Design

- Federally Managed (EPA)
 - QA program
 - Data management & analysis
 - Selection of core group of indicators
 - Standard field & lab protocols
- State Managed (DEP subcontracted with FWRI)
 - Field Sampling



NCCA Survey Design

- 93 sampling sites in Florida
- 10% resample to examine temporal variability (13 sites revisited in FL)



Selected Indicators

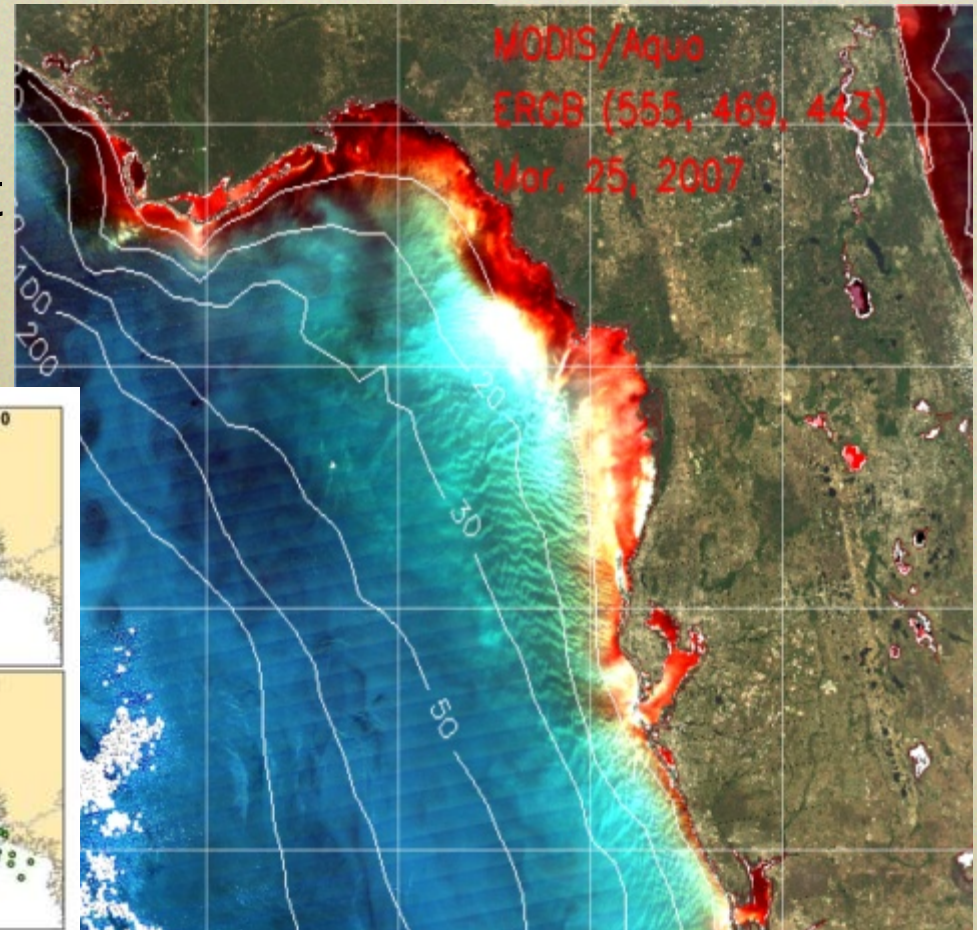
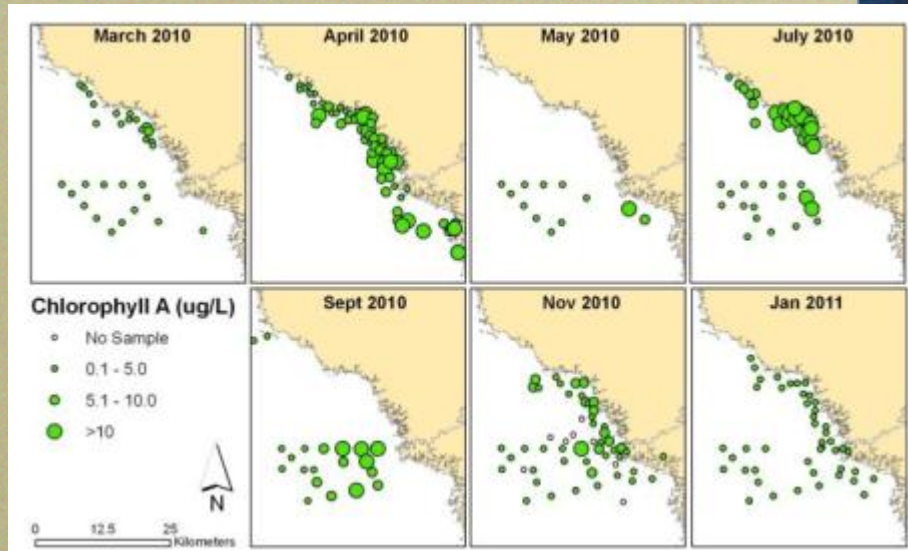
- In Situ Water Quality Measurements
- Light Attenuation
- Secchi Disk Transparency
- Water Chemistry
- Sediment Assessment
- Fecal Indicator (Enterococci)
- Benthic Macroinvertebrate Assemblage
- Habitat Assessment
- Fish Tissue



NASA Remotely Sensed Optical Water Quality



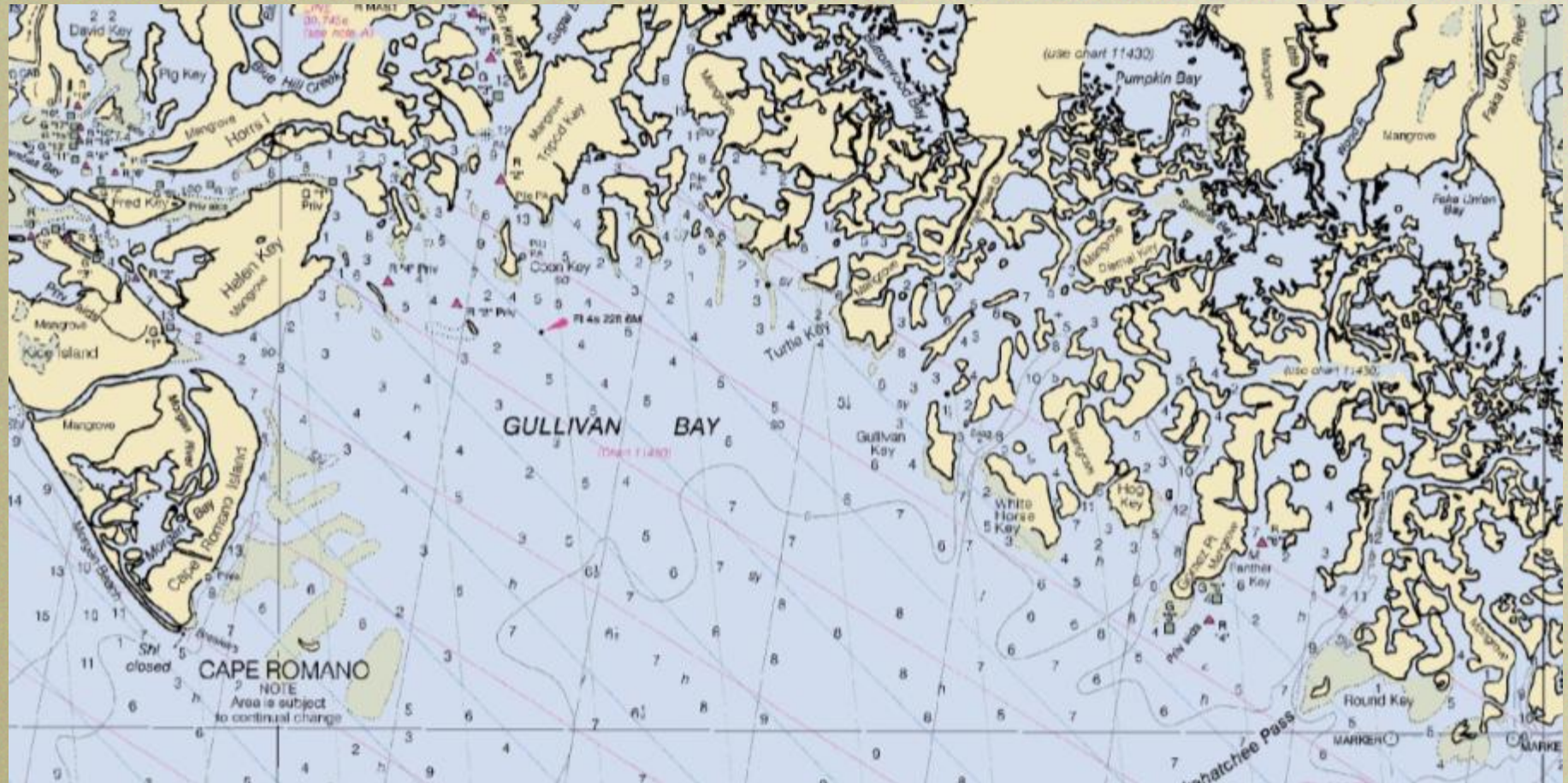
NASA Remotely Sensed Optical Water Quality project for decision support in the Suwannee Estuary



- Collaboration with FDEP and USF
- Calibrate satellite water quality products
- Hindcast water quality from 10 years of satellite data and compare to seagrass gains and losses in Big Bend.



SIMM- Seagrass Integrated Mapping and Monitoring



The SIMM Program- Seagrass Integrated Mapping and Monitoring

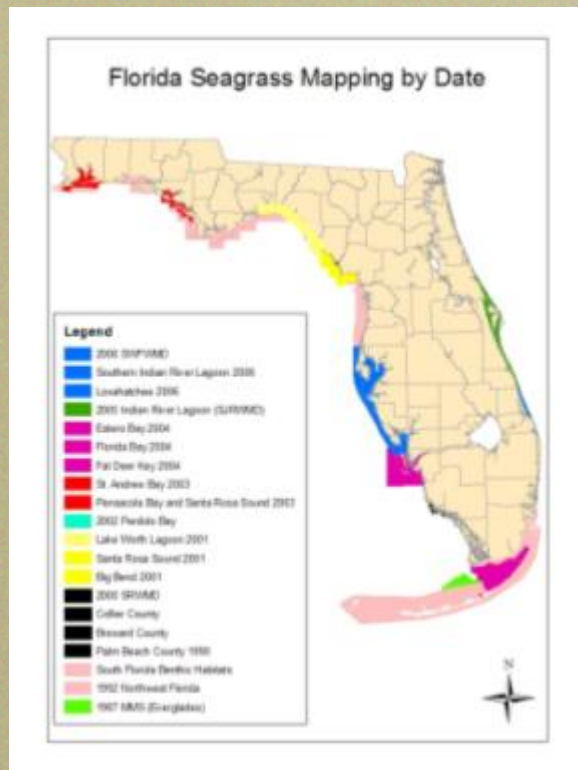
Program Elements

Map all seagrass within the State on a six-year cycle.

Monitor seagrass throughout Florida annually

Biennial monitoring report

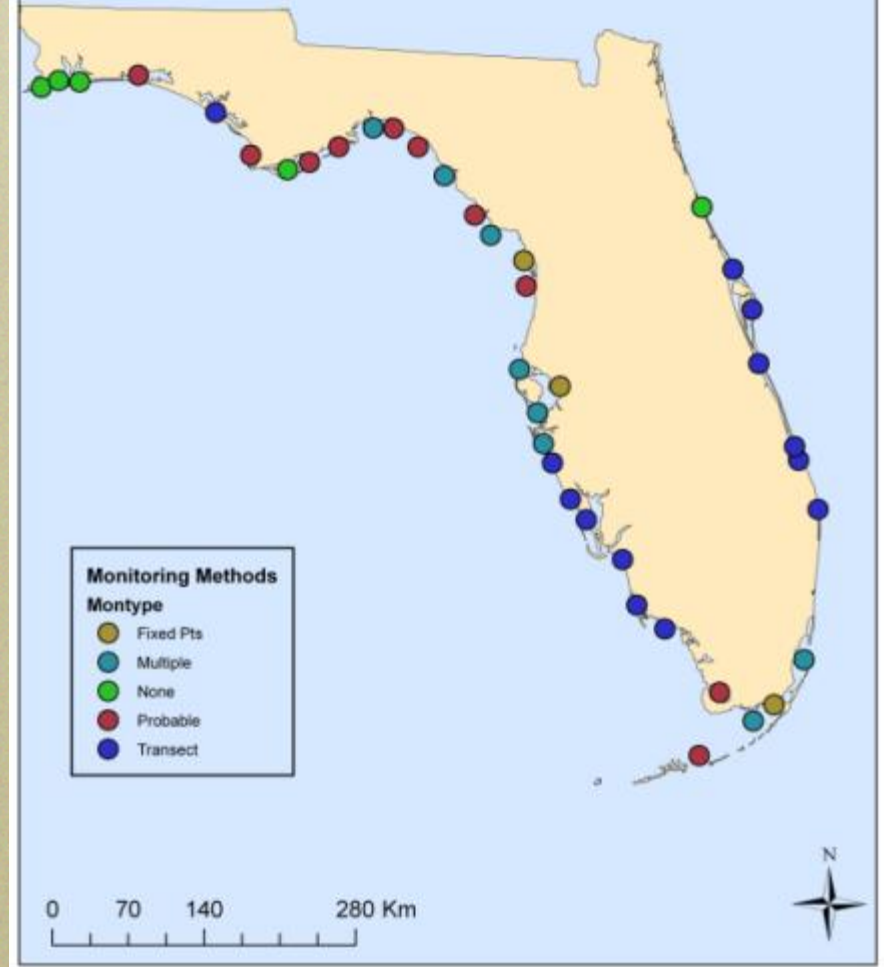
Hexennial mapping and monitoring report



Agencies Conducting Seagrass Monitoring



Seagrass Monitoring Techniques by Estuary





VEGETATION

- Braun Blanquet cover
- Epiphyte load
- Epiphyte light attenuation
- Biomass
- Morphometrics



WATER QUALITY

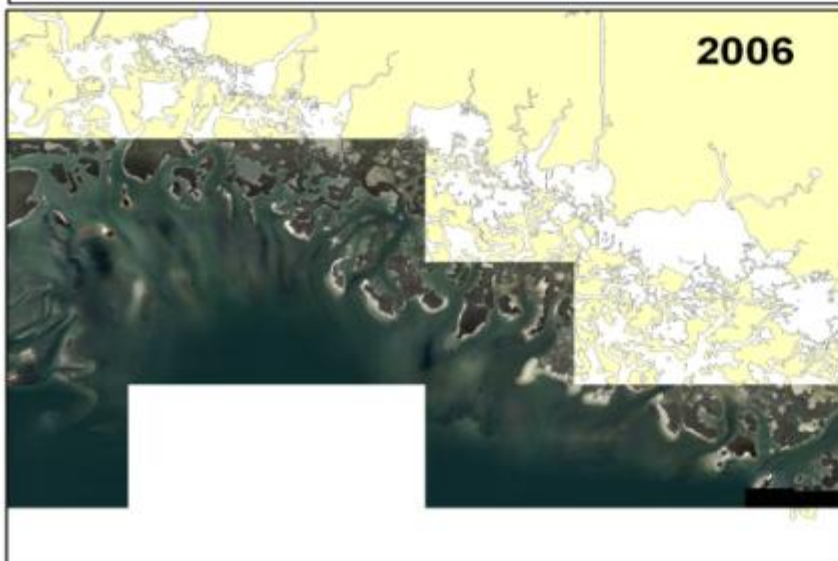
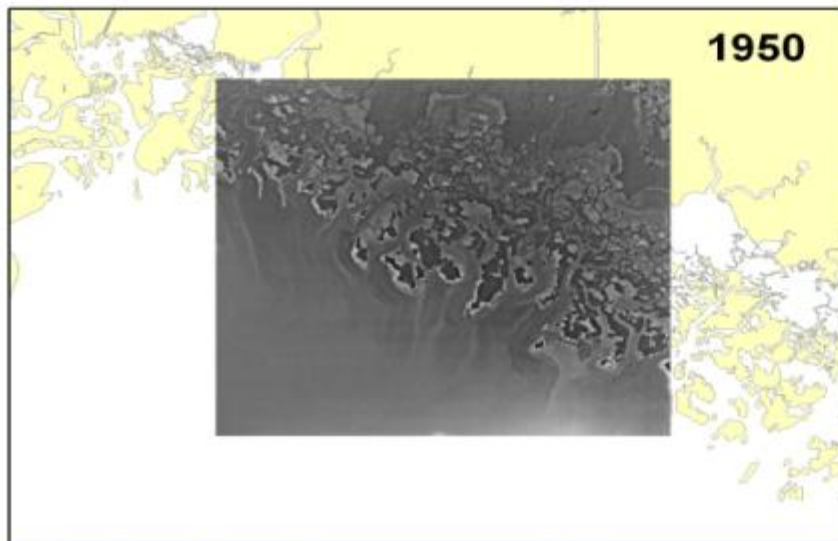
- Salinity, Temperature
- Secchi depth
- Water depth (MLW)
- PAR vertical profiles
- Color, turbidity
- Chlorophyll



Mapping and Monitoring are Complementary

<u>Characteristics</u>	<u>Mapping</u>	<u>Monitoring</u>
Spatial coverage	Large- 100s km ²	Small- 100s m ²
Spatial resolution	Coarse- 0.2 ha	Fine- 1m ²
Classification	Coarse- 9113,16	Fine- scalar
Species Comp	None	Complete
Revisit interval	Long- 5 to 10 y	Short- 6 to 12 mos
Data lag time	Long- 12 to 24 mo	Short- 1 to 2 mos





Ten thousand Islands



<http://atoll.floridamarine.org/MRAID> requires GE 5+



FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION
FISH AND WILDLIFE RESEARCH INSTITUTE

HOME

DATA

CONTACTS



MRAID Marine Resource Aerial Imagery Database

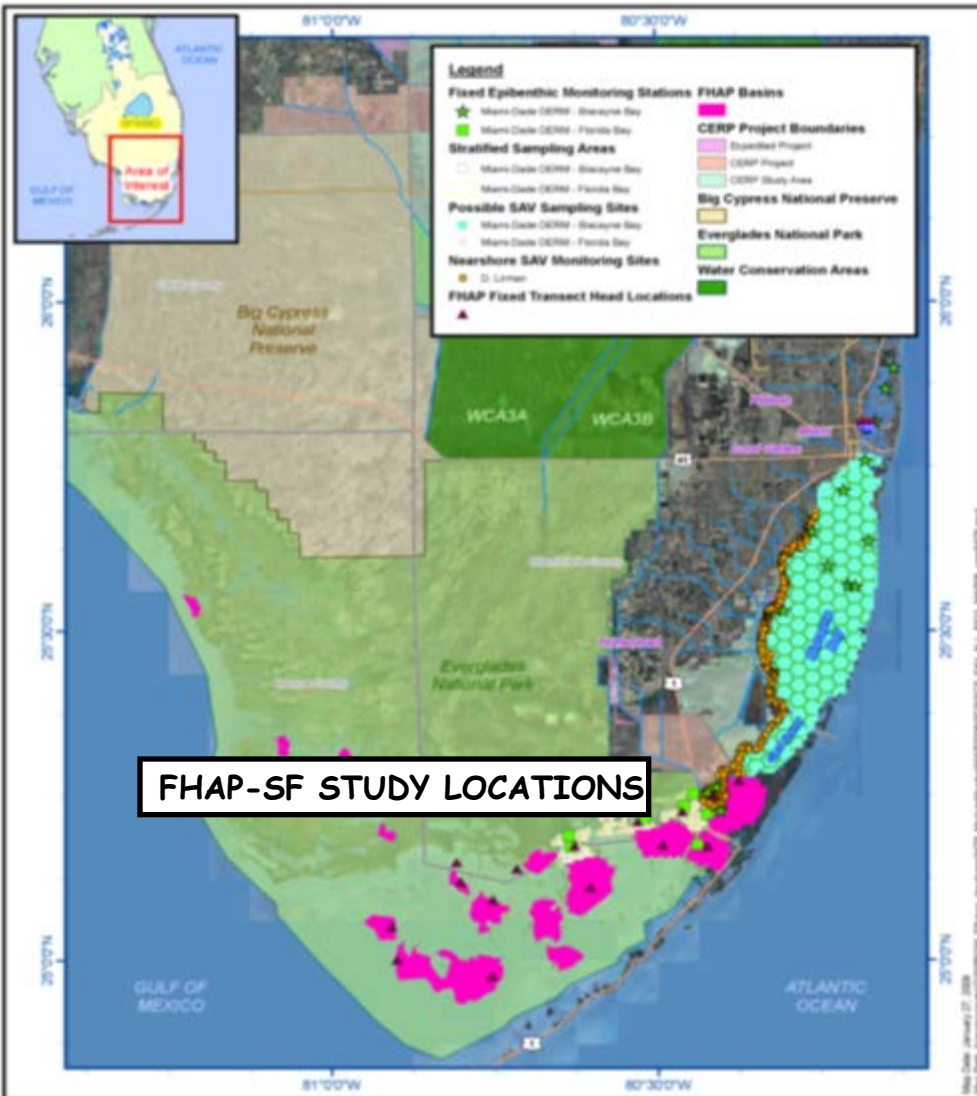




SOUTH FLORIDA FISHERIES HABITAT ASSESSMENT PROGRAM (SF-FHAP)



SOUTH FLORIDA FISHERIES HABITAT ASSESSMENT PROGRAM (FHAP-SF)

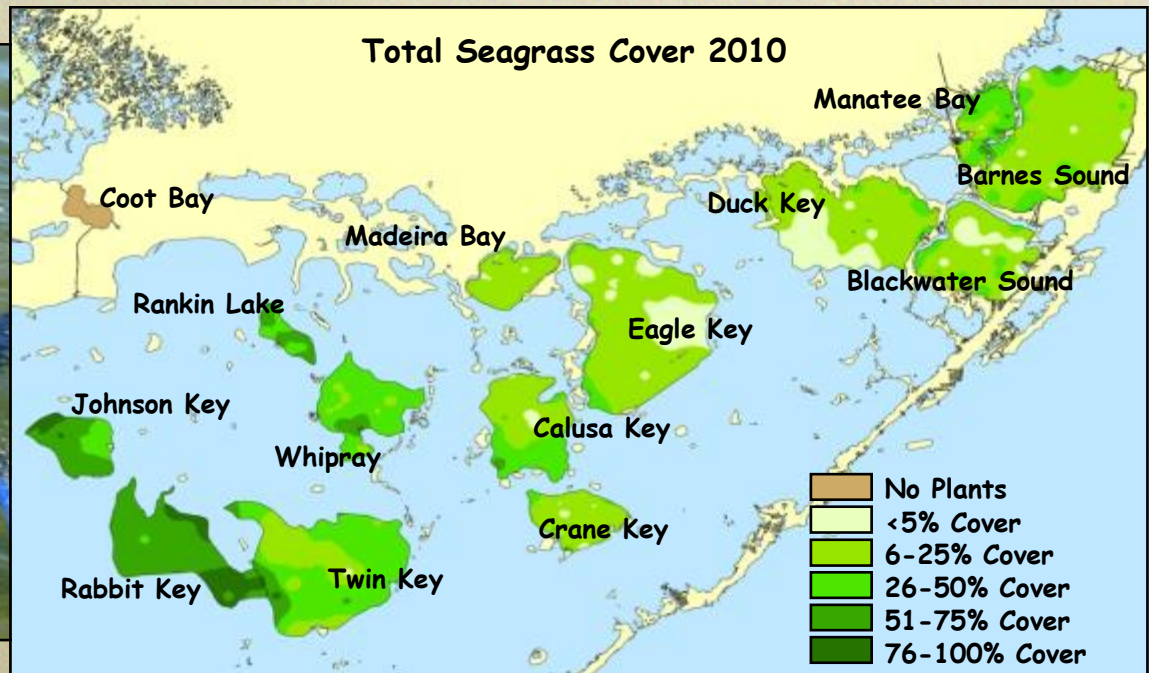


CHANGES IN SEAGRASS COMMUNITY STRUCTURE WILL BE USED AS THE CENTRAL PERFORMANCE MEASURE TO ASSESS CERP (COMPREHENSIVE EVERGLADES RESTORATION PROGRAM) EFFECTS IN SOUTH FLORIDA ESTUARIES.

WHY MONITOR SEAGRASSES?

- DOMINANT BENTHIC COMMUNITIES IN THE SOUTH FLORIDA COASTAL WATERS LIKELY TO BE AFFECTED BY CERP.
- PROVIDE CRITICAL FISHERIES HABITAT IN SOUTH FLORIDA REGION.
- SENSITIVE INDICATORS OF CHANGES IN WATER QUALITY CONDITIONS.





MAJOR OBJECTIVES OF FHAP-SF:

- TO DETERMINE THE DISTRIBUTION, ABUNDANCE, AND SPECIES COMPOSITION OF SEAGRASS COMMUNITIES IN THE SOUTH FLORIDA REGION (since 1995).
- TO DEVELOP A BASIC UNDERSTANDING OF RELATIONSHIPS AMONG WATER QUALITY PARAMETERS AND SEAGRASS COMMUNITY DYNAMICS.
- TO PROVIDE DATA TO SEPARATE ANTHROPOGENICALLY INDUCED CHANGES FROM NATURAL ECOSYSTEM VARIATION.



Halophila johnsonii Monitoring



Monitoring efforts for *Halophila johnsonii* throughout its southern range

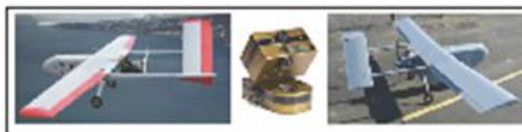
Halophila johnsonii (Hj) is a threatened species of seagrass that only occurs on the southeast coast of Florida.

FWRI was tasked with annual monitoring of the southern range of Hj from 2006 through 2015. At the end of the 10 yr period, results will be used to help determine possible delisting of the species.

30 sites, from Jupiter Inlet down to Biscayne Bay, are monitored for Braun-Blanquet seagrass and algal abundances, seagrass canopy heights, seagrass short shoot counts, and water quality parameters.



High Resolution Assessment of Carbon Dynamics In Seagrass and Coral Reef Biomes



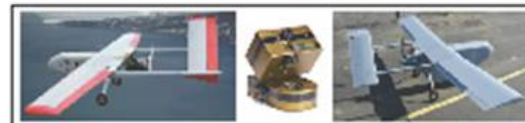
Project Timeline

Date: 10 August 2011

- **Phase 1** (August, 2011): Define Science Research Objectives and Data Requirements
- **Phase 2** (August-September, 2011): Establish Airborne and Ground-Based Data Acquisition Methods
- **Phase 3** (September-October, 2011): Payload Integration
 - Hyperspectral sensor installation in SIERRA and Bat-4 UAV pods
 - Lab-based testing
 - Analysis of lab-based data
- **Phase 4** (November 2011-March 2012): Predeployment Airborne Testing of Integrated Payload
 - Test flights of integrated SIERRA and Bat-4 UAVs at Crows Landing, CA
 - Analysis of airborne data
- **Phase 5** (late April-early May 2012): Airborne and Ground-Based Data Collection at Cedar Key, Florida
- **Phase 6** (late May-early June 2012): Airborne and Ground-Based Data Collection at Buccoo Reef, Tobago
- **Phase 7** (early November 2012): Airborne and Ground-Based Data Collection at Cedar Key, Florida
- **Phase 8** (early December 2012): Airborne and Ground-Based Data Collection at Buccoo Reef, Tobago



High Resolution Assessment of Carbon Dynamics In Seagrass and Coral Reef Biomes



Research Team: Principal Investigator (PI) & Co-Investigators (Co-I)

PI, Stanley Herwitz, Ph.D.
UAV Collaborative
NASA Research Park

Co-I, Frank Muller-Karger, Ph.D.
Institute for Marine Remote Sensing
University of South Florida (USF)

Co-I, Chuanmin Hu, Ph.D.
Optical Oceanography Laboratory
University of South Florida (USF)

Co-I, Paul Carlson, Ph.D.
Florida Fish and Wildlife Research Institute

Co-I Kimberly Yates, Ph.D.
St. Petersburg Coastal and Marine Science Center
U.S. Geological Survey (USGS)

Co-I, Deanesh Ramsewak
Institute of Marine Affairs, Trinidad-Tobago

Executive Summary

Coral reef and seagrass coastal biomes have been shaped throughout geologic history by global-scale earth processes including geomorphological changes, climate change, and physical and chemical changes in seawater. Despite significant advances, several key questions remain unanswered due to technology limitations and the lack of coordinated and concurrent multi-disciplinary measurements. Understanding the productivity dynamics of these vulnerable nearshore environments is critical for assessing their current state and predicting their response to the effects of global climate change (e.g., sea level rise; changes in seawater chemistry and temperature). Our proposed research objective is to determine the optimal spatial, temporal, and spectral resolutions for monitoring the productivity dynamics of these optically-complex biomes. Repeated high-resolution airborne observations of diurnal and seasonal variation will be made at representative sites in the Gulf of Mexico and the Caribbean Sea (Cedar Key in Florida at 29°8'N, 83°3'W; and Buccoo Reef in Tobago at 11°10'N, 60°4.5'W) using two low-flying long-duration Unmanned Aircraft Systems (UAS) equipped with complementary hyperspectral sensors. The airborne datasets will be augmented by simultaneous in-water measurements and satellite data. We predict that our coordinated inter-disciplinary earth science mission will provide new insights into coastal benthic productivity dynamics, and new advancements in remote sensing technology. These new advancements will be made available to coral reef and seagrass monitoring programs, providing a tool for acquiring data in remote areas of the world where traditional in-water methods are logistically difficult or limited in spatial coverage. Our proposed earth science mission also will serve as a valuable guide for the design of current and future aerial and satellite platforms, and will serve as a timely baseline study for NASA's GeoCape and HypSIRI Decadal Survey Missions.



CORAL Monitoring



CREMP is funded by the US EPA and NOAA



MONITORING OF CORAL REEF HABITATS

- Identify status and trends of coral reef resources in three geographical areas (Dry Tortugas, Florida Keys, Southeast Florida) to provide EPA, NOAA, NPS, and FDEP Resource Managers with data to evaluate condition of resource



ESA Listed *Acropora cervicornis* in the Dry Tortugas



Objectives & Methods

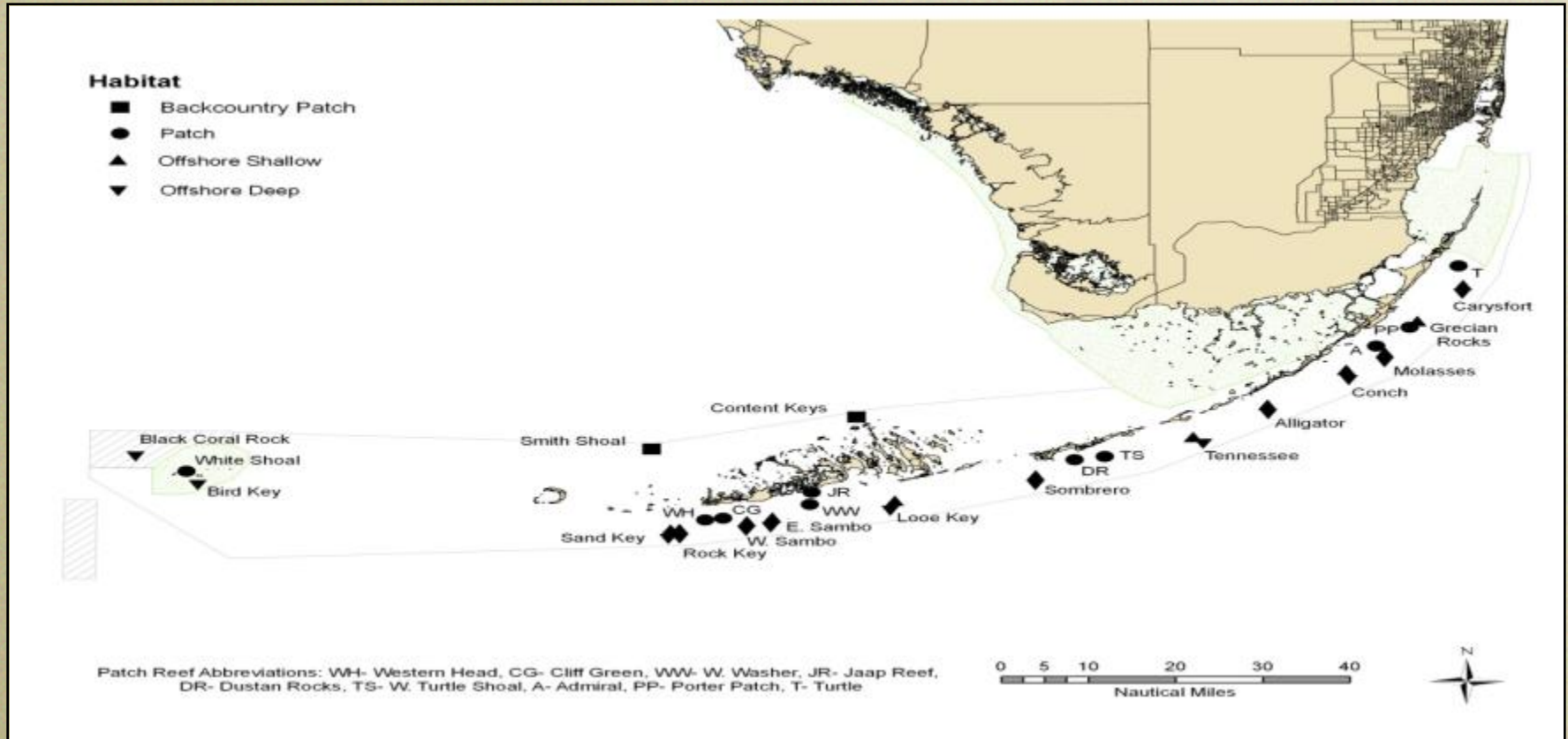
- Established permanent monitoring sites starting in 1996 and uses of a repeated measures design that provides information on the temporal changes in benthic cover and diversity of stony corals and associated marine flora and fauna.
- The core field methods are underwater videography and timed surveys that determine stony coral species richness, abundance, and condition (e.g. incidence, prevalence, and severity of coral diseases and bleaching).



Diver conducting a timed survey



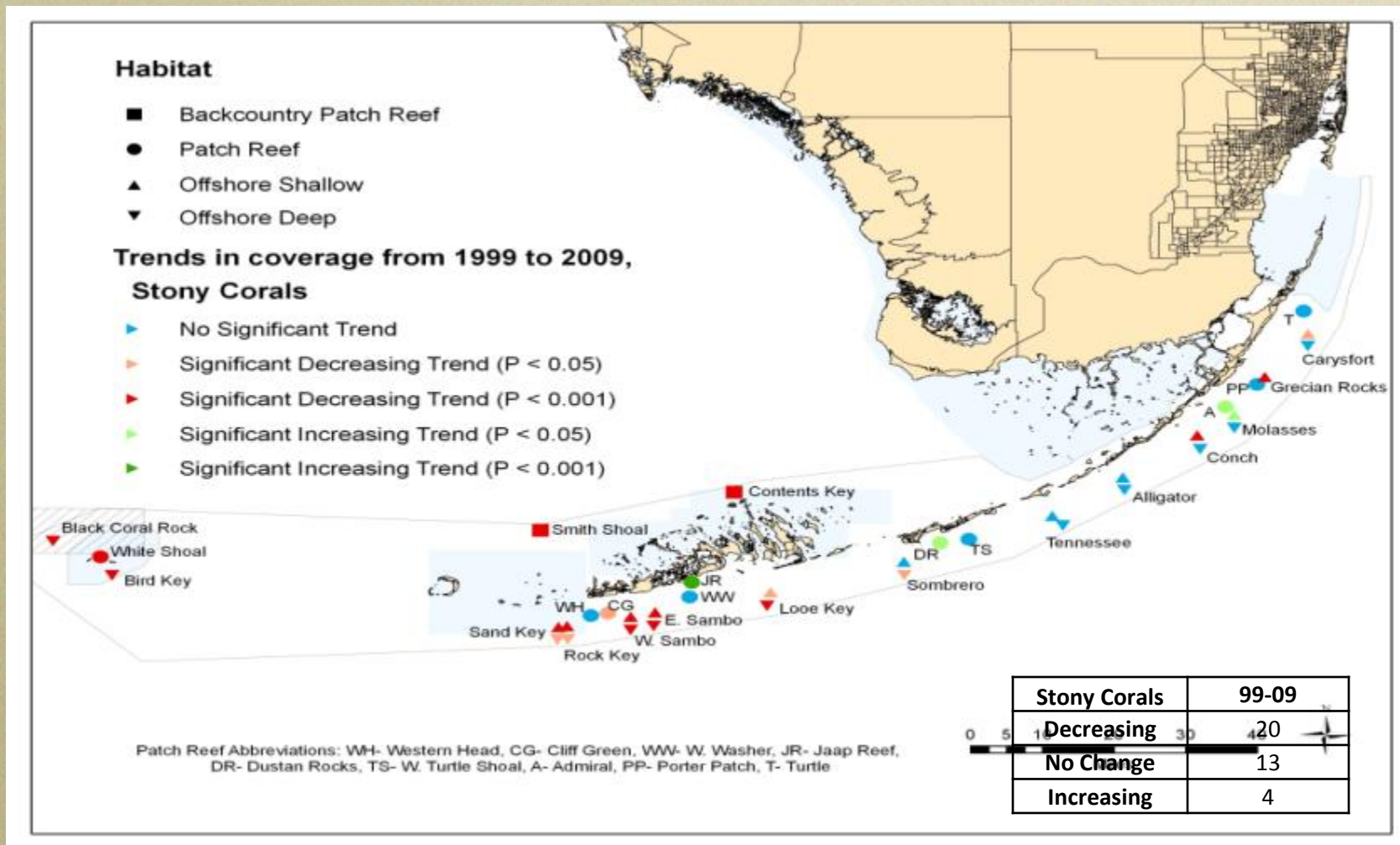
Current Sampling Effort



- Peak Sampling effort reached in 1999 (172 stations at 43 fixed sites) in Florida Keys & Dry Tortugas
- Data presented here includes 109 stations at 37 sites.
- Expansion into SE FL (SECREMP) and Dry Tortugas



Trends in Coral Cover



N varies per site; Mixed Model Regression; non-adjusted p values

- Negative trend for 54% of all sites
- Trend is negative for 13 of 16 of sites in Lower Keys



GIS Analyses

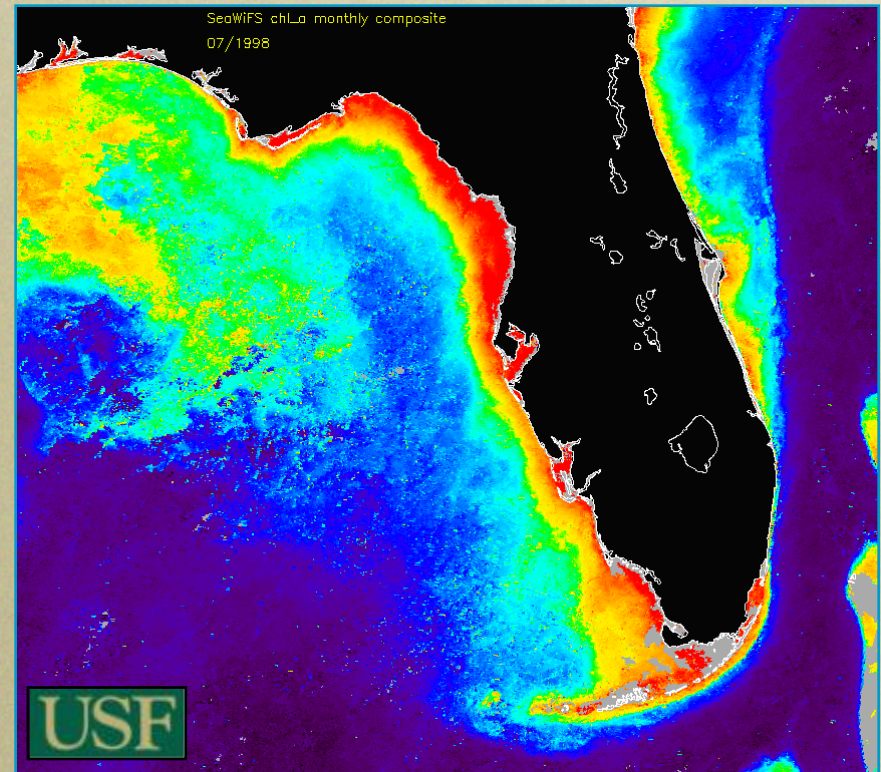


Water Clarity

Satellite-derived water quality (USF) over coral reefs are calibrated/validated from *in situ* data

Annual field surveys
with EPA

Maintain a permanent
optics package in
Key Largo



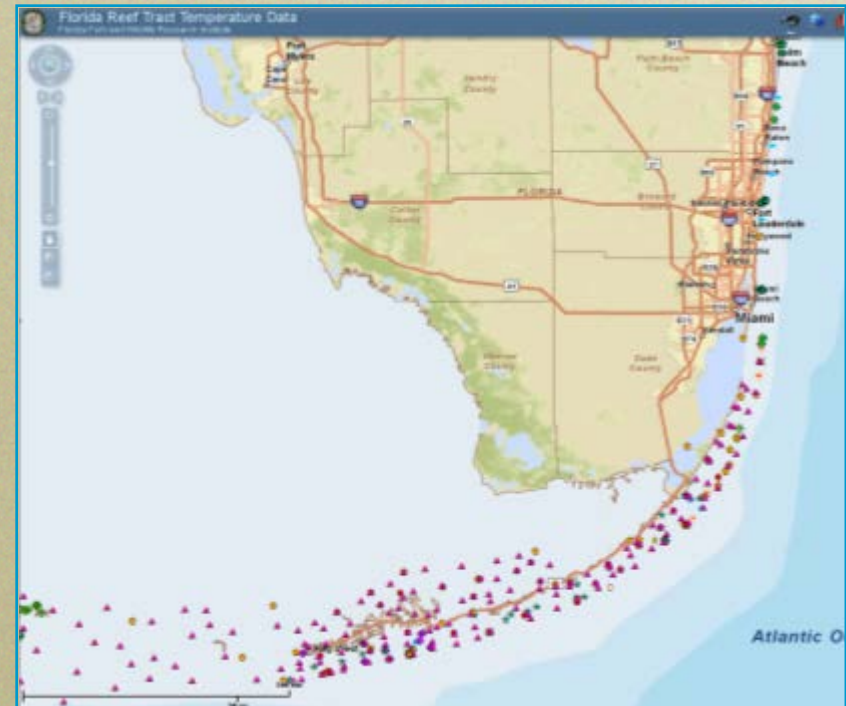
Water Temperature

Satellite-derived sea-surface temperature is used in conjunction with *in situ* temperature sensors at benthos

Deriving bottom vs. surface T relationship

In situ sensors from many agencies

Data are shared online



Harmful Algal Bloom(HAB)Monitoring



Harmful Algal Bloom(HAB)Monitoring:

- samples collected by HAB staff, volunteers, state & local agencies, researchers
- weekly regional HAB status reports inform public, state and local resource managers, and provide data to groundtruth satellite detection and forecasting models (NOAA, USF).
- Provide HAB data in support of FDACS management of shellfish harvesting areas
- Phytoplankton species ID and enumeration,
- When possible, coincident environmental data (temperature, salinity, DO)
- (Slide 2 – sample of typical coverage for weekly HAB monitoring. We report on *Karenia* (although monitor for all HAB spp) and are heavily focused on central and SW coast where red tides occur most often.



Statewide *Karenia brevis*
concentrations
05/21/2011 - 05/28/2011

Karenia brevis scale (cells/liter)

- NOT PRESENT – BACKGROUND (0 to 1,000)
- VERY LOW (>1,000 to 10,000)
- LOW (>10,000 to 100,000)
- MEDIUM (>100,000 to 1,000,000)
- HIGH (>1,000,000)



Data: SIO, NOAA, U.S. Navy, NGA, GEBCO
Image: USDA Farm Service Agency

132 mi

lat 27.767029° lon -83.715978° elev 0 ft

©2008 Google

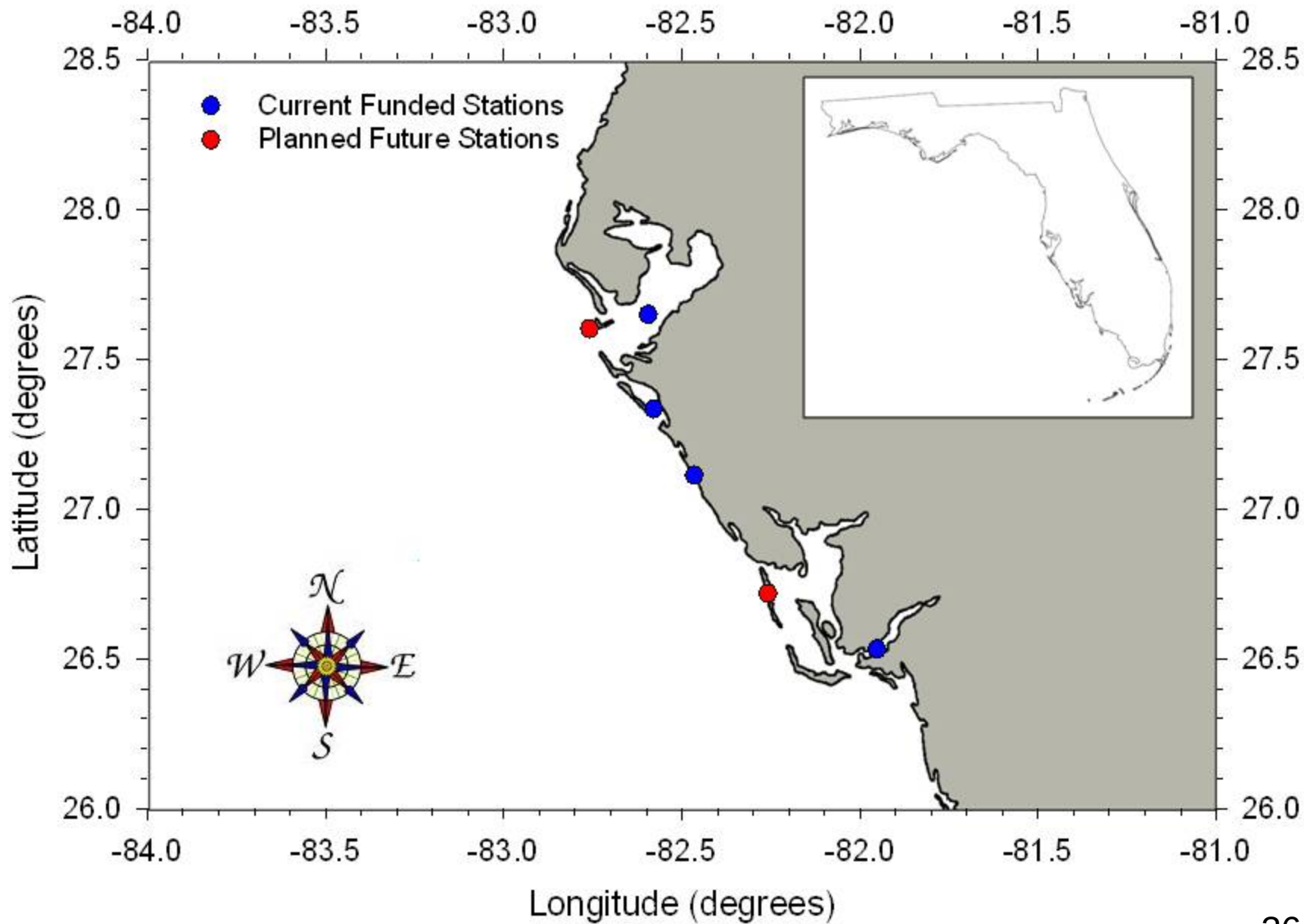
Eye alt 436.71 mi

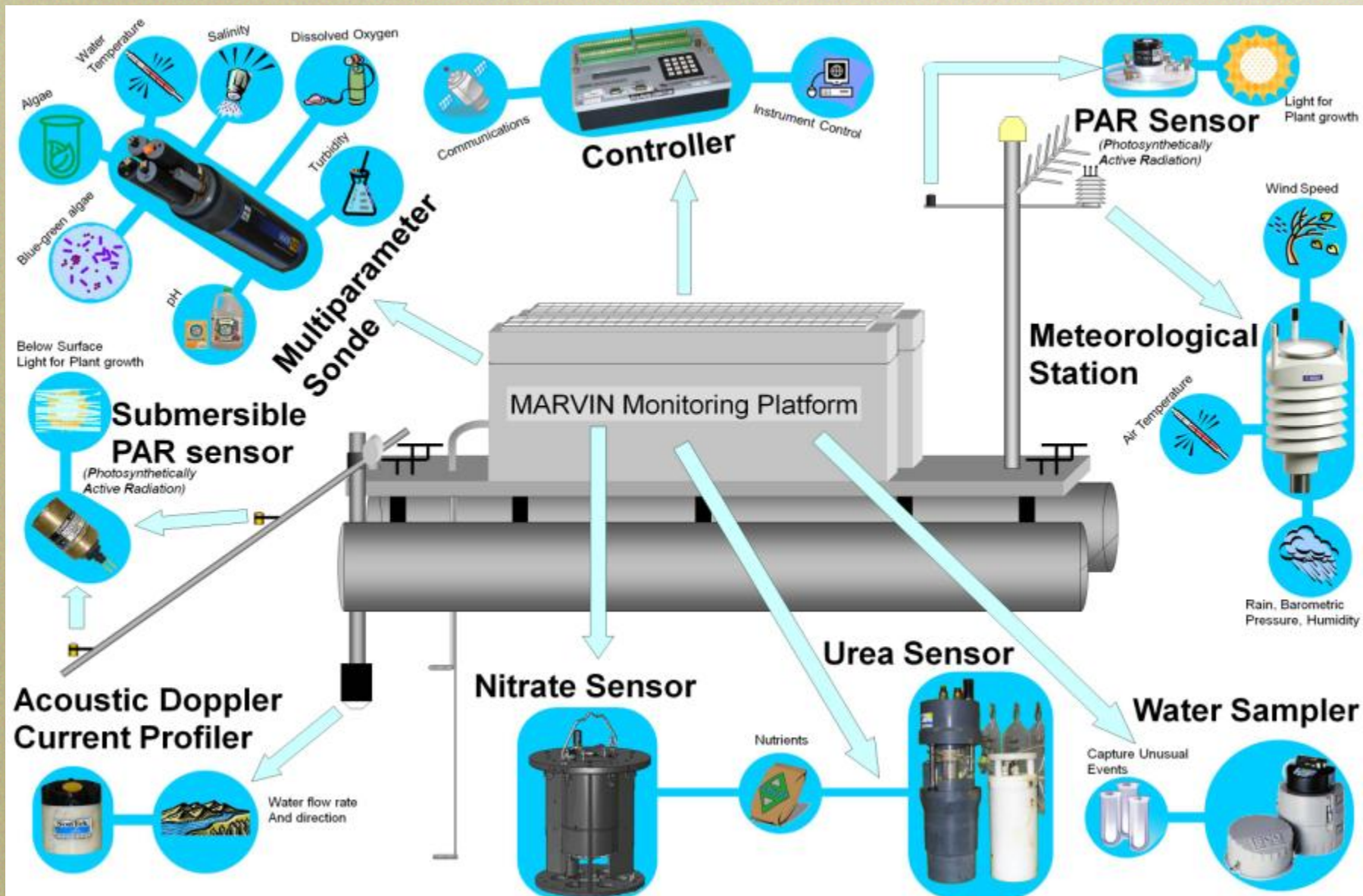


MARVIN



MARVIN

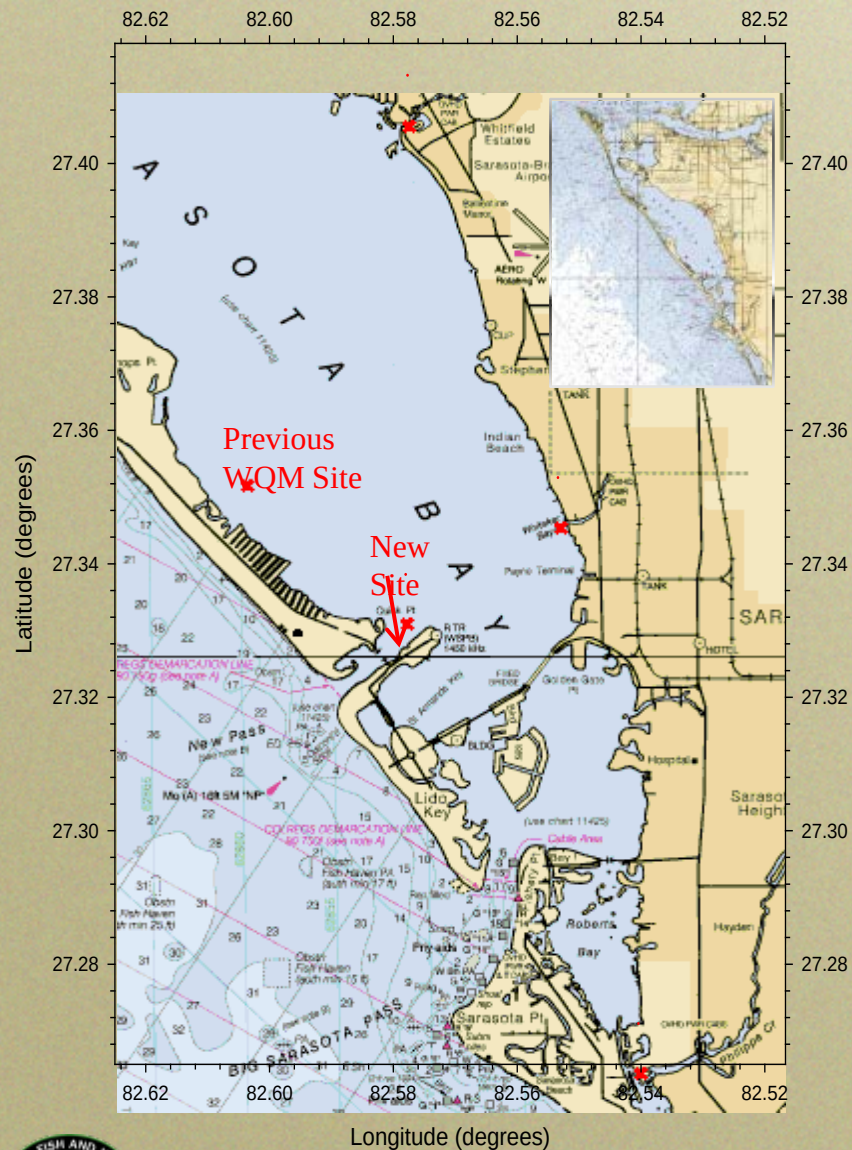




Instrument	Measurement	Final Output	Sample Location
YSI 6600 Data Sonde	Chlorophyll	$\mu\text{g l}^{-1}$	Sfc and Bottom
YSI 6600 Data Sonde	Salinity	Practical Salinity Units	Sfc and Bottom
YSI 6600 Data Sonde	Temperature	Degrees Celsius	Sfc and Bottom
YSI 6600 Data Sonde	pH	pH	Sfc and Bottom
YSI 6600 Data Sonde	Phycocyanin	Cells l^{-1}	Sfc and Bottom
YSI 6600 Data Sonde	Dissolved Oxygen	mg l^{-1}	Sfc and Bottom
YSI 6600 Data Sonde	Dissolved Oxygen	Percent saturation	Sfc and Bottom
YSI 6600 Data Sonde	Turbidity	Nephloid Turbidity Units	Sfc and Bottom
YSI 9600	Nitrate	$\mu\text{M l}^{-1}$	Sfc and Bottom
Envirotech	Urea	$\mu\text{M l}^{-1}$	Bottom
Vaisala WXT-520	Wind Speed	m s^{-1}	4 m above surface
Vaisala WXT-520	Temperature	Degrees Celsius	4 m above surface
Vaisala WXT-520	Precipitation	Inches hr^{-1}	4 m above surface
Vaisala WXT-520	Barometric Press.	inches hg	4 m above surface
Vaisala WXT-520	Relative Humidity	percent	4 m above surface
Licor LI-190	Downwelling PAR	$\mu\text{einsteins m}^{-2} \text{s}^{-1}$	4 m above surface
Licor LI-192	Downwelling PAR	$\mu\text{einsteins m}^{-2} \text{s}^{-1}$	Sfc and one meter
Sontek ADCP	Current	m s^{-1}	North, South & up
Sontek ADCP	Water depth	m	Water column



Typical Data Set



Sarasota Bay, Florida Map: Station locations are depicted as red X's. The previous HAB –MAPP site is located at Station 3. The HAB-MAPP location is indicated by the red arrow.

The standard field sampling parameters: cell counts, dissolved inorganic nutrient (NO_3 , NO_2 , SiO_4 , and PO_4), particulates (C, N, and P), total dissolved N and P, biogenic Si, urea, and size fractionated chlorophyll *a*. YSI Sonde casts measure over depth; salinity temperature, dissolved oxygen, turbidity, chlorophyll fluorescence, phycocyanin fluorescence, and pH.

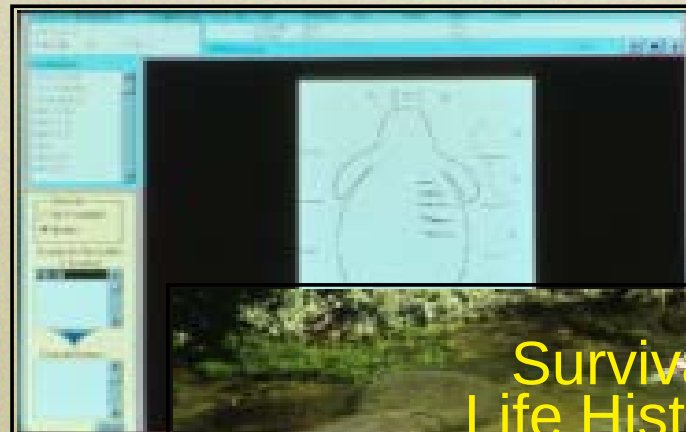
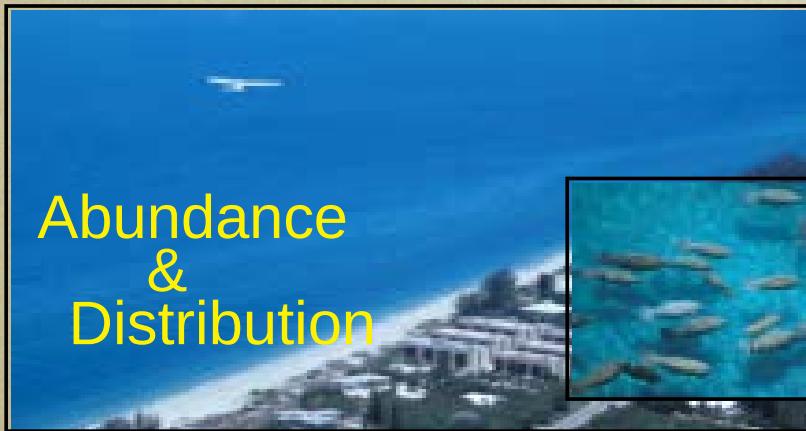


The Florida Manatee



Manatee Monitoring

Abundance
&
Distribution



Survival &
Life History



Mortality



Rescue



Movement
& Behavior



Mortality

Carcass Salvage & Necropsy

Determine cause of death



Population Monitoring

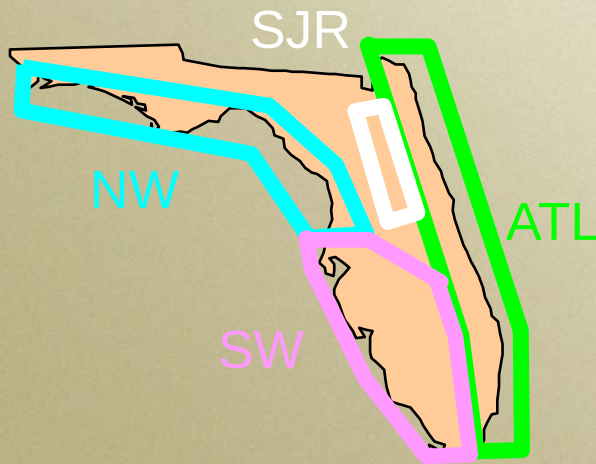
Purpose of Aerial Surveys:

- (1) Abundance
- (2) Seasonal Distribution & Habitat

Statewide Synoptic Survey

Highest Count = 5076 (Jan 2010)

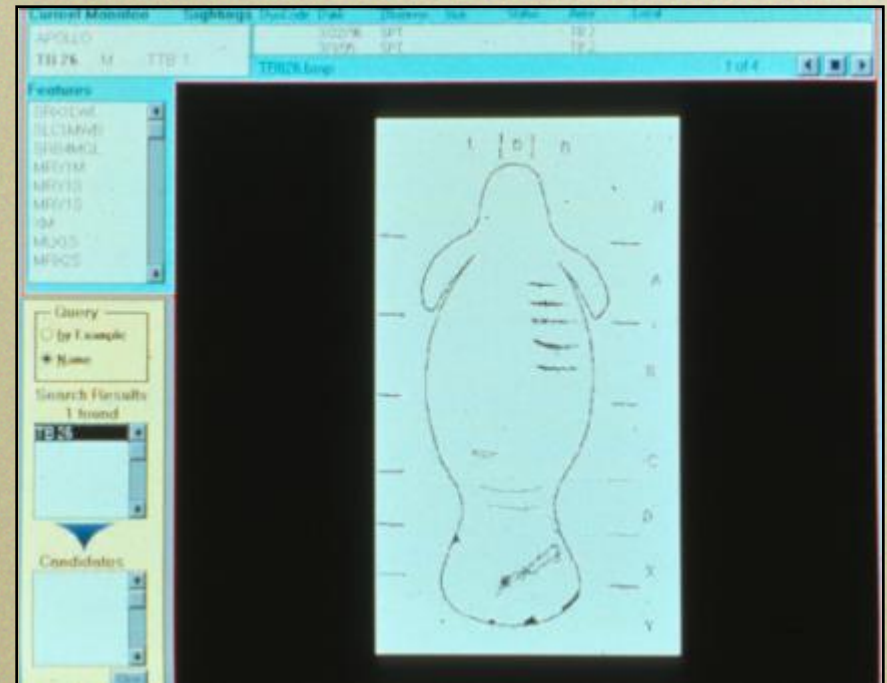
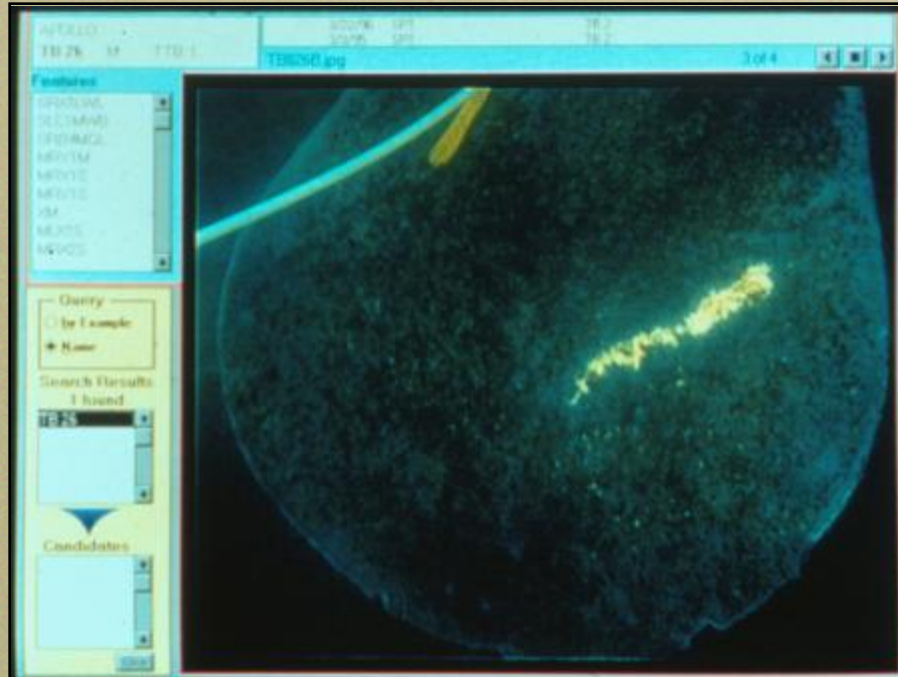
4 Subpopulations



Survival & Life History

Manatee Individual Photo-identification System

- ❑ Identify individual manatees by unique scar patterns
- ❑ Computerized catalog facilitates matching



Survival & Life History

Manatee Individual Photo-identification System

- ❑ Survival Rate (sight-resight analyses)
- ❑ Reproductive Traits
- ❑ Long-term Movements
- ❑ Site Fidelity
- ❑ Provides essential data for population models



Movement and Behavior

Satellite-linked Radio-telemetry (Argos System)

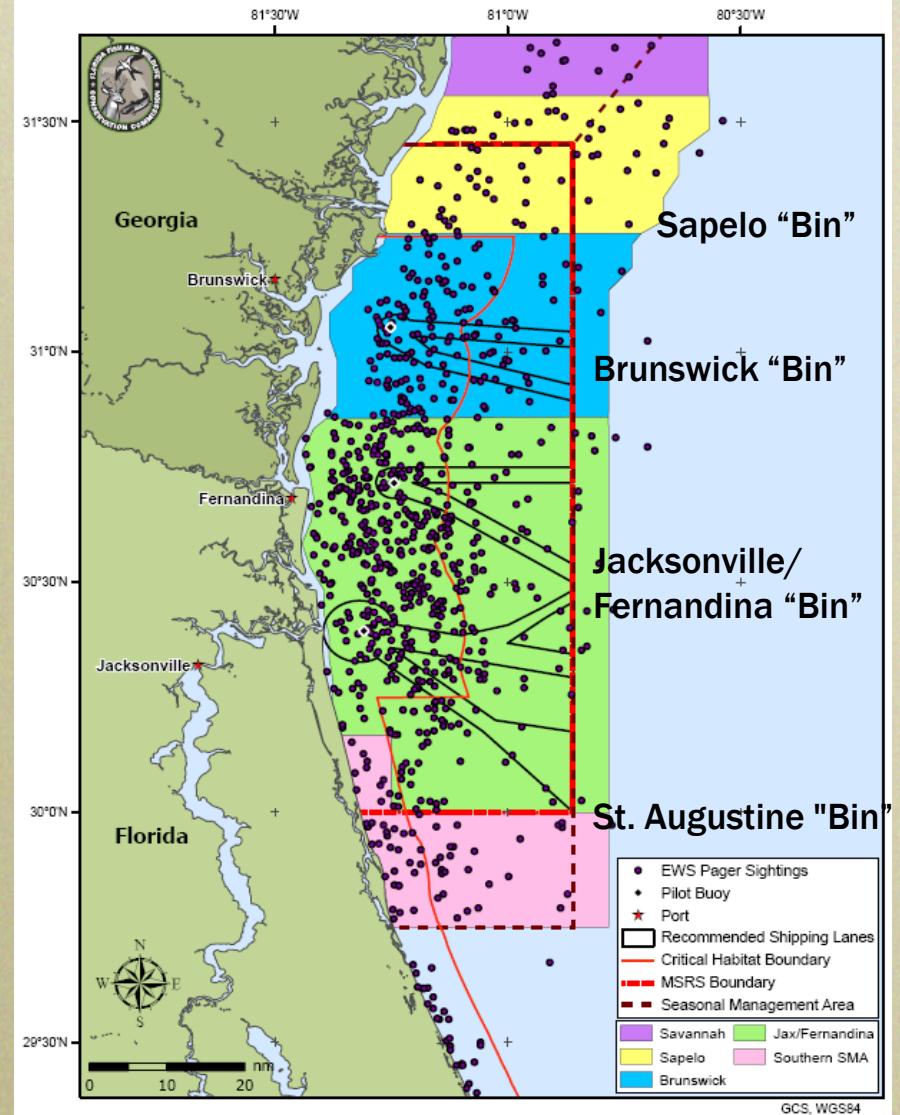
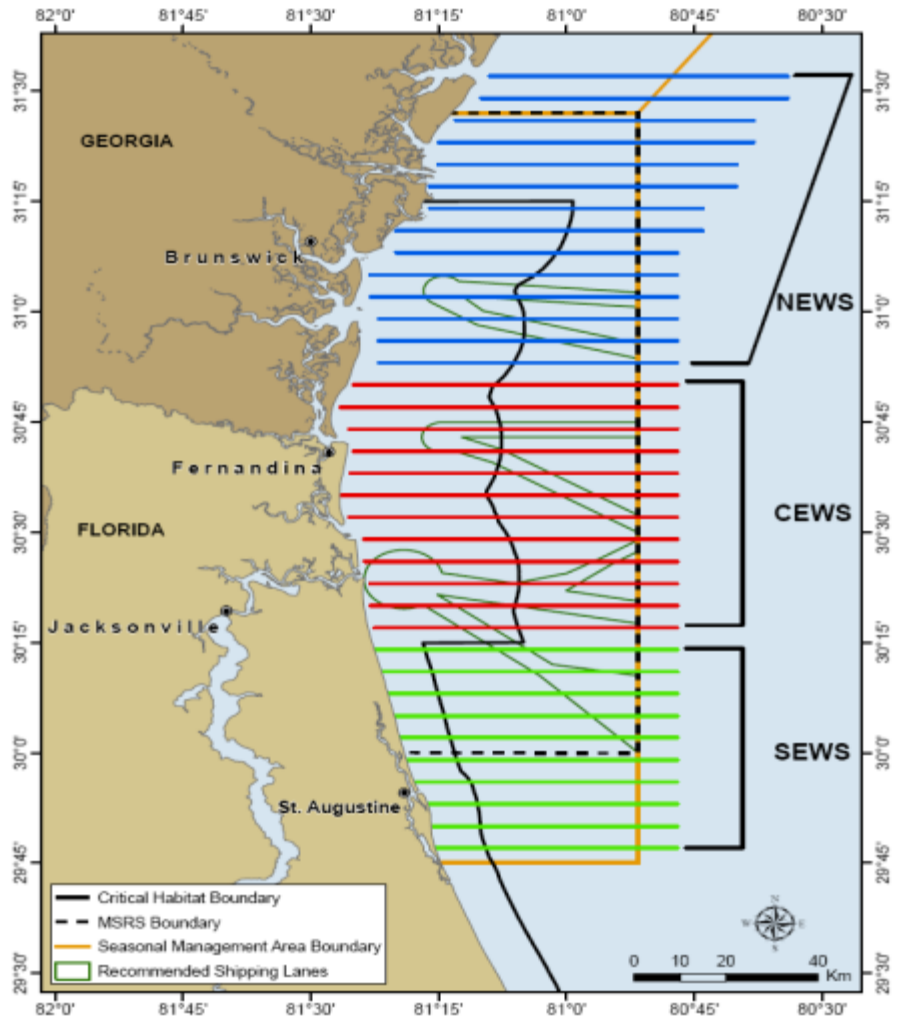
- ❑ Seasonal Migrations
- ❑ Habitat Use
- ❑ Home Range & Site Fidelity
- ❑ Daily movement patterns



North Atlantic Right Whales



Early Warning System (EWS) Survey Tracklines



Early Warning System (EWS)



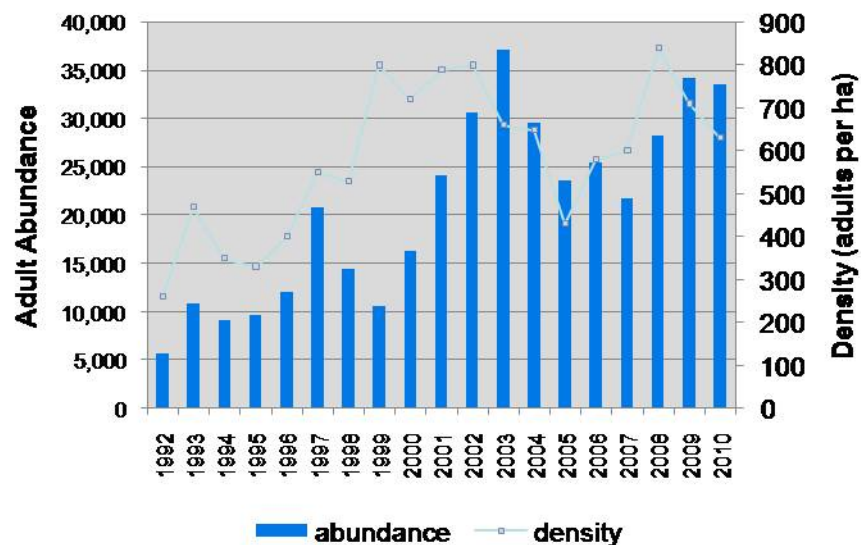
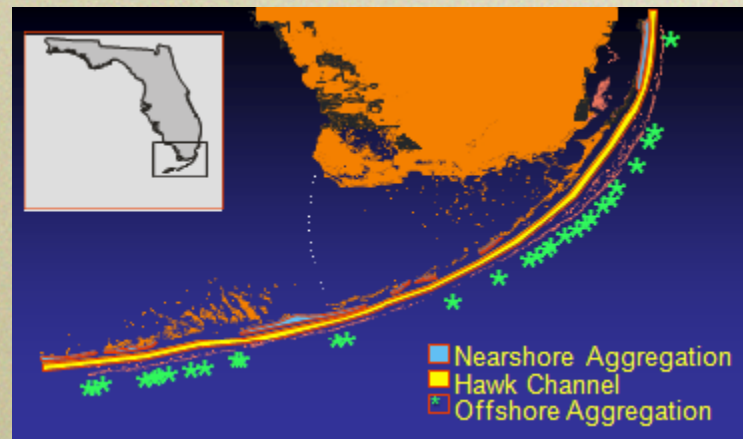
Fisheries Monitoring





Queen Conch Monitoring

- Conch spawning stock monitoring to examine recovery of stock
- Recovery has been slow
- Annually since 1992



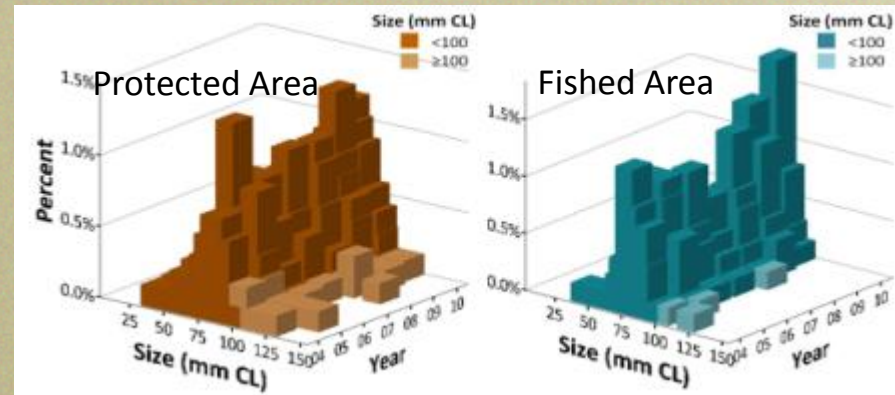
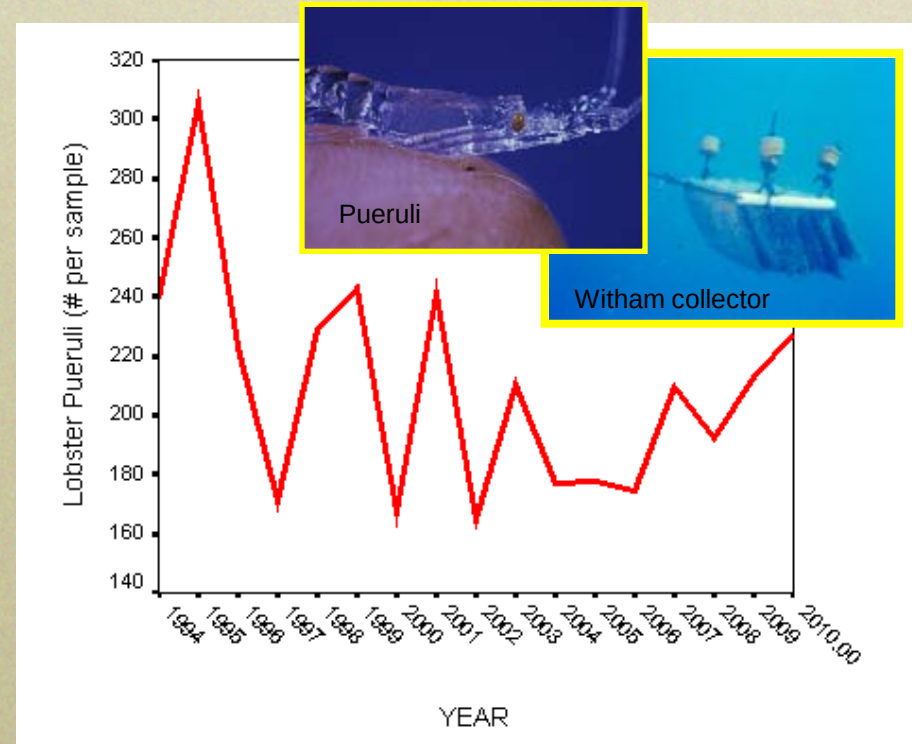
Spiny Lobster Monitoring

- Postlarvae are captured each month on collectors to assess annual recruitment to the Florida Keys.

- Recruitment varies but poorly corresponds with adult abundance.
- Monthly since 1994

- Lobsters are surveyed in fished and unfished areas to assess changes in lobster abundance and size.

- Large unfished areas contain more and larger lobsters than fished areas.
- Annually since 1997



Keys Finfish Research Monitoring Programs

Reef Visual Census (Point Counts). Joint Program

FWC/NOAA/UM/NPS

- Document reef fish community composition, abundance, and size structure and determine changes in these parameters over time within the Florida Keys region.
- Special attention is paid to exploited reef fish species (snappers and groupers).
- Annually since 2002



Stratified-random Seine sampling in near shore seagrasses of the middle Keys.

- Cost-effective sampling program to develop reliable recruitment indices for reef fishes.
- Determine the effect of spatial (e.g. location, habitat) and temporal factors (e.g. season, lunar phase, tides) on abundance of reef fishes.
- Monthly since 2006

Mutton snapper



Typical catch



21.3m offshore seine net
with 3.2mm mesh





Fisheries-Dependent Monitoring (FDM)

Mandatory since 1984

1,200 licensed commercial dealers

15,000 licensed commercial fishers

350,000 trip tickets edited annually

Data submitted monthly

Average annual harvest: 120 M pounds

Average annual value: \$200 M



Marine Fisheries Trip Ticket Program



Fisheries-Dependent Monitoring (FDM)

Biostatistical Sampling

8 Samplers in 7 locations

(Pensacola, Cedar Key, St.
Petersburg, Port Charlotte,
Marathon, Melbourne,
Jacksonville)

1,500 trip interviews conducted and
100,000 fish measured annually

Data collected: species,
length, weight, gender,
hard parts

At-sea observations





FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION

**Florida Marine Research Institute
Marine Fisheries Trip Ticket Office**
100 8th Avenue SE
St. Petersburg, FL 33701-5020
727-822-8783

Marine Fisheries Trip Ticket FISHING AREA CODE MAP

Fishery Management Regulations can be found at the following Web sites:

Federal Waters

South Atlantic Fishery Management Council www.safmc.net/

Gulf of Mexico Fishery Management Council www.gulfcouncil.org/

NOAA Fisheries www.nmfs.noaa.gov

National Marine Fisheries Service Southeast Regional Office caldera.sero.nmfs.gov/

State Waters

Florida Fish & Wildlife Conservation Commission www.floridacommervation.org

Our Website

Florida Marine Research Institute www.floridamarine.org

FWC FMRI St Petersburg

Marine Fisheries Trip Ticket Office 727/822-8783

FMRI Fax (Trip Ticket Office) 727/894-6181

Florida Marine Research Institute 727/896-8626

FWC Tallahassee

Division of Marine Fisheries 850/487-0554

Licenses and Permits Section 850/487-3122

Marine Fisheries Management 850/488-6058

Marine Fisheries Services 850/922-4340

LAW ENFORCEMENT 888/404-3922

National Marine Fisheries Service

St. Petersburg—Fisheries Mgmt. 727/570-5305

St. Petersburg—Permits 727/570-5326

Federal Councils

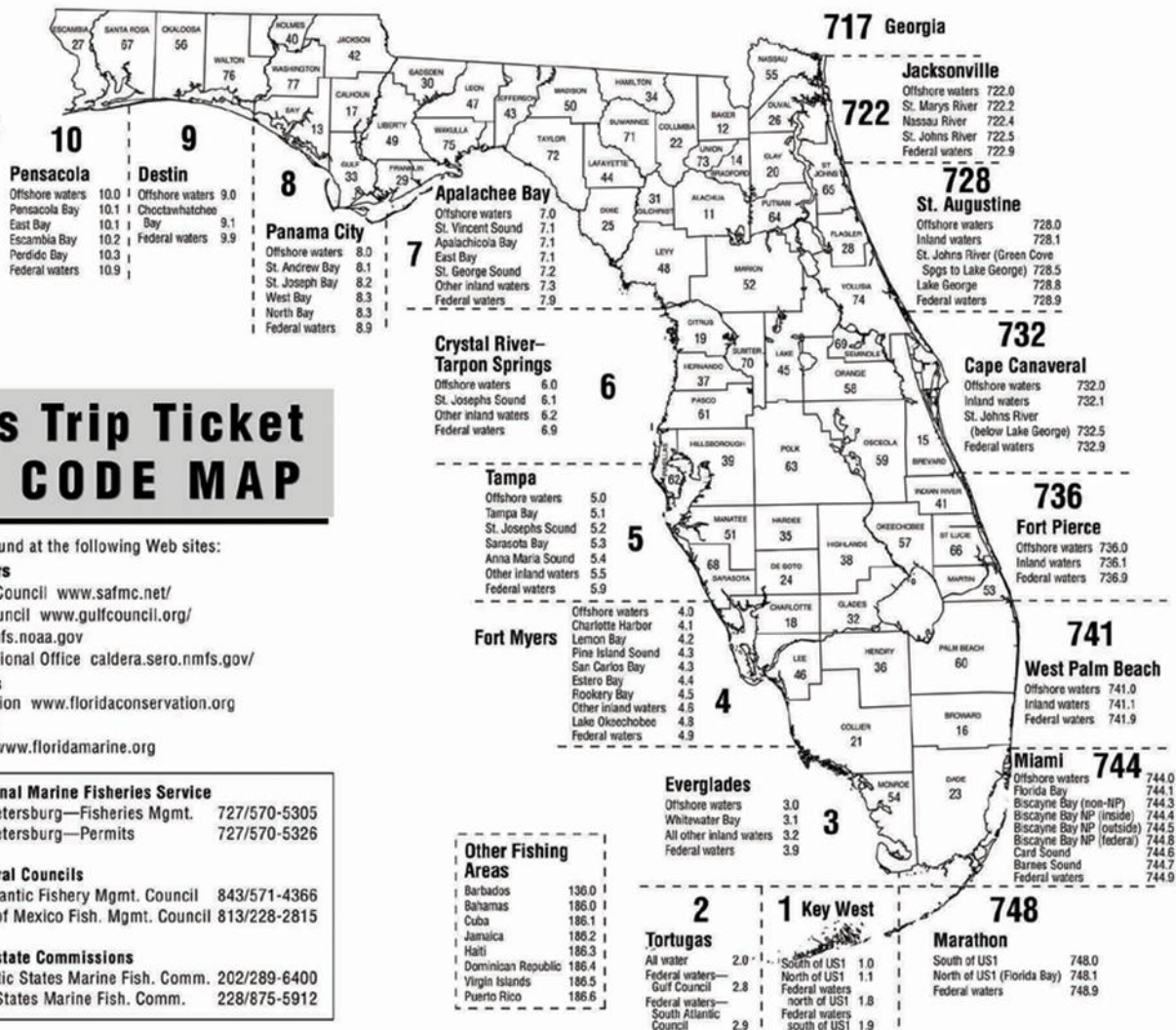
S. Atlantic Fishery Mgmt. Council 843/571-4366

Gulf of Mexico Fish. Mgmt. Council 813/228-2815

Interstate Commissions

Atlantic States Marine Fish. Comm. 202/289-6400

Gulf States Marine Fish. Comm. 228/875-5912



Fisheries-Dependent Monitoring (FDM)

Recreational Surveys

32 samplers in 13 locations statewide
33,000 - 42,000 angler interviews annually
> 30,000 fish measured
Socioeconomic surveys
Site surveys
Data collected on kept and released fish
Shore and boat anglers
Charter boats, head boats, guide boats



Florida's Fisheries-Independent Monitoring (FIM) program



**Saltwater
Recreational Fishing
License**



FIM program objectives

Detect changes in relative abundance of fishes and select macroinvertebrates through time:

- Develop young-of-the-year recruitment indices
- Develop indices of recruitment for species as they enter the fishery
- Correlate juvenile and adult relative abundances
- Predict future adult relative abundances
- Detect changes in size or age structure of fish and select macroinvertebrate populations



FIM program objectives

(Continued)

Improve existing knowledge and understanding of individual species:

- Life history parameters
 - age and growth
 - age/size at sexual maturity
 - fecundity
 - reproductive patterns
- Habitat utilization at different life stages (EFH and HSI)
- Recruitment
- Describe spatial and temporal distribution patterns



FIM program objectives

(Continued)

Describe Florida's estuarine systems:

- Assess ecological communities
- Describe biodiversity in Florida's estuaries
- Identify important fisheries habitat

Document changes in the biological condition of Florida's estuaries:

- Develop baseline data on fish and select macroinvertebrate health to be used as indicators of an estuaries condition

Establish minimum flow levels in riverine systems



FIM program history

Began sampling in 1989 in Tampa Bay and Charlotte Harbor

- seasonal (spring and fall) stratified-random sampling
- monthly sampling at fixed stations
- sample design emphasized juvenile life stages

Progressively expanded through the state

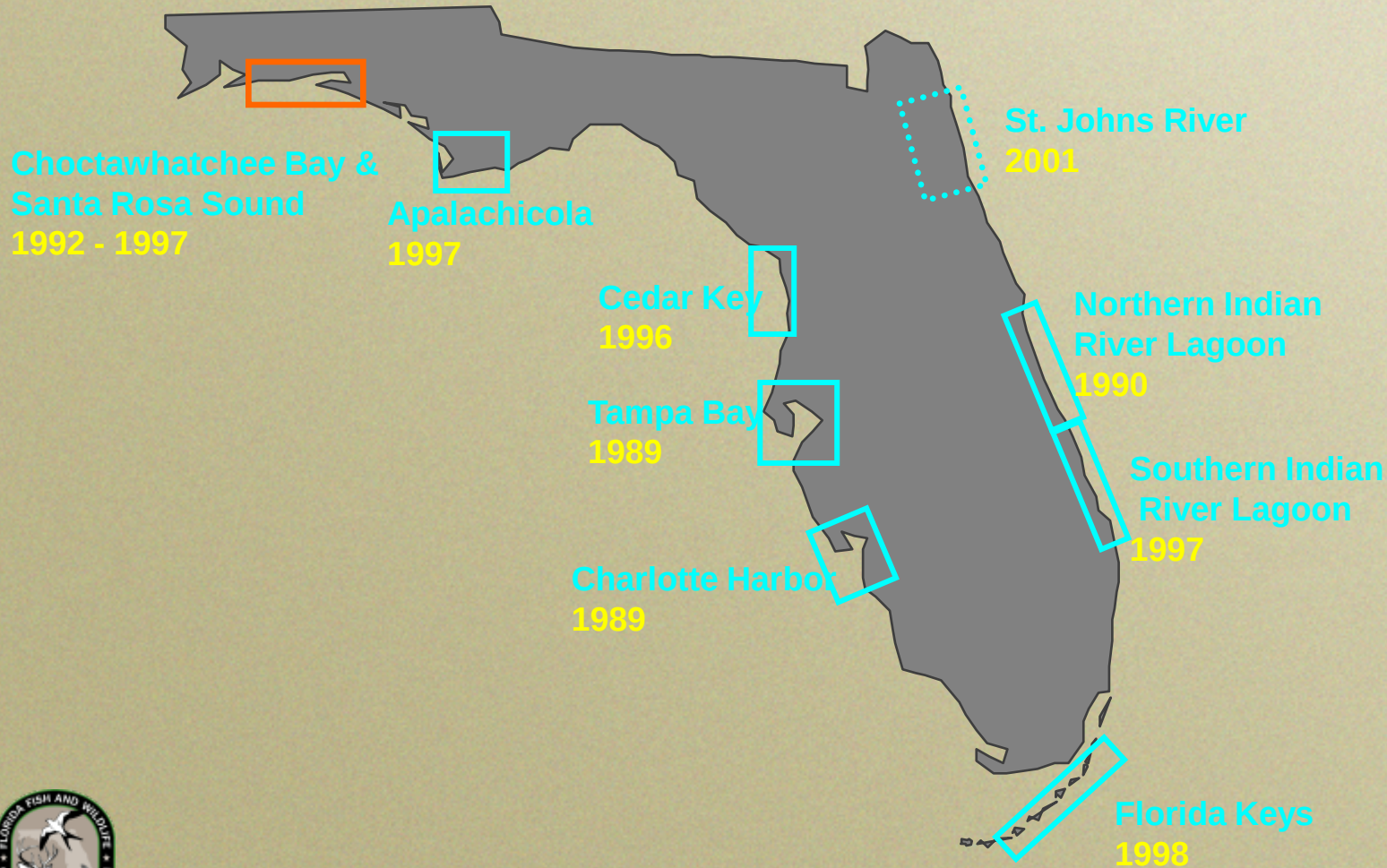
- currently sample seven estuaries
- will begin sampling in St. Johns River next year

Significantly modified sampling design in 1996

- initiated monthly stratified-random sampling
- omitted fixed station sampling
- incorporated gears for sampling subadult/adult fishes

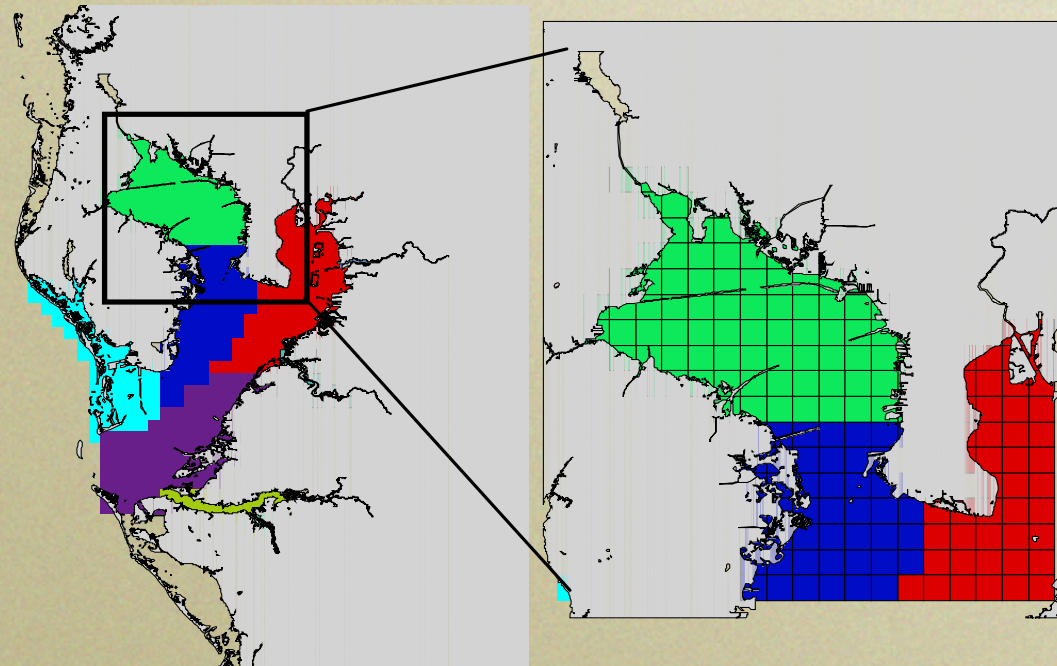


FIM program Field Labs



FIM program sampling design

- Stratified-random
 - each estuary is subdivided into zones
 - each zone is further subdivided into grids (1nm²)
 - available habitat in each grid is identified
 - set number of sampling grids randomly selected from each zone each month
 - sampling site within each grid is randomly selected



Data Collected

Data collected at each sampling site include:

- Location information
- Habitat characteristics (bottom type, SAV, shore type)
- Water chemistry (salinity, temperature, DO, etc.)
- Weather (tide, wind, cloud cover, time, etc.)
- Species data
 - Number
 - Representative sizes
 - Random culls for life history studies
 - Specimens with obvious external abnormalities culled
 - Specimens culled for analysis of mercury concentration

