Regional Connectivity:

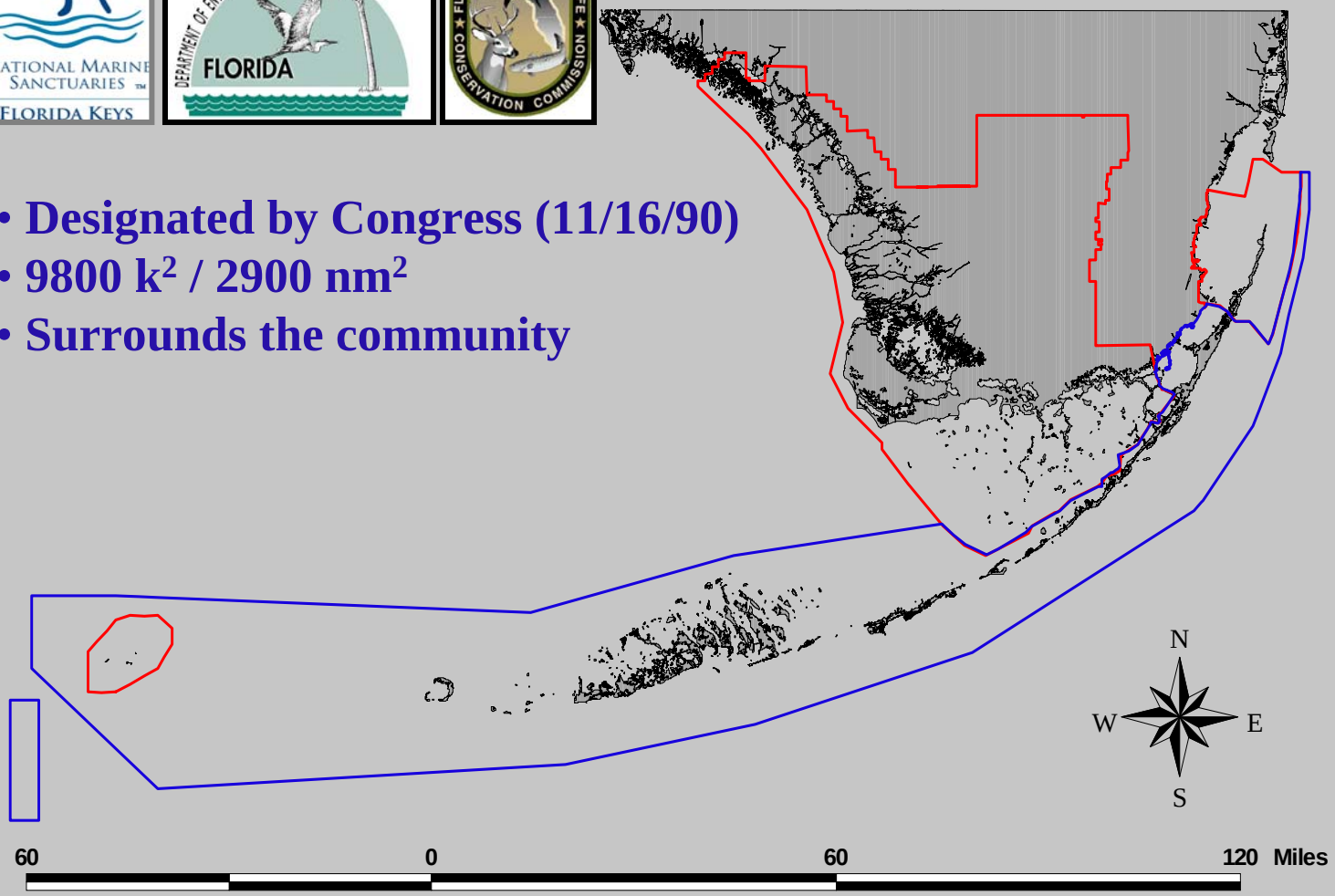
Southwest Florida and Florida Bay's Influence on the Coral Reefs of the Florida Keys

South Florida Ecosystem Restoration Task Force
&
SFWMD Water Resources Advisory Commission Joint Meeting

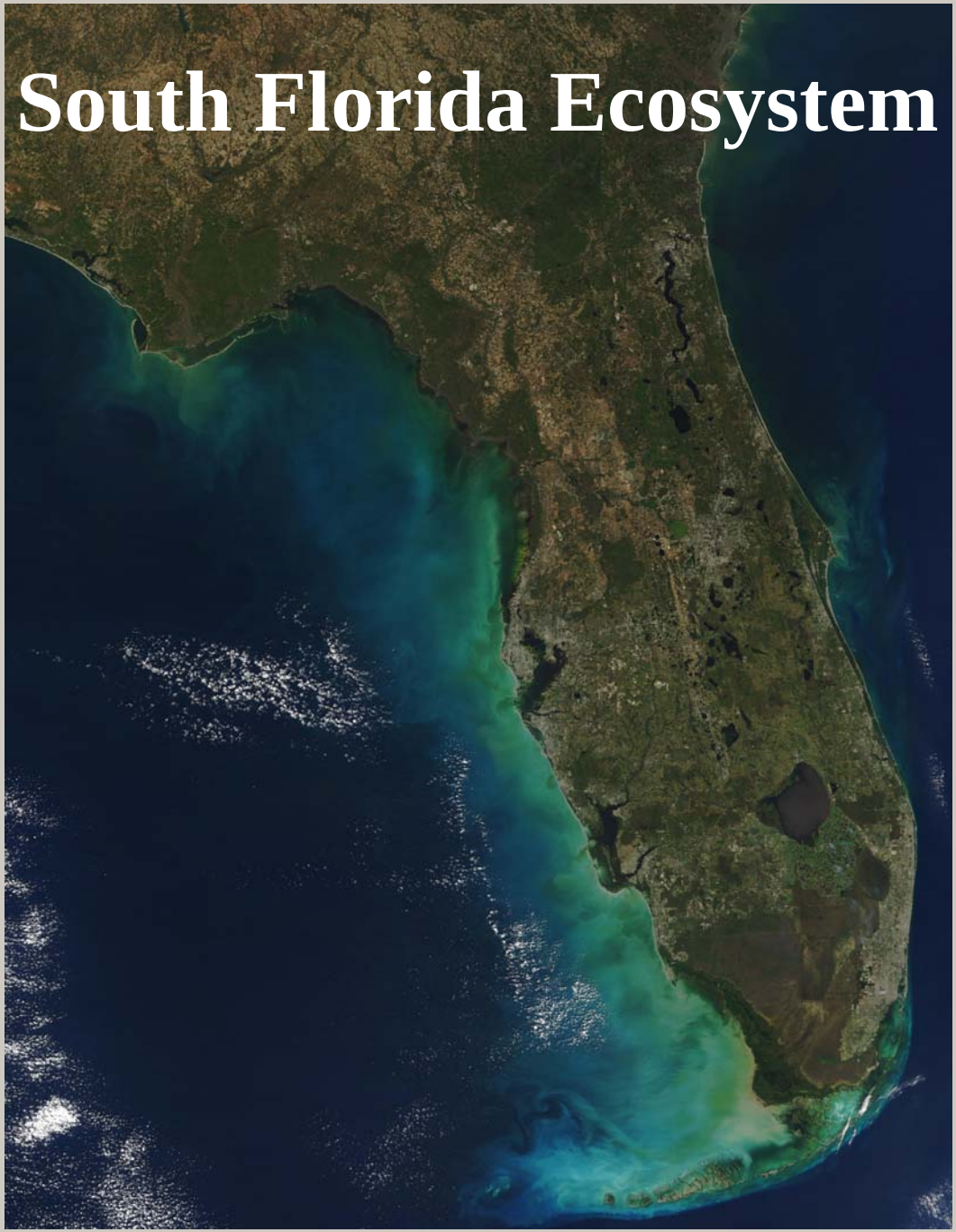
Billy D. Causey, Regional Director
Southeast Atlantic, Gulf of Mexico and Caribbean Region
National Marine Sanctuary Program
December 6-7, 2006
Key West, Florida

Florida Keys National Marine Sanctuary

- Designated by Congress (11/16/90)
- 9800 k^2 / 2900 nm^2
- Surrounds the community

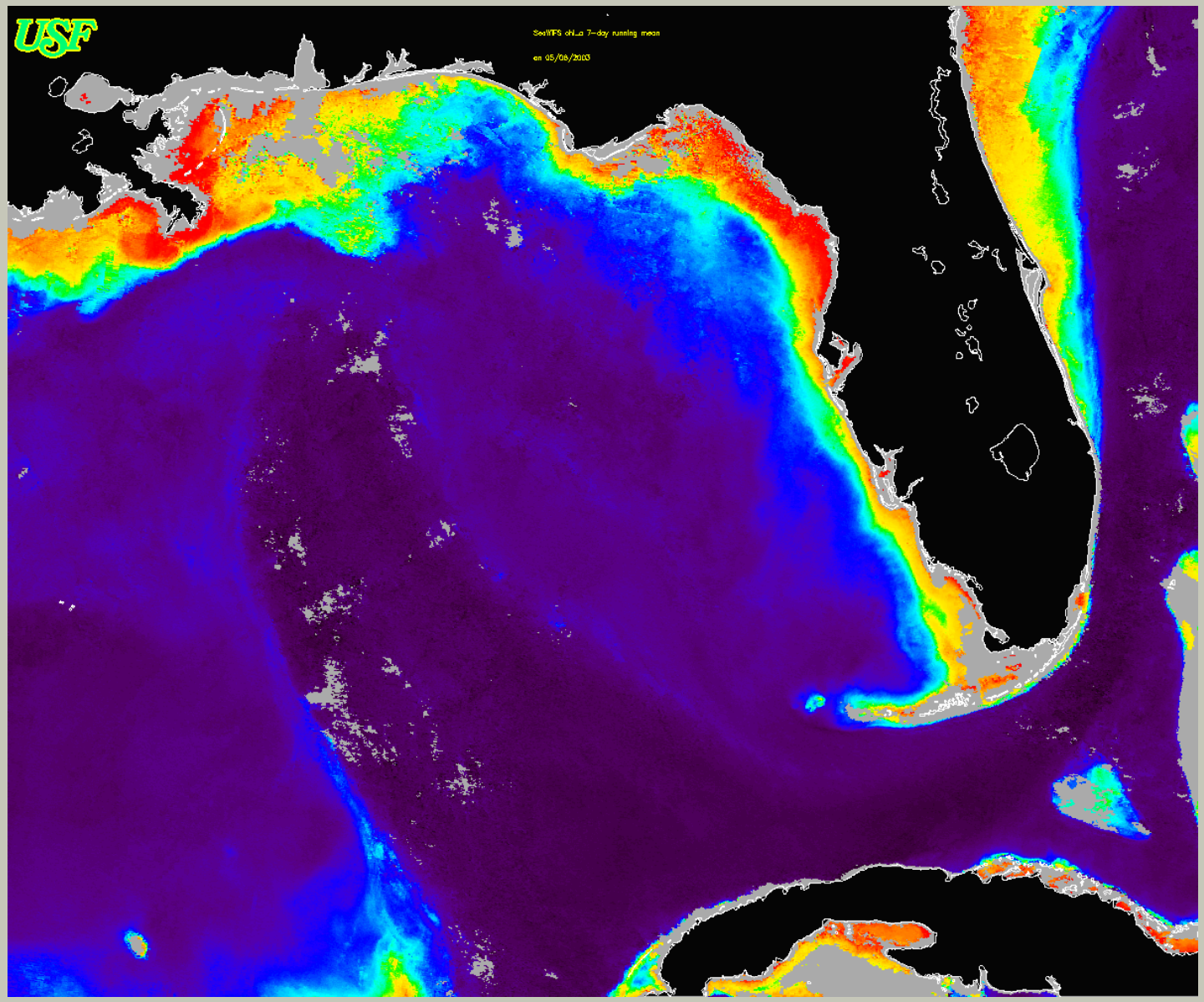


South Florida Ecosystem



NATIONAL MARINE SANCTUARIES ™
FLORIDA KEYS

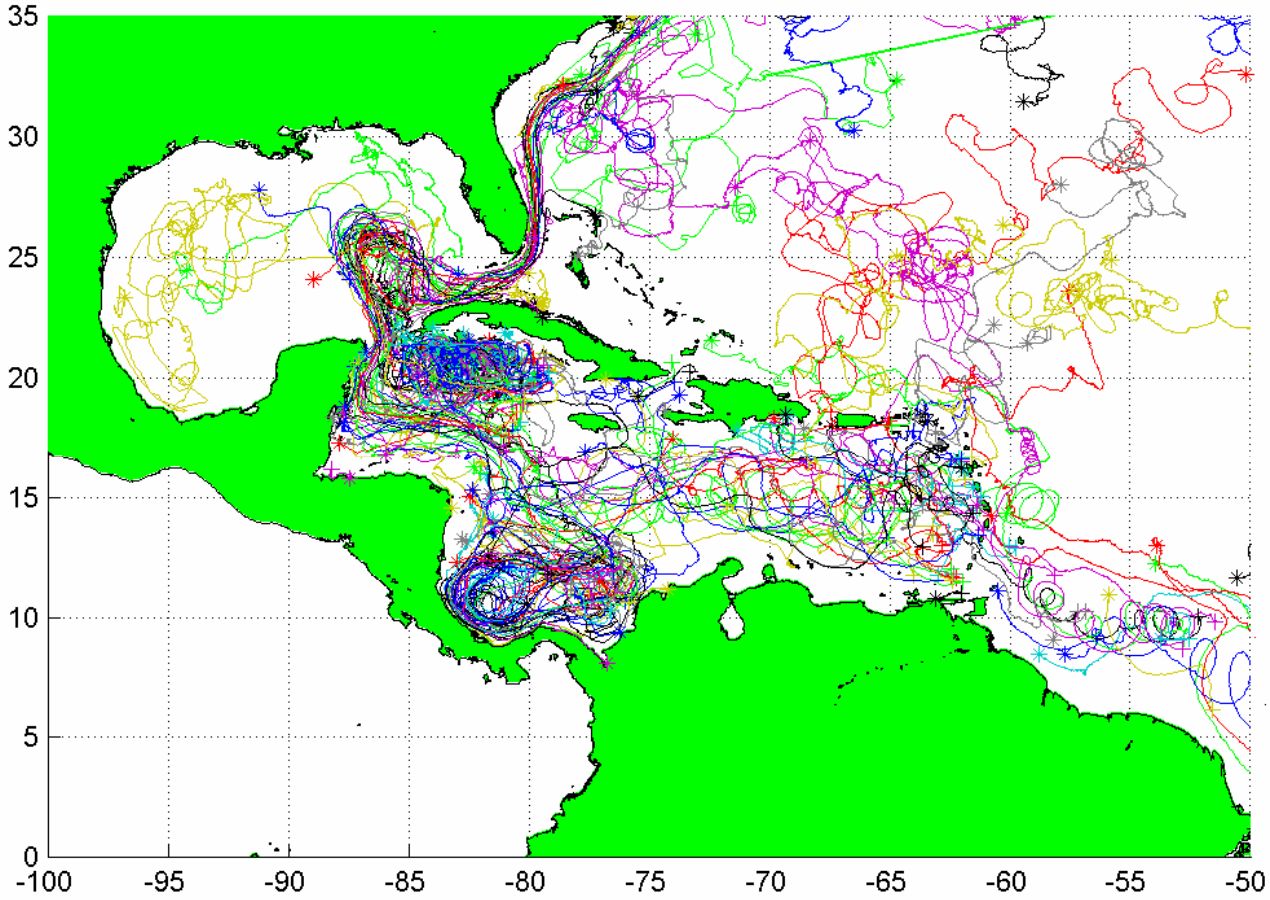
Connectivity: The Loop Current



C. Hu
Univ of South Florida

Current Drifters (1998-2000)

Credit: Kevin Leaman (UM/RSMAS)



NATIONAL MARINE SANCTUARIES

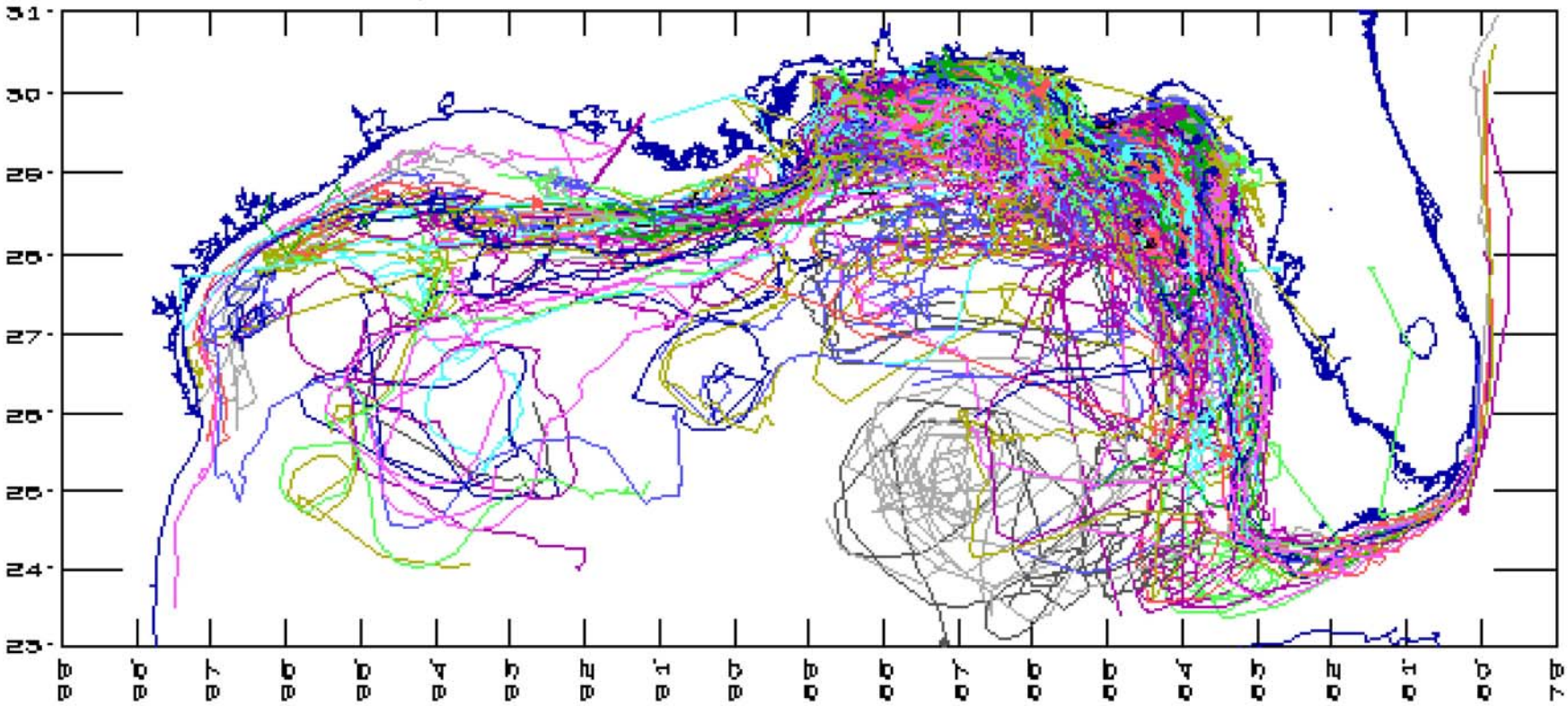
NATIONAL MARINE SANCTUARIES ™

FLORIDA KEYS

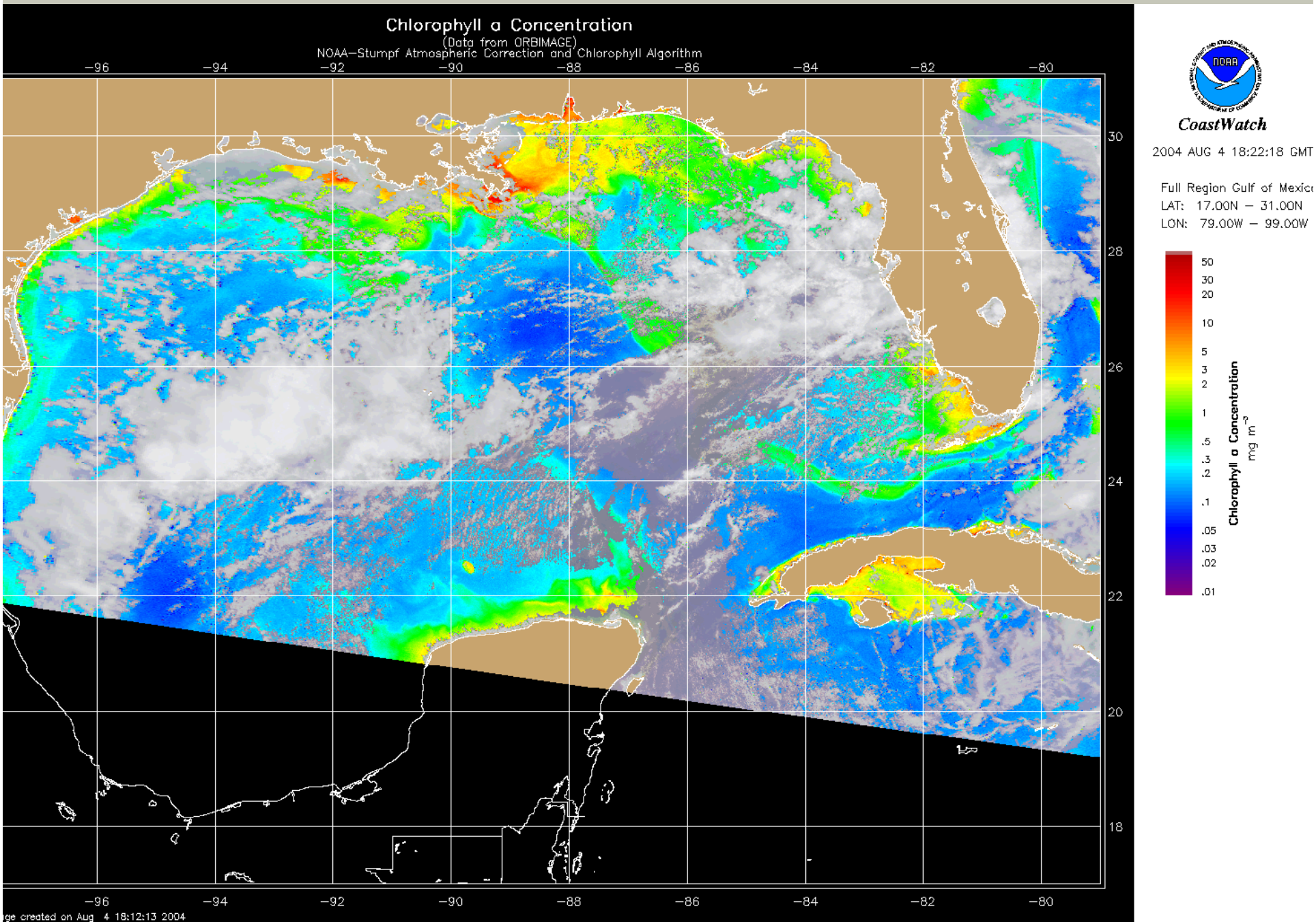
Mississippi River Basin

MMS

Gulf of Mexico, Feb. 1996-Feb. 1997



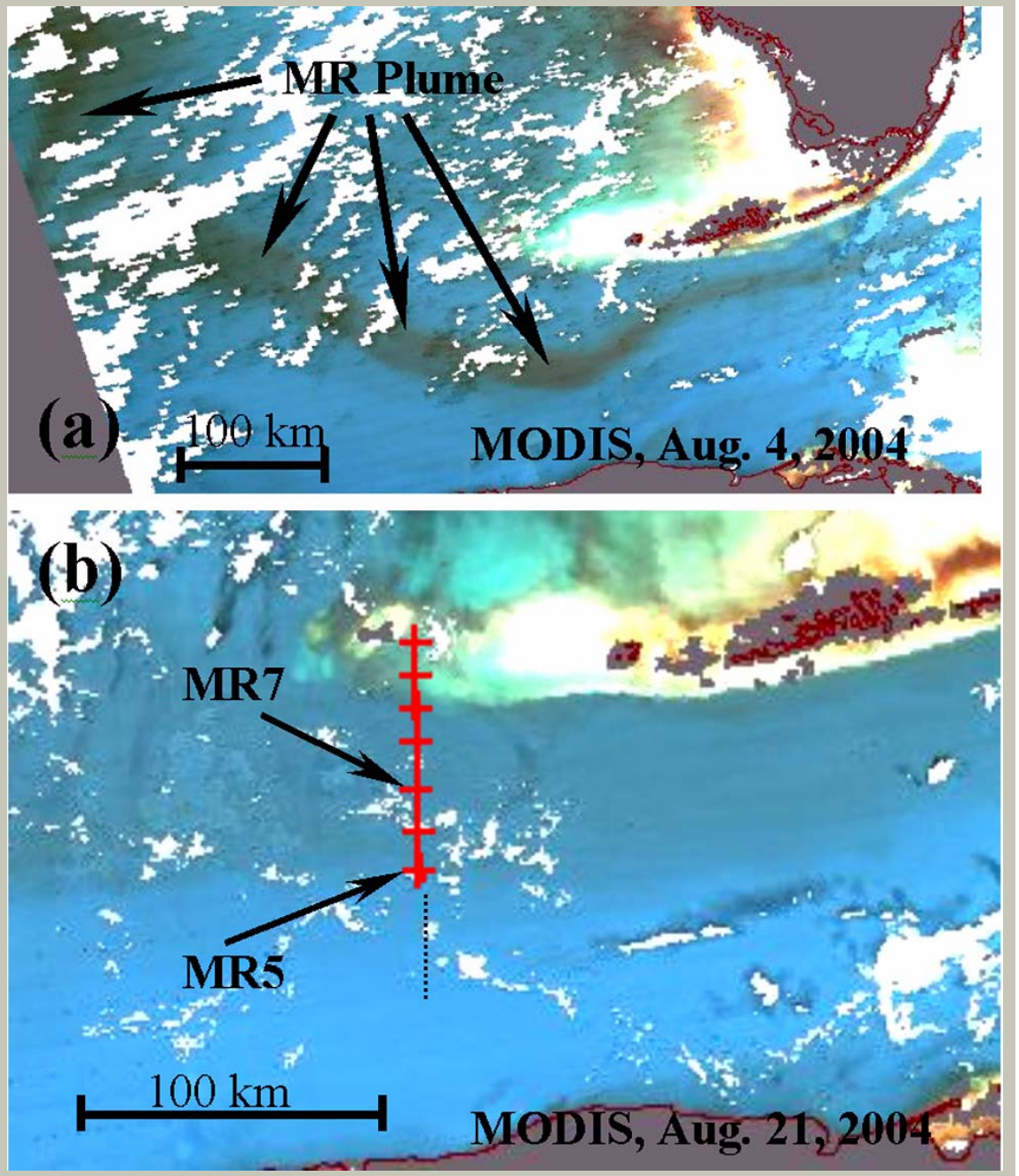
http://coastwatch.noaa.gov/hab/bulletins_ms.htm



Mississippi River water in the Florida Straits and in the Gulf Stream off Georgia in summer 2004

GRL vol. 12, L14606, July 2005

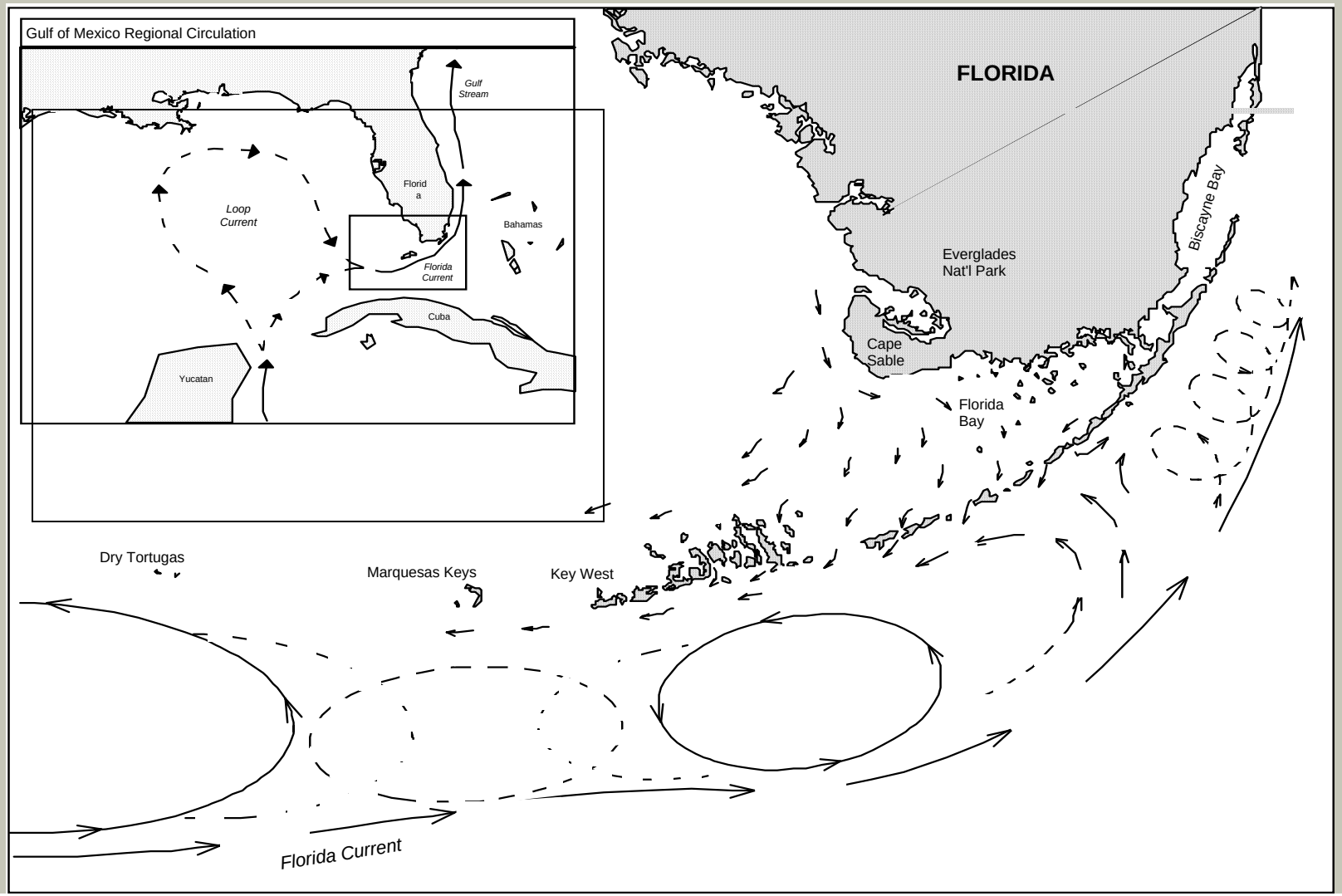
Chuanmin Hu, J. R. Nelson, E. Johns, Z. Chen, R. H. Weisberg, and F. E. Muller-Karger



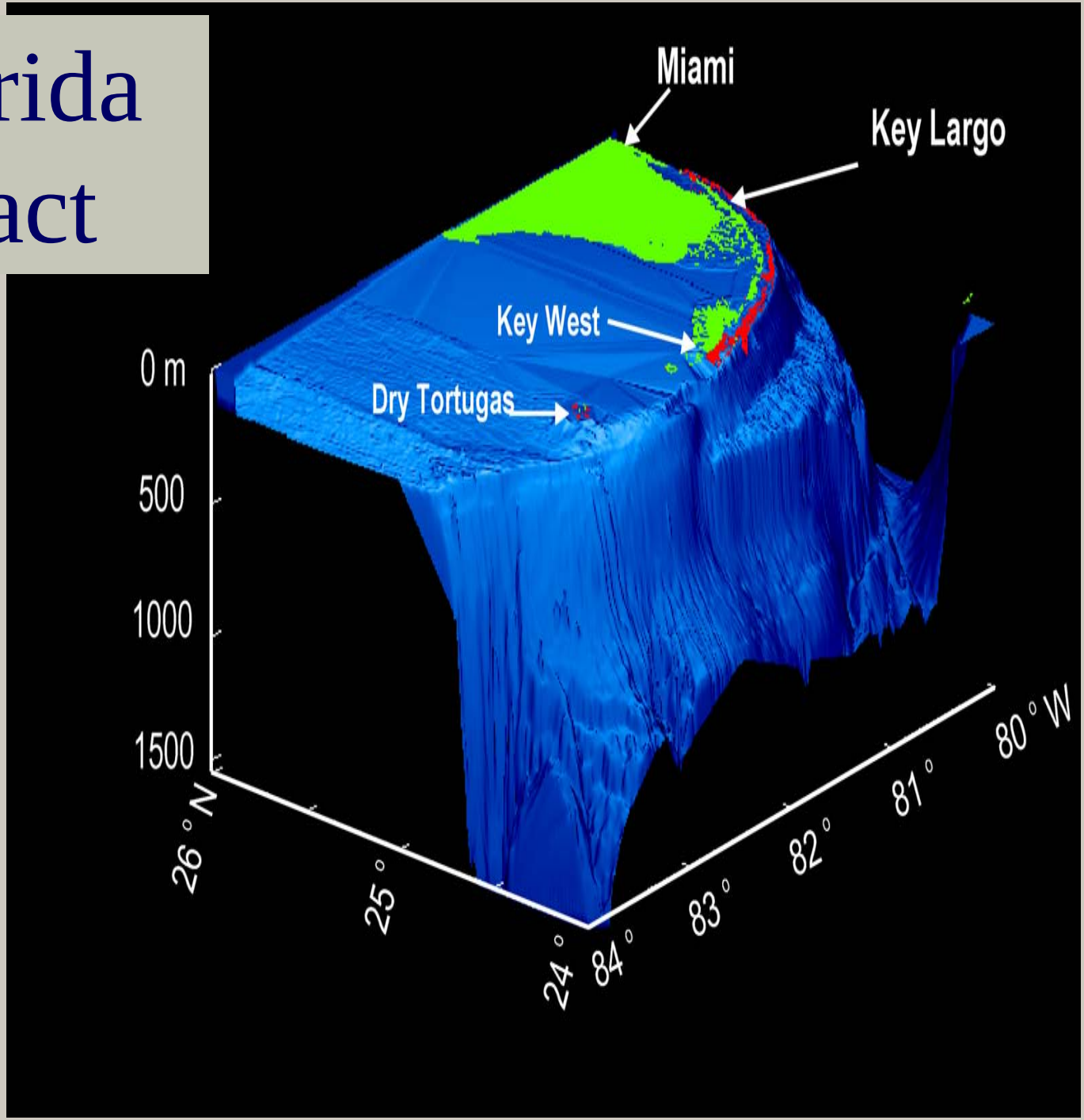
Influence from Ocean Currents

Florida Keys and coral reef are influenced by currents and flows from Florida Bay, Gulf of Mexico, Florida west coast, and Florida Current/Gulf Stream

(Lee and Williams - Univ of Miami)

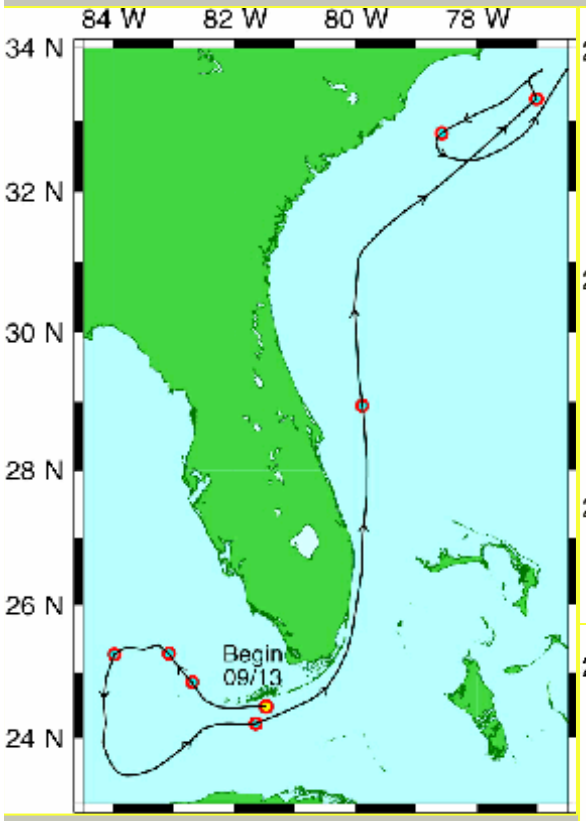


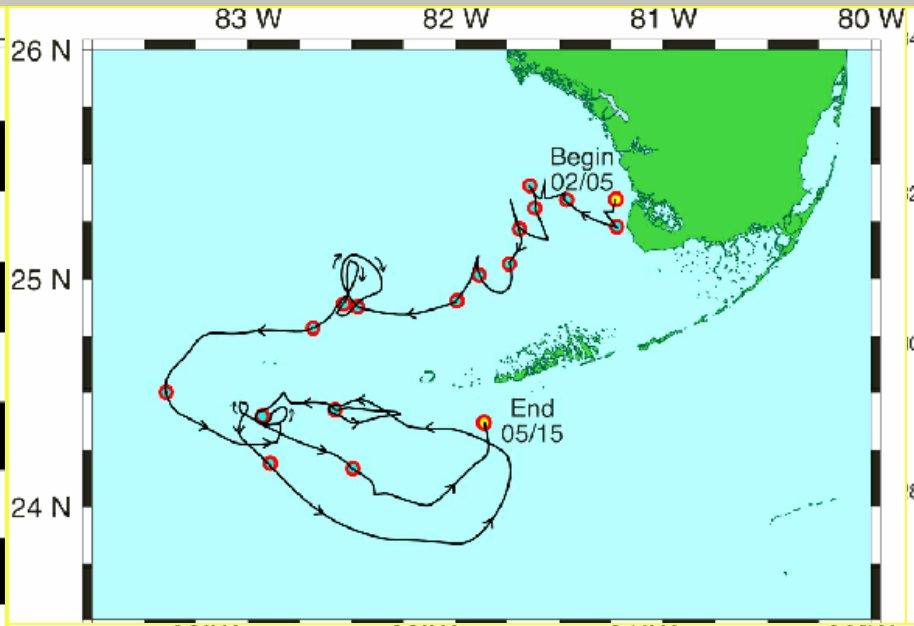
The Florida Reef Tract

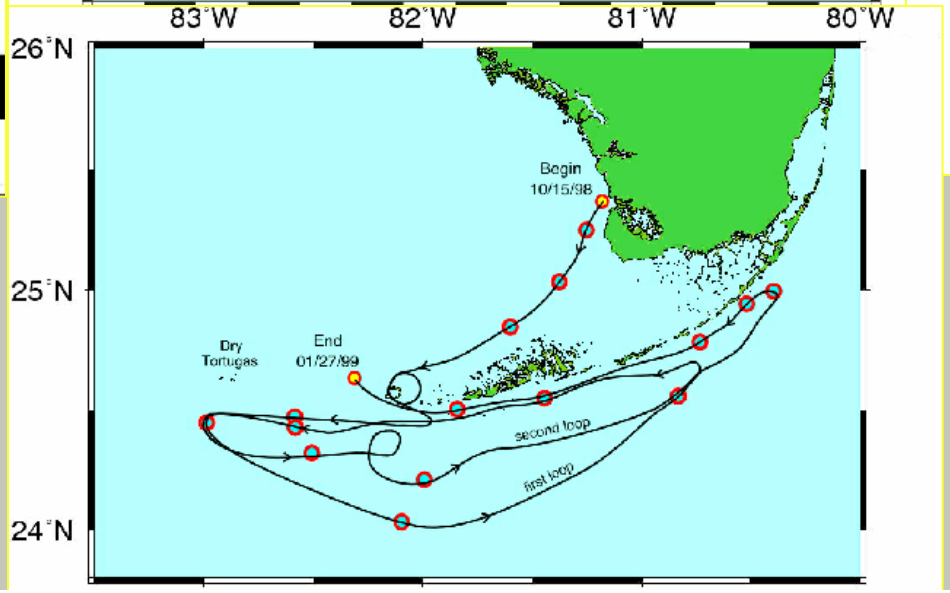


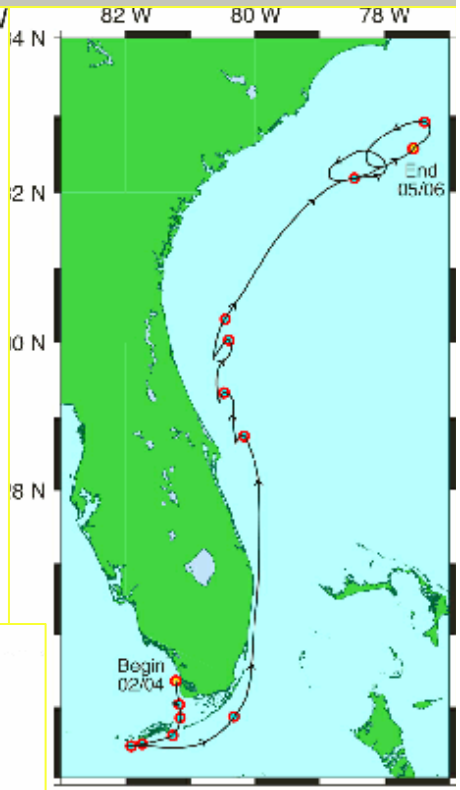
NATIONAL MARINE SANCTUARIES ™
FLORIDA KEYS

Four Paths of Satellite Current-Tracking Meters









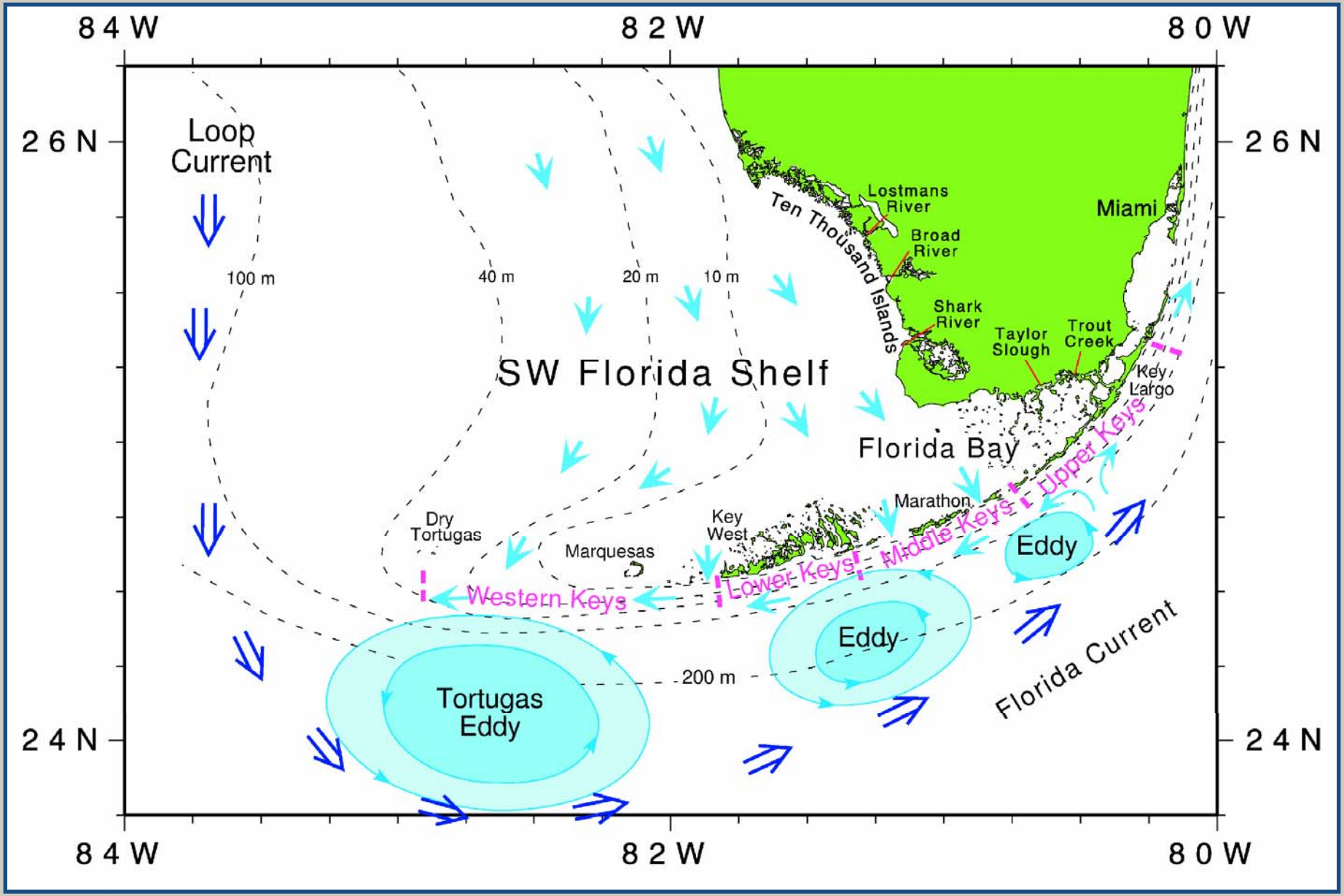
Investigators:

Dr. Tom Lee

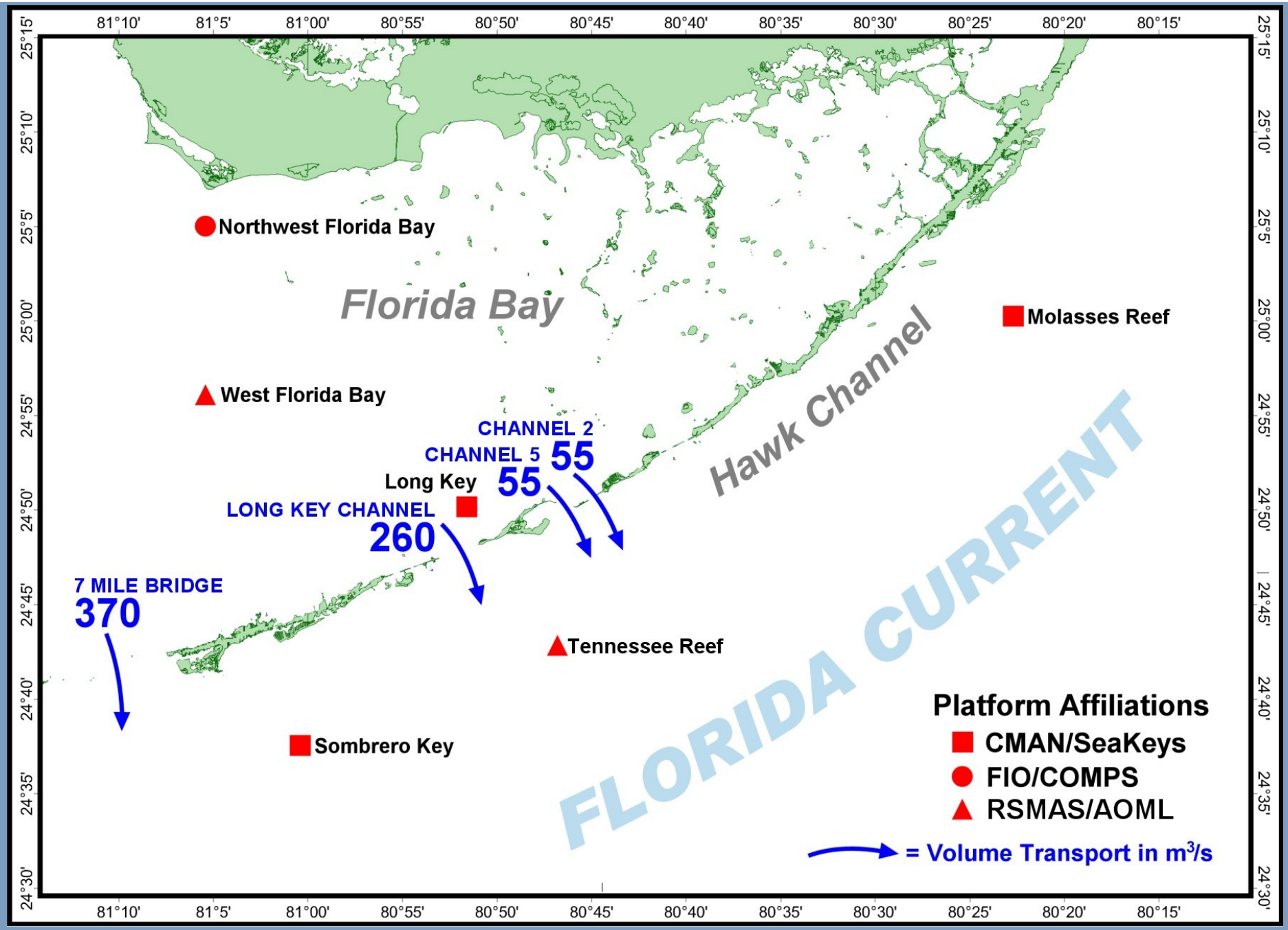
Dr. Liz Williams

Univ of Miami

Shark River Slough/ FL West Coast Releases



Lee et al. 2002

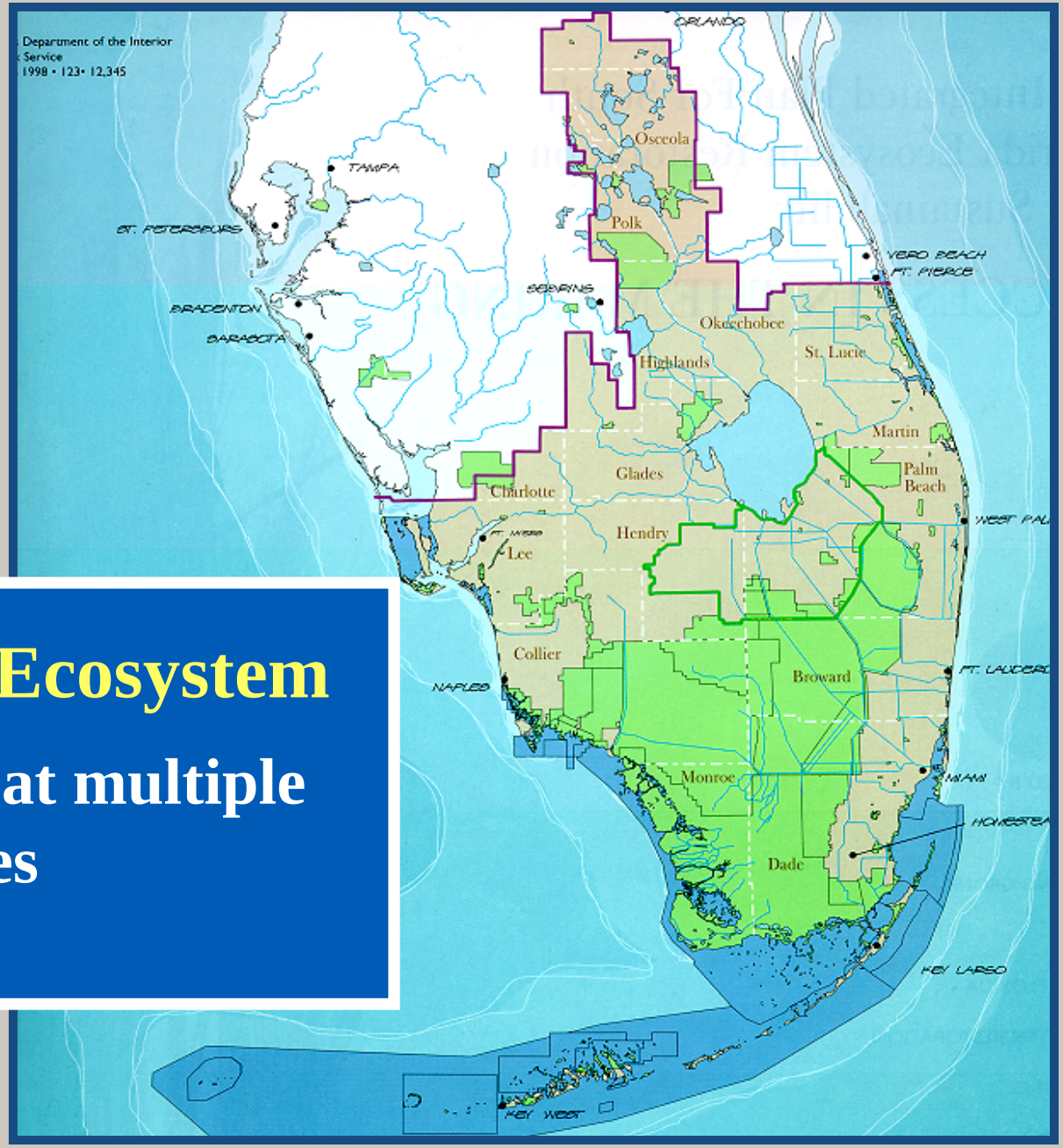


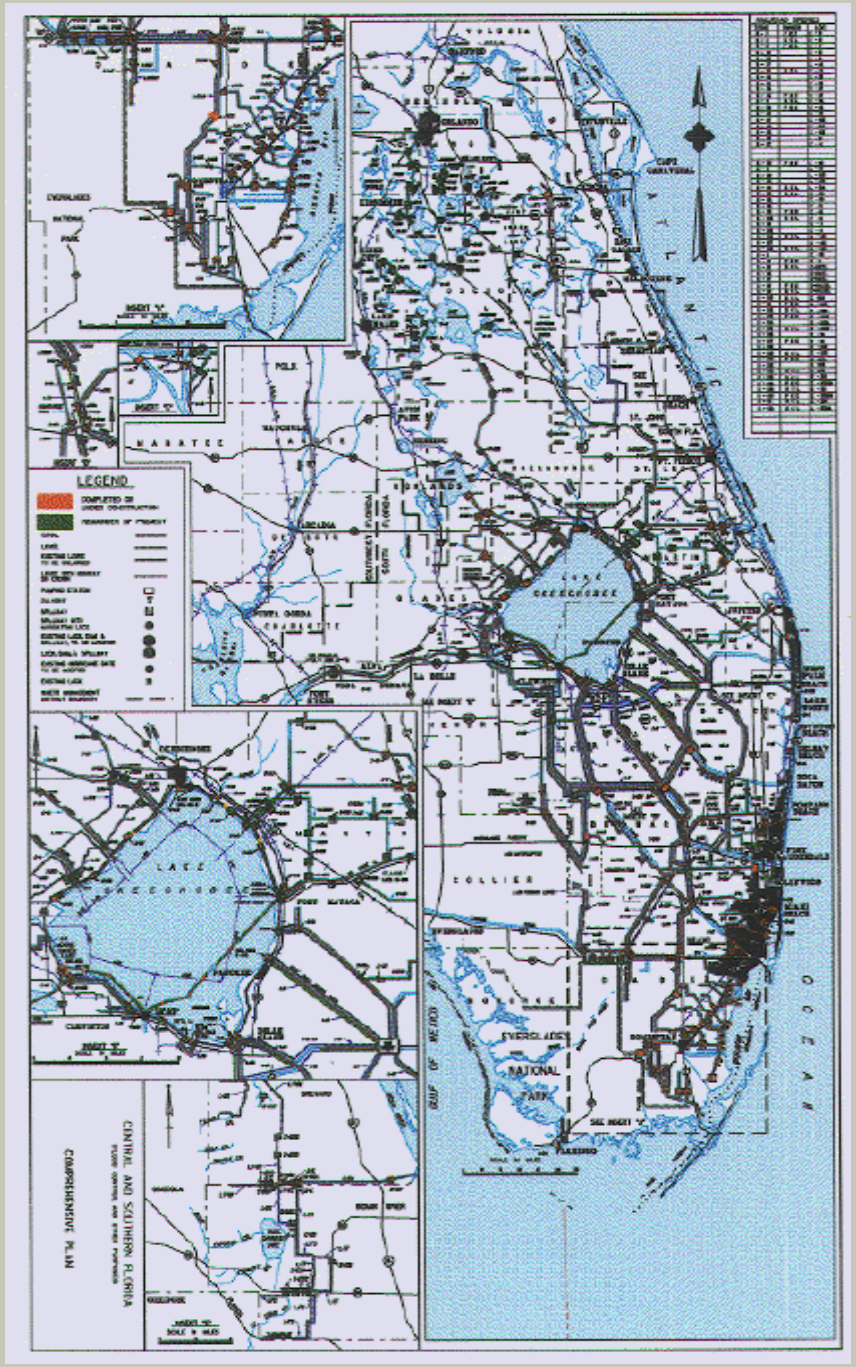
Lee & Smith 2002

1990-1992 Witnessed the Near Collapse of Florida Bay

South Florida Ecosystem

Connectivity at multiple scales




LEGEND
CENTRAL AND SOUTHERN FLORIDA
COMPREHENSIVE PLAN
EVERGLADES
NATIONAL
PARK
GULF OF MEXICO
OCEAN

South Florida
1992
NORTH

FKNMS Resource Monitoring Programs

- **Water Quality Protection Program: includes three long-term, status-and-trends projects:**
  - Seagrass – funded by EPA/NOAA
  - Coral – funded by NOAA/EPA
  - Water Quality – funded by EPA

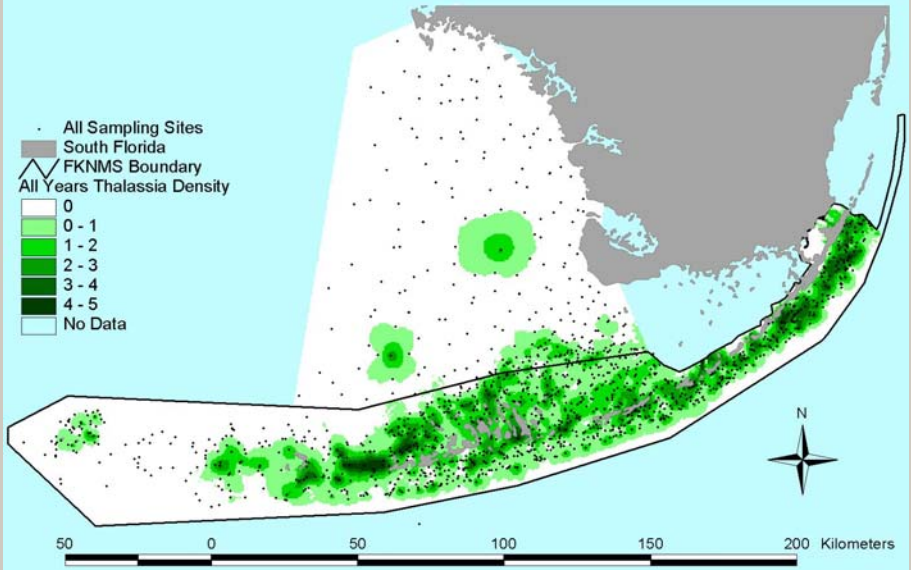
floridakeys.noaa.gov/research_monitoring

FKNMS ***BASELINE***

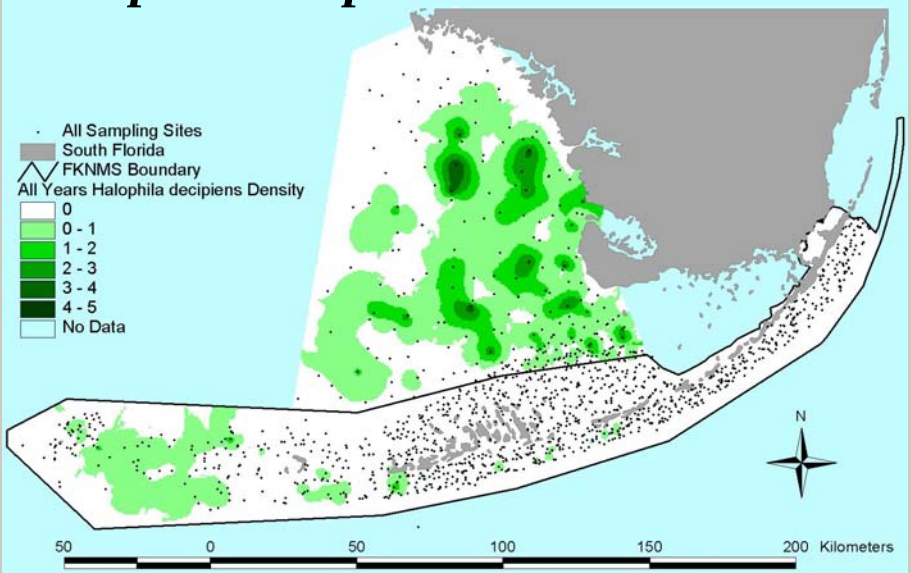
Synoptic Surveys: Seagrass species distributions

www.fiu.edu/~seagrass/

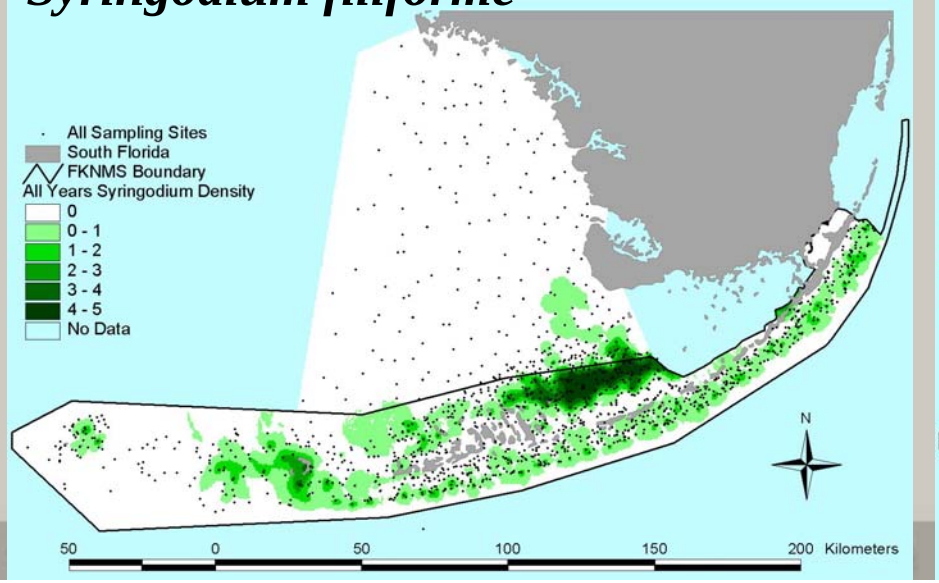
Thalassia testudinum



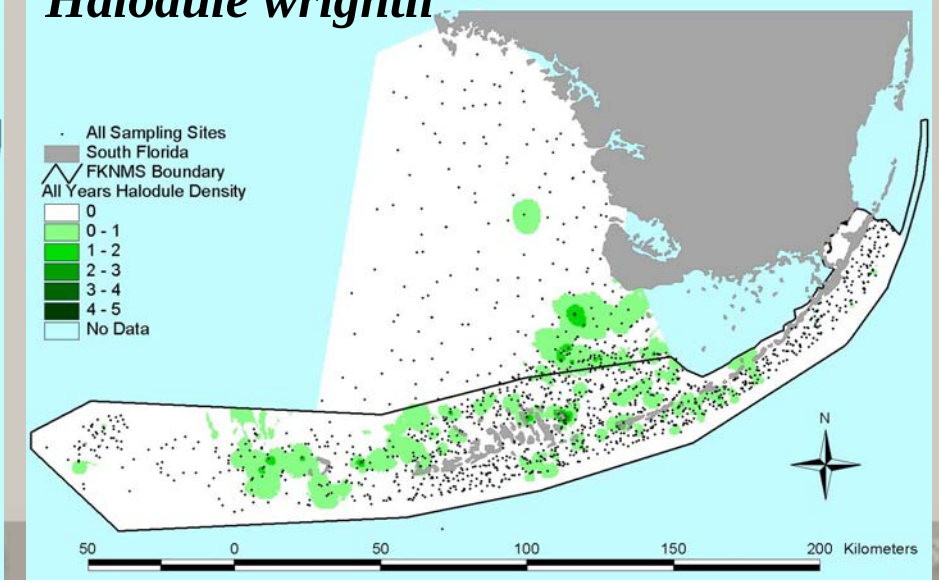
Halophila decipiens



Syringodium filiforme



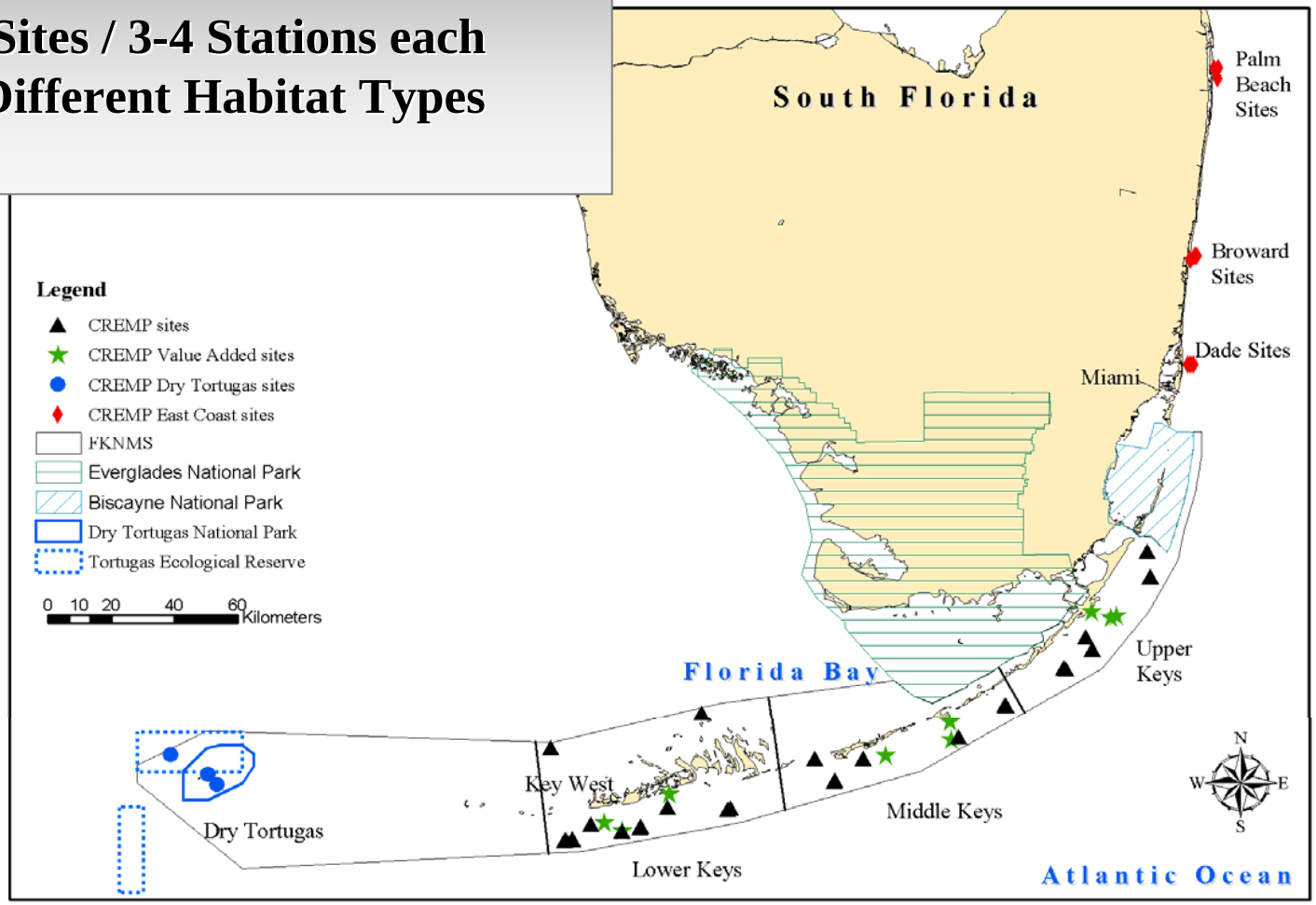
Halodule wrightii



Coral Reef Evaluation and Monitoring Project (CREMP)

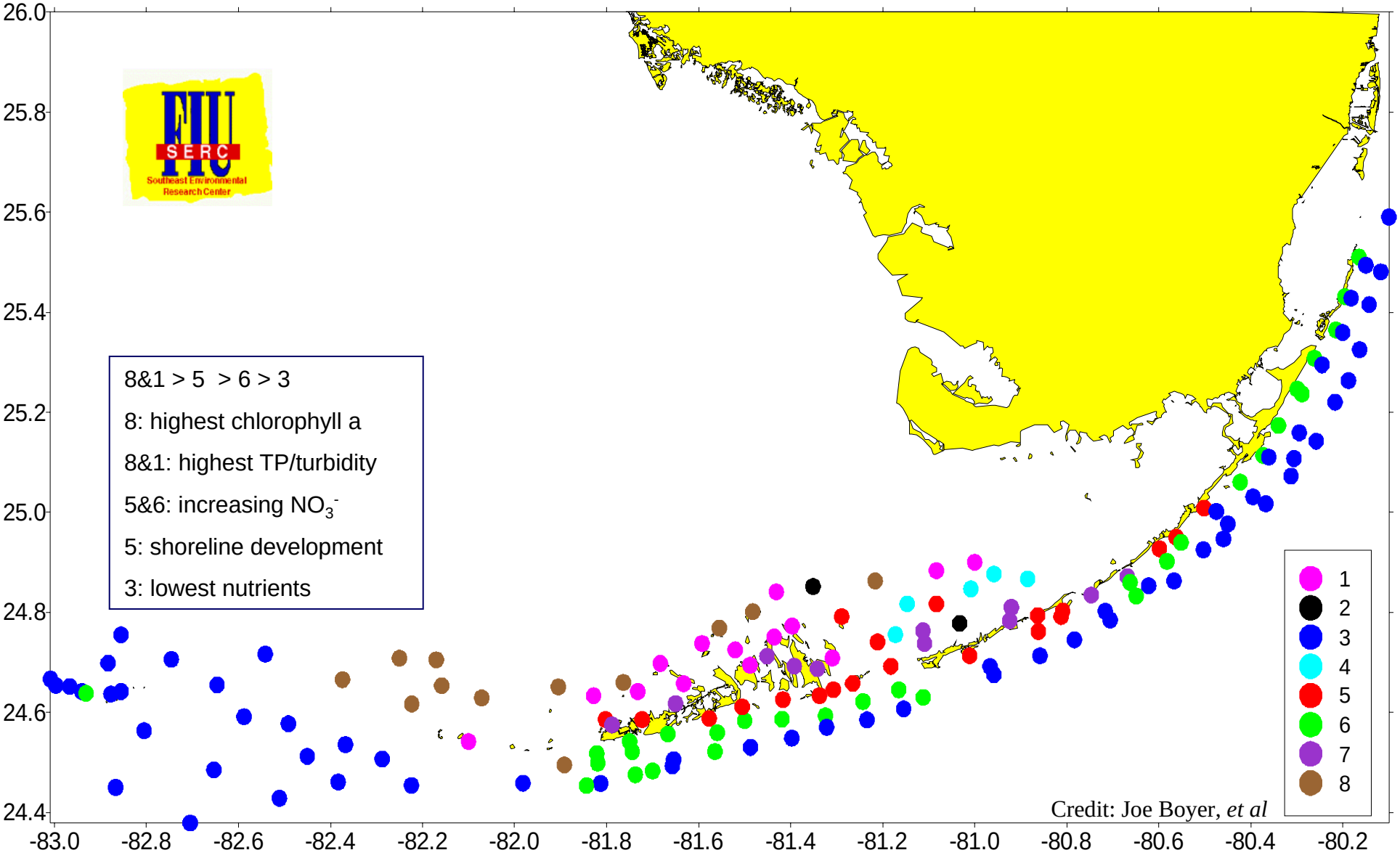
Sandra Brooke, Carl Beaver, et al., FWC

- **43 Sites / 3-4 Stations each**
- **4 Different Habitat Types**



WWQP: Water Quality Monitoring Project

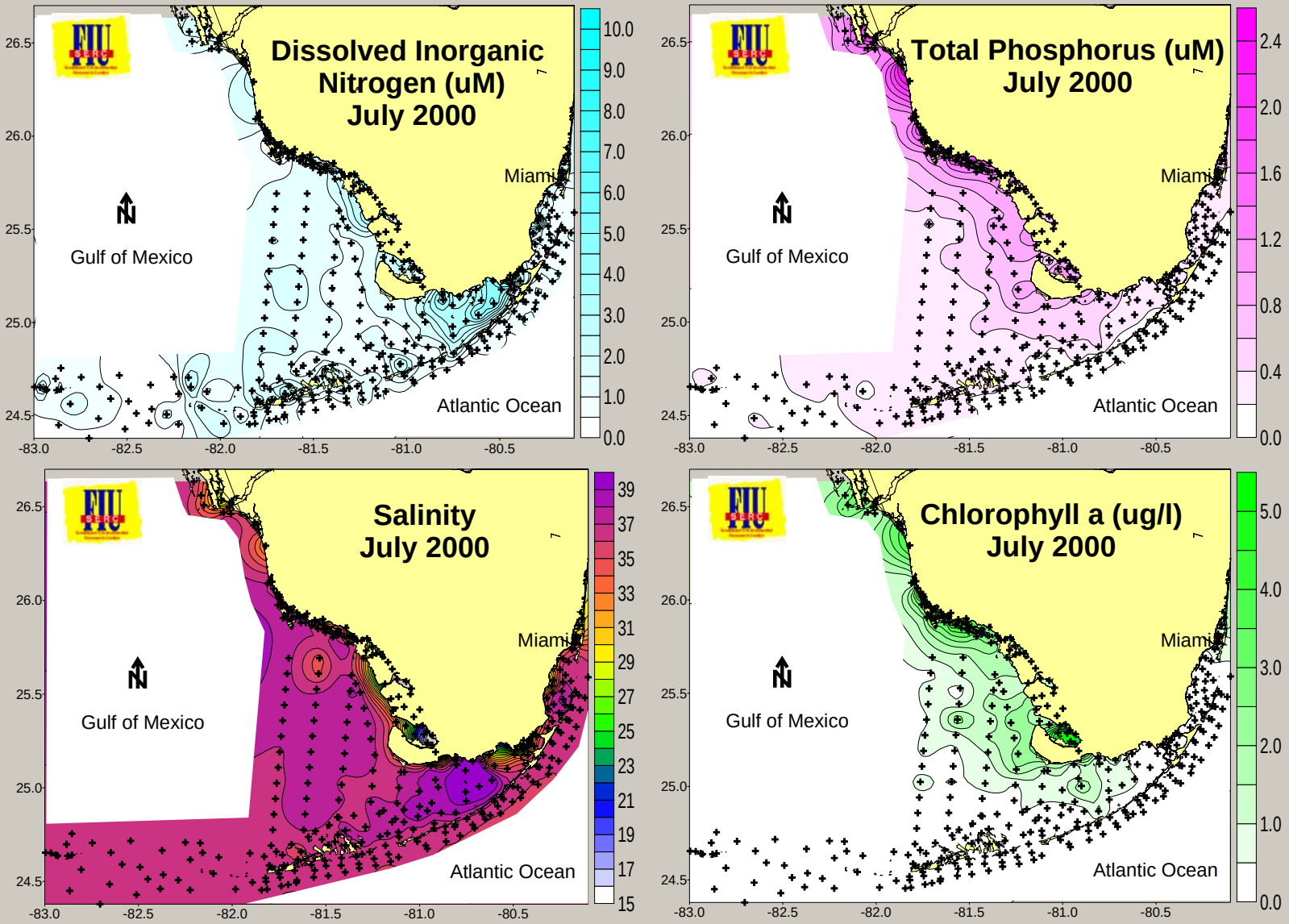
serc.fiu.edu/wqmnetwork/



Credit: Joe Boyer, *et al*

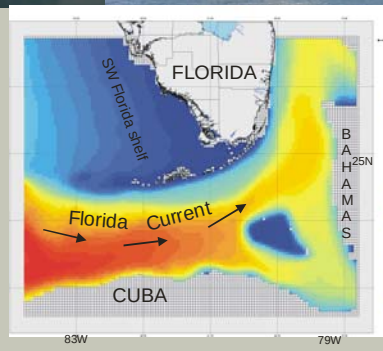
WWQP: Water Quality Monitoring Project

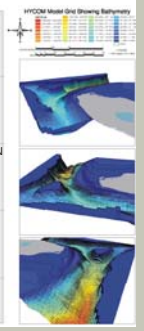
serc.fiu.edu/wqmnetwork/



Credit: Joe Boyer, *et al*

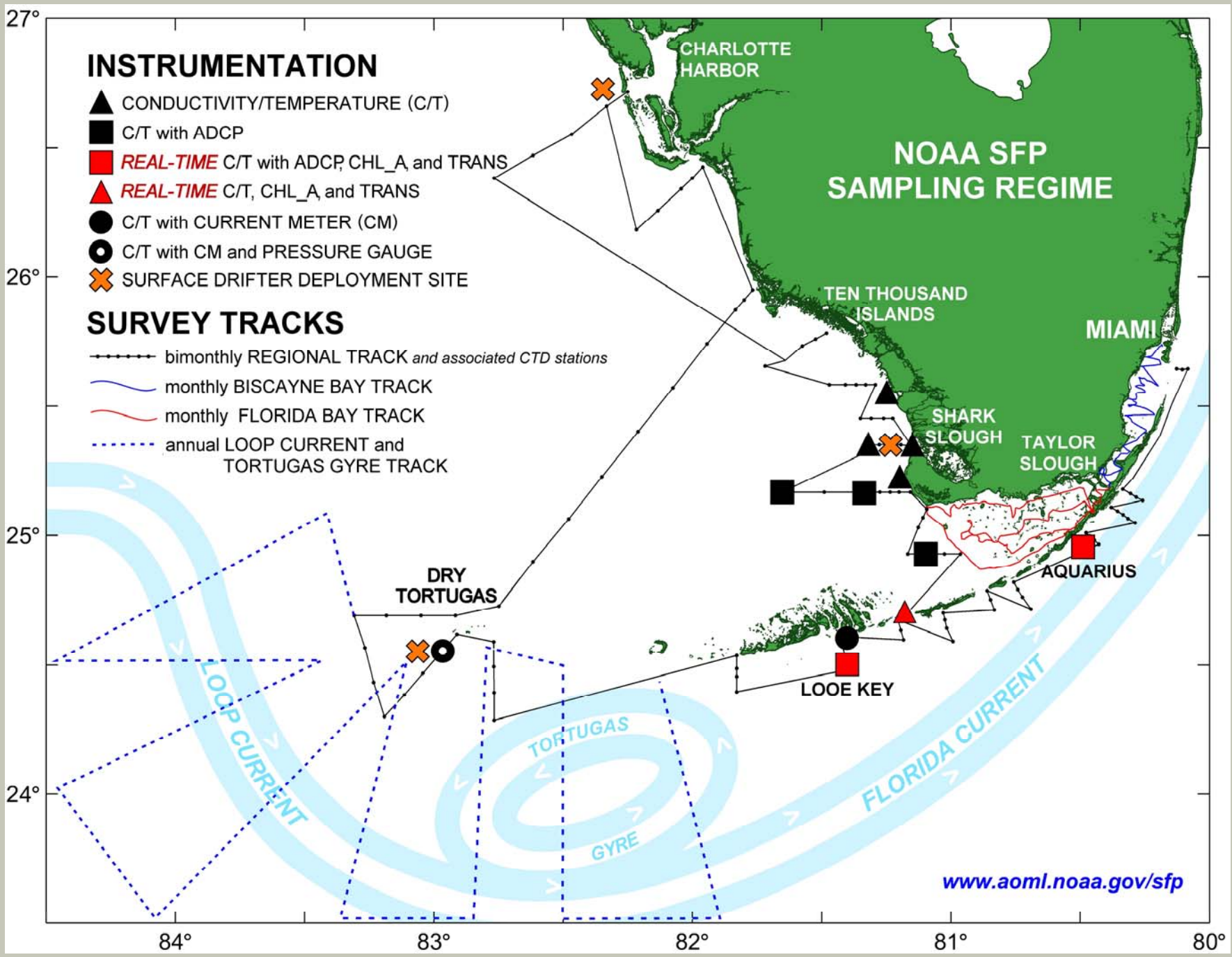
South Florida Ecosystem Research and Monitoring Program

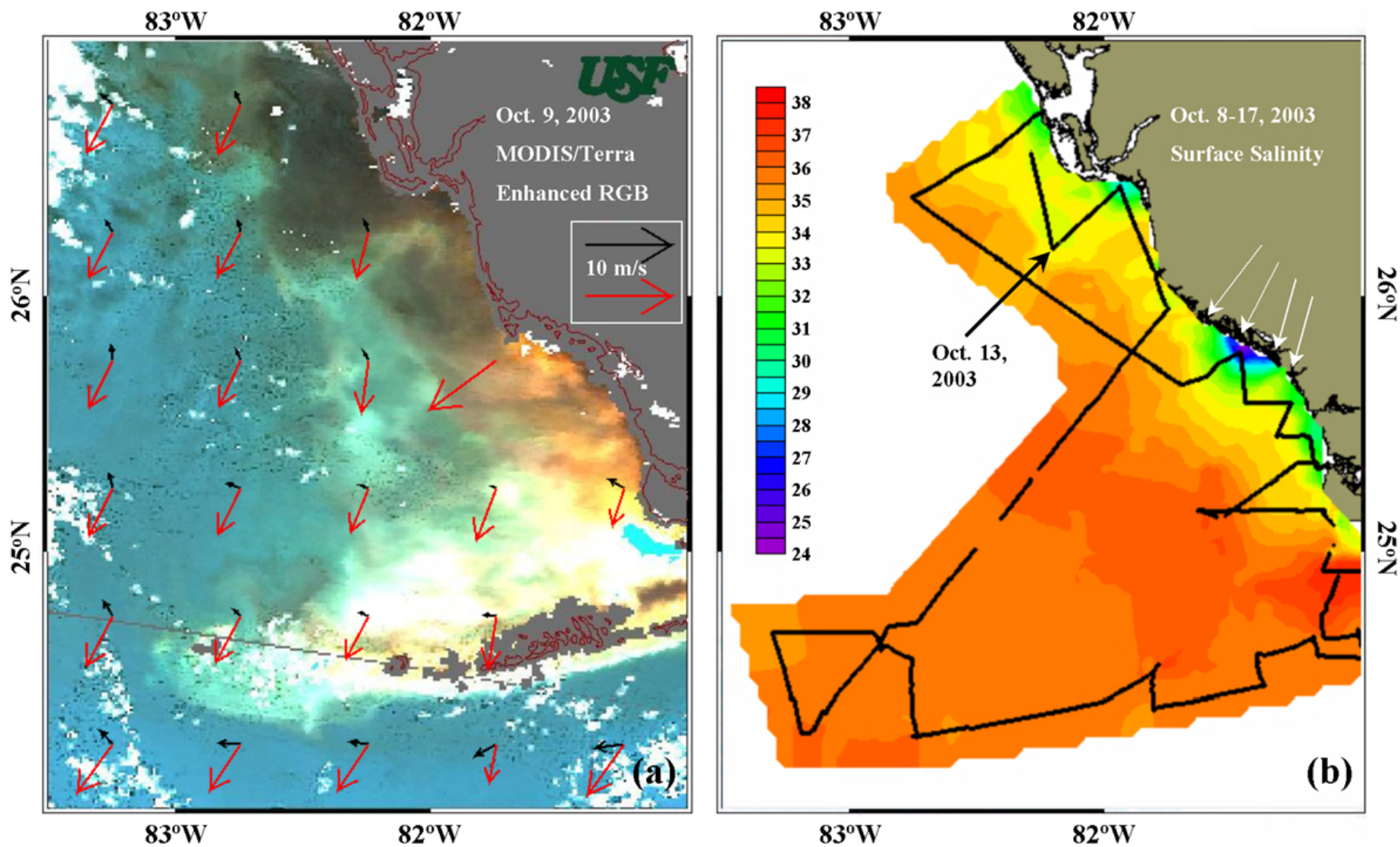




- **Process Studies** — **T. Lee**
- **Interdisciplinary Sustained Observations** — **P. Ortner**
- **Realtime Event Detection** — **E. Johns**
- **Modeling** — **V. Kourafalou**

NOAA NOS/NCCOS, OAR/AOML, NMFS/SEFSC & SFWMD


NOAA SFP
SAMPLING REGIME
INSTRUMENTATION
CONDUCTIVITY/TEMPERATURE (C/T)
C/T with ADCP
REAL-TIME C/T with ADCP, CHL_A, and TRANS
REAL-TIME C/T, CHL_A, and TRANS
C/T with CURRENT METER (CM)
C/T with CM and PRESSURE GAUGE
SURFACE DRIFTER DEPLOYMENT SITE
SURVEY TRACKS
bimonthly REGIONAL TRACK and associated CTD stations
monthly BISCAYNE BAY TRACK
monthly FLORIDA BAY TRACK
annual LOOP CURRENT and TORTUGAS GYRE TRACK
CHARLOTTE HARBOR
TEN THOUSAND ISLANDS
MIAMI
SHARK SLOUGH
TAYLOR SLOUGH
AQUARIUS
DRY TORTUGAS
LOOE KEY
LOOP CURRENT
TORTUGAS GYRE
FLORIDA CURRENT
www.aoml.noaa.gov/sfp
27°
26°
25°
24°
84°
83°
82°
81°
80°



C. Hu, F.E. Muller-Karger, G.A. Vargo, and E. Johns (2004)

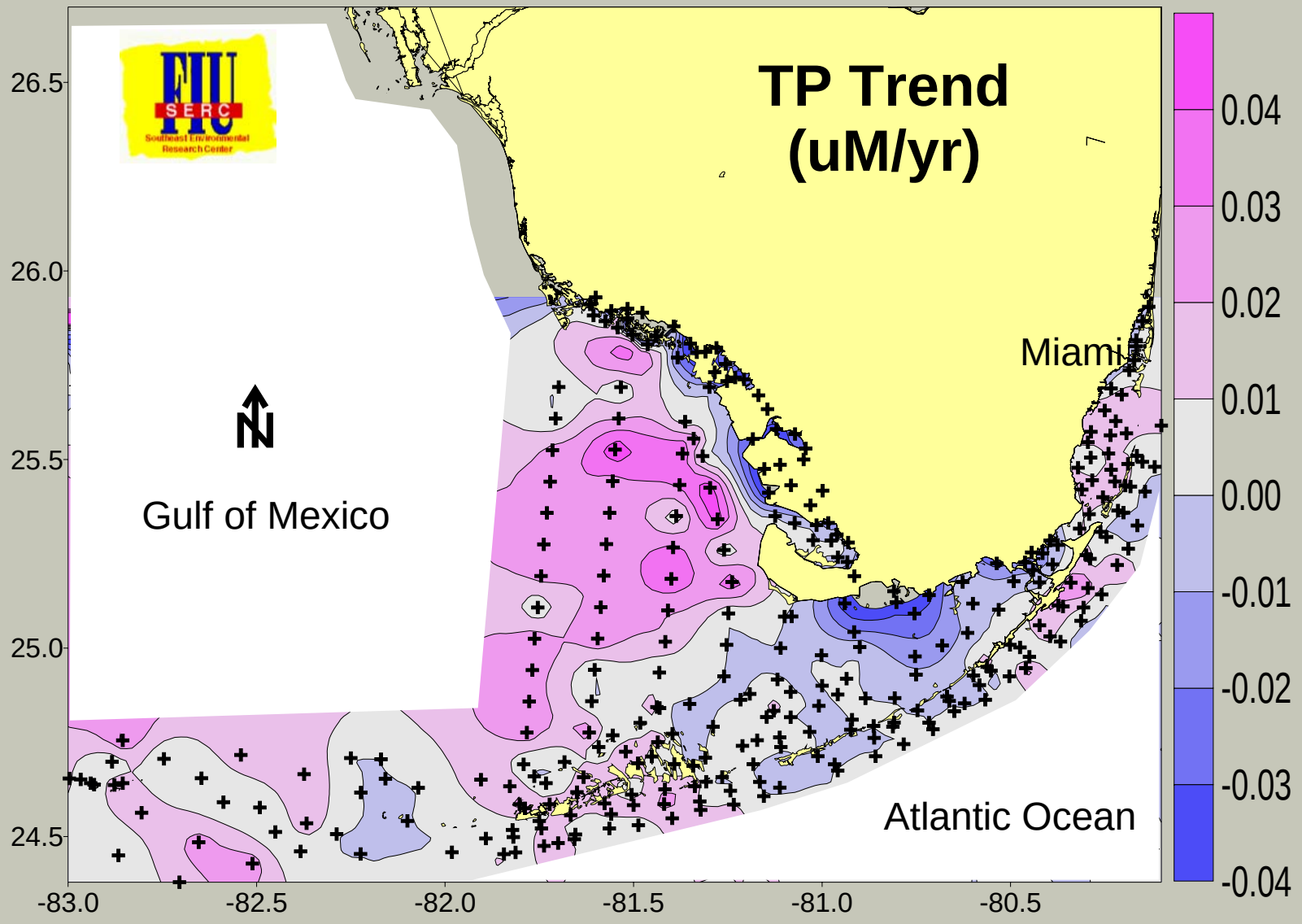
Geophysical Research Letters, 31, L15307

"Linkages between coastal runoff and the Florida Keys ecosystem: A study of a dark plume event"

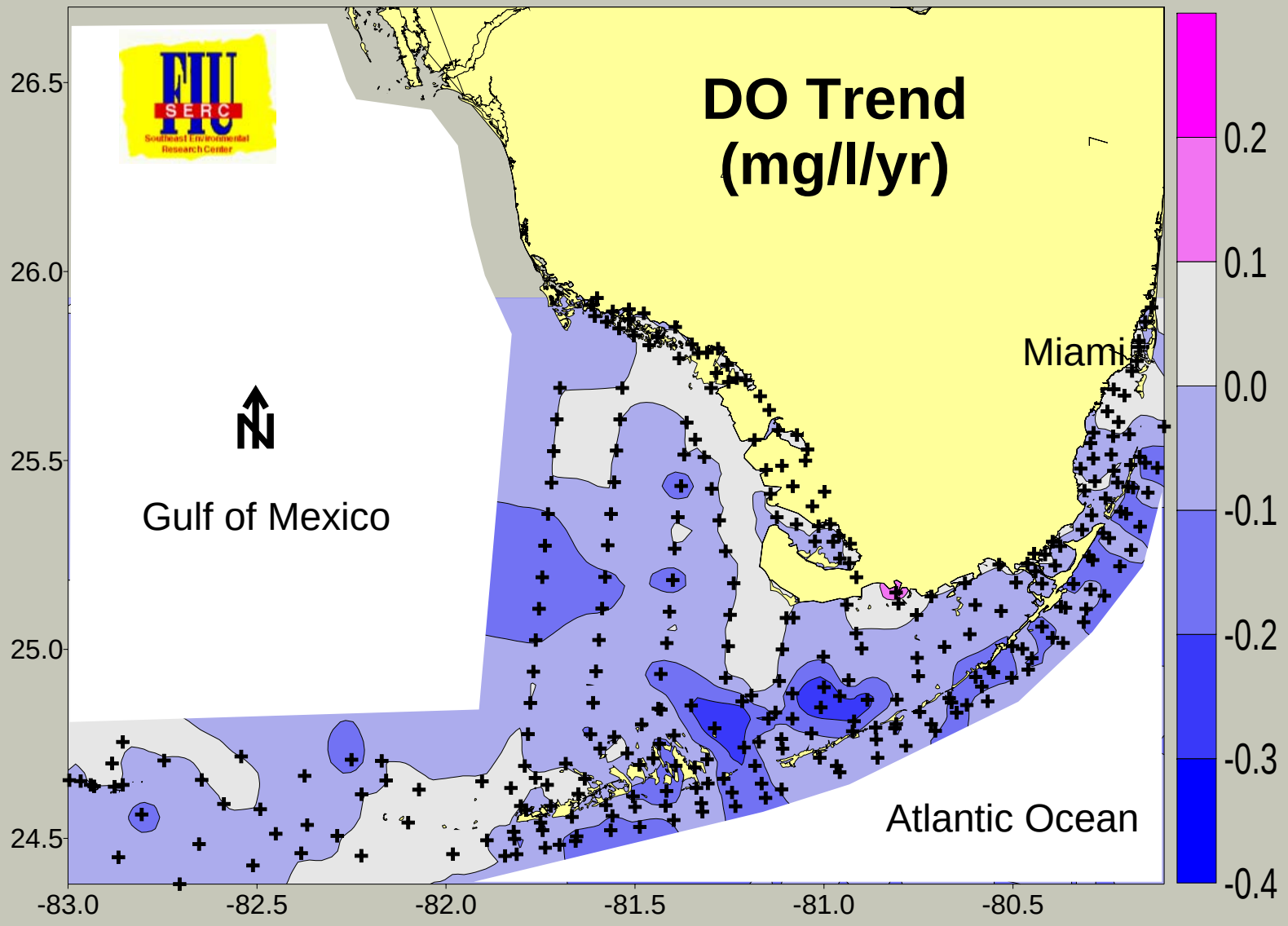
Thermograph Locations in the FKNMS

- 32 meters to record water temperature
- 7 CMAN Stations along reef tract and Florida Bay

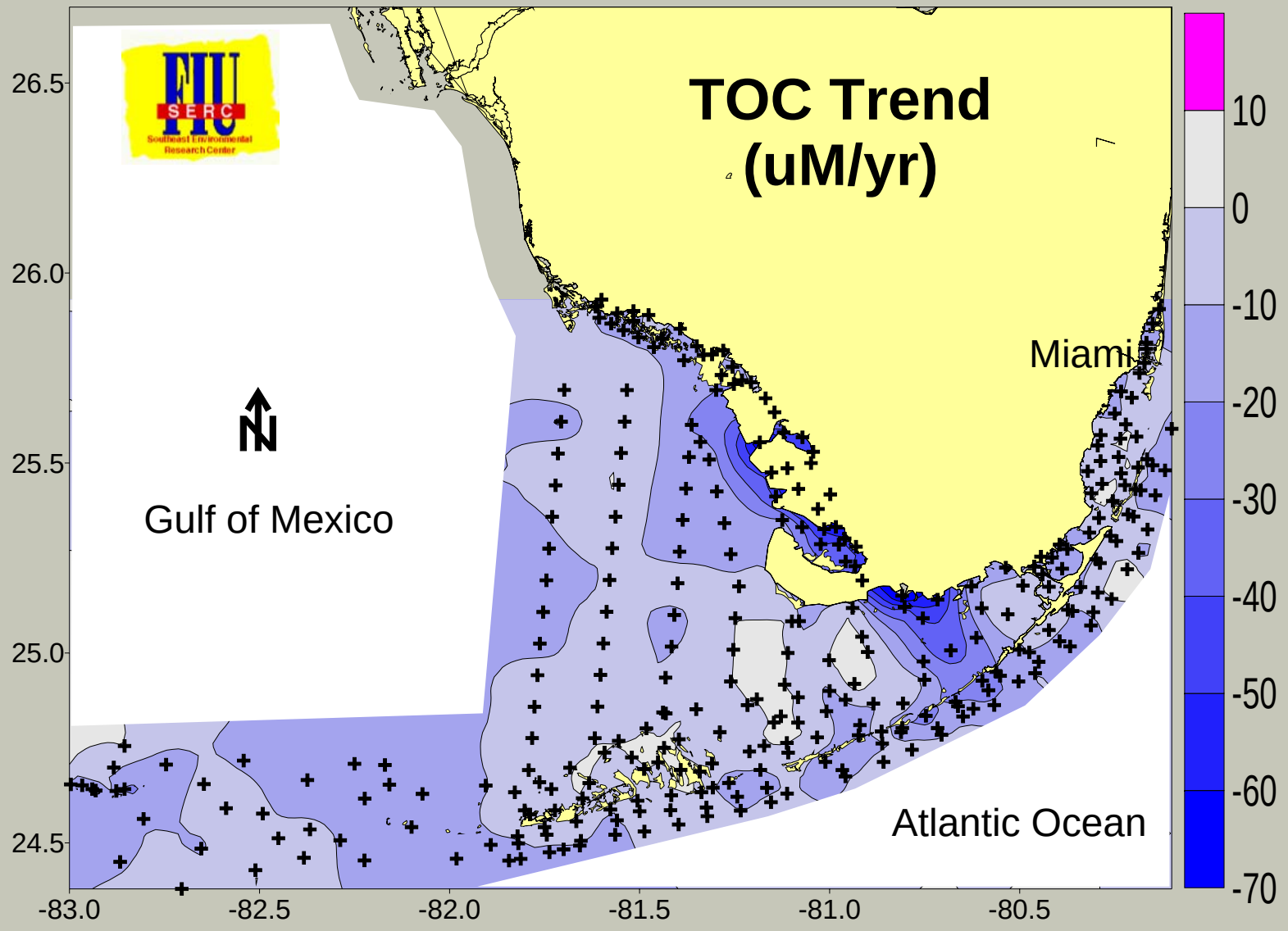
Summarizing Spatial and Temporal Trends



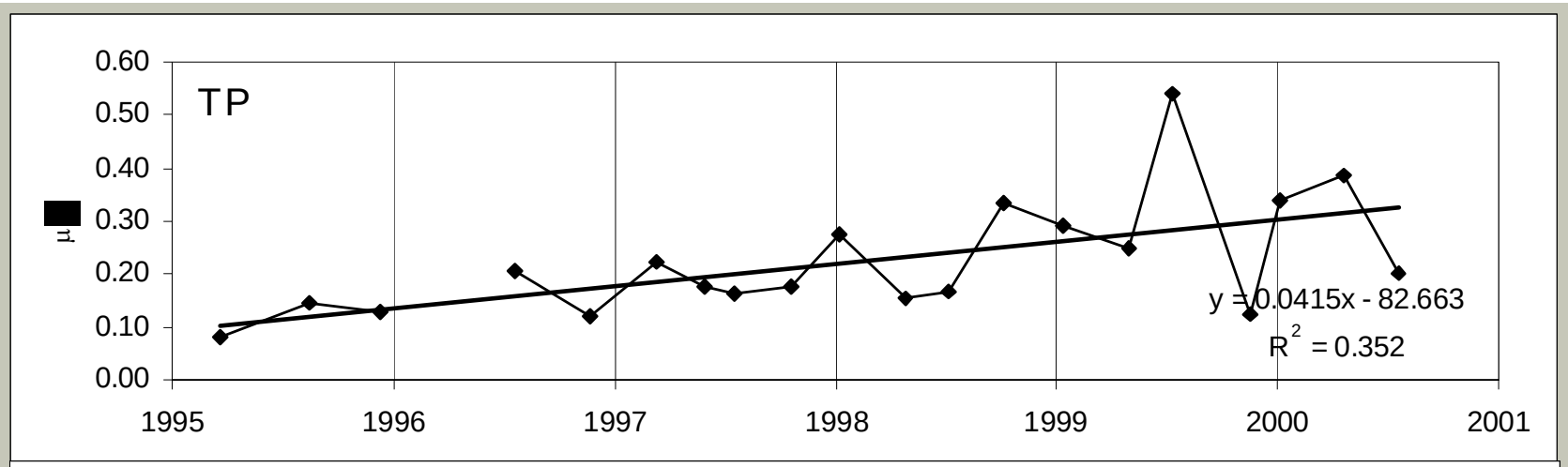
Credit: Joe Boyer, *et al*

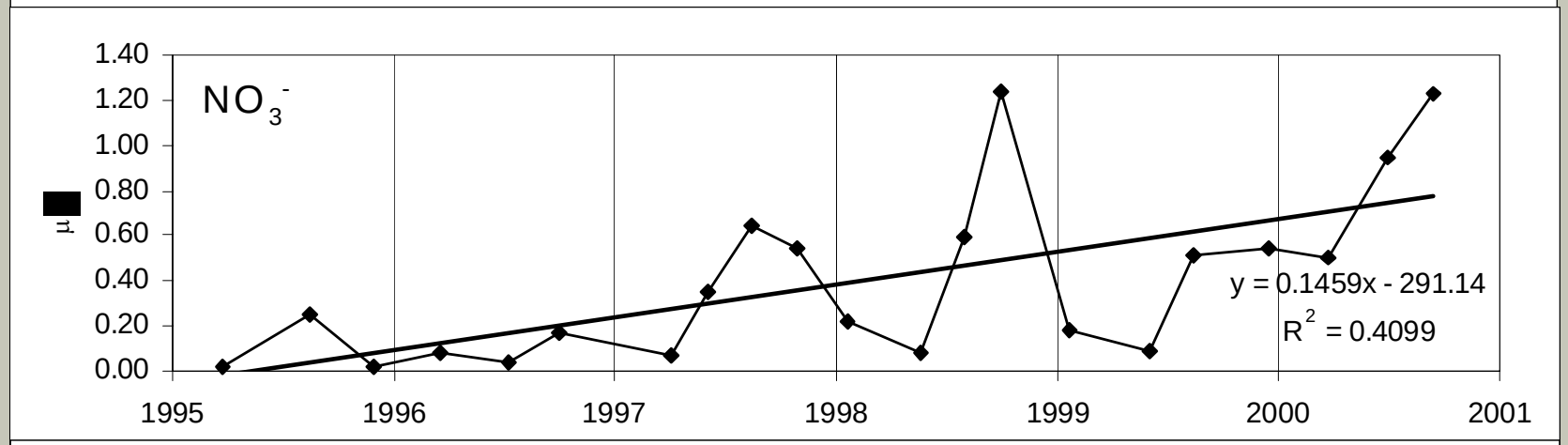


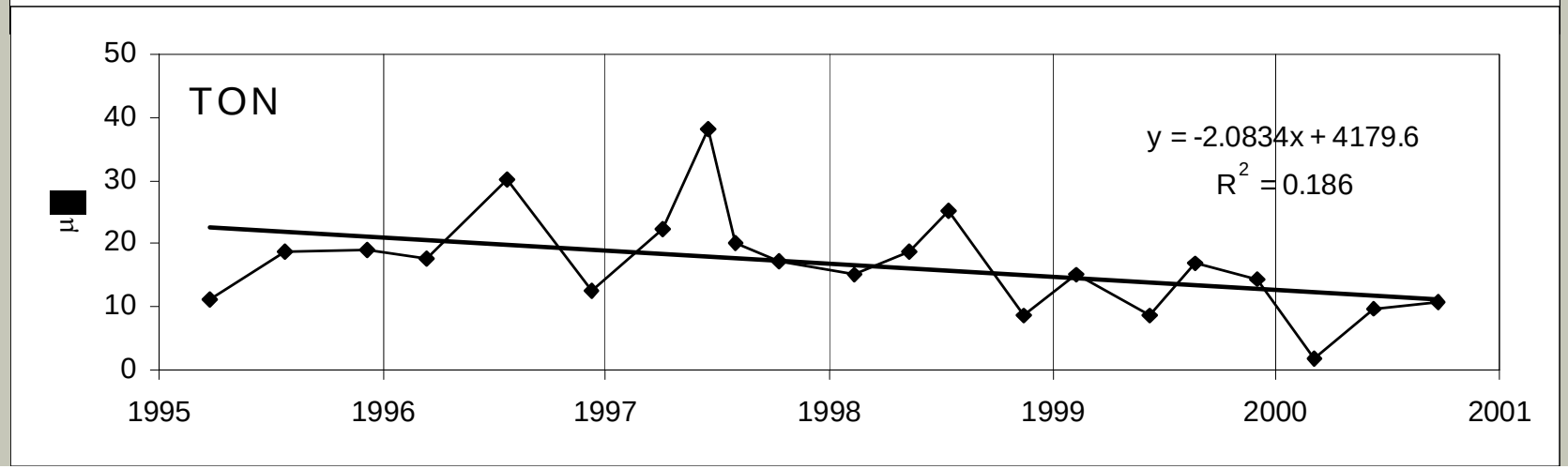
Credit: Joe Boyer, *et al*



Credit: Joe Boyer, *et al*


TP
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1995
1996
1997
1998
1999
2000
2001
y = 0.0415x - 82.663
R2 = 0.352


NO3-
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1995
1996
1997
1998
1999
2000
2001
y = 0.1459x - 291.14
R2 = 0.4099


TON
50
40
30
20
10
0
1995
1996
1997
1998
1999
2000
2001
y = -2.0834x + 4179.6
R2 = 0.186

Terrestrial vs. Gulf/Ocean influences on water quality

Spatial:
- Inshore waters of the keys are elevated in DIN and TOC relative to Tortugas – terrestrial source
- Upper Keys have slightly better WQ than Lower Keys – geomorphology

Temporal:
- Increasing trends in TP driven by Florida Shelf
- Decreasing trends in TOC driven by Everglades
- Decreasing trends in DO driven by ?

Regional:
- Florida Shelf currents bring elevated TP to FKNMS
- Upwelling of high nutrient deep ocean water onto reef
- Gyres bring low nutrient waters into FKNMS

Climactic:
- El Nino precipitation effects?

Suspected Results from Everglades Restoration

-Small increases in freshwater output to eastern Florida Bay (but within normal range of interannual variability)

-Large increases in freshwater output from Shark River

-May see more low salinity water traversing Keys passes

-Nutrient inputs to Bay and Shelf will increase, but not proportionally (increased load but decreased concentration)

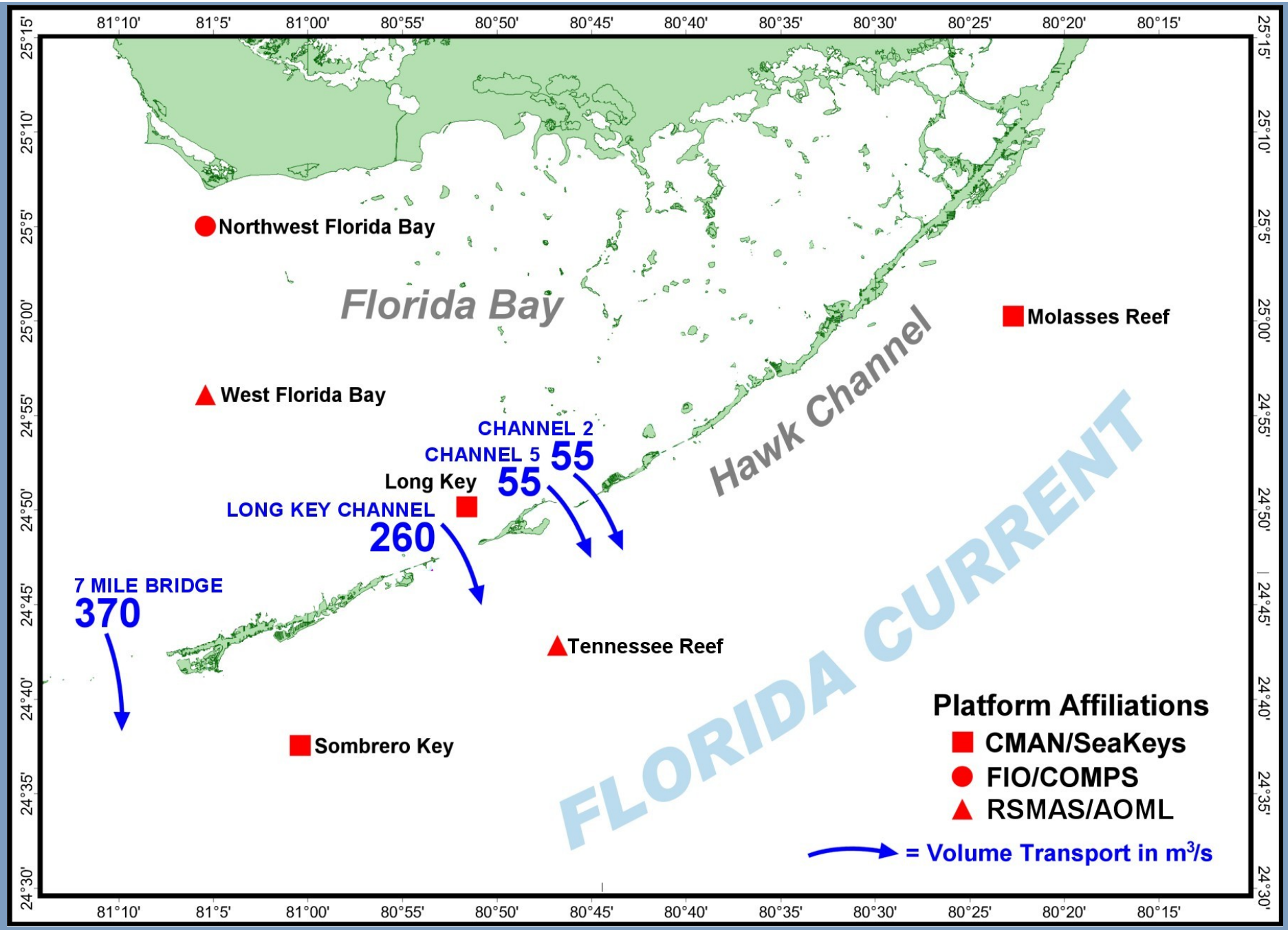
Nutrient Export from Florida Bay to the Florida Keys National Marine Sanctuary

Approx Annual Net Flux through Long Key Pass

- **3850 metric tons of TN (6% inorganic)**
- **63 metric tons of TP (17% inorganic)**
- **Driven by water transport / Varies seasonally**
- **No variation in concentration of inflow and outflow (Long Key Pass – 70% of outflow in middle Keys)**

Reference: Patrick Gibson & Joseph Boyer (FIU)

Ned Smith (Harbor Branch Oceanographic Institute)



Lee & Smith 2002

Nutrient Export from Florida Bay to the Florida Keys National Marine Sanctuary

Approx Annual Net Flux through total Middle Keys

- **5500 metric tons of N**
- **90 metric tons of P**
- **Current flows in Upper Keys and Lower Keys isolate Middle Keys**
- **Represents an estimated total direct mass flux between Fl Bay and the Atlantic**
- **About half of previous estimates by Rudnick *et al* (1999)**

Reference: Patrick Gibson & Joseph Boyer (FIU)

Ned Smith (Harbor Branch Oceanographic Institute)

Nutrient Export from Florida Bay to the Florida Keys National Marine Sanctuary

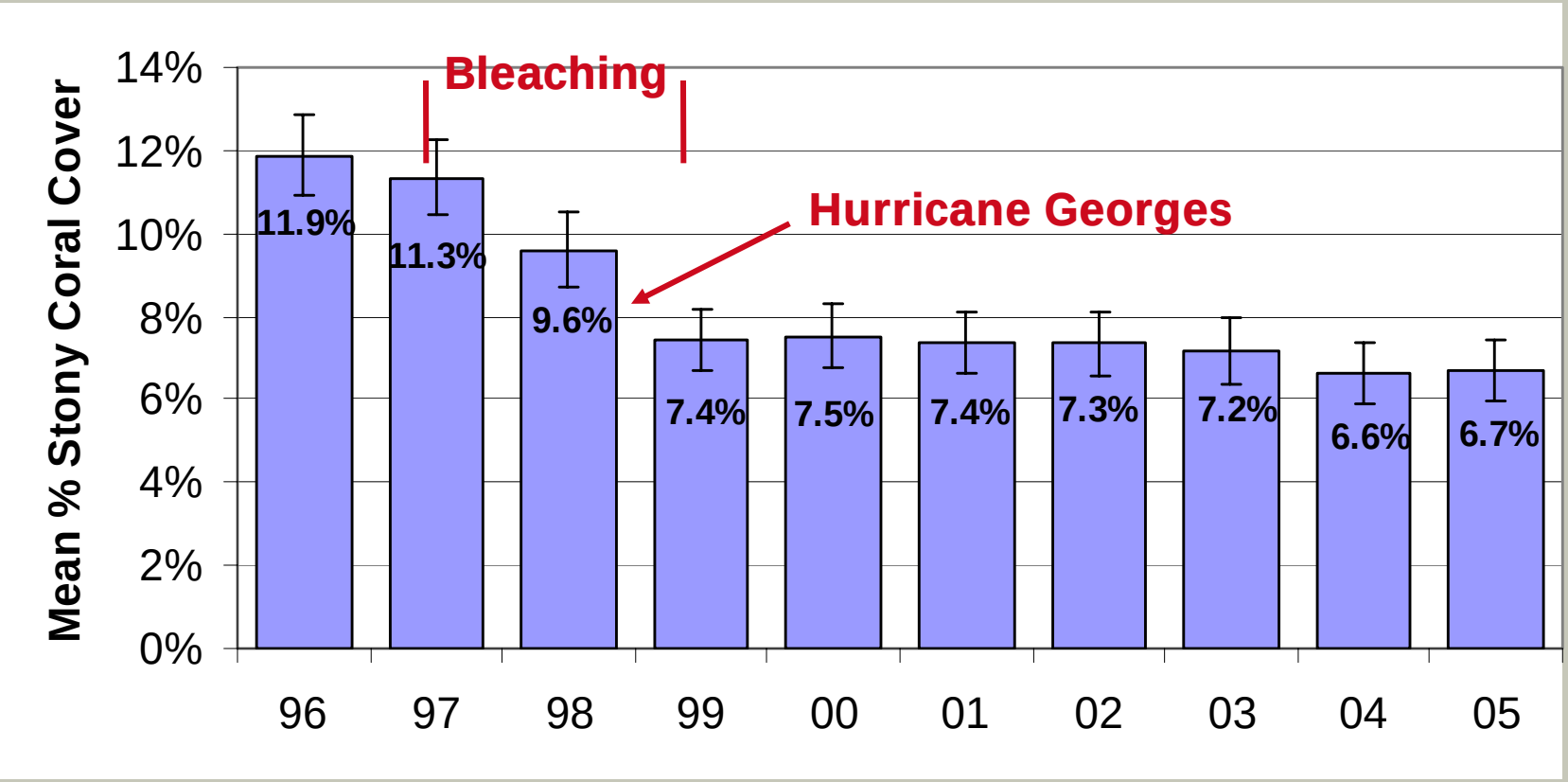
Outflow of Florida Bay Water through Hawk Channel out to Atlantic

- **Nutrient Concentration of Florida Bay water is equivalent to that of surrounding water column**
- **Input of Florida Bay Nutrients to Keys Coral Reefs is minimal compared to offshore tidal bores / upwellings**

Reference: Patrick Gibson & Joseph Boyer (FIU)

Ned Smith (Harbor Branch Oceanographic Institute)

Stony Coral Cover Sanctuary-wide 1996-2005



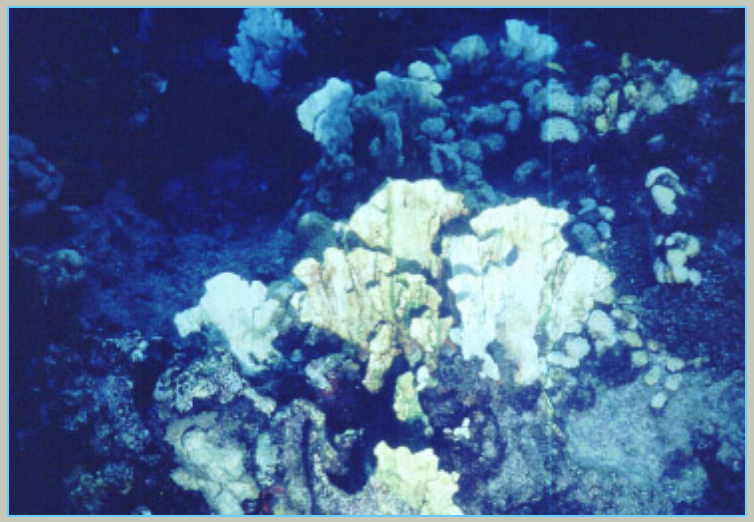
A decrease in stony coral cover was observed sanctuary-wide for each year from 1997 through 1999. Mean percent stony coral cover in 2005 did not change significantly (alpha = 0.05). Sanctuary-wide during 2005, mean stony coral cover was 6.7%.

http://www.floridamarine.org

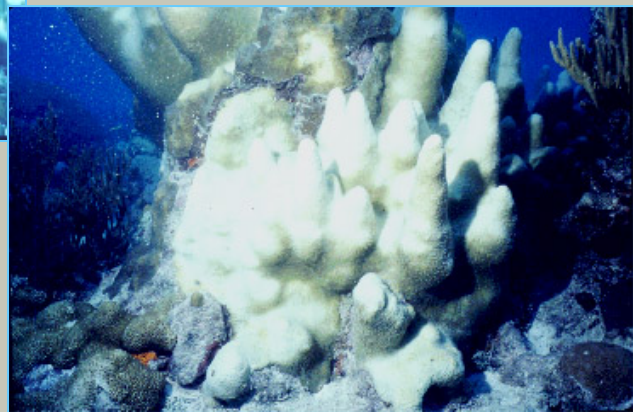
Coral Bleaching

1990

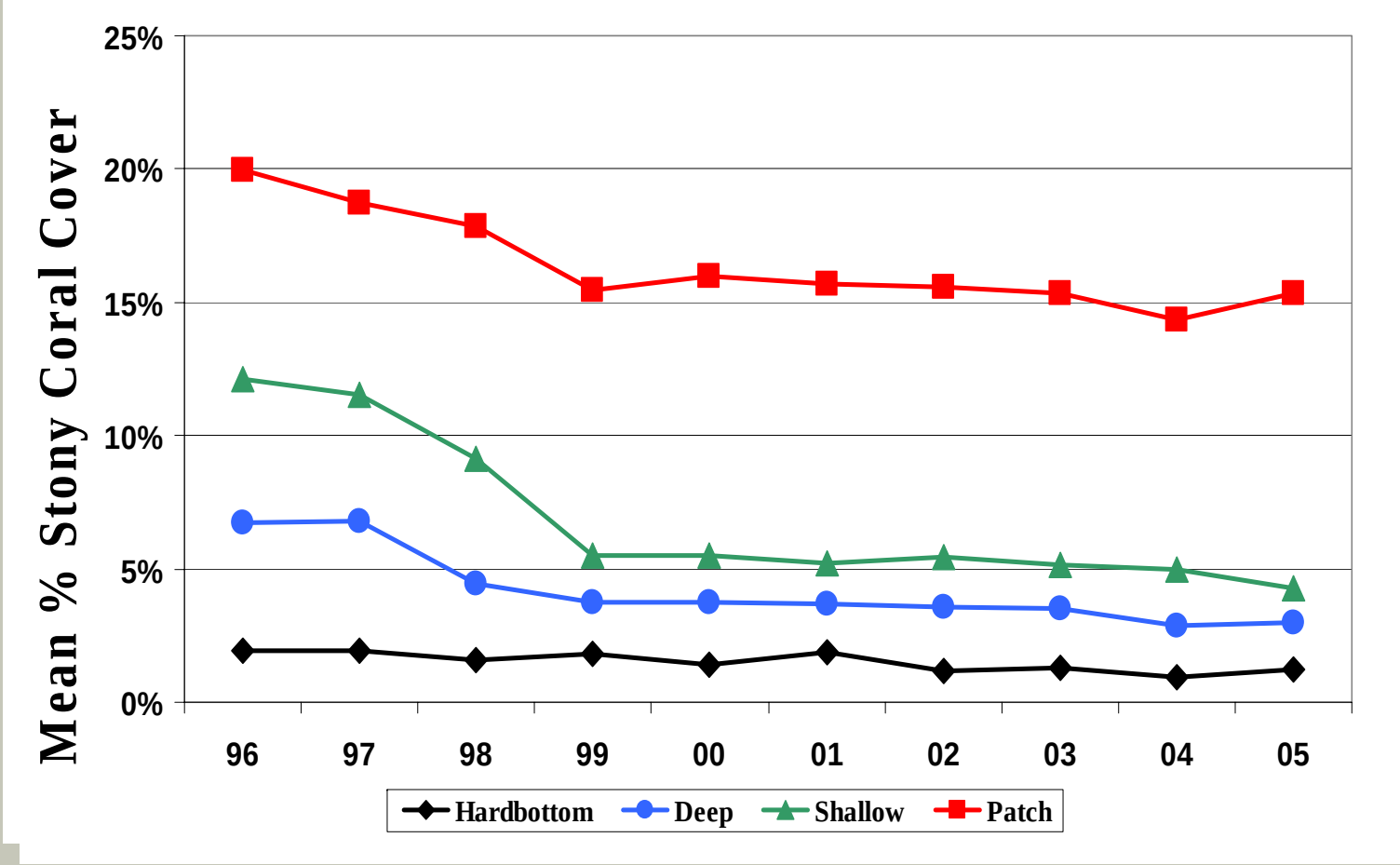
1990

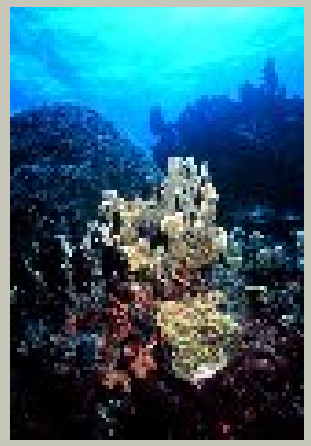


1997- 1998



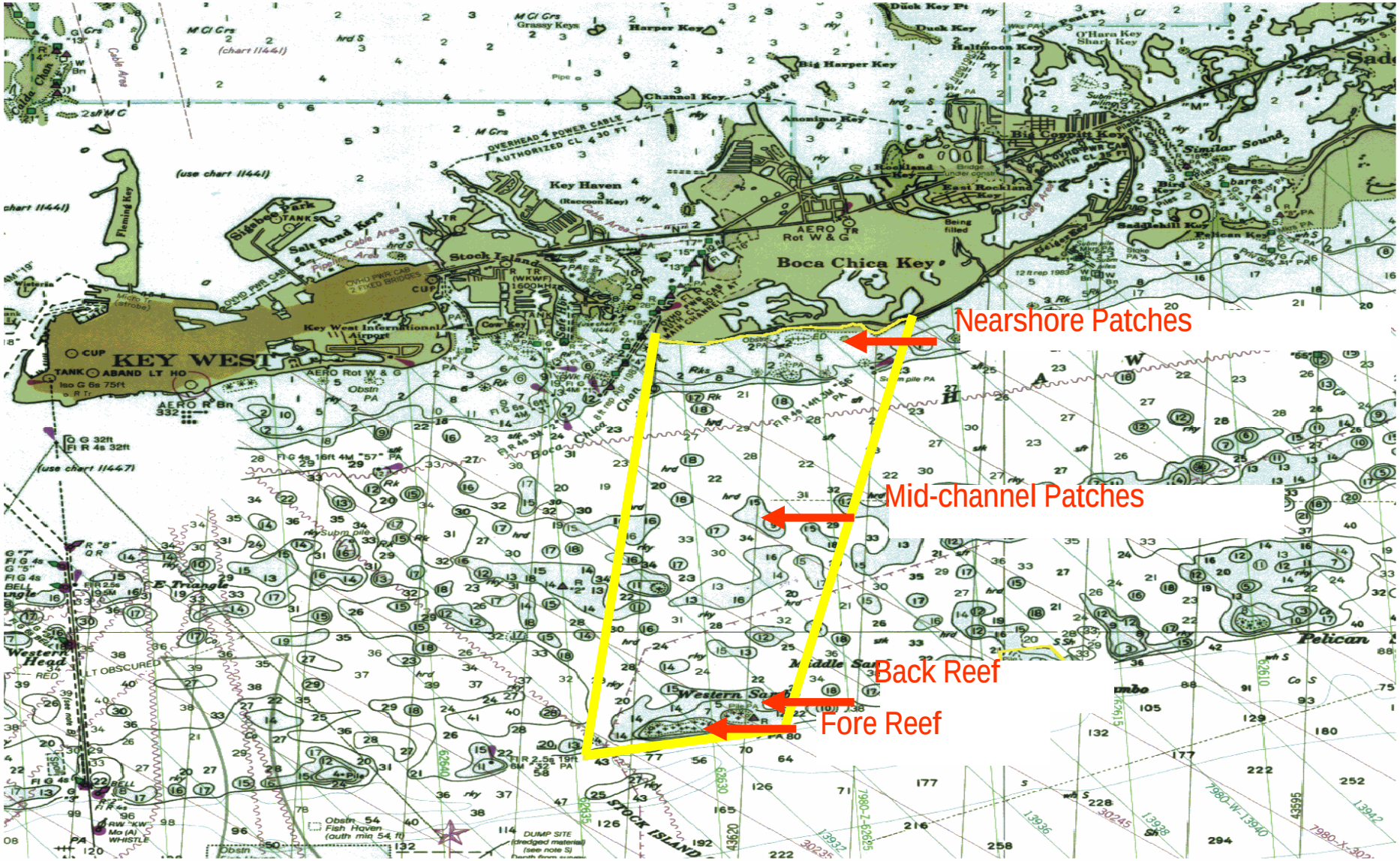
Stony Coral Cover by Habitat Type, 1996-2005





During 2005, stony coral cover increased at patch reef habitats, decreased at shallow reef habitats and remained unchanged at hard bottom & deep reef habitats.

Western Sambo Ecological Reserve



Mid-channel Patch Reefs

Recent Examples of Connectivity Between Southwest Florida and the Florida Keys

The 2002 Blackwater Event

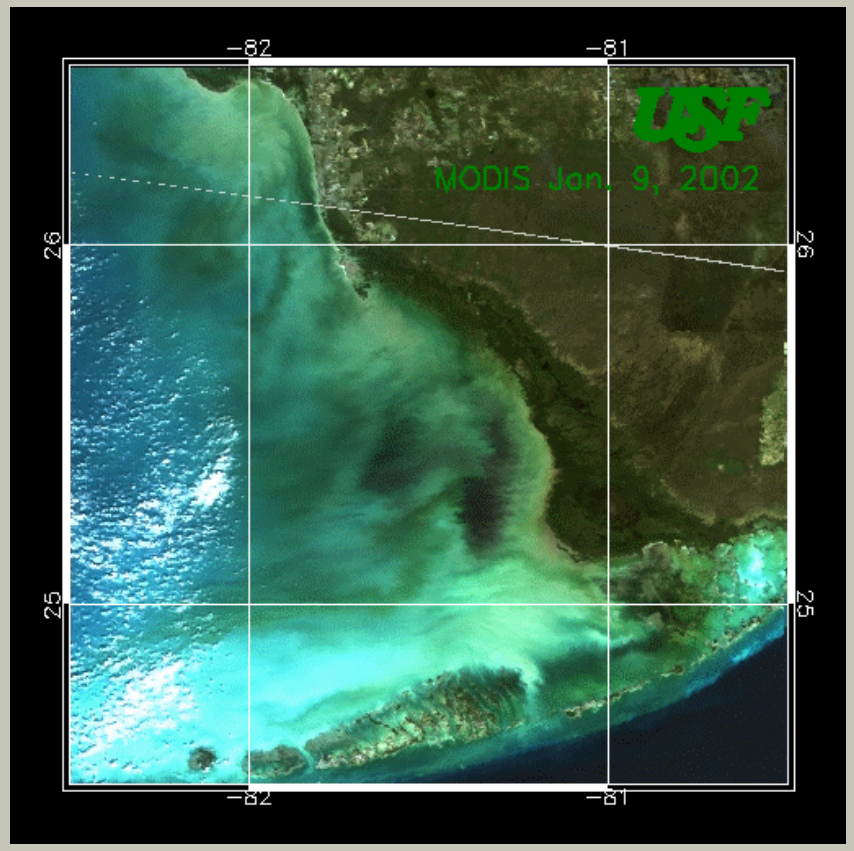
Southwest Florida Shelf Through the Florida Keys

Satellite Imagery and Oceanographic Measurements,

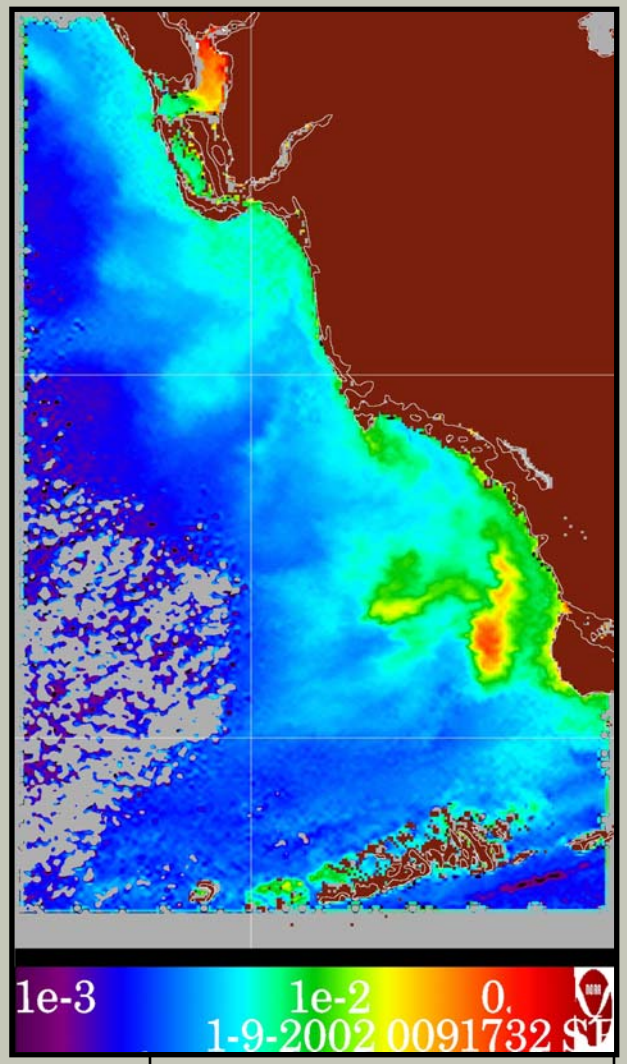
9 January - 4 April 2002

Blackwater Imagery

9 January 2002



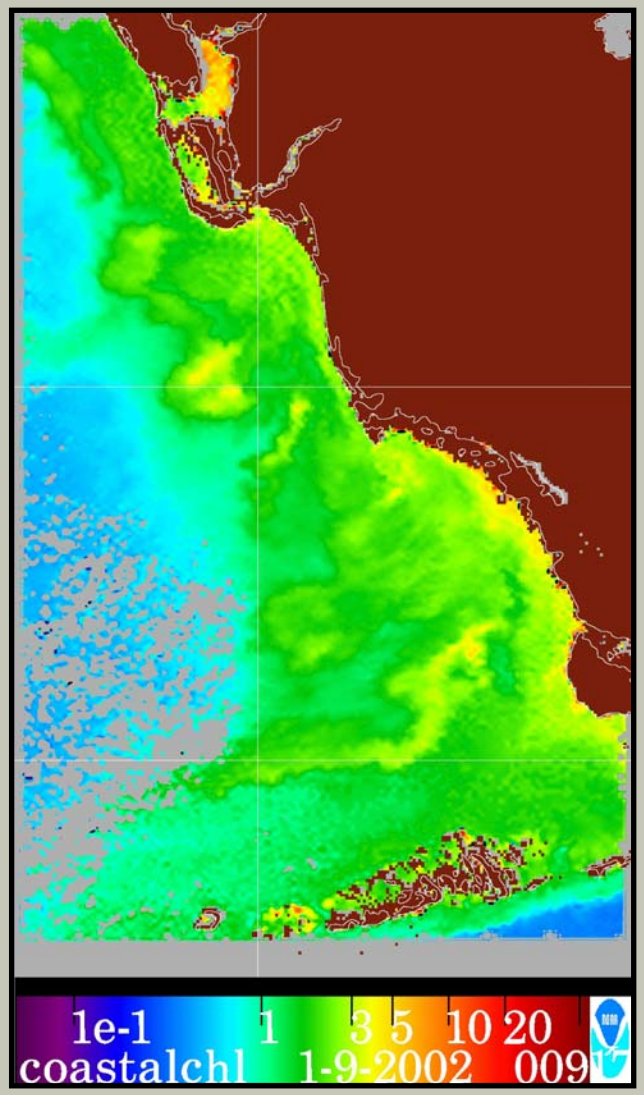
True color image



R. Stumpf, NOAA

Drs. Frank Muller-Karger & Chuanmin Hu (USF)

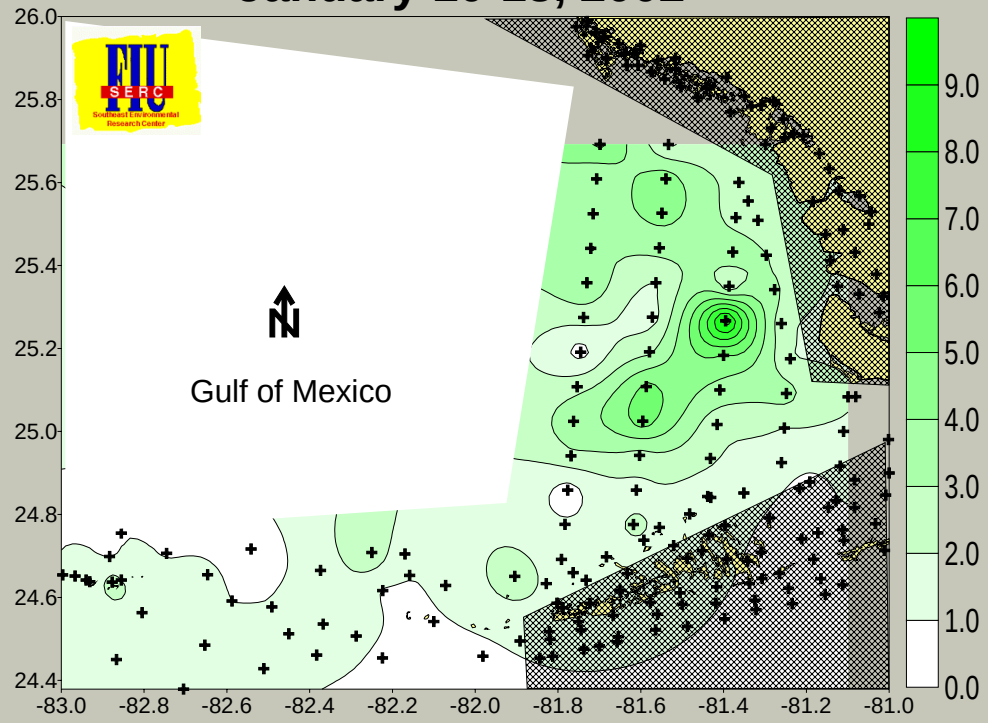
Image enhanced for blackwater "signal" (tannins, humic acid)



R. Stumpf, NOAA CoastWatch

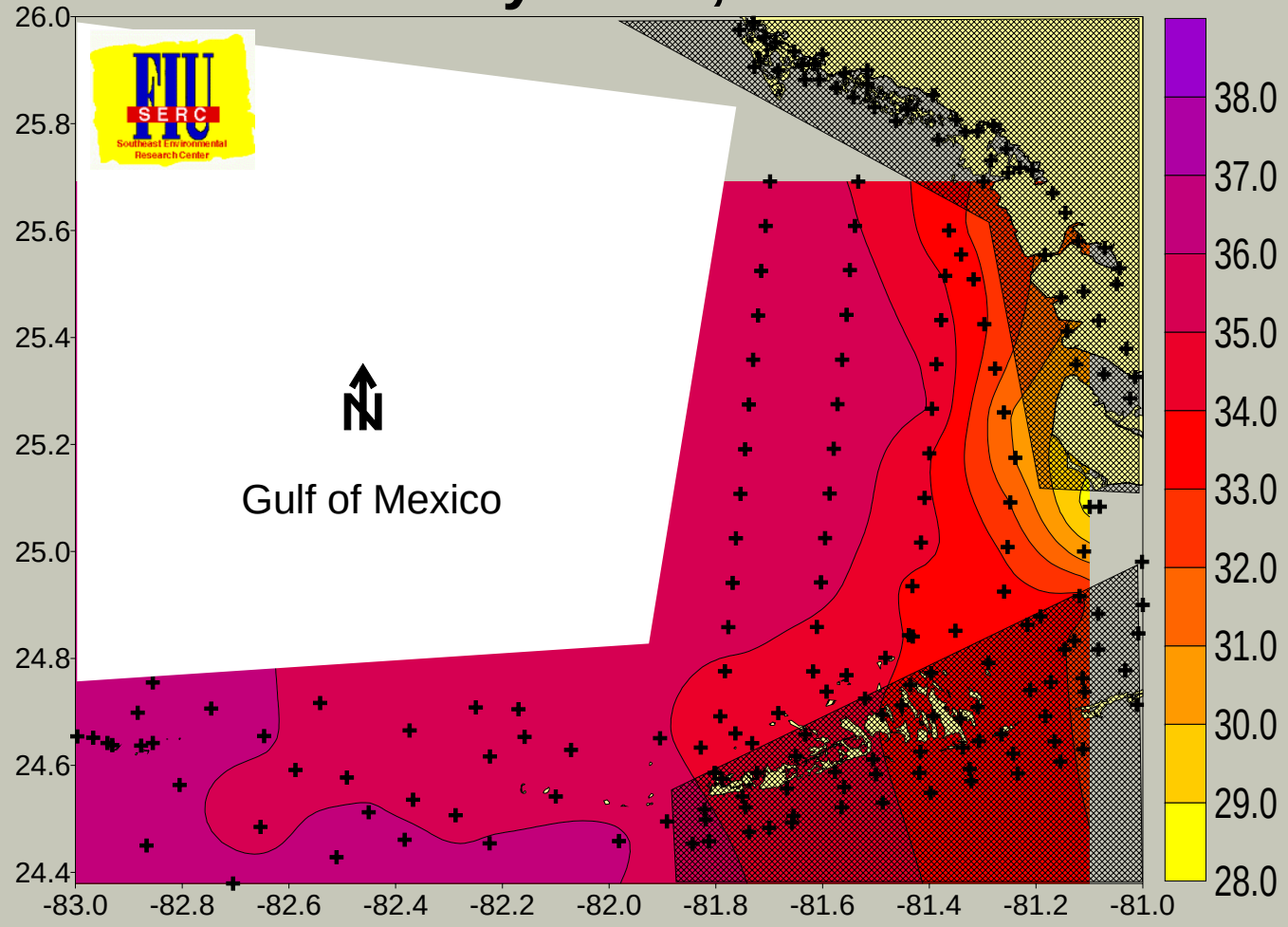
1/9/02: Image enhanced for chlorophyll concentration (amount of phytoplankton)

Chlorophyll a (ug/l)
January 10-13, 2002



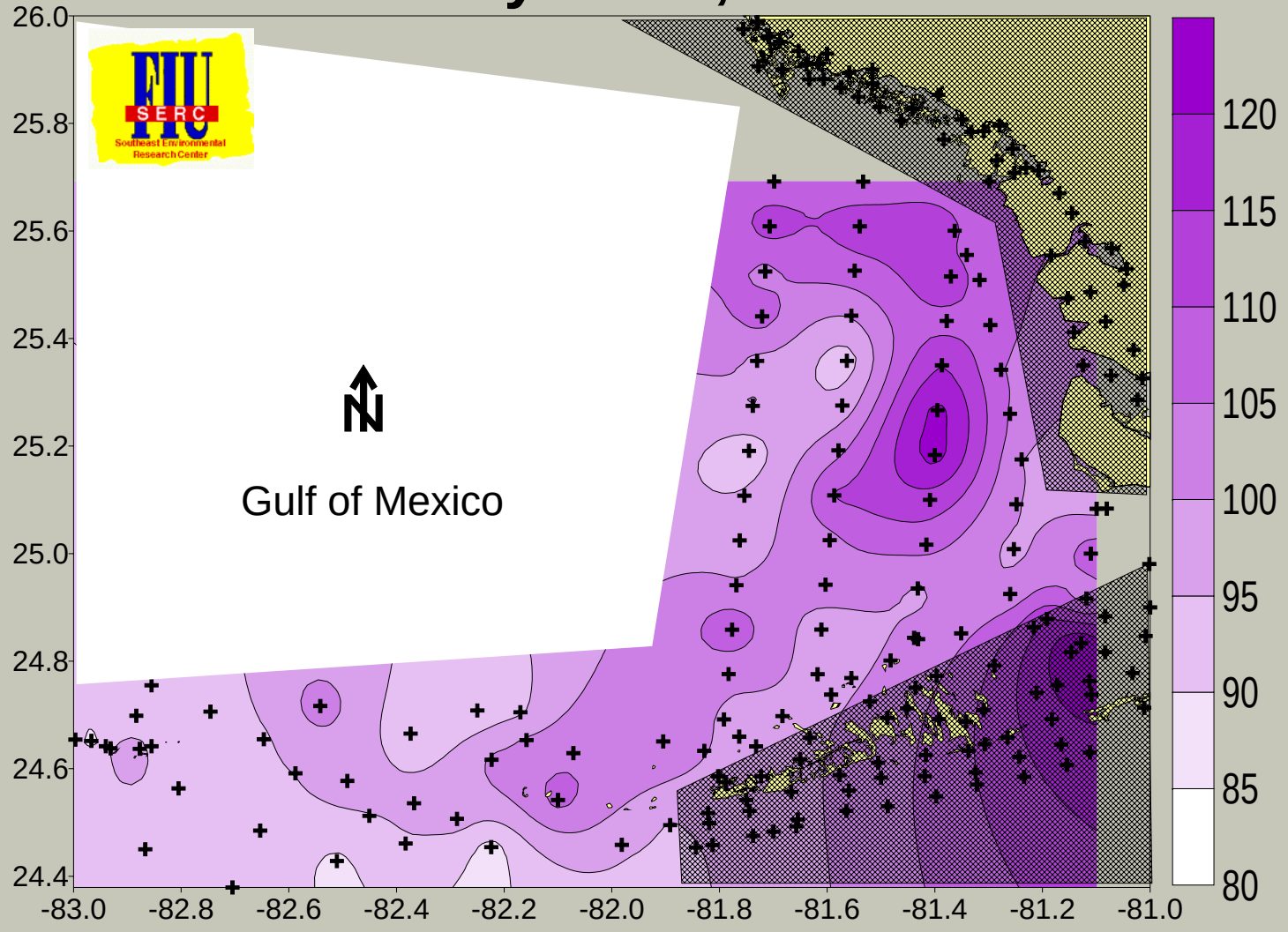
Highest concentration of chlorophyll *a* measured in this region since quarterly monitoring began in 1995

Salinity (psu)
January 10-13, 2002



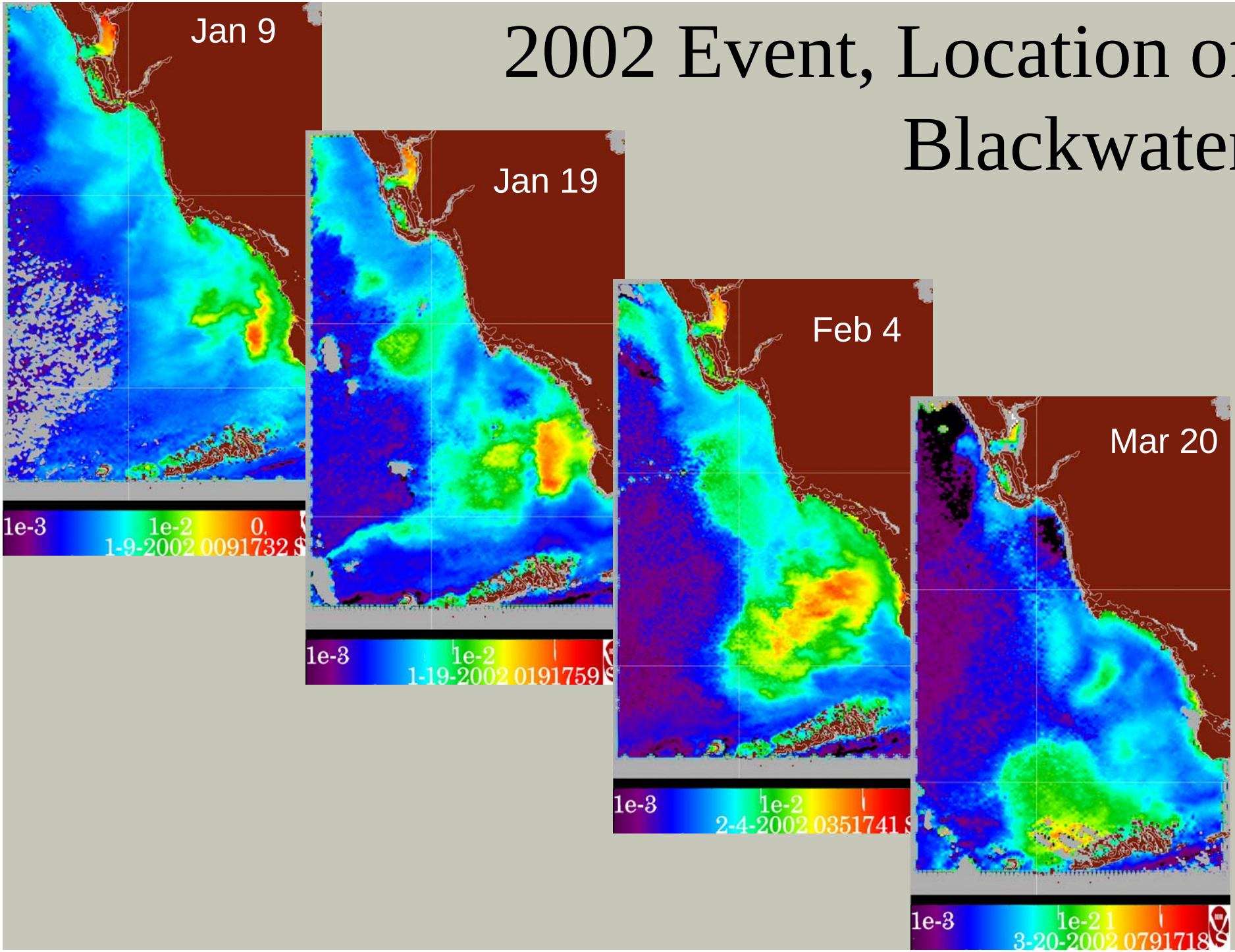
Plume of low-salinity water emanating from the mainland

DOsat (%)
January 10-13, 2002



Water column saturated with oxygen (daytime): this was not a “dead zone”

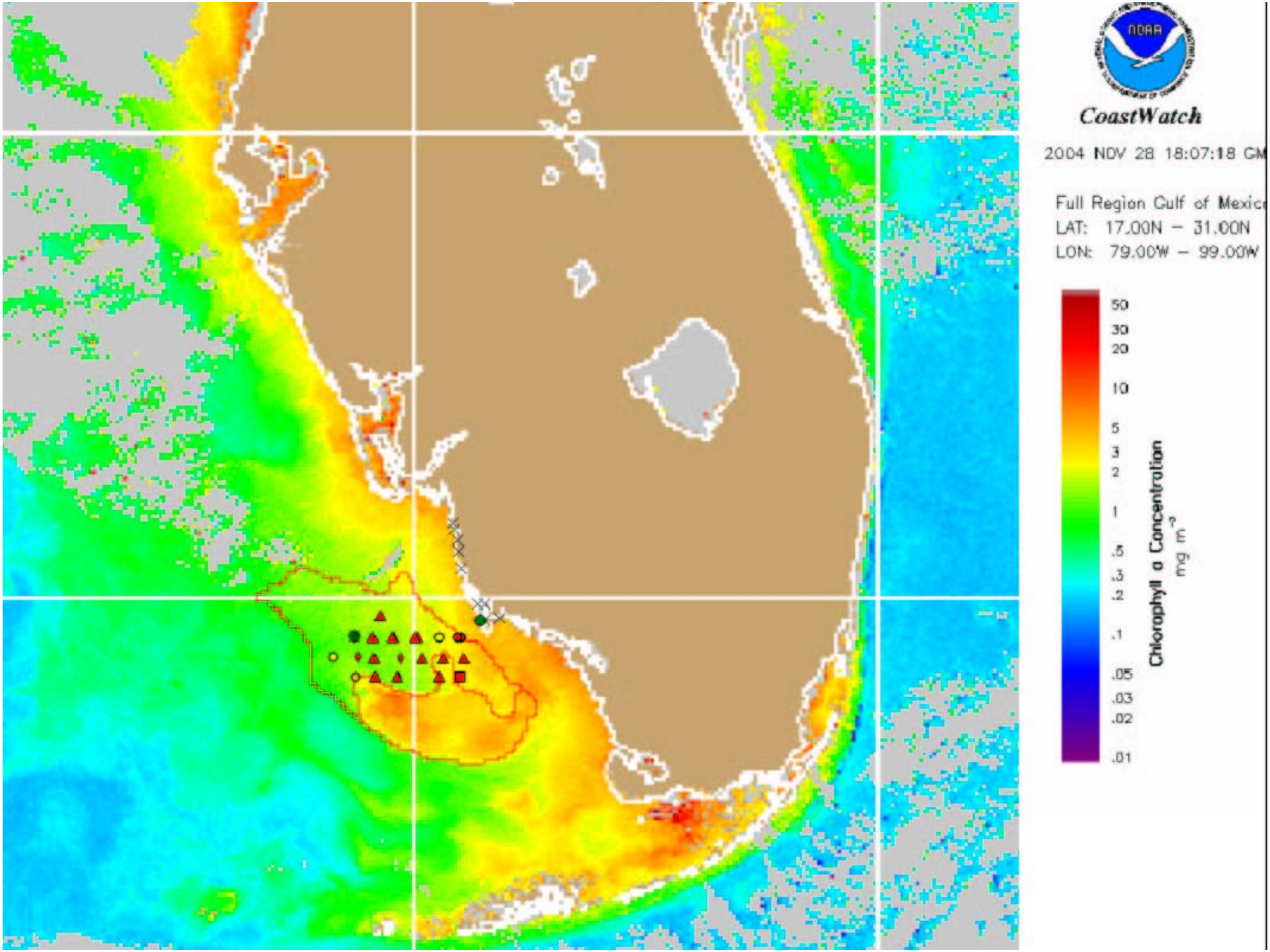
2002 Event, Location of Blackwater

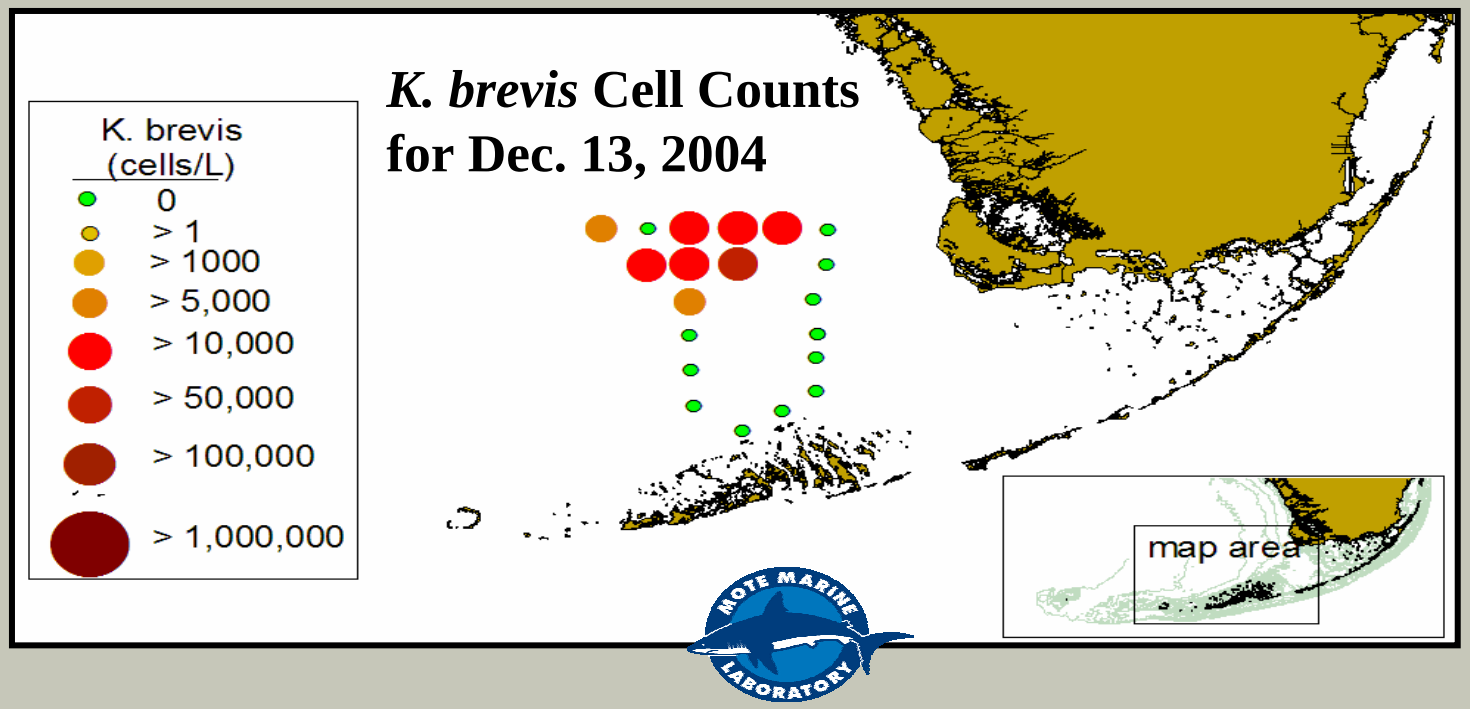


Because We Have Monitoring Data:

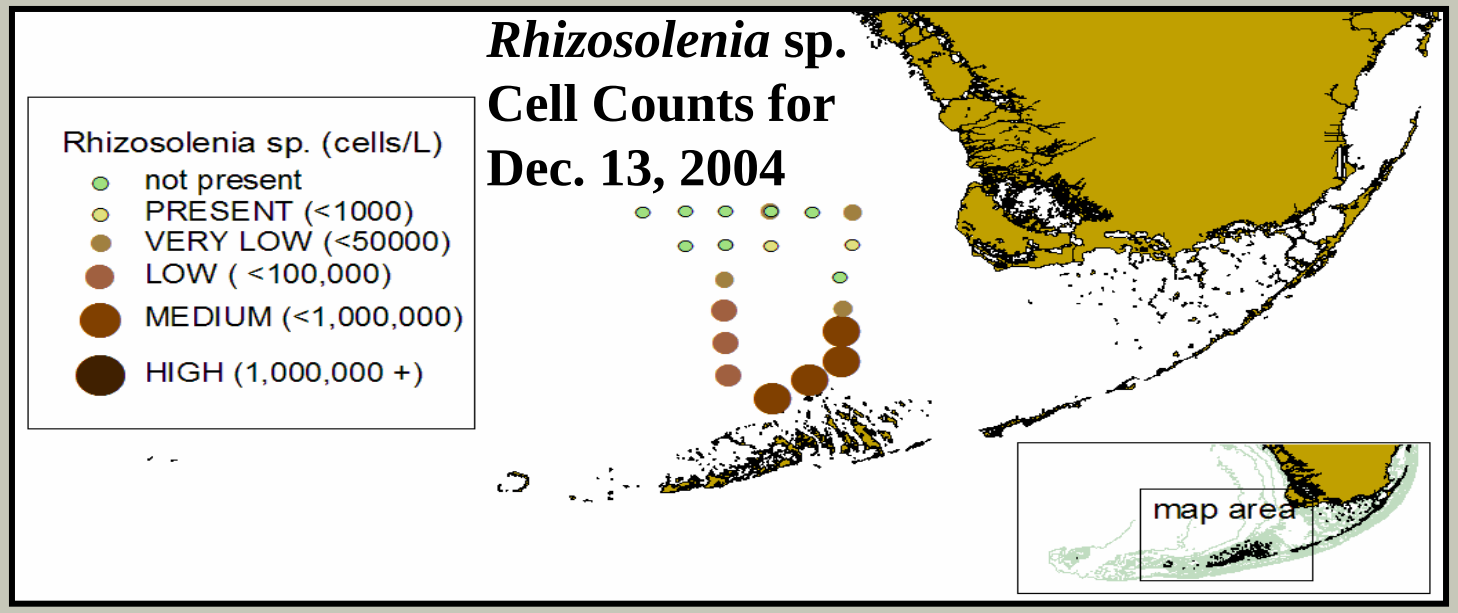
We can say it was an historical event

- **Blackwater Events had been reported in the 1800's and early 1900's**
- **Satellite Monitoring has made these events easier to track in modern times**
- **Cause – some speculate – a dissipating red tide collided with an annual diatom bloom originating at mouth of Shark River Slough**


CoastWatch
2004 NOV 28 18:07:18 GM
Full Region Gulf of Mexic
LAT: 17.00N – 31.00N
LON: 79.00W – 99.00W
50
30
20
10
5
3
2
1
.5
.3
.2
.1
.05
.03
.02
.01
Chlorophyll a Concentration
mg m-3

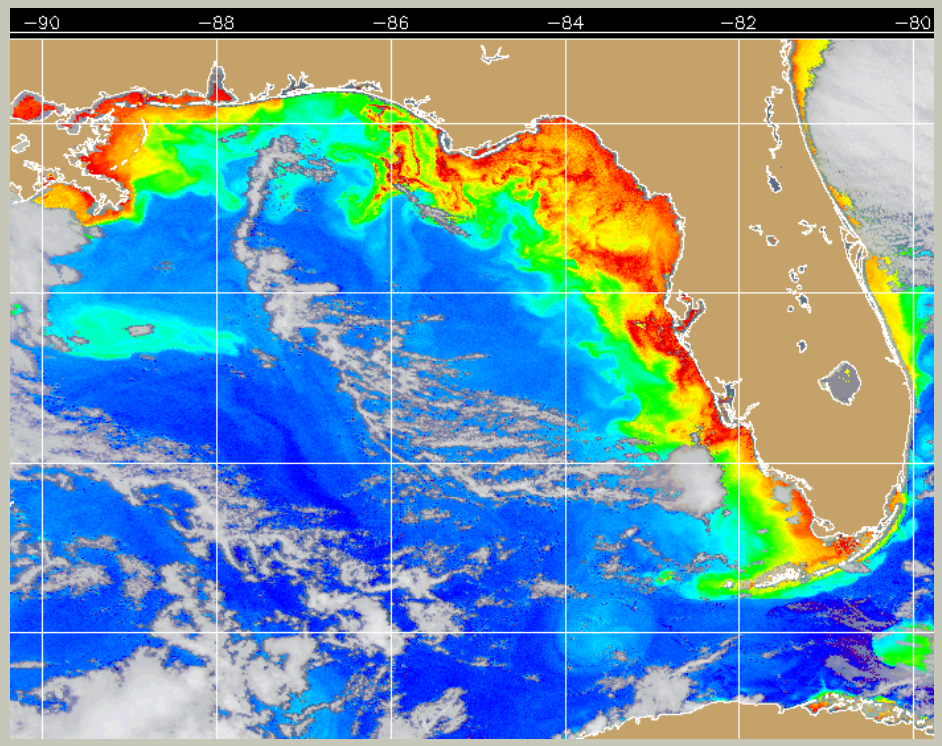


***K. brevis* Cell Counts for Dec. 13, 2004**

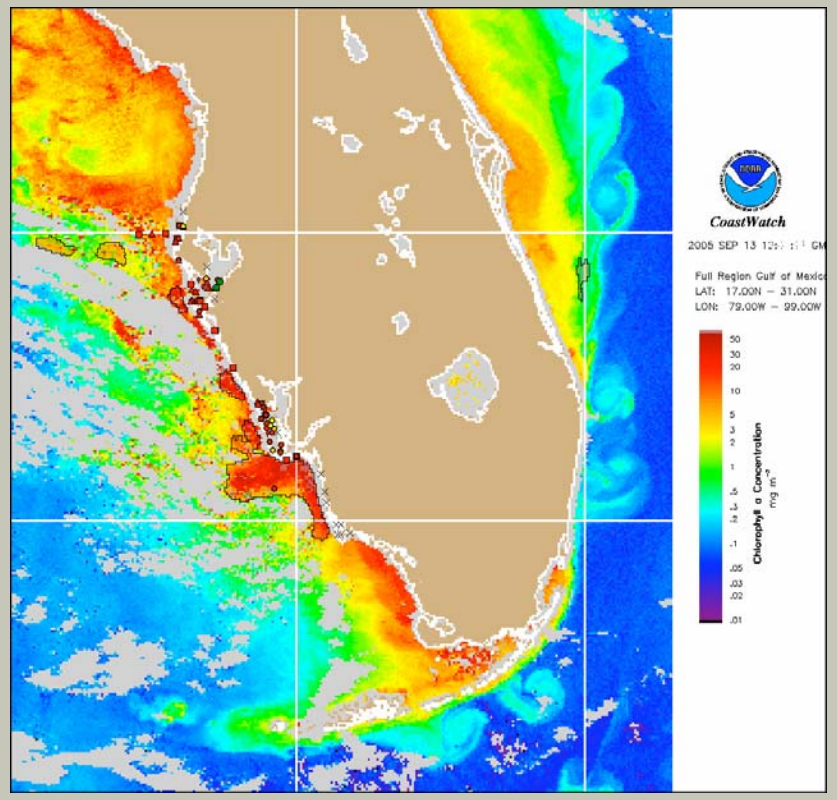


***Rhizosolenia* sp. Cell Counts for Dec. 13, 2004**

09/14/05



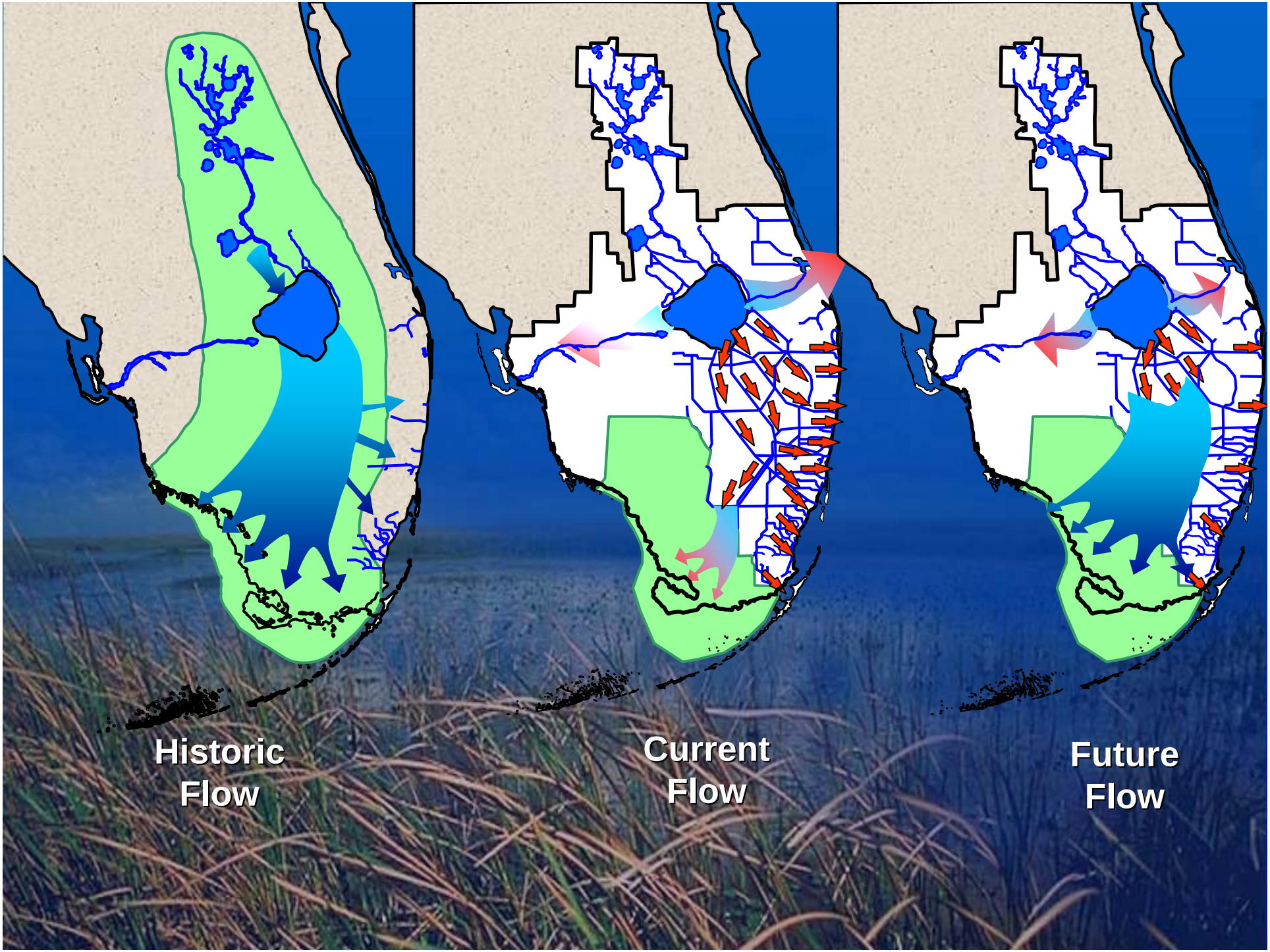
09/15/05



NOAA Harmful Algal Bloom Bulletin

http://coastwatch.noaa.gov/hab/

Comprehensive Everglades Restoration Plan (CERP) is... *Getting the Water Right!*


Historic
Flow
Current
Flow
Future
Flow

Questions?