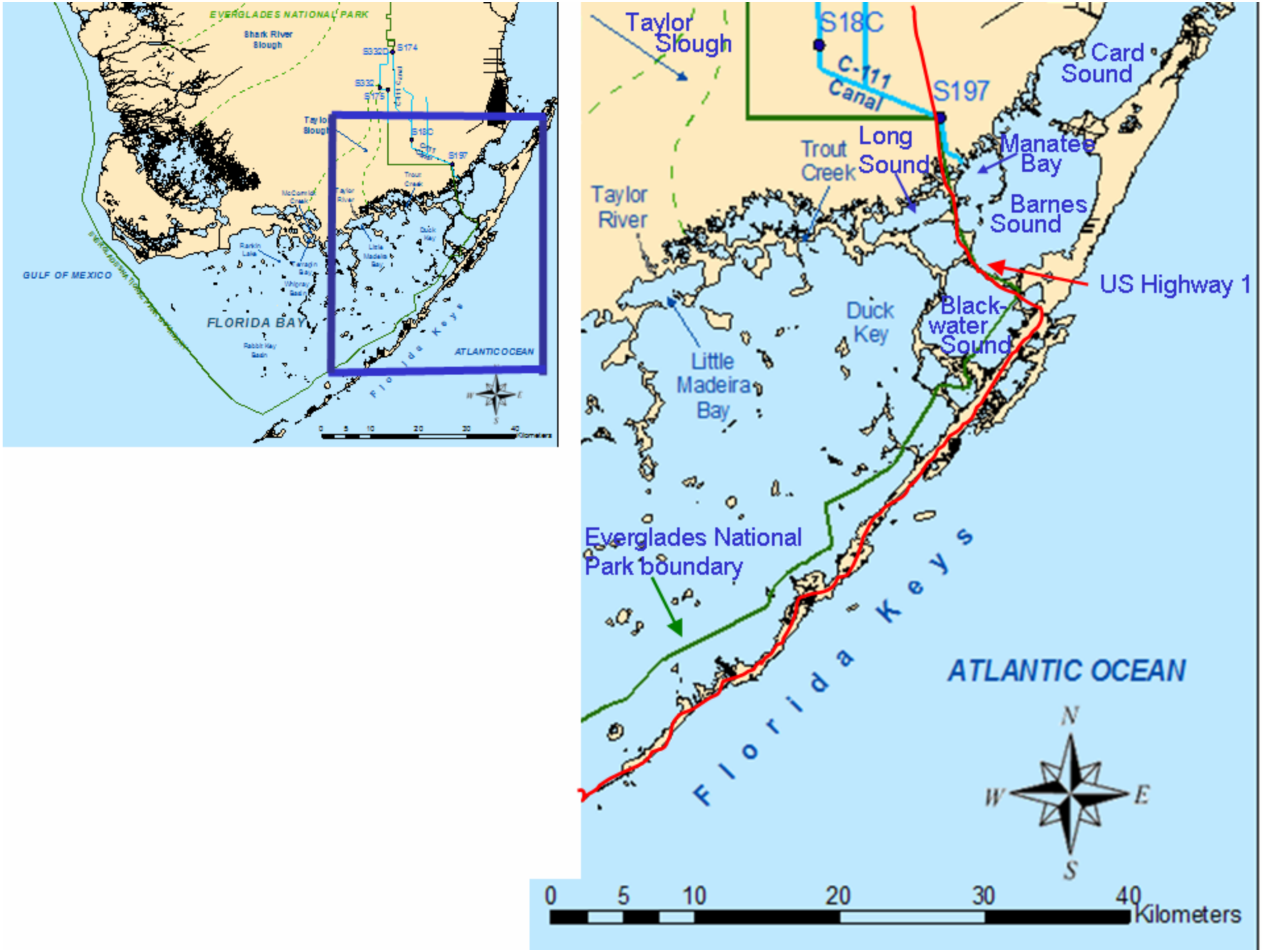
SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Algal Blooms in Eastern Florida Bay and Southern Biscayne Bay

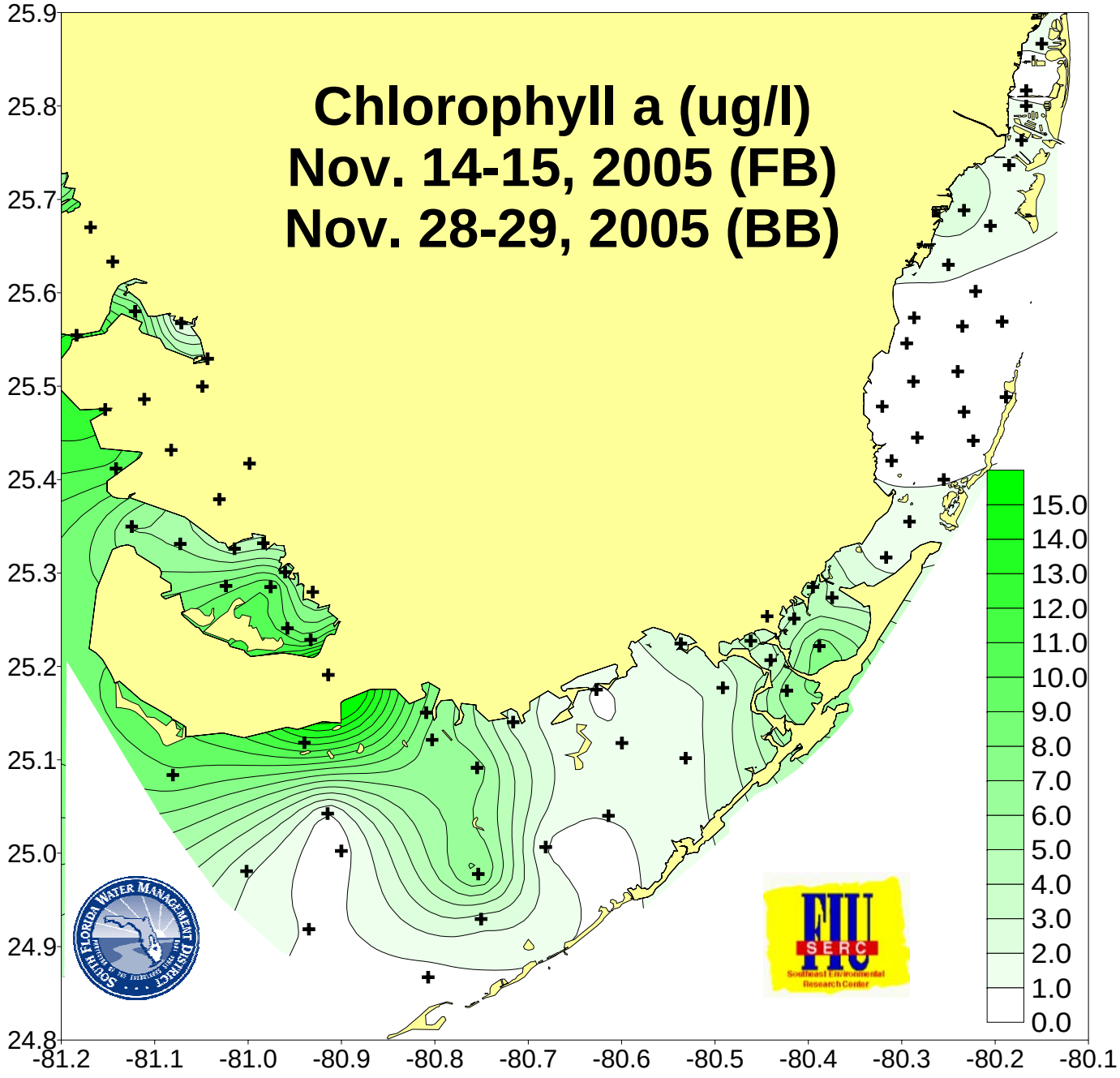
Chip Merriam

South Florida Water Management District

December 6, 2006

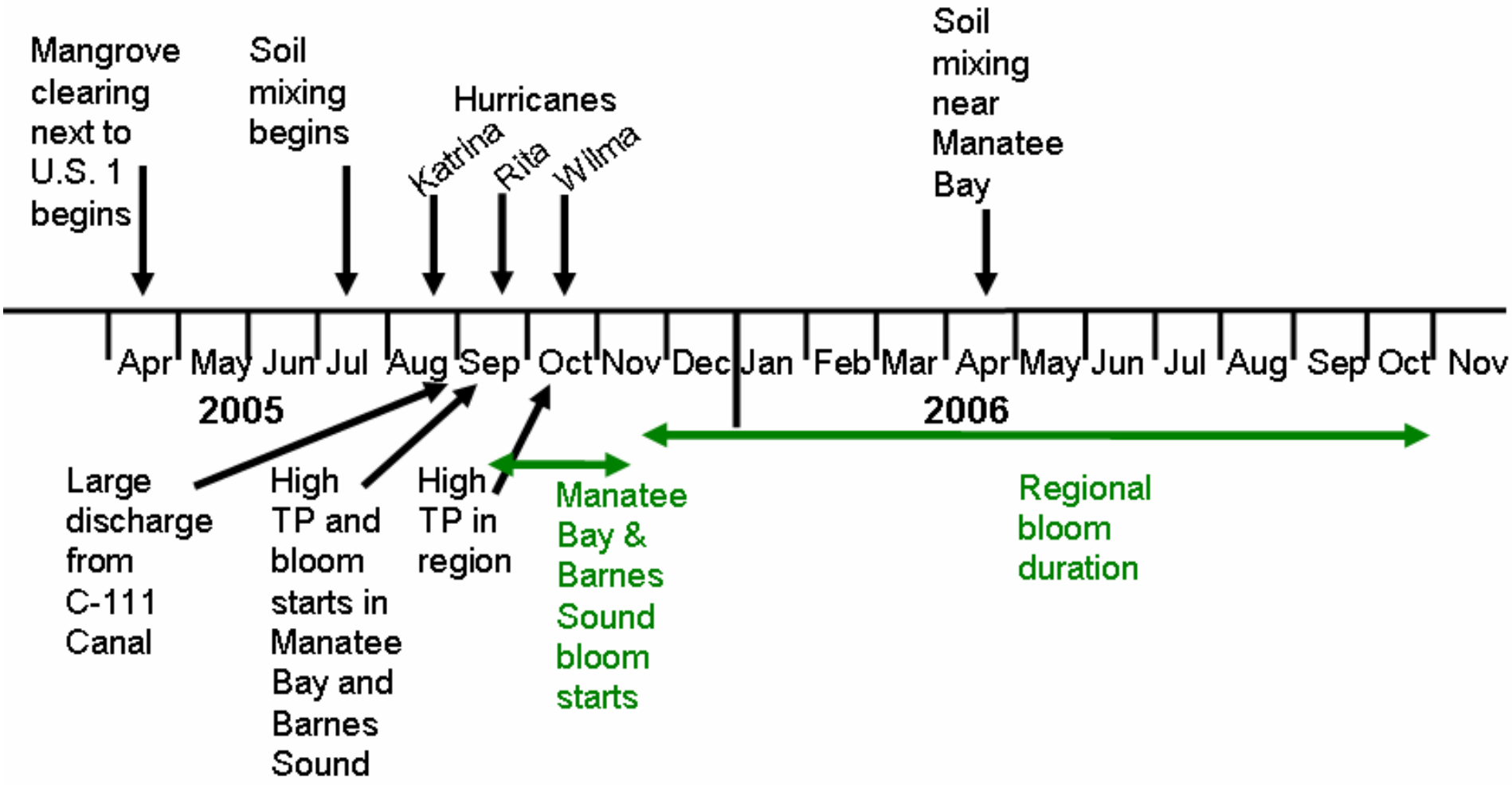

EVERGLADES NATIONAL PARK
Shark River Slough
S332D
S174
S332
S175
C-111 Canal
Taylor Slough
S18C
S197
Trout Creek
McCormick Creek
Taylor River
Duck Key
Rankin Lake
Little Madeira Bay
Tarpon Bay
Whipray Basin
GULF OF MEXICO
FLORIDA BAY
Rabbit Key Basin
ATLANTIC OCEAN
Florida Keys
0 5 10 20 30 40 Kilometers
Taylor Slough
S18C
C-111 Canal
S197
Card Sound
Long Sound
Trout Creek
Manatee Bay
Barnes Sound
Taylor River
US Highway 1
Duck Key
Black-water Sound
Little Madeira Bay
Everglades National Park boundary
Florida Keys
ATLANTIC OCEAN
N
W
E
S
0 5 10 20 30 40 Kilometers

Algal bloom initiated by November 2005



from:
J. Boyer

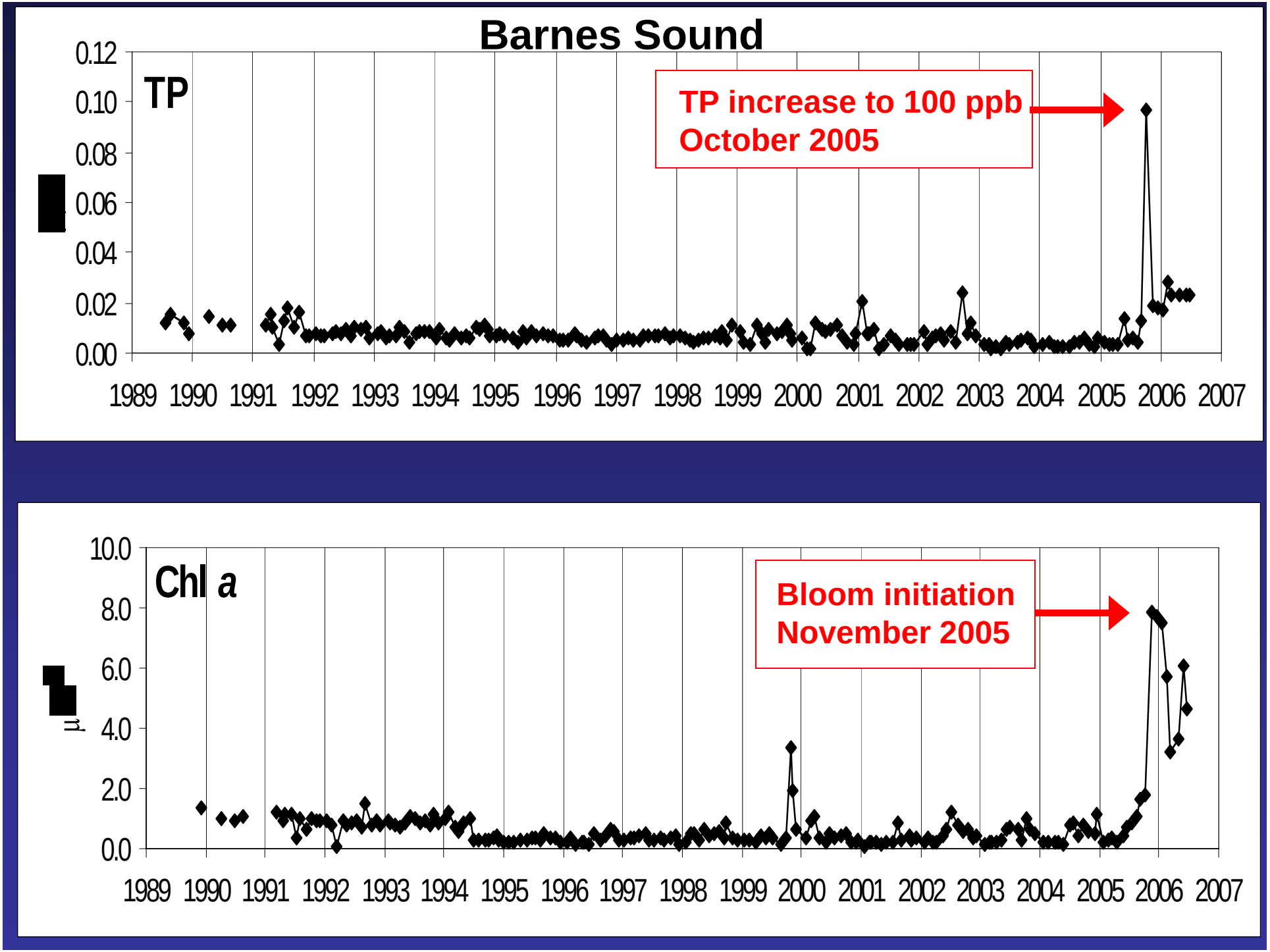
Timeline of Eastern Florida Bay – Southern Biscayne Bay Algae Blooms and Potentially Related Events



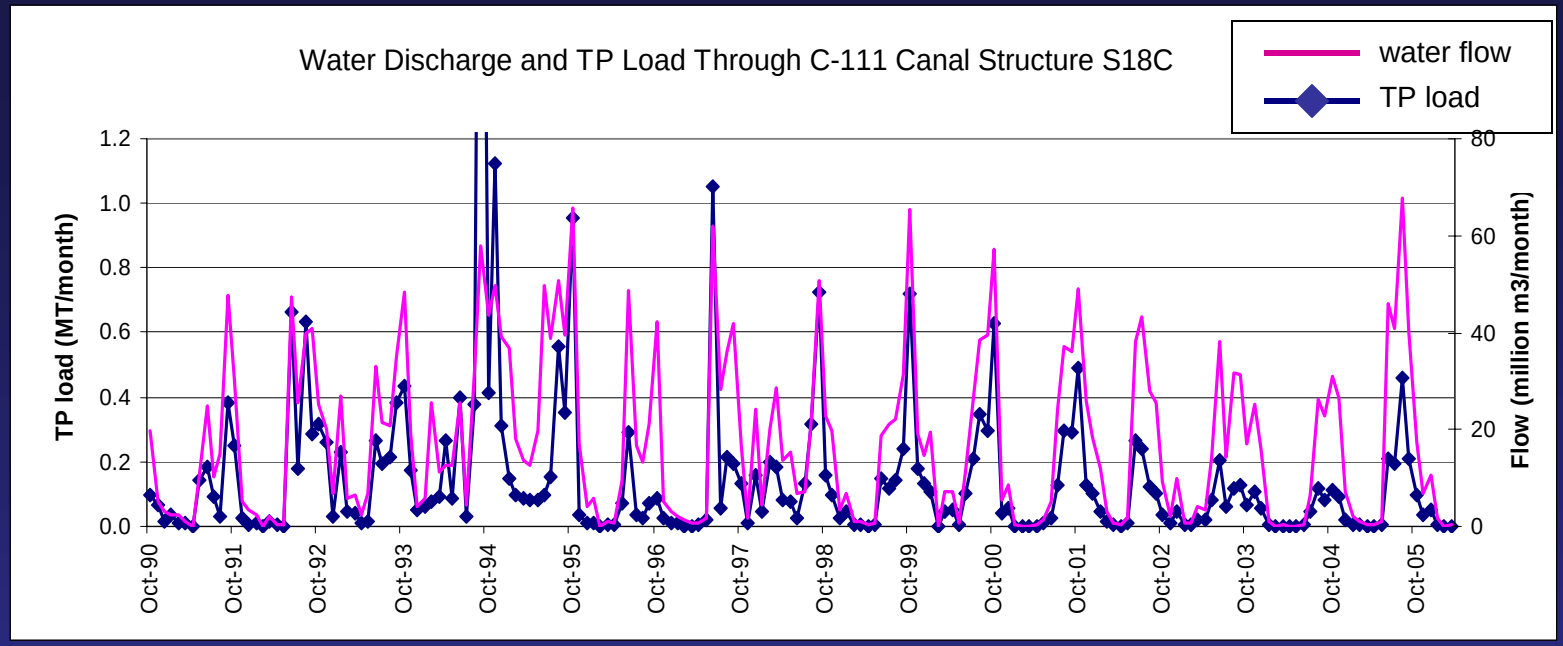
Spatial distribution of bloom consistent with road disturbance hypothesis and ……

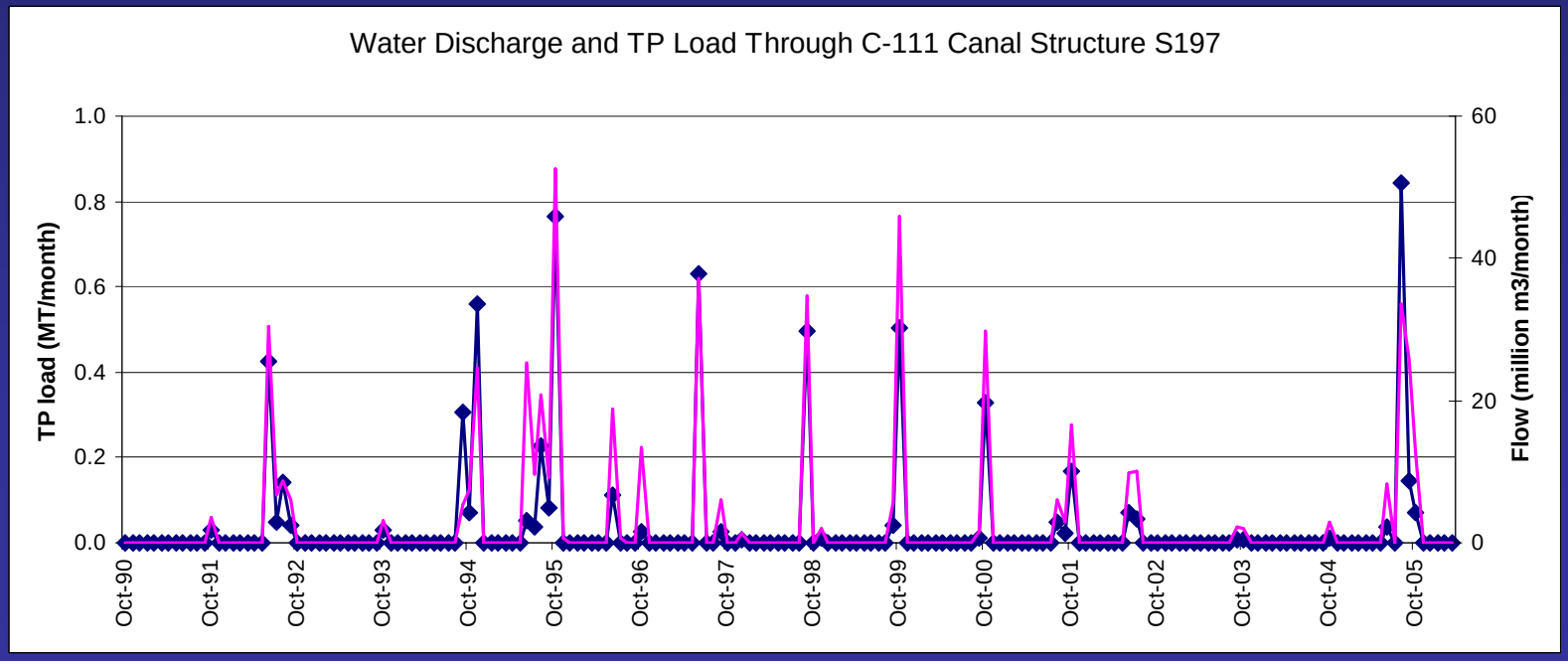
…. timing of bloom initiation consistent with hurricane disturbance hypothesis.

photos by H. Carman

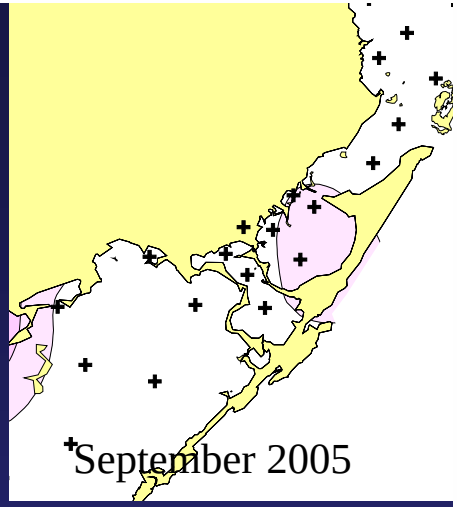

Barnes Sound
TP
TP increase to 100 ppb
October 2005
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Chl a
Bloom initiation
November 2005
10.0
8.0
6.0
4.0
2.0
0.0
1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007

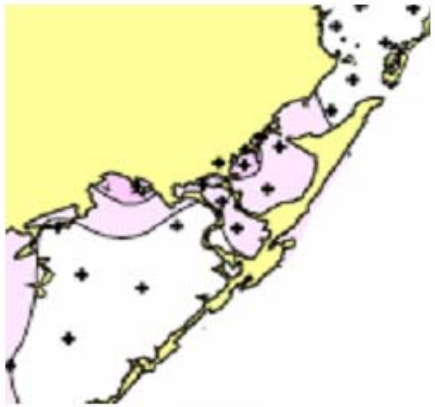
Discharge and TP load through the C-111 canal since 1991

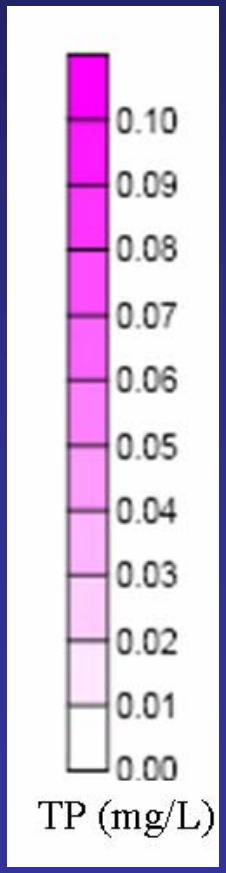




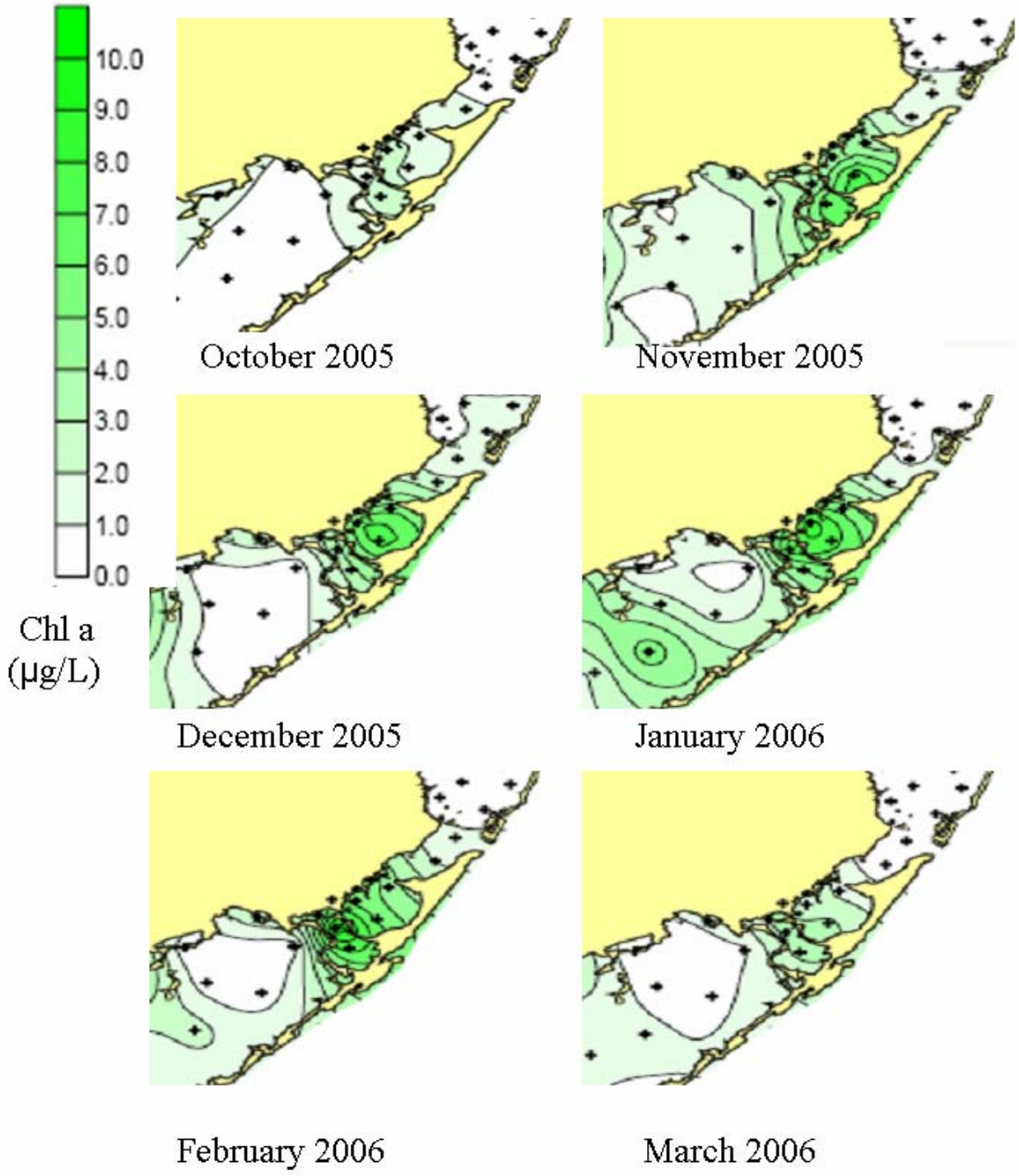
Total phosphorus concentrations in eastern Florida Bay and southern Biscayne Bay.







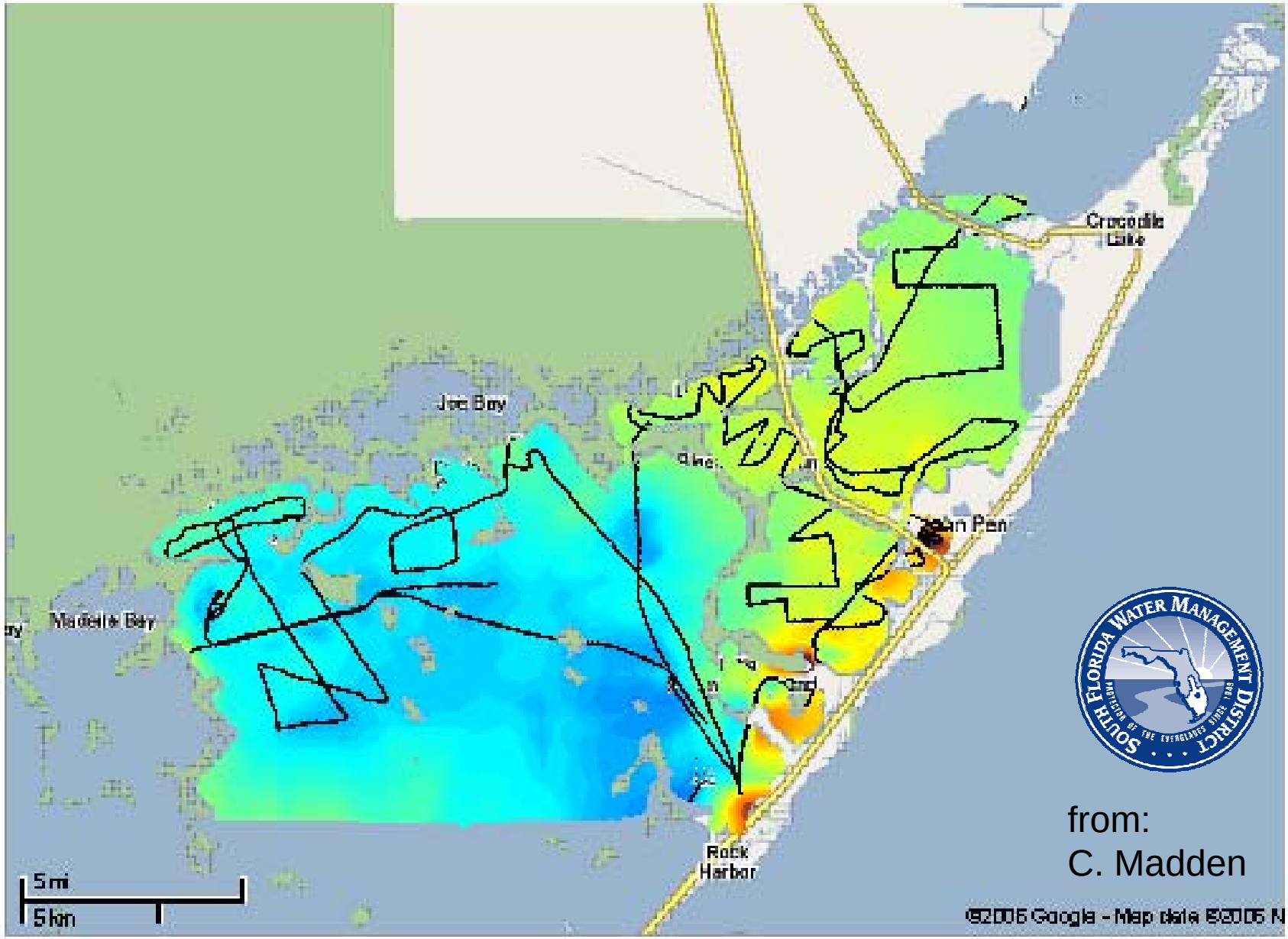
Concentration contours calculated by J. Boyer.



Chlorophyll-a concentrations in eastern Florida Bay and southern Biscayne Bay

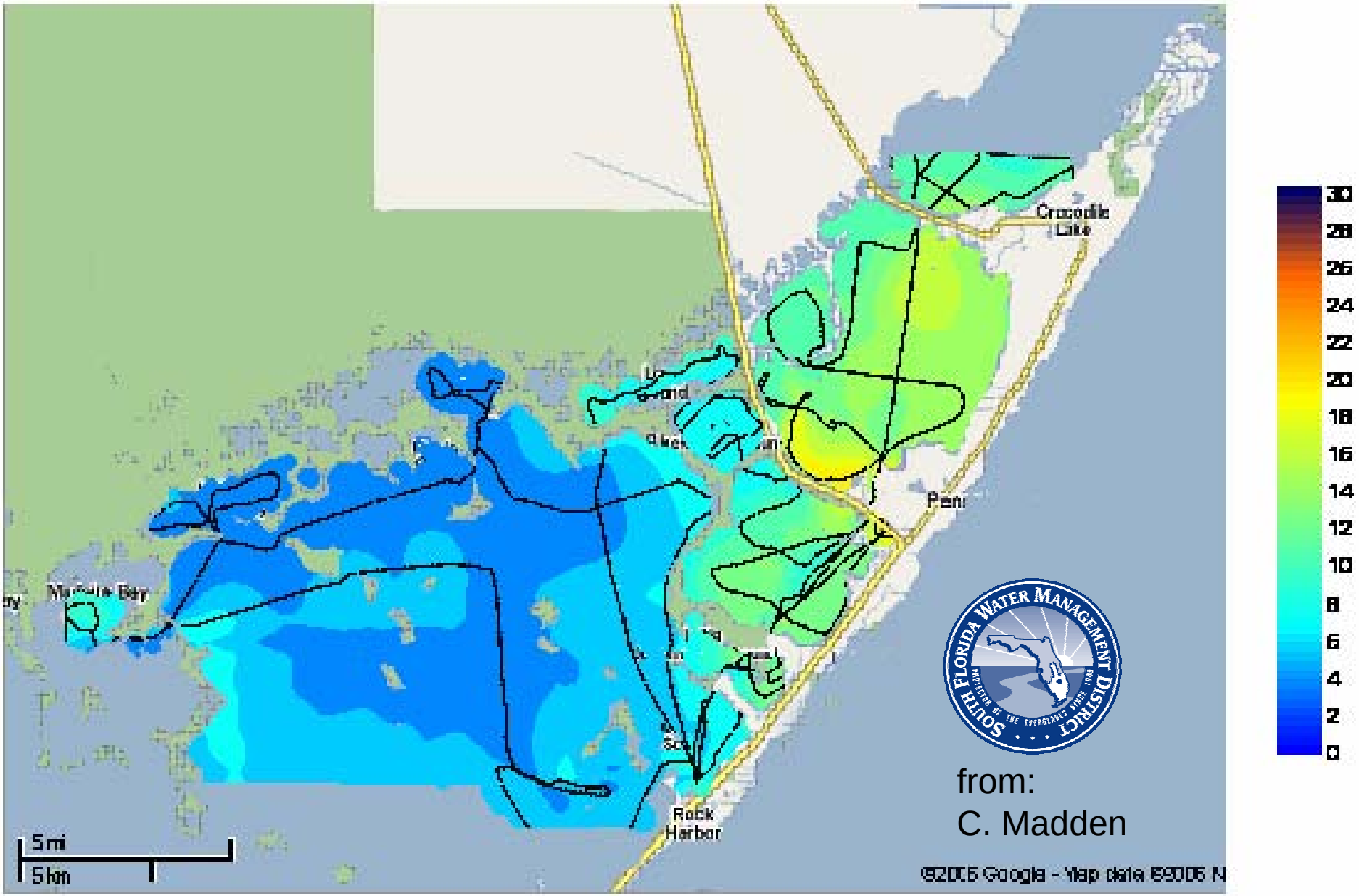
Concentration contours calculated by J. Boyer.

High resolution map of chlorophyll-*a* (µg /L) – January 24-26, 2006



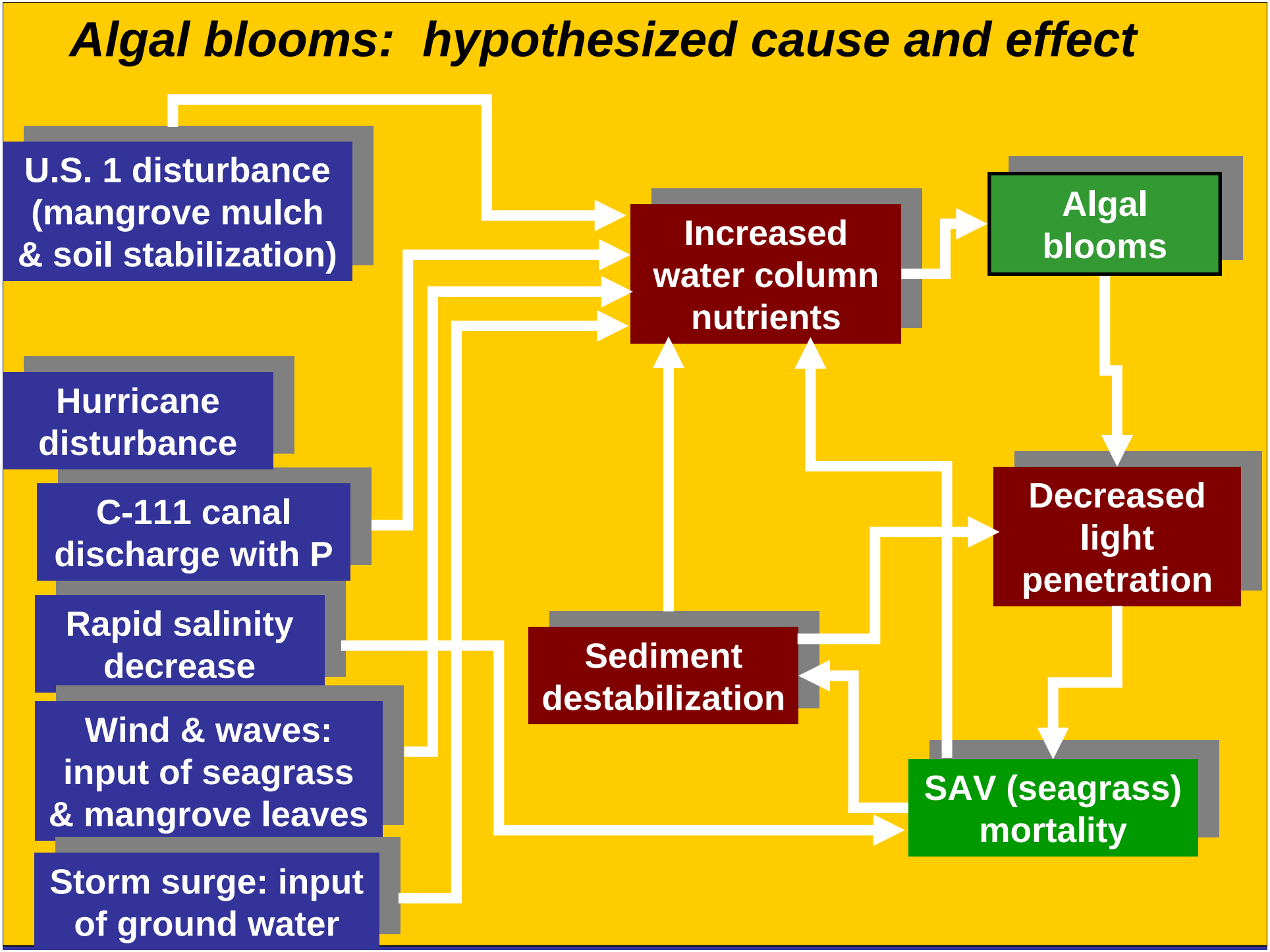
from:
C. Madden

High resolution map of chlorophyll-*a* (µg /L) – July 19-20, 2006



from:
C. Madden

Algal blooms: hypothesized cause and effect

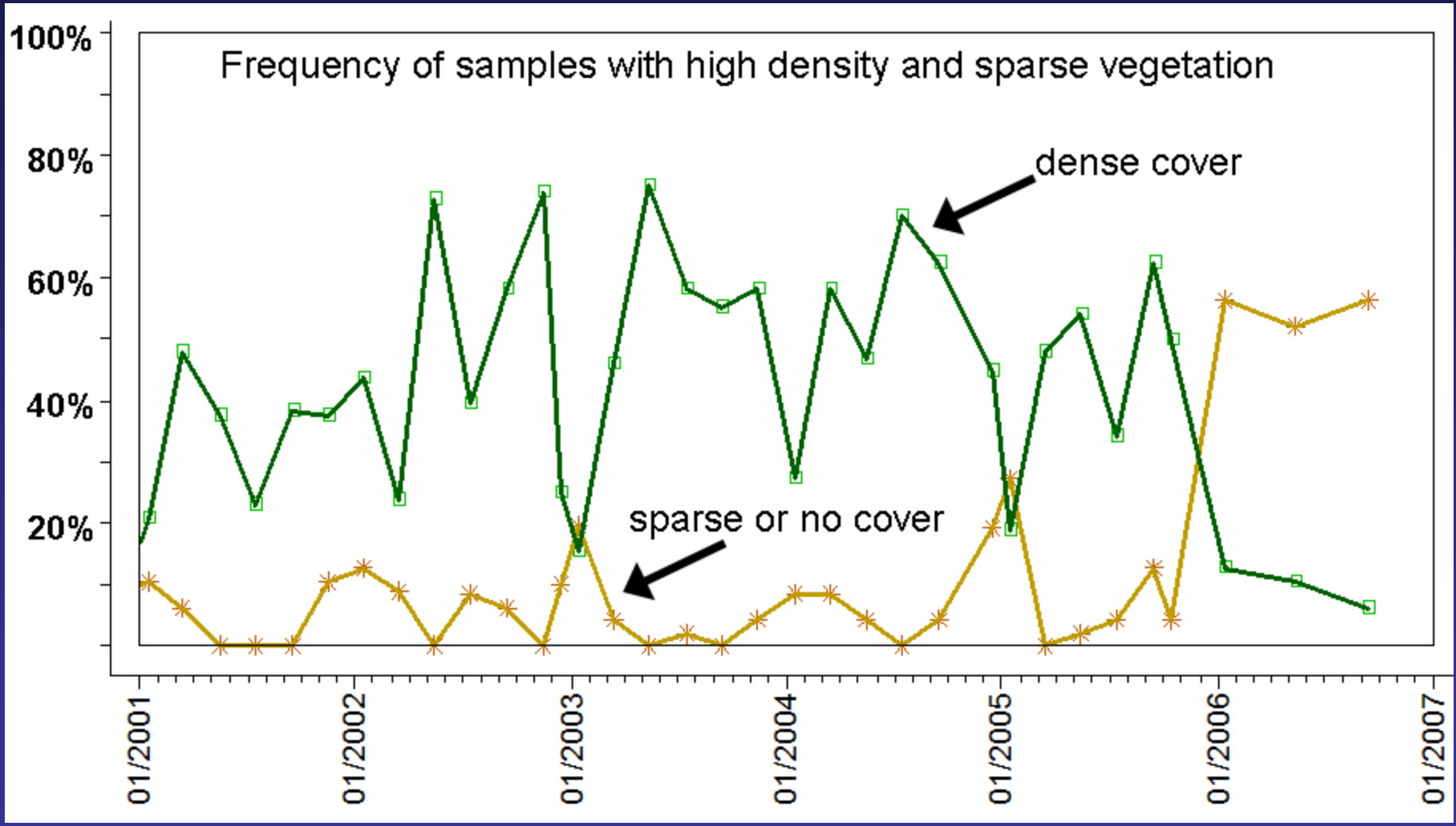


Estimated phosphorus budget for the bloom

	Metric tons P
Bloom P requirement (biomass over 65 sq. miles)	3
C-111 Canal discharge (2005 hurricane season)	2.6
Decomposing mangrove & seagrass leaves (from hurricane wind & waves)	?
Ground water nutrients (from Keys and Florida Bay)	?
Seagrass mortality (storm salinity stress, post-bloom light stress)	?
US 1 mulched mangroves (maximum above-ground through November 2005)	0.9
US 1 below-ground nutrients (mangrove roots, soils, sediments)	?

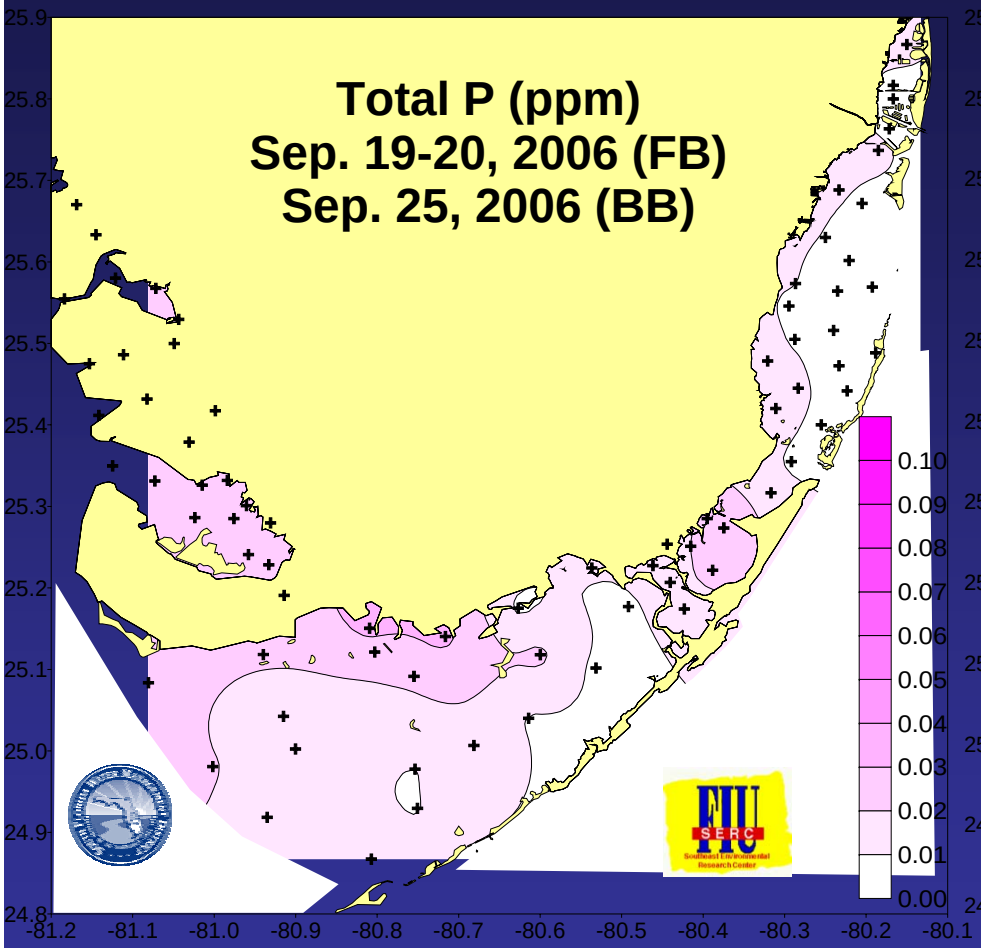
Submerged Aquatic Vegetation Status: Barnes Sound

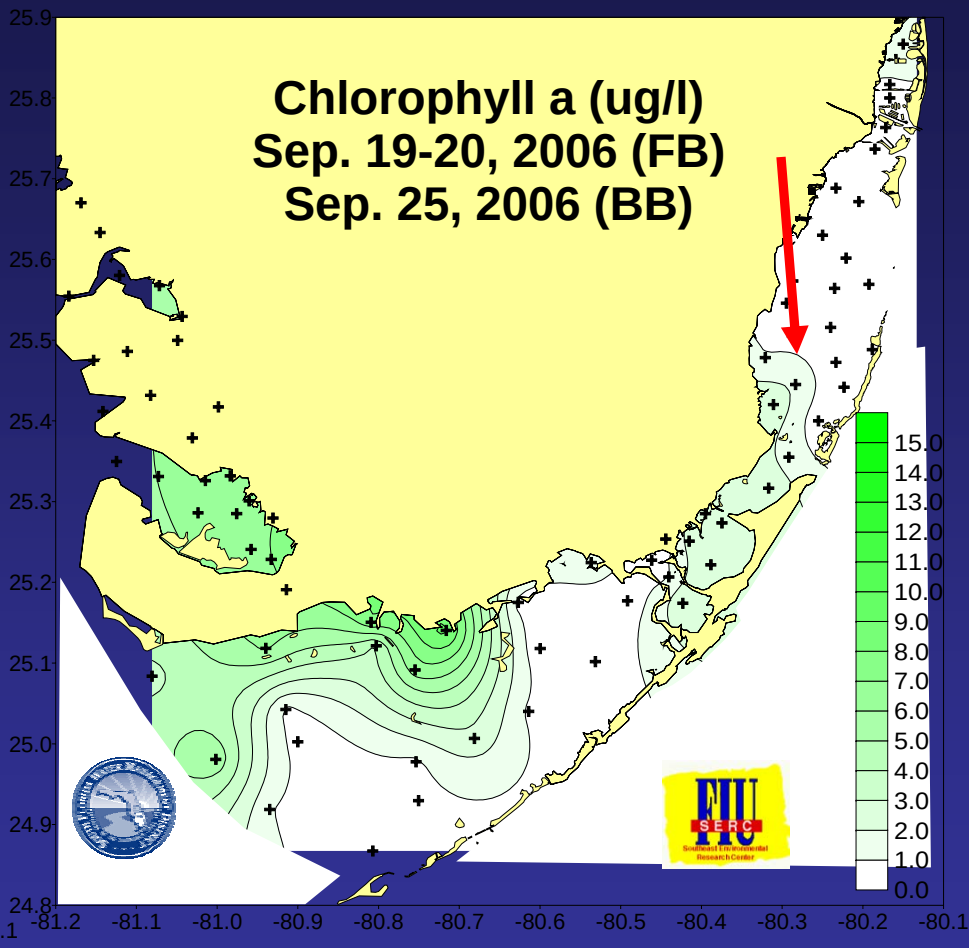
(recent loss - mostly macroalgae)



data from: Miami-Dade DERM

Current Bloom Conditions: decreased intensity, but expansion in Biscayne Bay





from: J. Boyer

Summary of Algal Bloom Information

Bloom Description: Structure, Distribution, Timing

- **Bloom mostly blue-green algae (bacteria)**
- **Bloom has covered 45 to 95 sq. miles in east Florida Bay & south Biscayne Bay**
- **Sustained since November 2005**
- **No similar bloom previously observed in region**
- **Bloom was first in Manatee Bay and Barnes Sound after Hurricane Katrina**
- **Bloom density (chlorophyll *a*) highly correlated with TP - likely P limited**
- **Bloom spread (with lower chl-*a*) as far as Turkey Point in late summer 2006.**

Summary of Algal Bloom Information

Bloom Causation: Hypotheses and Evidence

Multiple factors probably caused the initiation and sustenance of the bloom

- **Spatial pattern of algae & P consistent with possible road construction effect**
- **Timing of bloom initiation & P peak consistent with possible hurricane effect**
- **TP load from C-111 Canal discharge very large – P transport and fate uncertain**
- **Bloom sustained by long water residence time (poor flushing) + efficient P retention (regardless of the nutrient source).**

Ongoing Scientific Activities

Multi-agency cooperation:

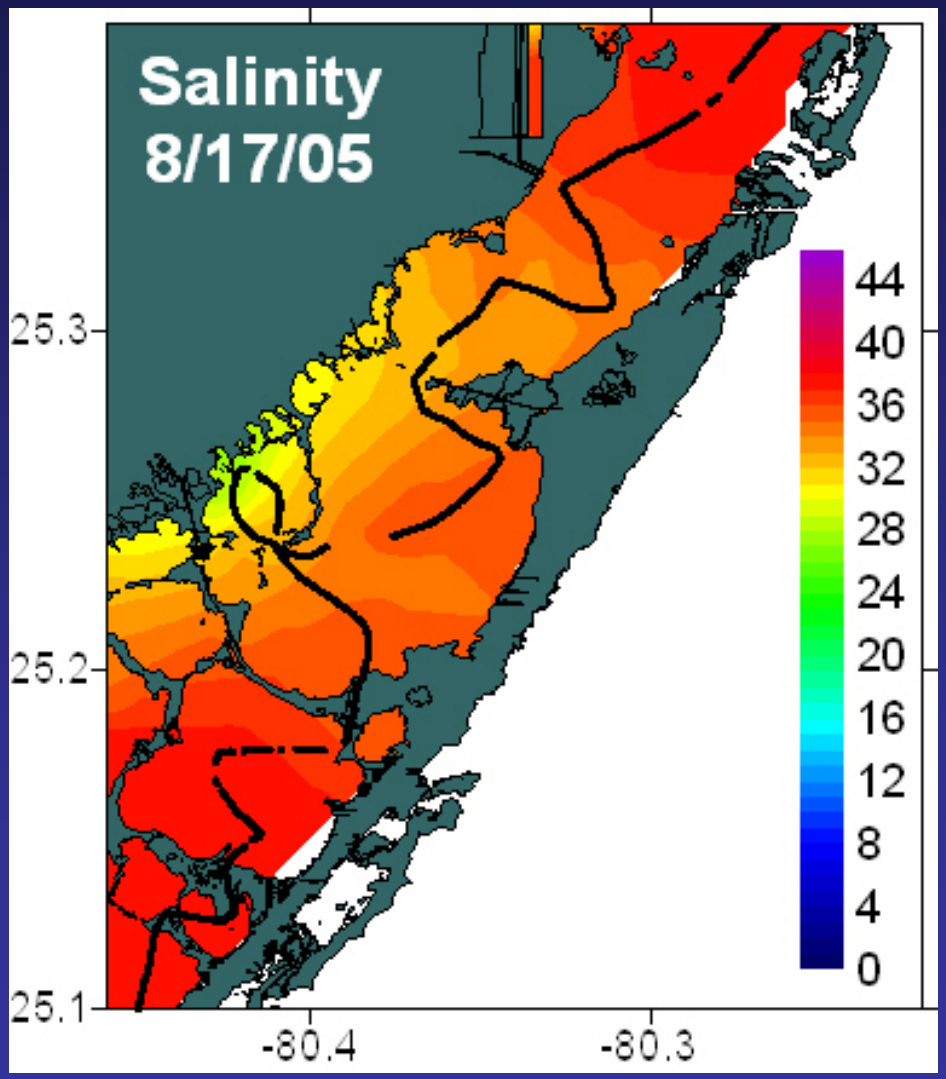
SFWMD, FIU, FDOT, Miami-Dade DERM, FFWCC, NOAA, NPS, USGS

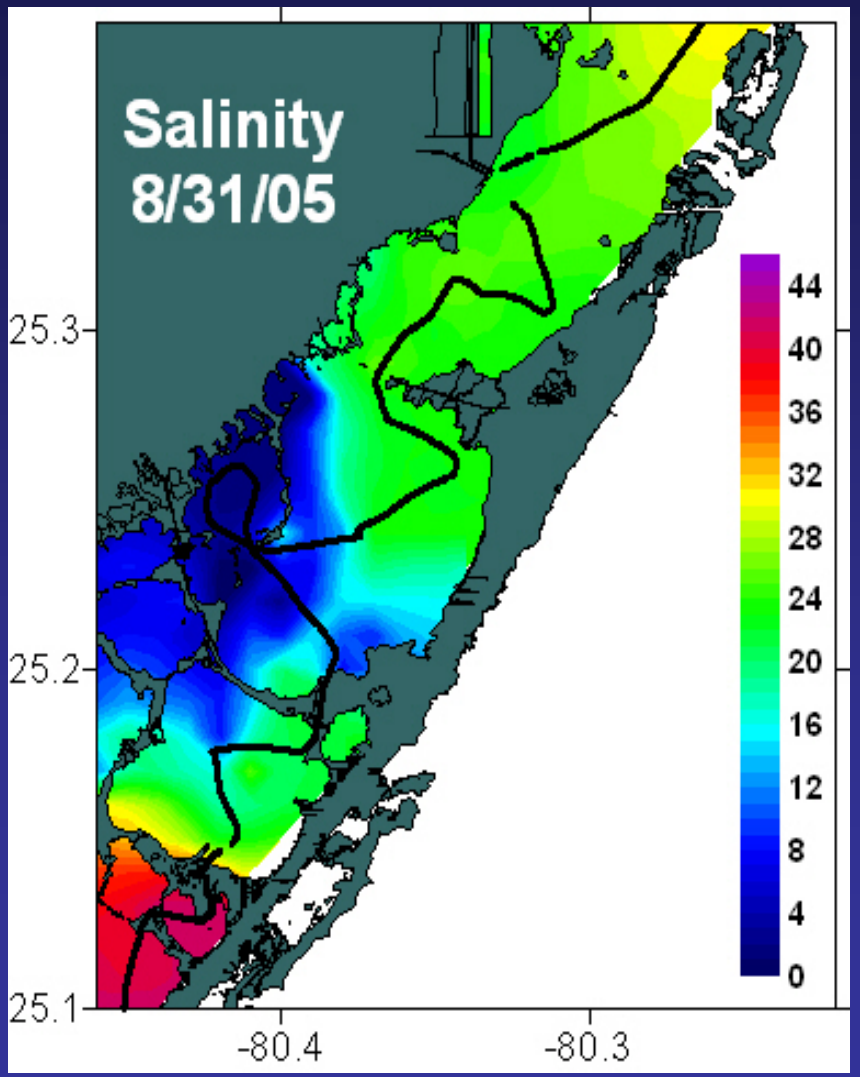
- **Chemical analysis of cement and slag additives (FDOT contractors)**
- **Soil coring and analysis of soil nutrient content (FDOT contractors)**
- **Analysis of nutrient loss from soil/mulch samples (FDOT contractors)**
- **Water quality sampling near and away from US 1 (SFWMD, FIU, DERM, NOAA)**
- **Baseline water quality sampling for Phase II construction (Manatee Bay to C-111 bridge) (FDOT, DERM, SFWMD)**
- **Bloom mapping about every three weeks (SFWMD, NOAA)**
- **Effects of soil extracts and cement/slag additives on algae (FFWCC, U. MD/NOAA)**
- **Dissolved oxygen monitoring (SFWMD)**
- **SAV monitoring (Miami-Dade DERM, FFWCC, SFWMD, FDOT)**


Hurricane Rita


DEC 28 2005

Salinity immediately before and after Hurricane Katrina (August 26, 2005)





From: C. Kelble and P. Ortner (NOAA)

Wind Speed During 2005 Hurricane Season