

**MONITORING AND ASSESSMENT OF
KARENIA RED TIDES
FOR
PUBLIC HEALTH THREATS:
FLORIDA COASTAL WATERS**

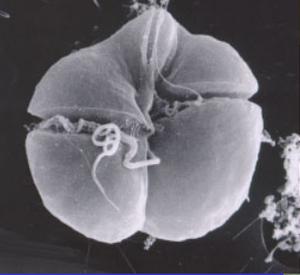
Karen A. Steidinger

Florida Marine Research Institute

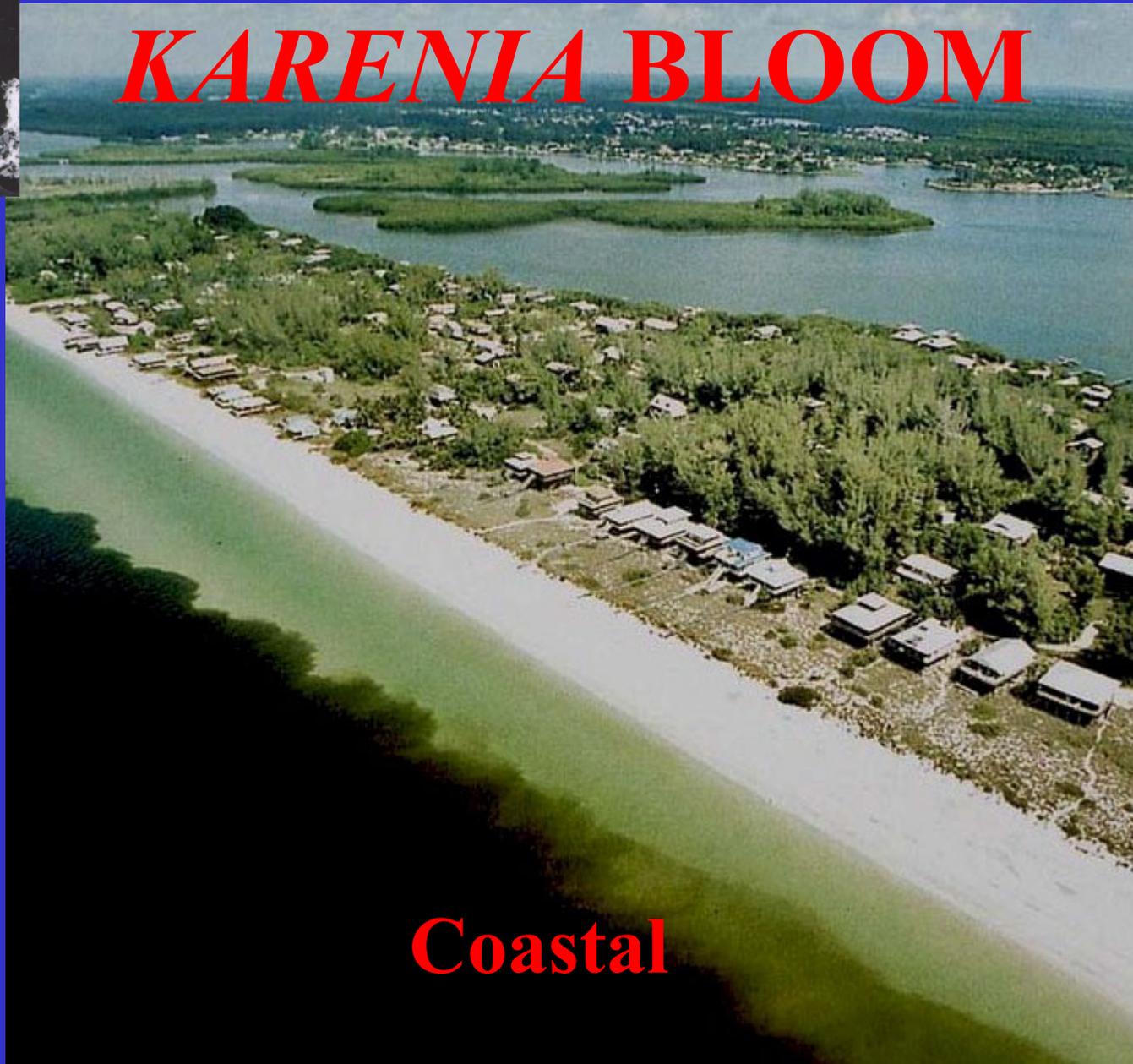
Florida Fish and Wildlife Conservation Commission



Harmful Algal Blooms occur world-wide, but nowhere else on earth are they as frequent or as long lasting as along Florida's west coast. Some coastal water blooms of the toxic dinoflagellate *Karenia brevis* have lasted up to 18 months.



KARENIA BLOOM



Coastal

Charlotte-Sun Herald

IMPACTS TO AQUATIC ANIMALS



HARMFUL/TOXIC



Times photos — FRASER HALL
Veterinarian P.K. Robbins listens to the manatee's heartbeat while technician Judy Kelly scrubs the back of a flipper. The manatee, from Englewood, is the third brought to Tampa in the past two weeks from that area.

Red Tide sickens another manatee

IMPACTS TO HUMANS



AEROSOL



TOXIC SHELLFISH



ECONOMY



RECREATIONAL ACTIVITIES

Economic Impact



In the 1970s, two red tide outbreaks caused by the toxic dinoflagellate *Karenia brevis* affected several west coast counties for 3 to 5 months and caused an estimated 15- to 20-million-dollar impact to those counties. A recent WHOI report estimates that Harmful Algal Blooms in the US (1987-1992) cost an average of 49 million dollars at year 2000 value.

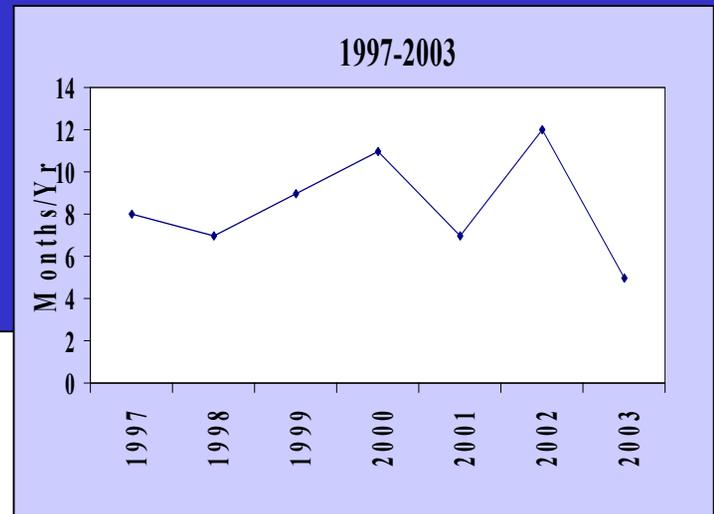
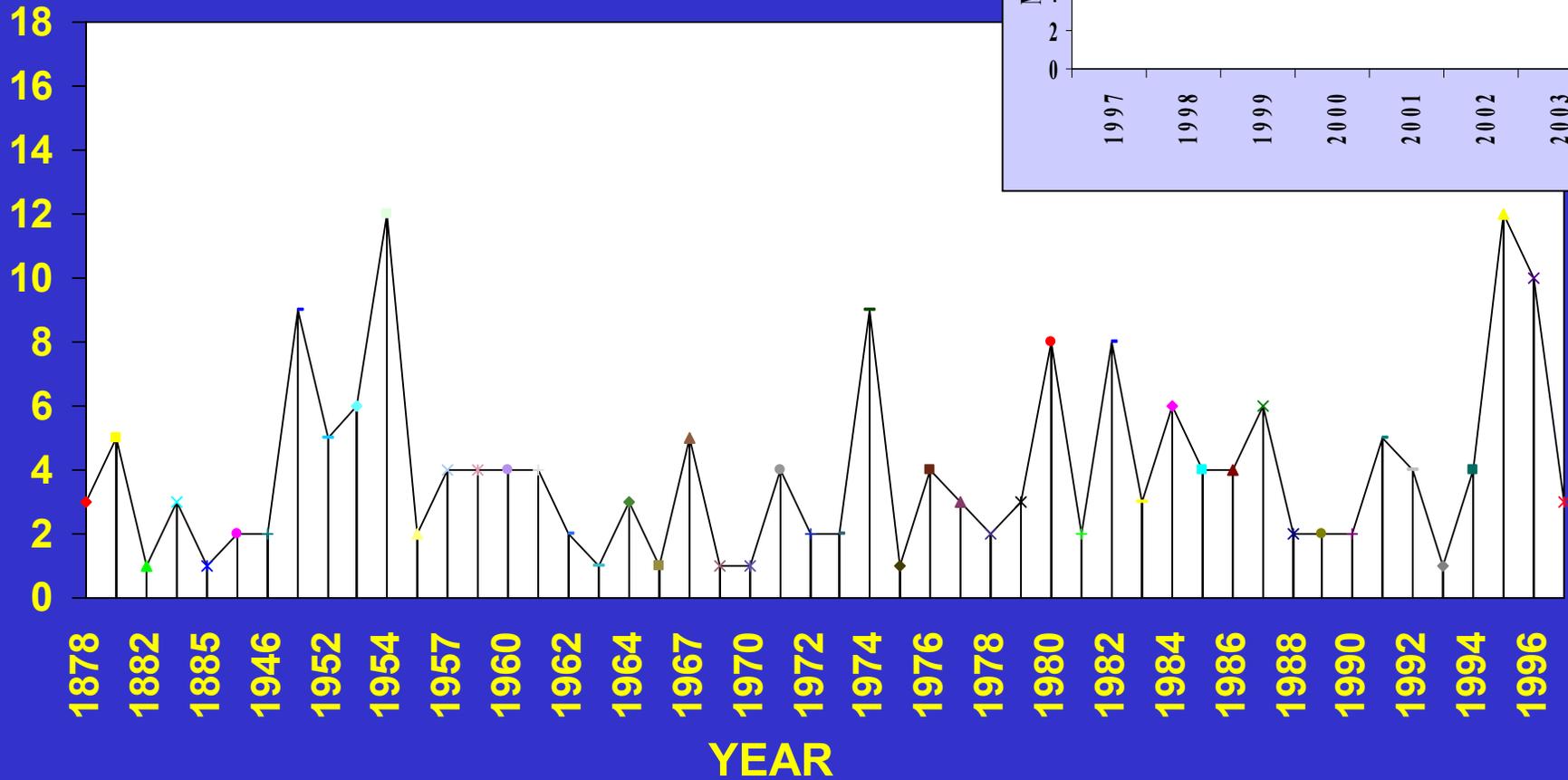
FLORIDA'S RED TIDES

A map of Florida is shown in the background. A red shaded area highlights the west coast of Florida, indicating the typical region where red tides occur. The rest of the state is shown in a light gray color.

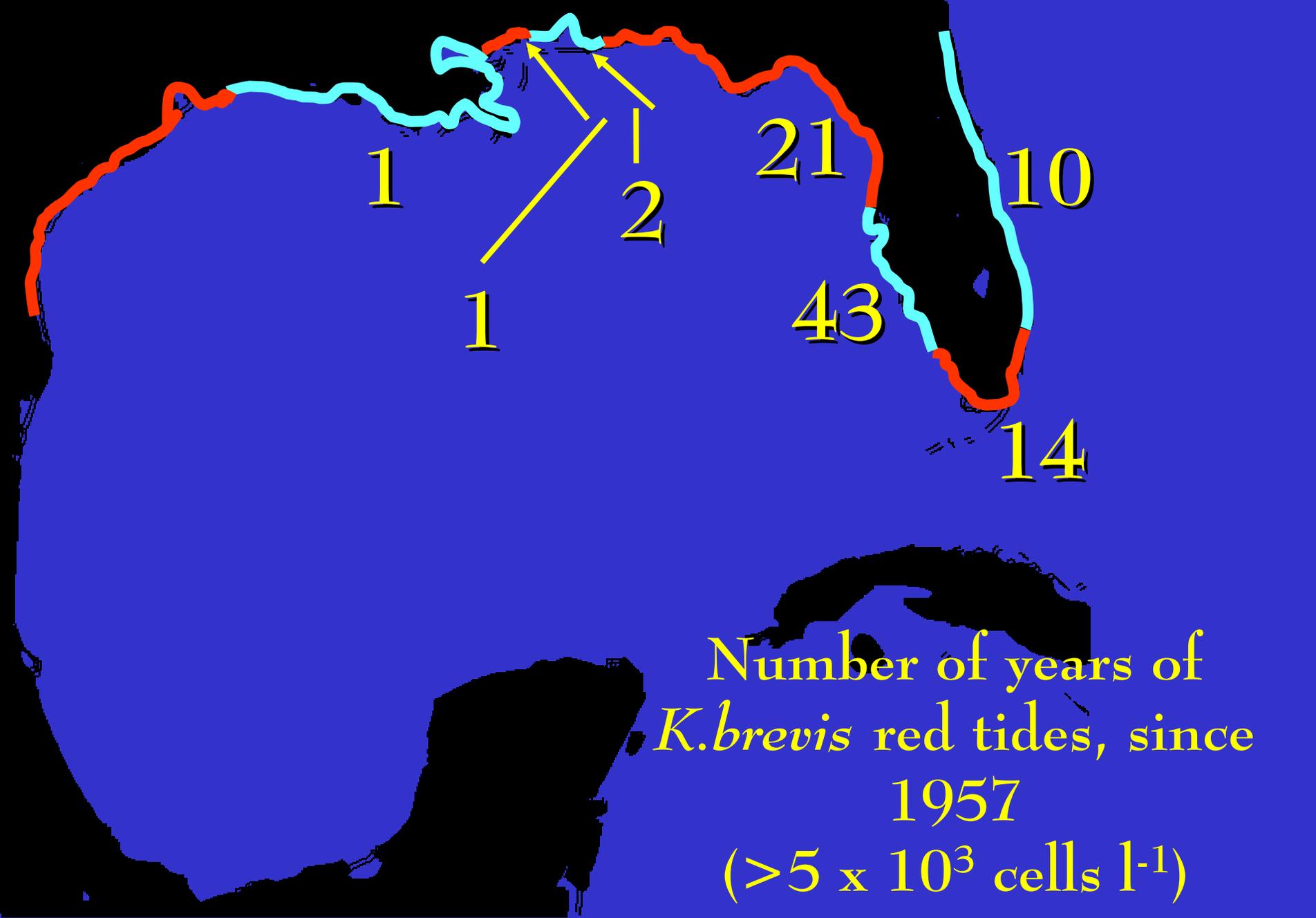
- ❖ Fish kills documented starting 1844
- ❖ Shellfish poisonings first reported in 1880
- ❖ Respiratory irritation first reported in 1916
- ❖ Occur almost every year along the west coast
- ❖ Can cover >10,000 square miles of Gulf
- ❖ Typically last 3-5 months, but records up to 18

FLORIDA WEST COAST RED TIDE DATA 1878-PRESENT (MONTHS PER YEAR)

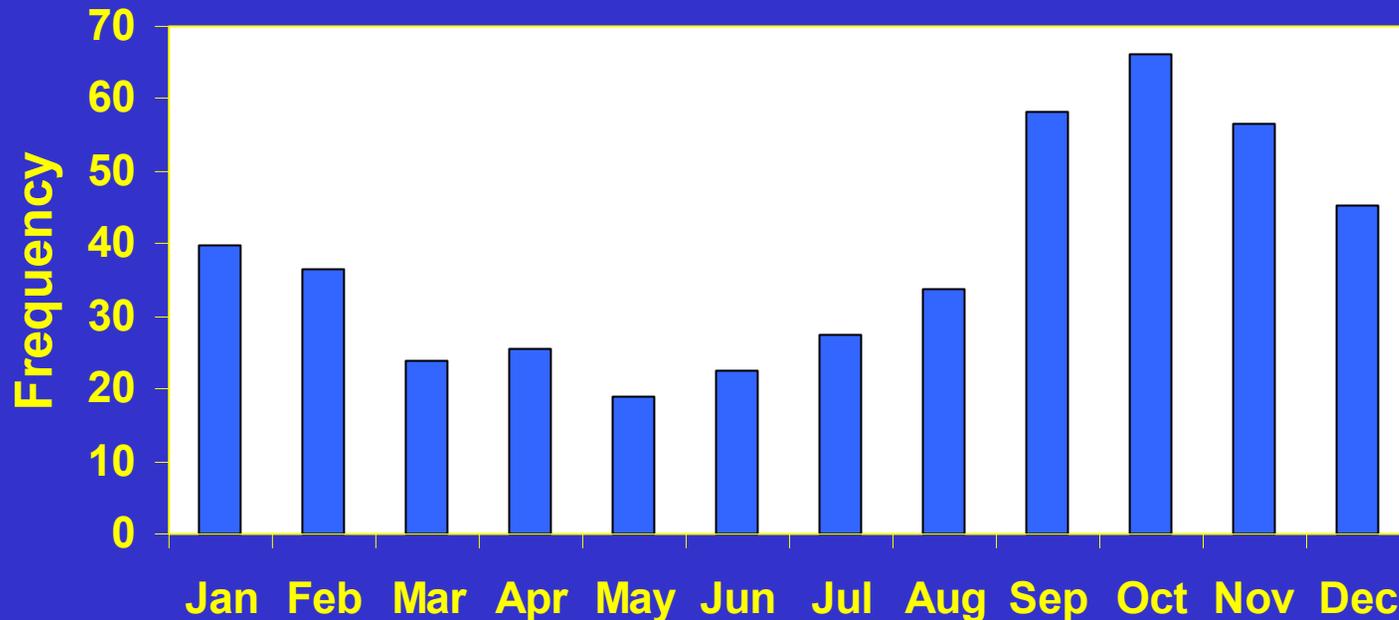
MONTHS/YR



Florida West Coast Red Tide Data: Number of Red Tide Months per year.



Red Tide Data Frequency By Month 1878 - 2003



56% of Florida West Coast Red Tide Blooms occur between September and December. 37% of blooms are first detected in September; 18% are first detected in October.

159 Years of Documented Red Tide

Off Florida's West Coast

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1844													Reports of Fish Kills, No Duration
1854													Reports of Fish Kills, No Duration
1856													Reports of Fish Kills, No Duration
1865													Reports of Fish Kills, No Duration
1878													
1879													Reports of Fish Kills, No Duration
1880													
1882													
1883													Reports of Fish Kills, No Duration
1884													Reports of Fish Kills, No Duration
1885													
1908													Reports of Fish Kills, No Duration
1916													
1935													Reports of Fish Kills, No Duration
1946													
1947													
1948													Reports of Fish Kills, No Duration
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2002													
2003													

* Suspected continuance of red tide was not confirmed by water sampling.

Note: Apparent increase in red tide beginning in 1976 reflects an increase in water sampling and recording.

HAB TOXINS MONITORING

●Water

●Shellfish



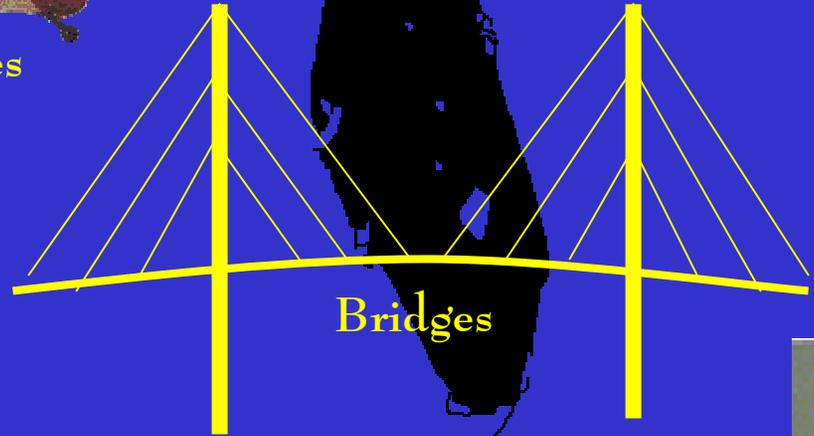
Airplanes



Satellite



Helicopters



Bridges



Small Boats



Research Vessels



Buoys and Mooring



Charter Boats

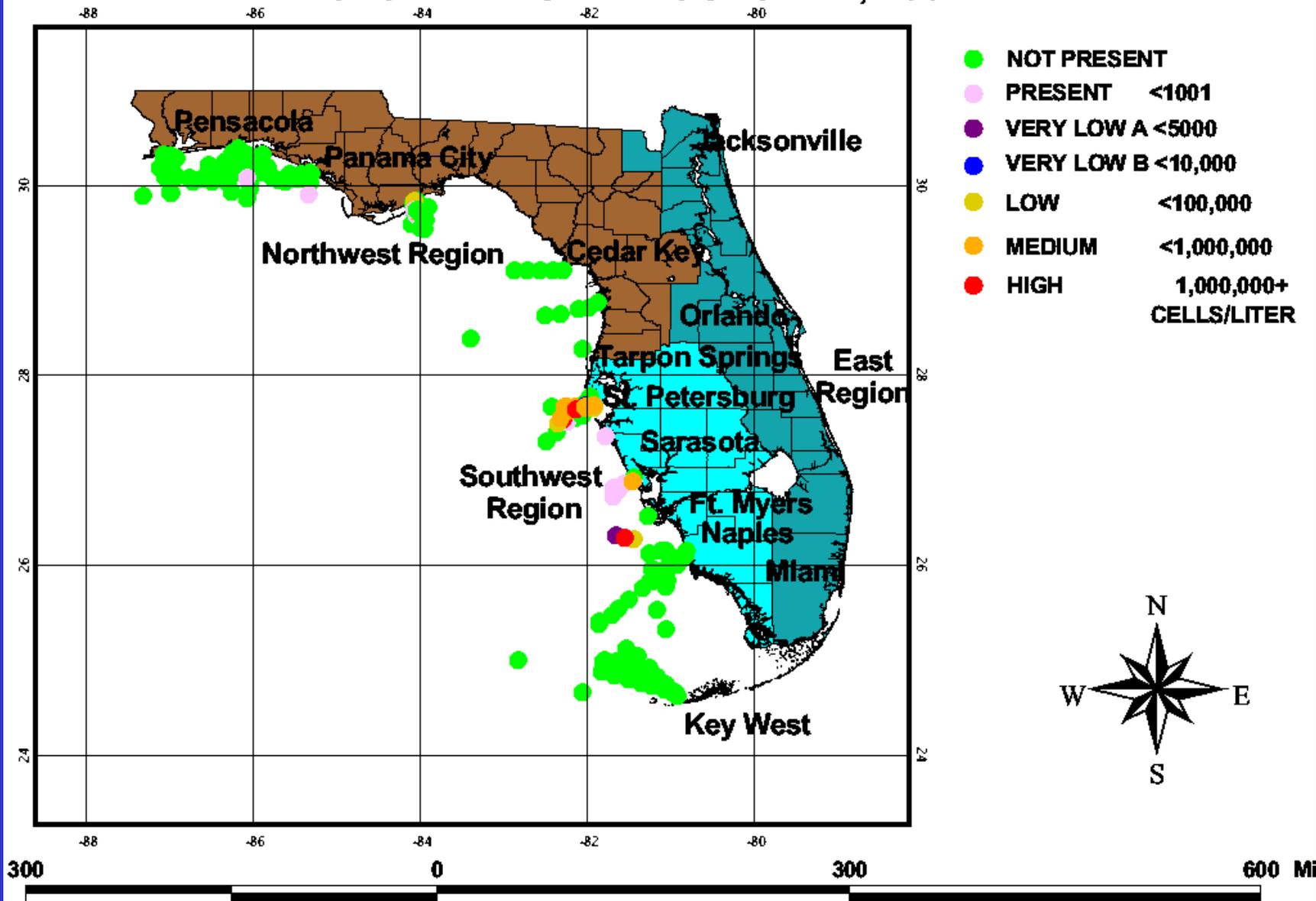


Piers and Jetties

OFFSHORE VOLUNTEER SAMPLING PROGRAM

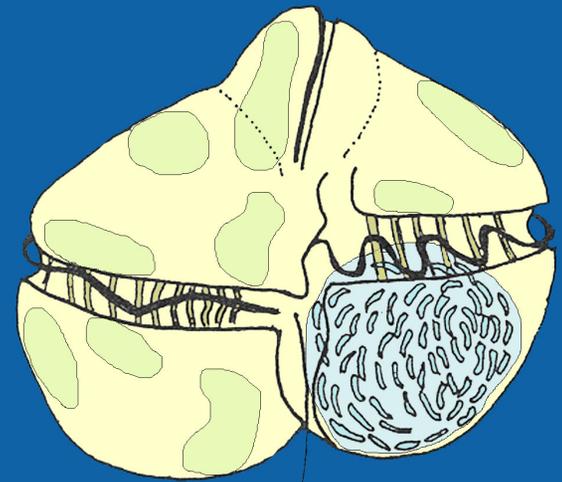
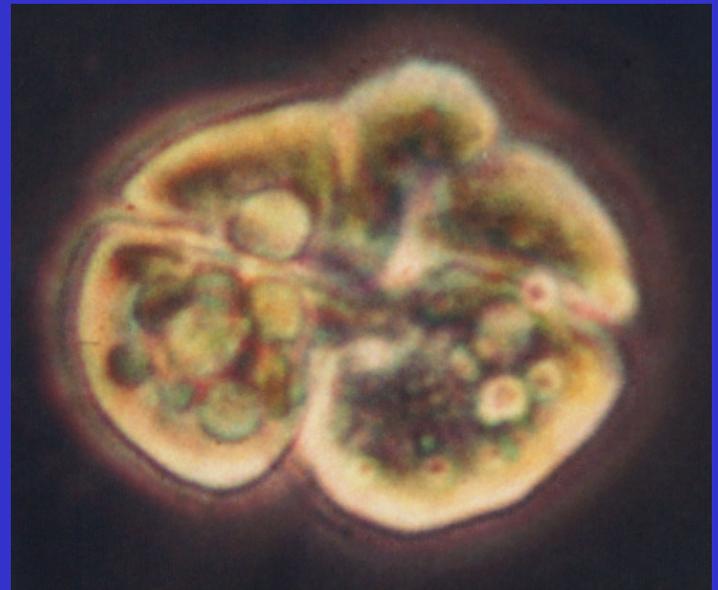


REDTIDE COUNTS FROM SAMPLES COLLECTED BY VOLUNTEERS MAY-OCTOBER, 2001



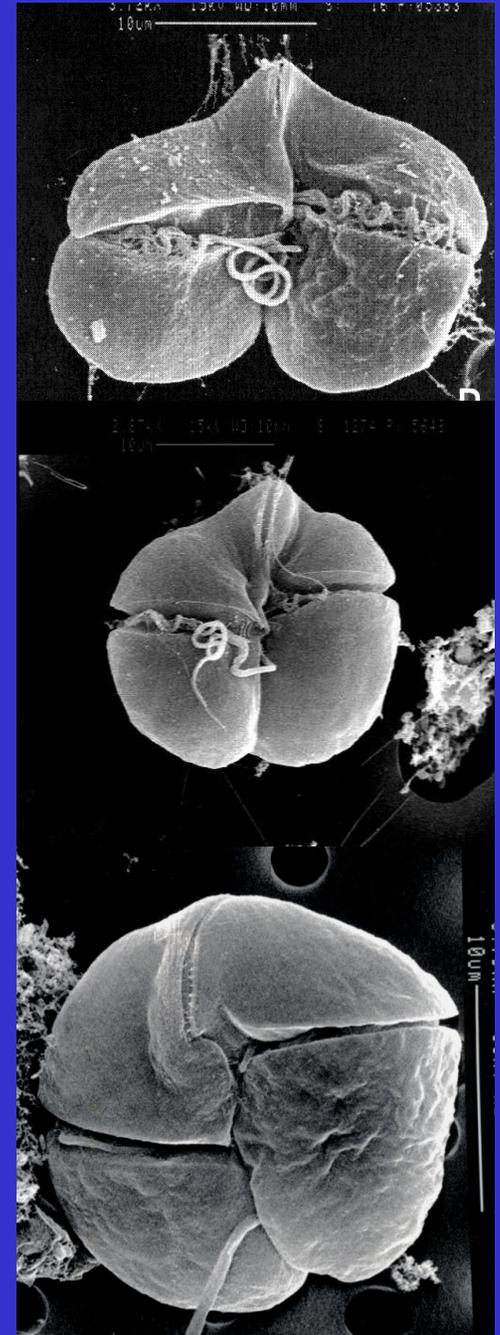


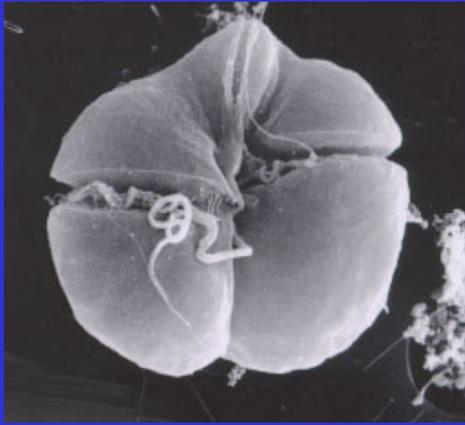
An inverted light microscope



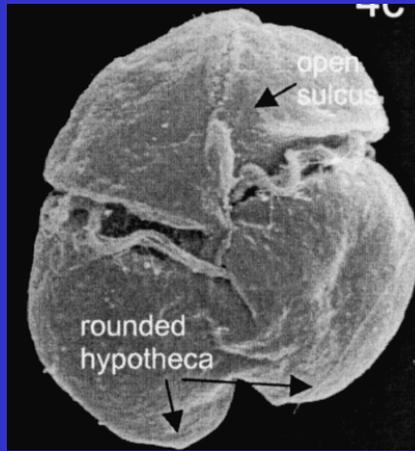
**Florida's red tide
dinoflagellate**

Scanning Electron Microscope





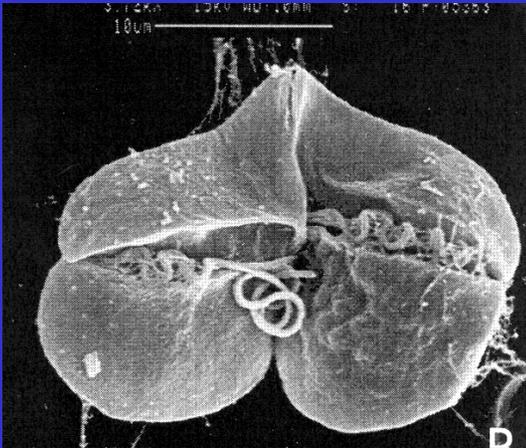
K. brevis



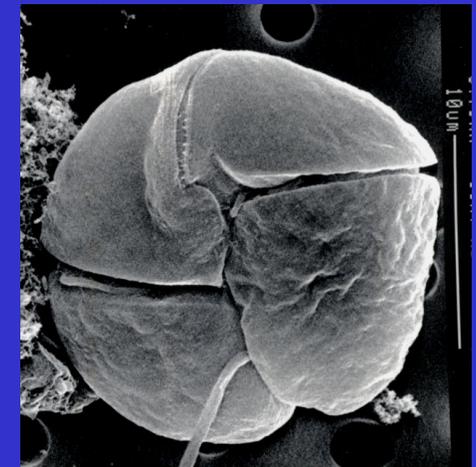
K.
"selliformis"



K. mikimotoi (1970s)

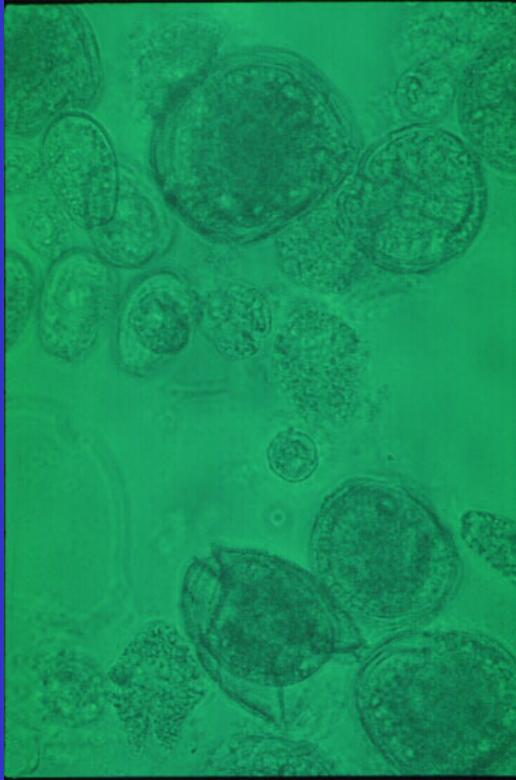


K. "papilionacea"

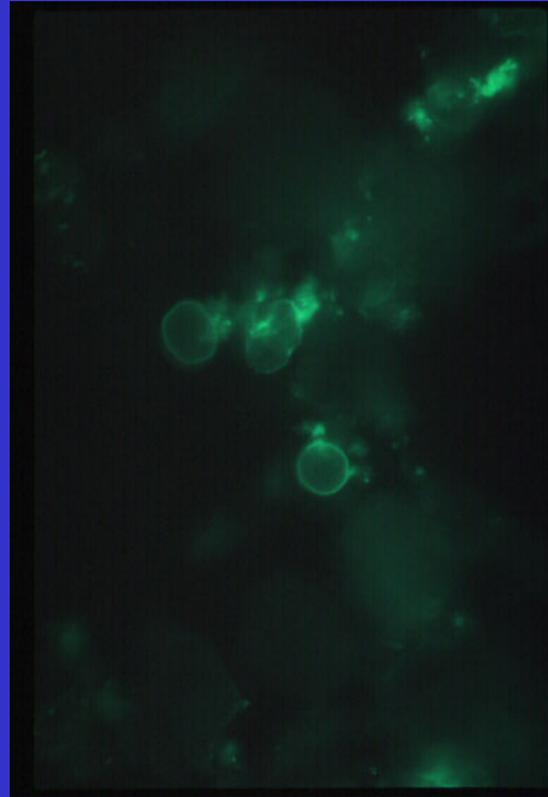


K. mikimotoi-like

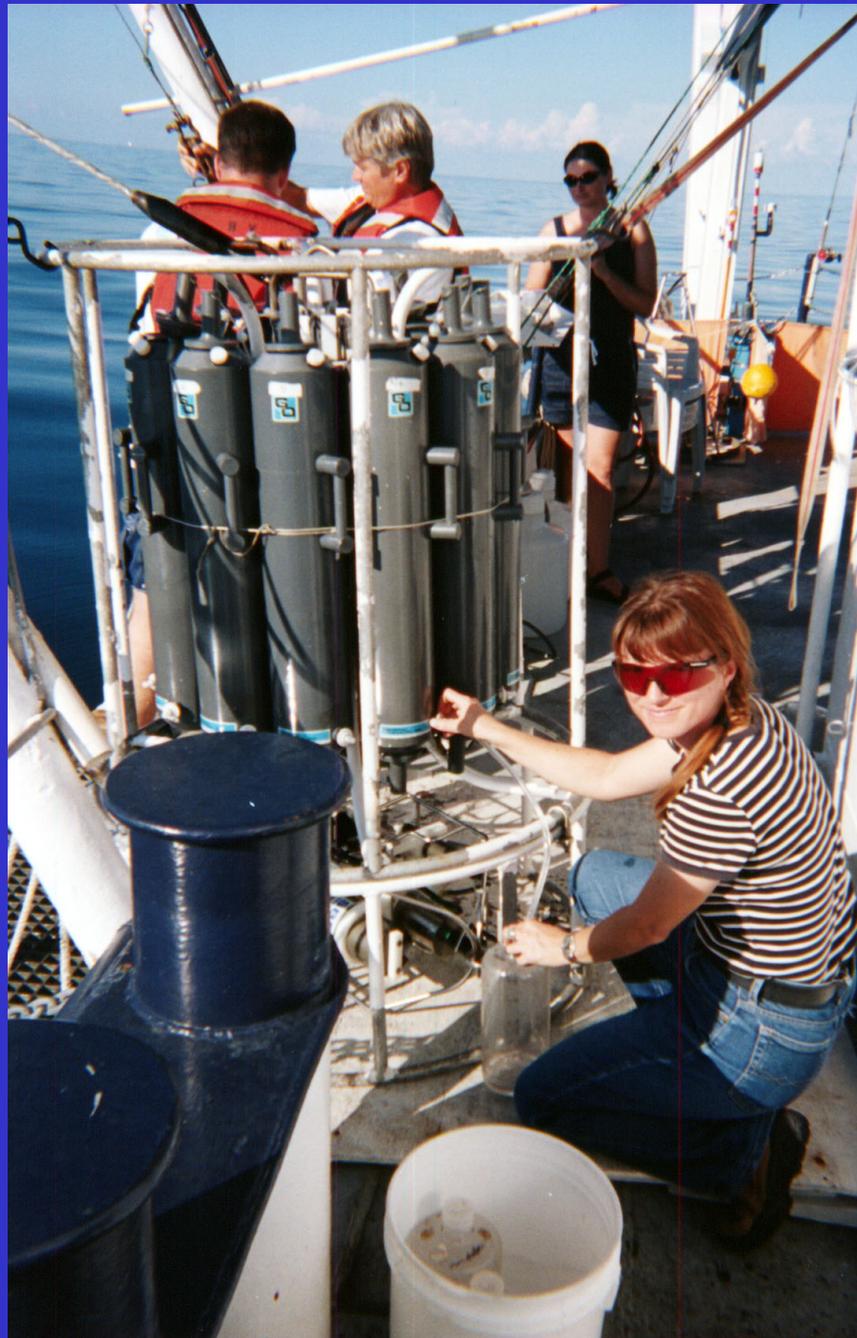
K. brevis surface recognition probe



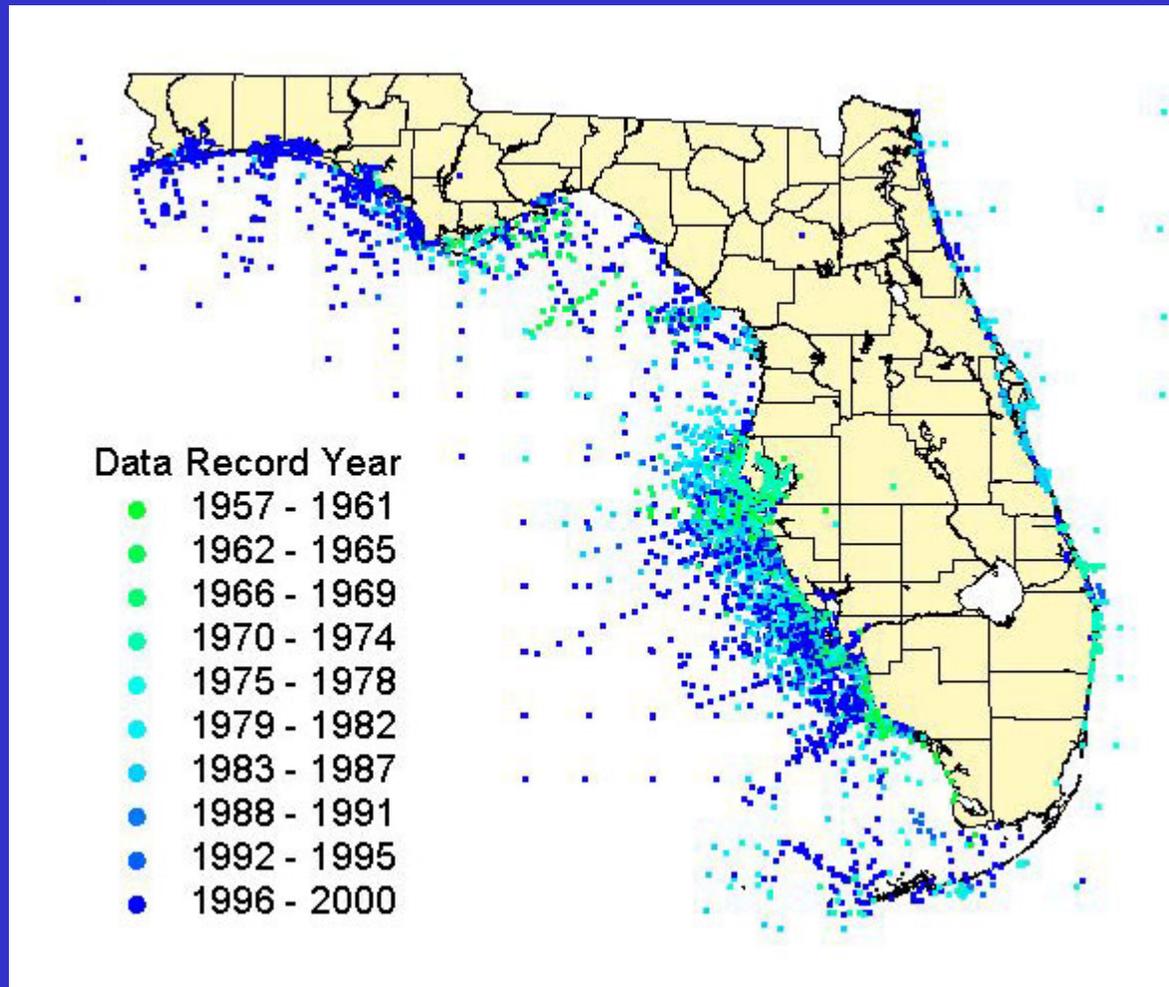
BF



FITC

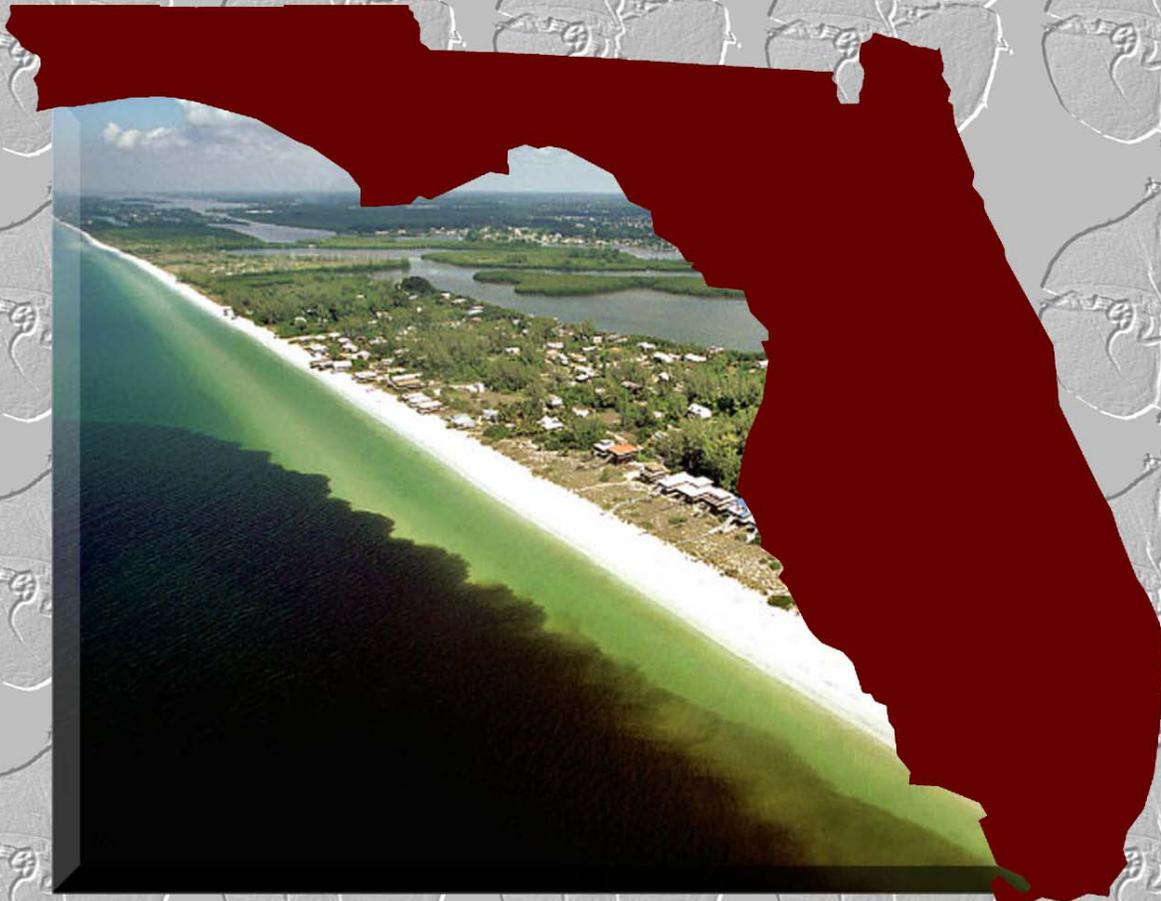


Florida Marine Research Institute (FMRI, NMFS/NOAA, Mote, USF, others) Historical Red Tide Database



Red Tides in Florida

Version 2.0 (1954-2002)



Cruise Years

1954-1961 – US Fish and Wildlife Service

1963-1965 – Florida State Board of Conservation

1966-1969 – Florida State Board of Conservation

1973-1975 – Florida Department of Natural Resources

1975-1980 – NASA – FDNR/Mote Marine Lab

1979-1982 - Florida Department of Natural Resources

1987-1989 - Florida Department of Natural Resources

1997-2002 – ECOHAB:Florida (NOAA/EPA)



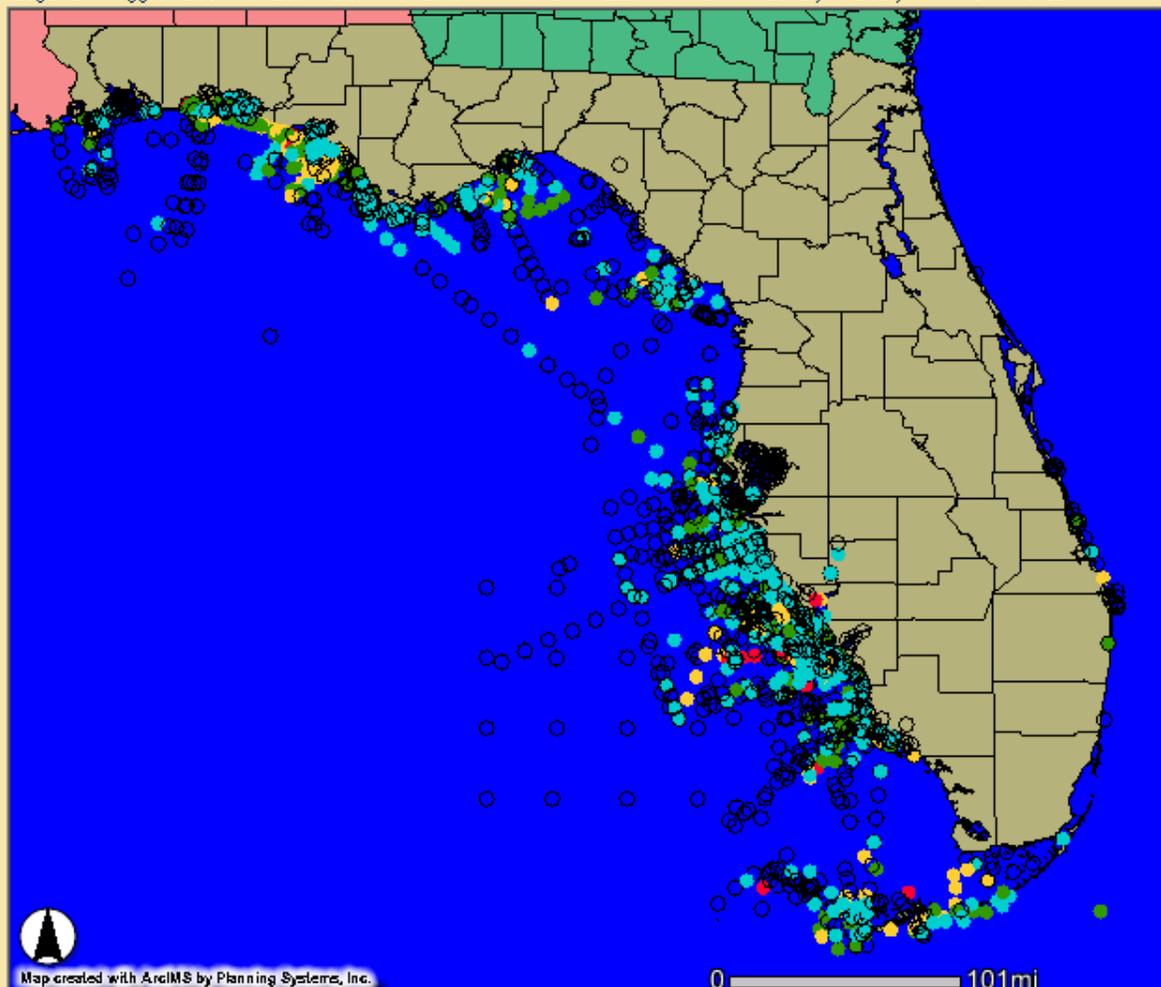
HABSOS - Harmful Algal Blooms Observing System

Layers

Visible Active

- TX Cell Counts
- TX PRISM Data
- FL Cell Counts
- FL Mouse Bio
- Shellfish Areas
- Bathymetry
- Buoys
- Counties
- Background

- Legend
- Toggle
- Zoom In
- Zoom Out
- Full Extent
- Active
- Last
- Pan
- Identify
- Query
- Find
- Clear
- Print



Daily Time Series

Month

Day

Year

Submit

The selected date is:

Refresh

Texas

Louisiana

Mississippi

Alabama

Florida

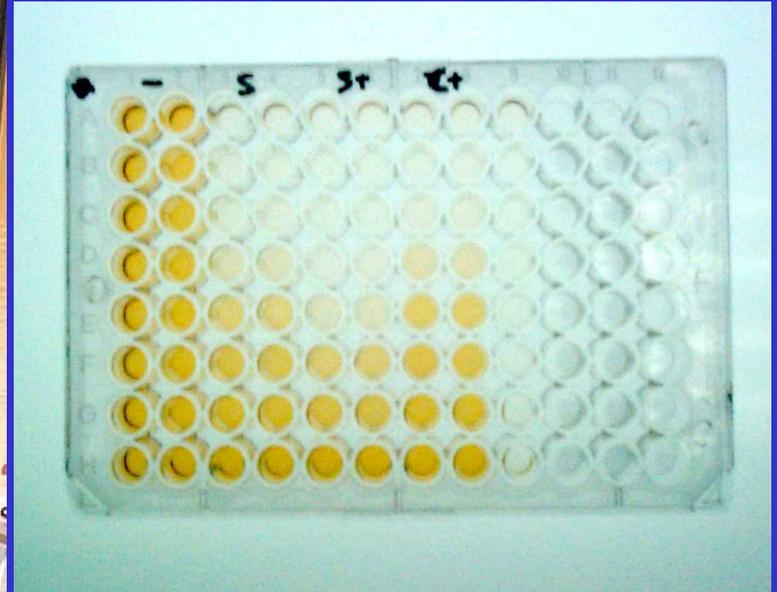
Map created with ArcIMS by Planning Systems, Inc.



BIOTOXIN CONTROL PLAN

- * Mouse Bioassay only approved FDA method
- * Mouse Bioassay takes 2 days to complete
- * Seeking more rapid chemical method
- * Participated in interlaboratory comparison test conducted by FDA





ELISA brevetoxin test

End product

* rapid

* field

* replace mouse bioassay



Red Tide Status Reports and Maps

- * Red Tide Counts and Areas
- * Shellfish Harvesting Area Closures
- * www.floridamarine.org

Red Tide Toxin Monitoring

- * New program to determine toxin level and compare that to cell count level in water
- * Toxin level in exposed marine mammals, birds, shellfish
- * Multiple methods

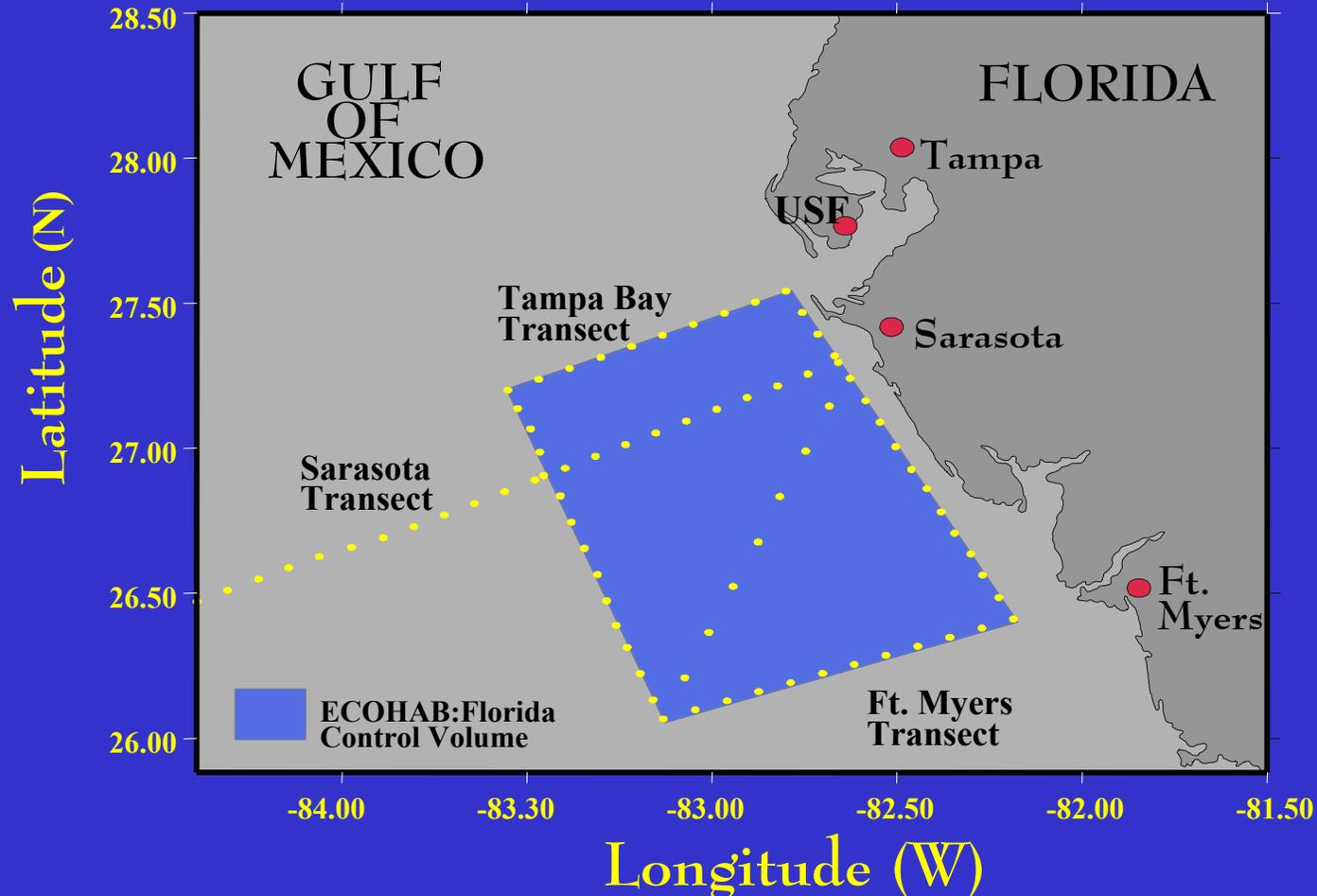
Red Tide Forecasting

**K.brevis BLOOM PREDICTION
and RESEARCH**

WHAT WE NEED TO KNOW ABOUT FLORIDA RED TIDES

- ❖ **Where do they start**
- ❖ **How do they move and where**
- ❖ **Are there phases to bloom development**
 - ❖ **What conditions precede blooms**
 - ❖ **How can we predict them**
- ❖ **Can we reduce the risks associated with red tides**

Approach



The backbone of the ECOHAB:Florida program consisted of three sampling strategies to gather data to develop a predictive 3D biophysical model. This figure represents monthly cruises and a weekly transect.

One Theory



Trichodesmium blooms in West Florida Shelf Waters

Saharan dust \Rightarrow wet deposition of iron \Rightarrow *Trichodesmium* blooms fix atmospheric N \Rightarrow released DON \Rightarrow conversion to ammonium and urea \Rightarrow fueling coastal *Karenia brevis* blooms \Rightarrow growth and movement of blooms

- * This theory can account for large *K. brevis* red tides but not small ones
- * The coupled biophysical model will incorporate several scenarios based on initiation and forcing factors at the time

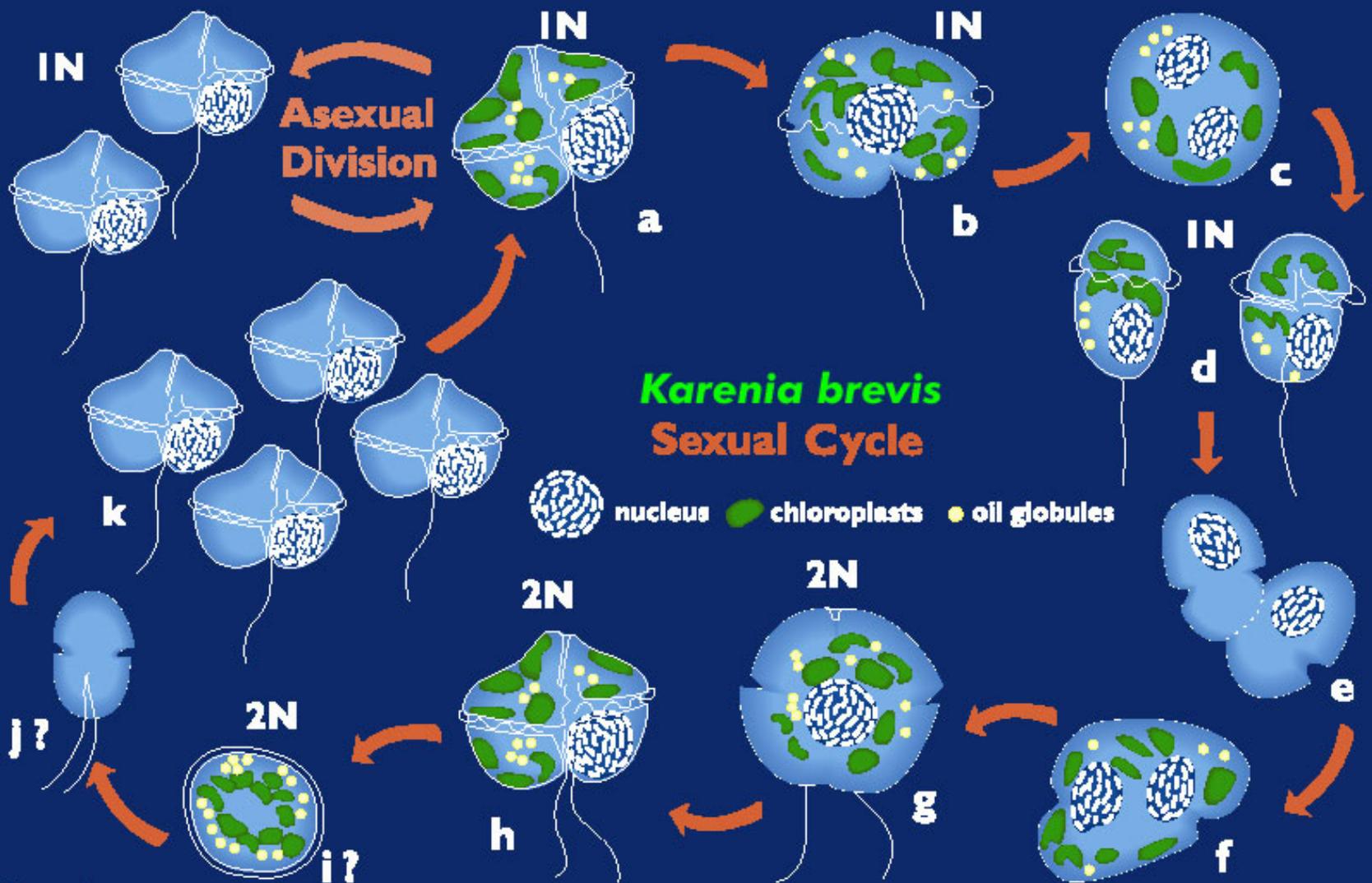
Nutrients



- * Different sources of nutrients and phytoplankton growth strategies can influence HABs on the WFS and different sources of inorganic and organic nutrients may play a role in different stages of bloom development, e.g., upwelled nitrate versus urea

1979 Case History for Model Testing

- * A simple, coupled biophysical model was able to replicate the alongshore transport of *Karenia brevis* on the West Florida shelf in 1979
- * Simulated landfall matches initial landfall
- * Future models will simulate successional processes in time-space that lead to *K. brevis* blooms after DON release on the WFS by: (1) cyanophytes and Saharan dust, (2) bacteria and diatom bloom decay from upwelled nutrients, (3) estuarine sources, and other sources. Different nutrient sources will be model-tested .



KAS-4

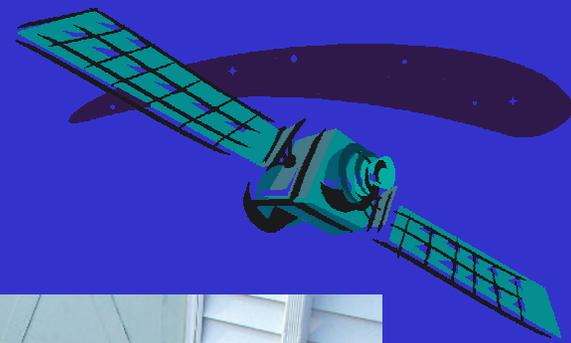


**NEW AND ADVANCED
TECHNOLOGY FOR MONITORING
AND EVENT RESPONSE**

Battery, 2000-km range,
200 m, 30 days, GPS
navigation, ARGOS
satellite two-way
communication



CTD, fluorometer,
PAR,
transmissometer,
G. Kirkpatrick's
"breve buster"



The Future of HAB Monitoring and Forecasting

Automated instrumentation packages on various platforms:

- * Buoys, bridges, and other fixed platforms
- * Automated underwater vehicles, e.g., slocum glider
- * Satellite remote sensing for tracking and forecasting

Meteorological Tower:

Compass, temperature, relative humidity, PAR, barometric pressure

Physical / Chemical:

Autonomous NO_3 & PO_4 analyzers, YSI (chlorophyll, conductivity, dissolved oxygen, pH, salinity, temperature, turbidity), *Acoustic Doppler Current/Tide Profiler*, PAR

Samples: ISCO volumetric sampler (24, 1-L episodic samples)

Data logging /

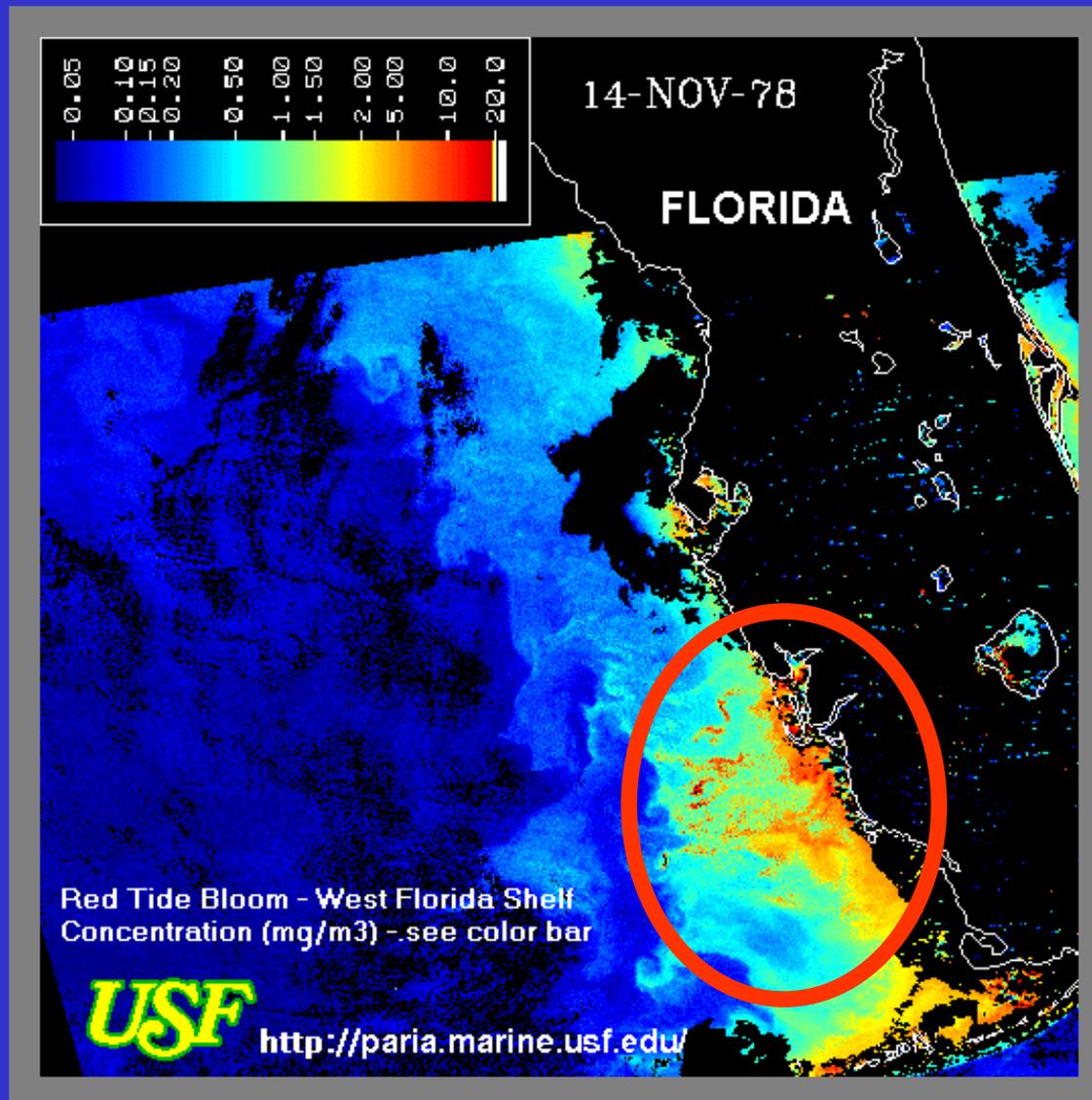
Communications: Campbell System transmitting via TGT1 GOES-satellite & cellular-telephone system.

Power: Marine batteries charged through solar panels.

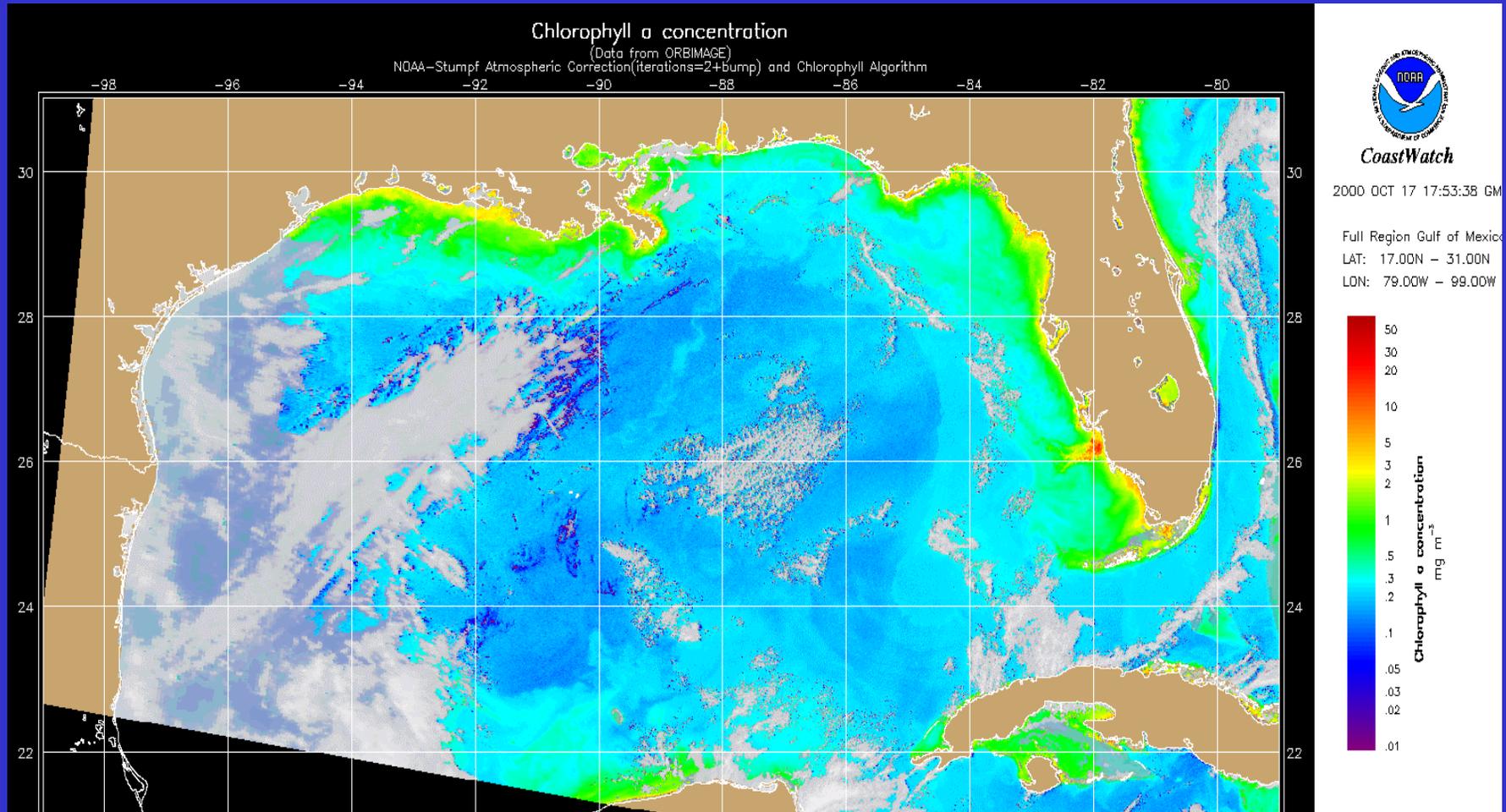
Automated in situ instrument platform



Florida Red Tide Bloom



Remote Sensing

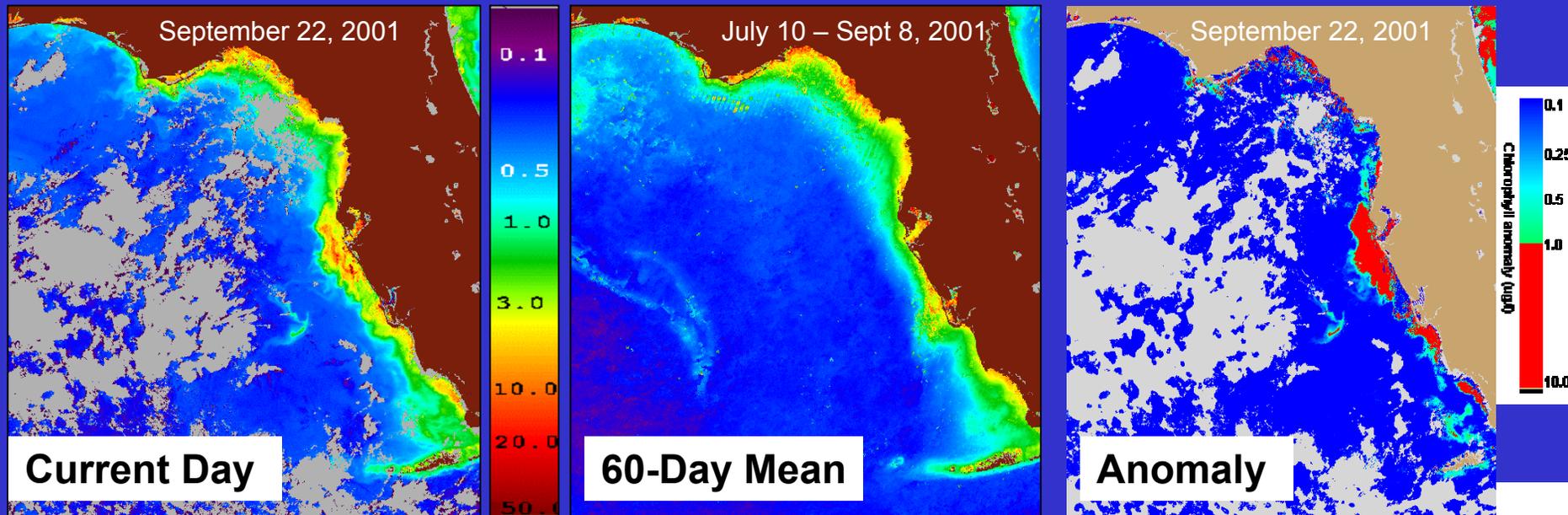


Remote sensing of chlorophyll, sea surface temperature, sea surface height, and other features with import of winds and currents can be used to track and forecast movement of surface HABs in the GOM

Anomaly method for finding west Florida blooms

Why?

- *K. brevis* dominates biomass in late summer
- Better in case 2 water (with turbidity) than optical algorithms
- Compatible with optical algorithms
- Accuracy > 80% during summer and fall (false negatives rare).



Near Real-Time Bulletins



Experimental Gulf of Mexico Harmful Algal Bloom Bulletin

2 October 2002

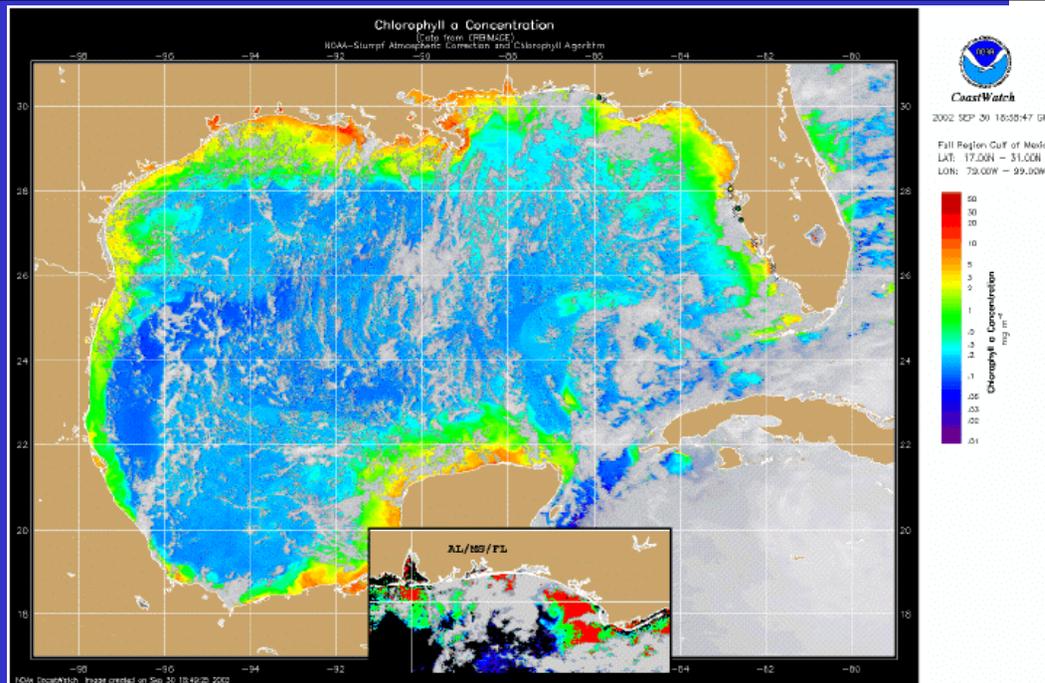
National Ocean Service/NCCOS and CSC
NESDIS/CoastWatch and NDBC
Last bulletin: September 19, 2002

Analysis

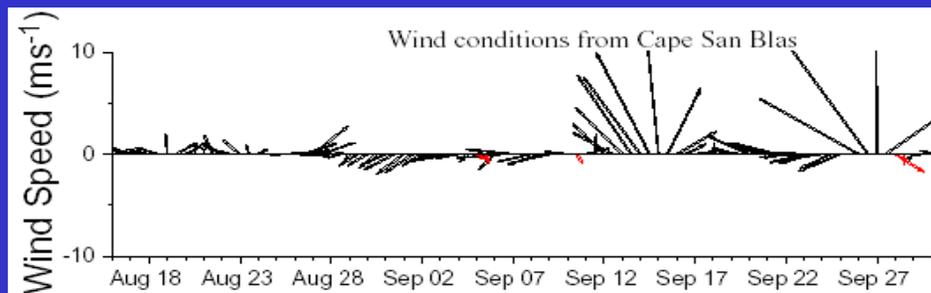
Tropical Storm Hanna pass through on Sep 14, Tropical Storm Isidore on Sep 26. Isidore stirred up much of the eastern Gulf Coast. A larger area of potential bloom is still identified in the Florida Panhandle region. Field data reports bloom around Cape St. Joe, it is likely that some westward spread has occurred along the Florida Panhandle. NE winds between events has favored westward transport.

The major diatom bloom along the south Texas coast is continuing.

--Stumpf



Chlorophyll concentration (above) and possible HAB areas shown in red (inset). Cell concentration sampling data from September 26, 2002 shown as red squares (high), red triangles (medium), red circles (low) orange circles (very low b), yellow circles very low a), green circles (present), and black "X" not present.

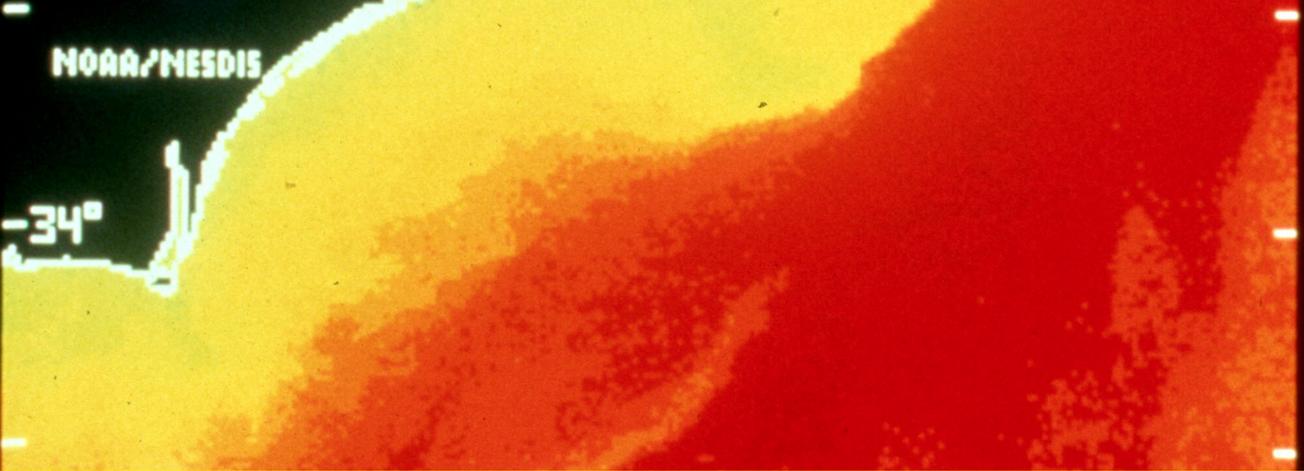
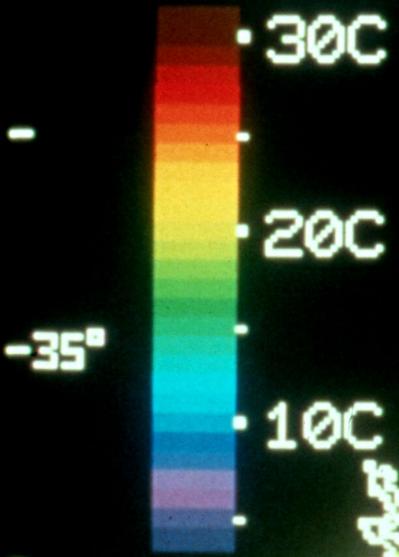


Wind speed and direction are averaged over 12 hours from measurements made on NOAA buoys. Length of line indicates speed; angle indicates direction. Red vectors indicate that wind direction favors upwelling near the coast.

Please note the following restrictions on all SeaWiFS imagery derived from CoastWatch:

1. These data are restricted to civil marine applications only; i.e. federal, state, and local government distribution is permitted.
2. Distribution for military, international, or commercial purposes is NOT permitted.
3. There are restrictions on Internet/Web public posting of these data.
4. These image products may be published in newspapers (any other publishing arrangements must receive OrbImage approval via the CoastWatch Program).

-36° 30 Oct 87 SST
1525 EST



HAB PARTNERS IN GOM(PARTIAL LIST)

EPA LABORATORIES AND GOMPO

NOAA LABORATORIES

FLORIDA FISH & WILDLIFE

OTHER STATE OF FLORIDA AGENCIES

MOTE MARINE LABORATORY

FLORIDA'S HAB TASK FORCE

TEXAS PARKS & WILDLIFE, DEPARTMENT OF HEALTH

LUNCOM, LA DEQ

ALABAMA DEPARTMENT OF HEALTH

MISSISSIPPI DEPARTMENT OF NATURAL RESOURCES

UNIVERSITY OF SOUTH FLORIDA

FLORIDA STATE, U OF FLORIDA,

U OF MIAMI, SO. MISSISSIPPI, UNIVERSITY OF TEXAS,

U OF MARYLAND, OTHERS

NZ SCIENTISTS

MONTEREY BAY AQUARIUM RESEARCH INSTITUTE