

# Complex Challenges to Sustainable Water Resources: Public Health Issues

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*University of Miami*



# Water Uses

- Drinking
- Hygiene
- Food preparation
- Irrigation
- Recreation
- Industry
- Waste Disposal
- **Ecosystem Health**

# Aquatic Toxins

- Harmful Algal Blooms
- Routes of Exposures
- Diseases
- Populations
- Prevention
- Surveillance
- Outreach & Education

# Science

31 August 2007 | \$10




AAAS

# Harmful Algal Blooms

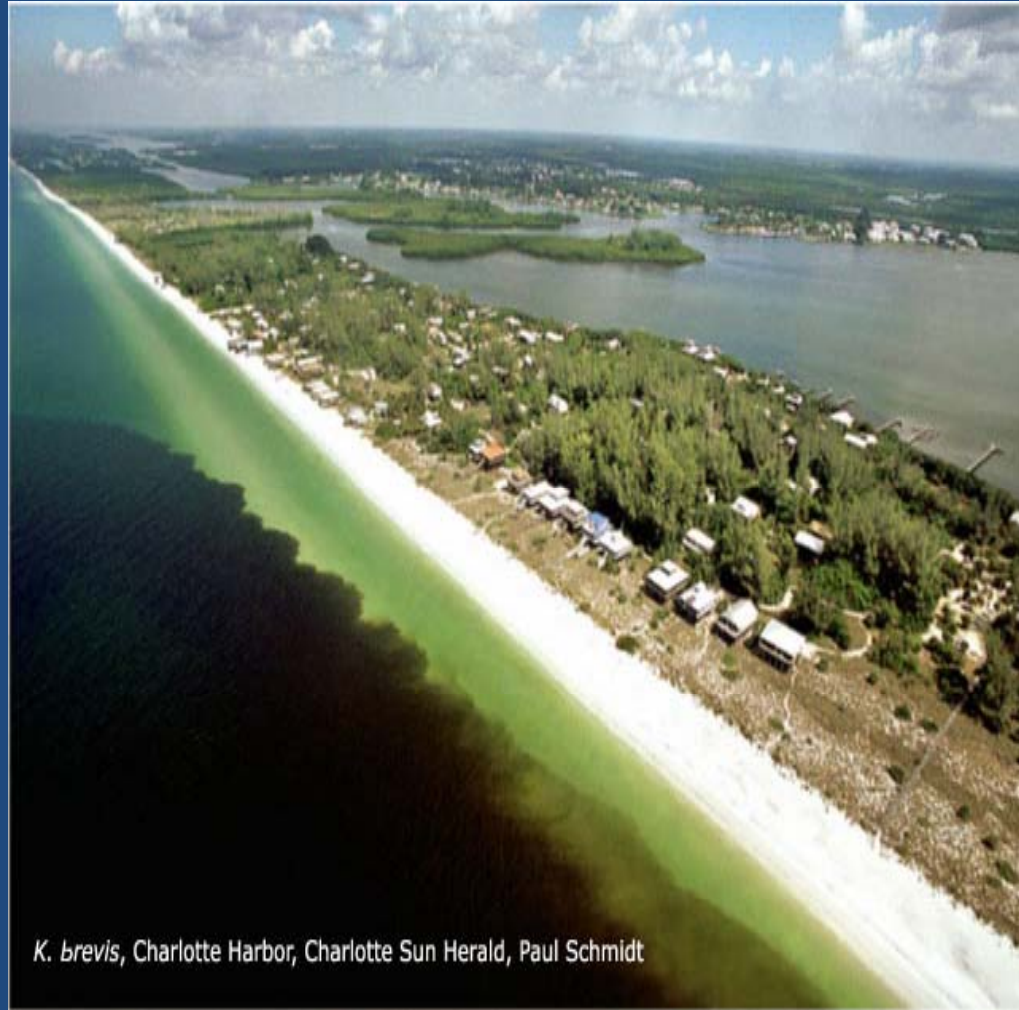


# Harmful Algal Blooms (HABs)

## Definition:

- “Red/Brown/Yellow/etc Tides”
- Proliferation of microscopic organisms
- Marine, fresh & estuarine waters
-  Potential danger to:
  - Environment
  - Wildlife
  - Humans

# Florida Red Tide



*K. brevis*, Charlotte Harbor, Charlotte Sun Herald, Paul Schmidt

# Our Filthy Seas





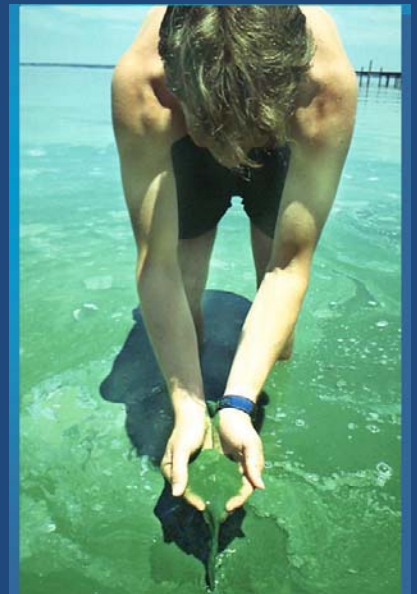
# Causes of HABs?

**DEPENDS on Individual Organism!!!!**

- **Environmental/Biological factors**
  - **Currents, temperature, wind**
- **?Anthropogenic Factors**
  - **?Human Interactions**
  - **?Pollution & Nutrients**
  - **?Global Change**

# Causes of HABs

- **Blooms of Microscopic organisms**
  - Dinoflagellates, diatoms, blue green algae (cyanobacteria)
- **“Harm” =**
  - Oxygen deprivation
  - Natural Toxin-production



# Florida Red Tide

## *Karenia brevis*

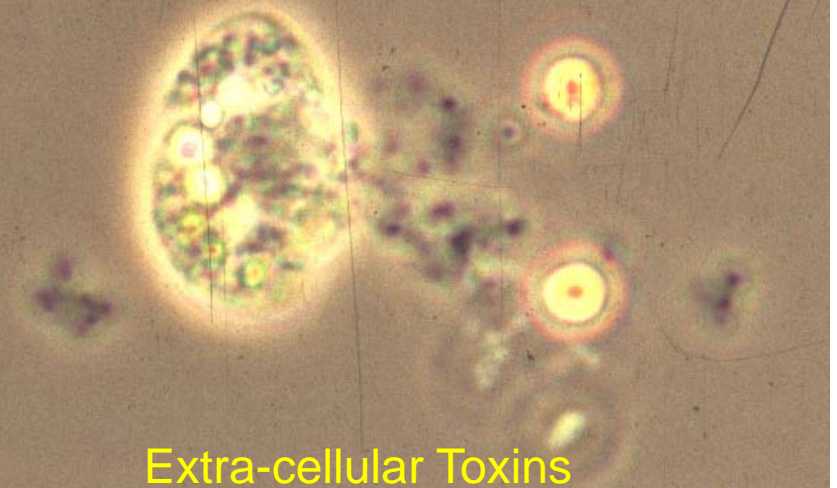
(formerly *Gymnodinium breve*, *Ptychodiscus brevis*)

Whole (live) Cell



Intra-cellular Toxins

Lysed (ruptured) Cell

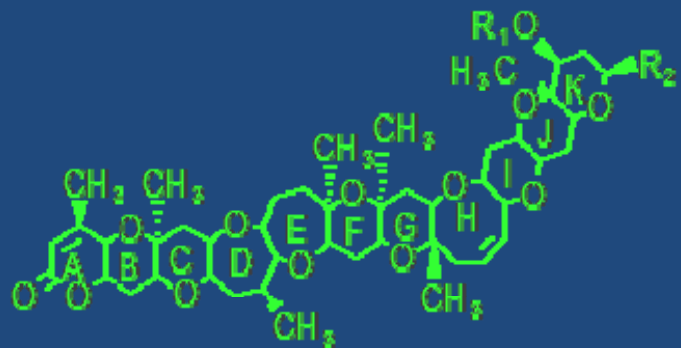


Extra-cellular Toxins

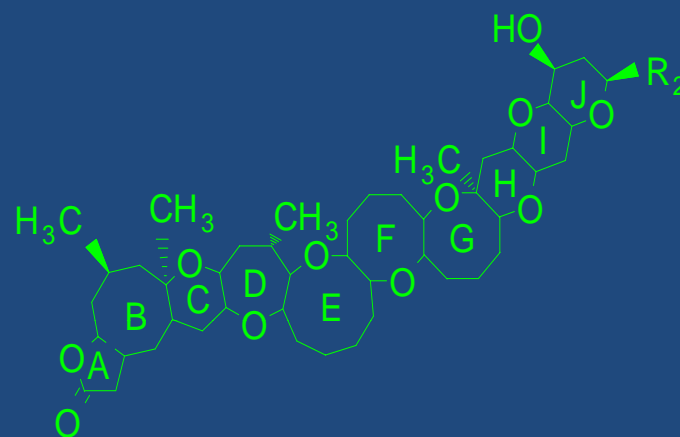
# HAB Toxins

- **Natural Toxins**
  - Harmful in minute (picogram) doses
- **Can NOT be**
  - detected
    - No taste or smell
  - eliminated
    - Heat and acid stable
    - Cleaning, storage, cooking
- **Work at cellular level**

# Brevetoxins



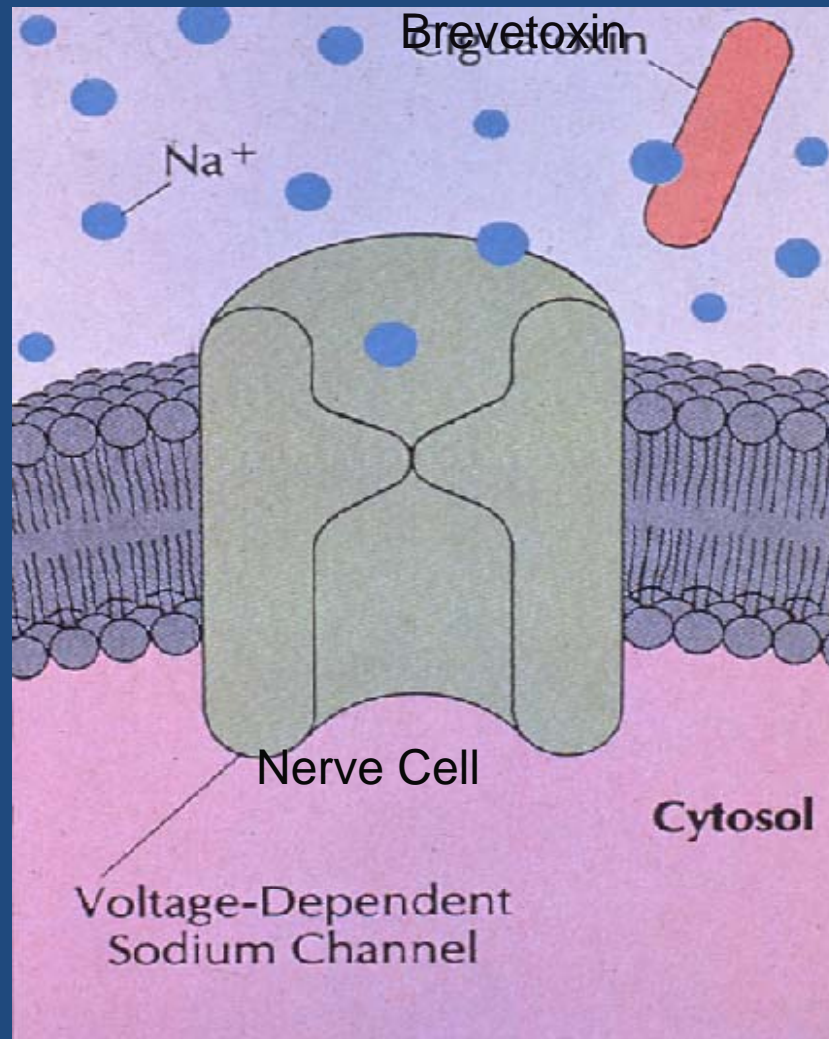
PbTx Type-2



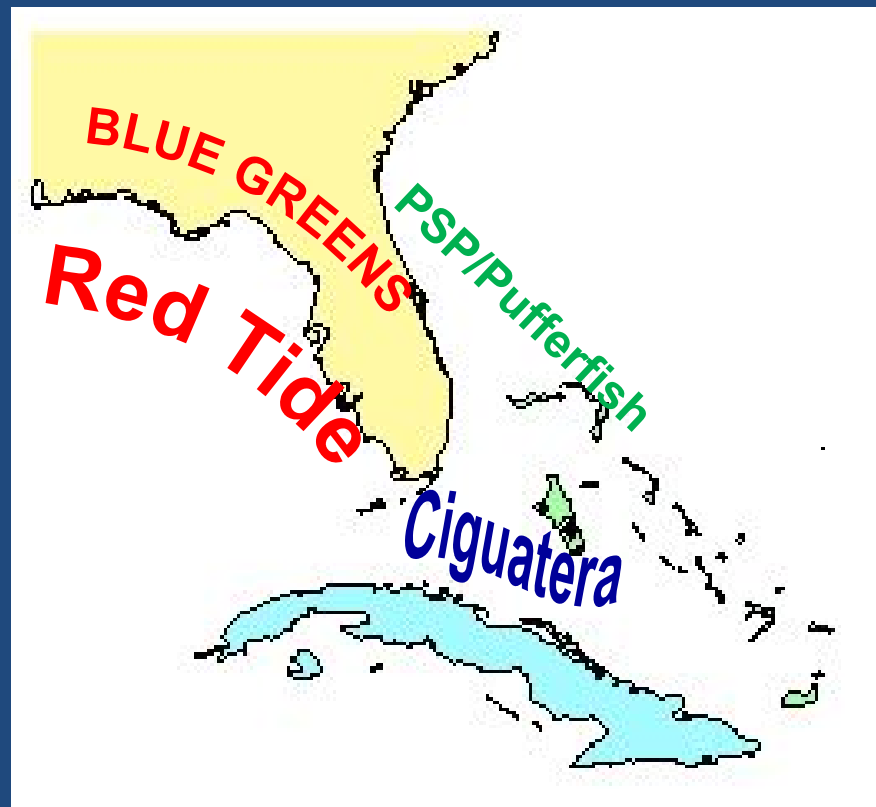
PbTx Type-1

	<u>R1</u>	<u>R2</u>		<u>R1</u>	<u>R2</u>
PbTx-2:	H	CH <sub>2</sub> C(=CH <sub>2</sub> )CHO	PbTx-1:	H	CH <sub>2</sub> CH(CH=CH <sub>2</sub> )CHO
PbTx-3:	H	CH <sub>2</sub> C(=CH <sub>2</sub> )CH <sub>2</sub> OH	PbTx-7:	H	CH <sub>2</sub> CH(CH=CH <sub>2</sub> )CH <sub>2</sub> OH
PbTx-5:	CH <sub>3</sub> CO	CH <sub>2</sub> C(=CH <sub>2</sub> )CHO			
PbTx-6:	H	CH <sub>2</sub> C(=CH <sub>2</sub> )CHO			
		27,28 peroxide			
PbTx-8:	H	CH <sub>2</sub> C(=CH <sub>2</sub> )COCH <sub>2</sub> Cl			
PbTx-9:	H	CH <sub>2</sub> CH(CH <sub>3</sub> )CH <sub>2</sub> OH	PbTx-10:	H	CH <sub>2</sub> CH(CH <sub>3</sub> )CH <sub>2</sub> OH

# Brevetoxin Effects on the Sodium Channel in Nerve Cells

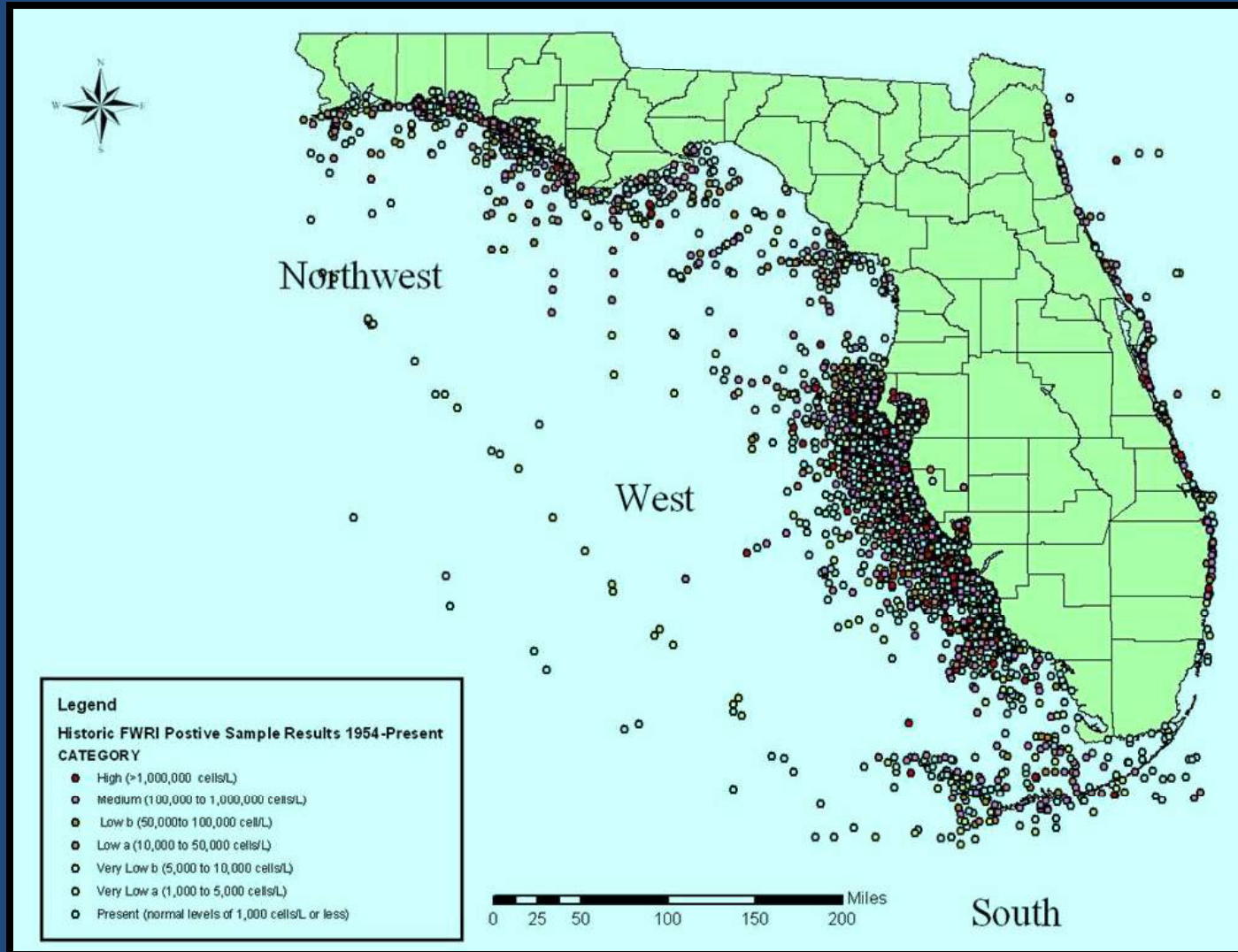


# Harmful Algal Blooms in Florida



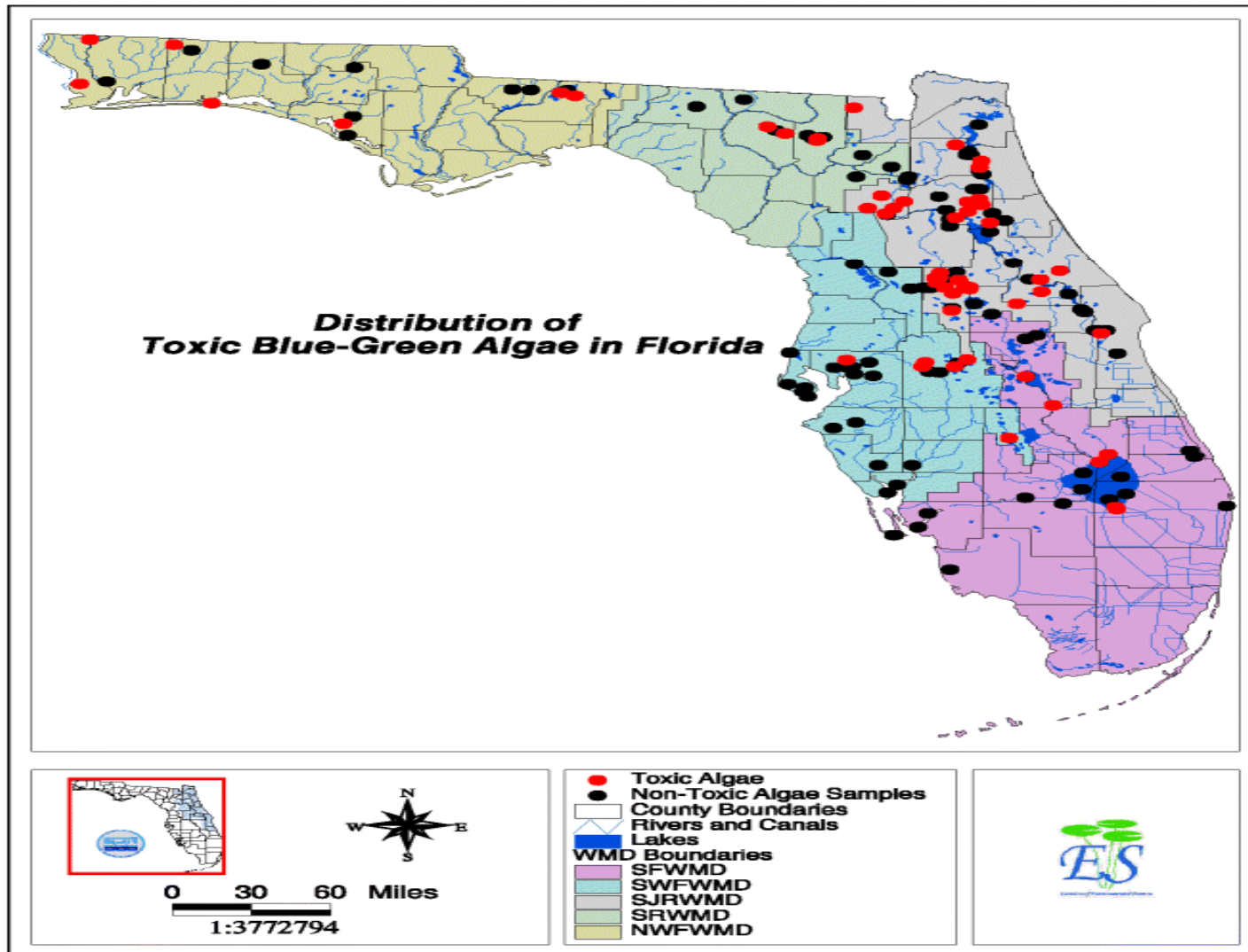
# Florida Red Tide

## Positive Samples, 1954 to Present



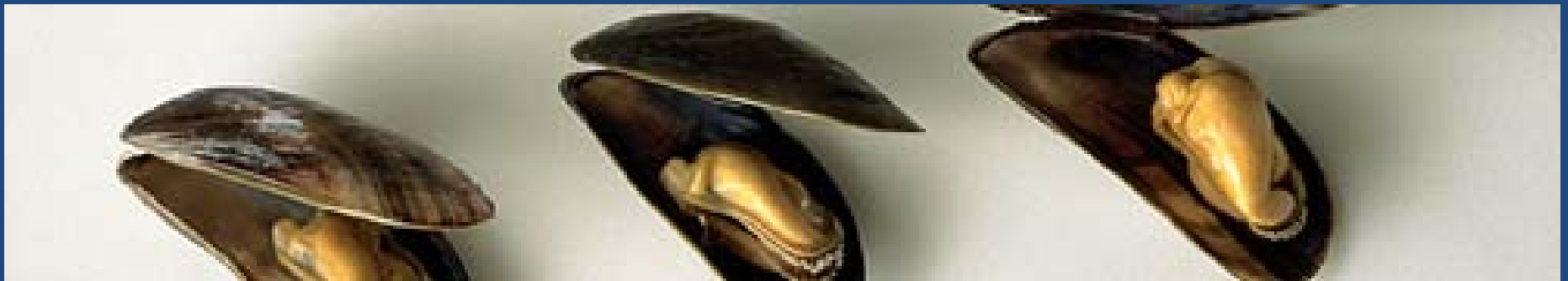


# Florida Blue Green Algae Sampling: Surface Water





# Seafood Consumption



# ?Brevetoxin Fish Poisoning

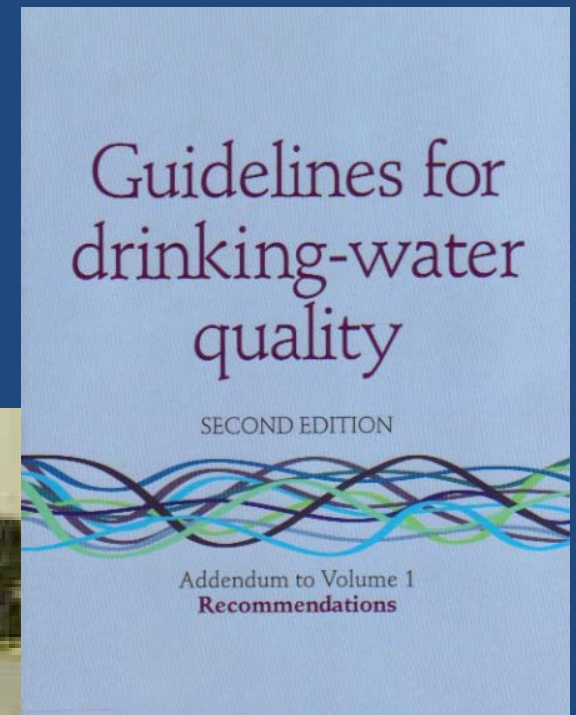
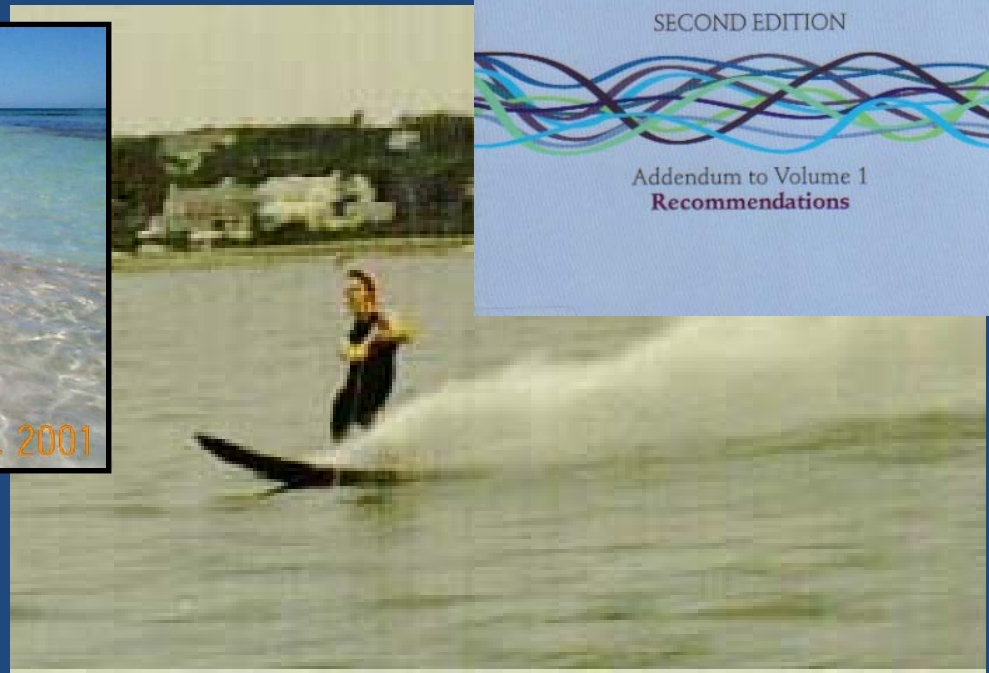
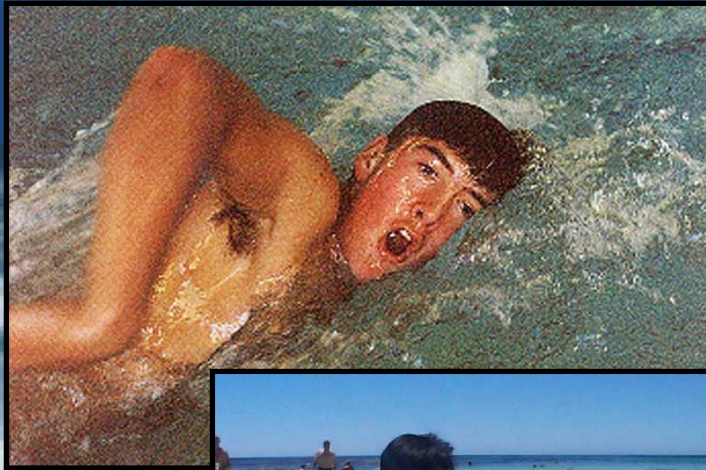
## Red tides and marine mammal mortalities

Unexpected brevetoxin vectors may account for deaths long after or remote from an algal bloom.

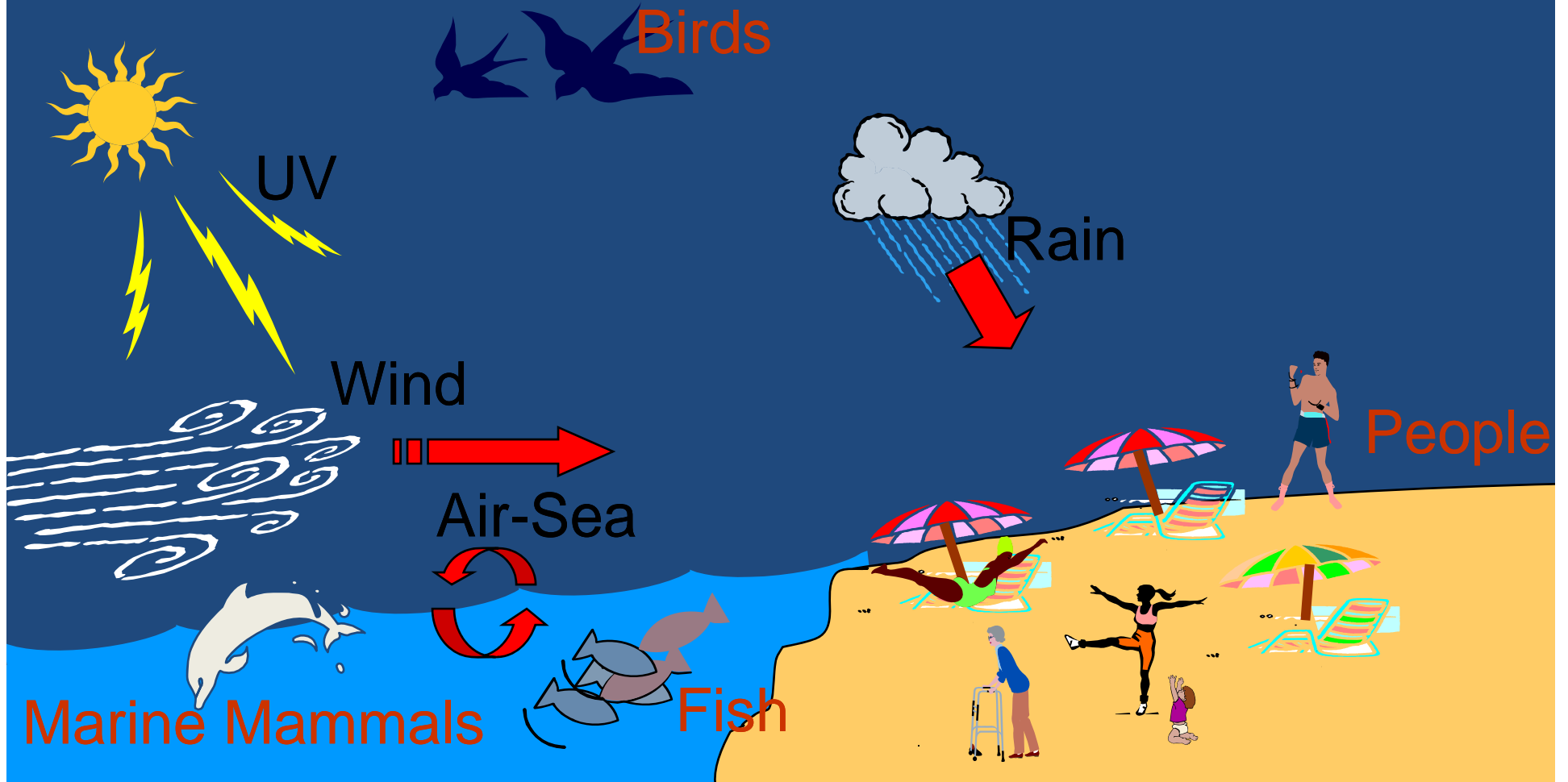
Flewelling et al. Nature 2005



# Air (Aerosol) & Water Exposure



# Natural Forces and Exposures



# Recreational Exposure



# Occupational Exposure



# Red Tides & Fish Kills







**Endangered Florida Manatee**

# Florida Red Tide Environmental Impact



# Economic Costs of HABs

1987-1992: > \$449,291,987

- **Public Health**

- Commercial Fisheries

- Recreation & Tourism

- Monitoring & Management

  - Anderson & Hoagland et al (2000/2002)

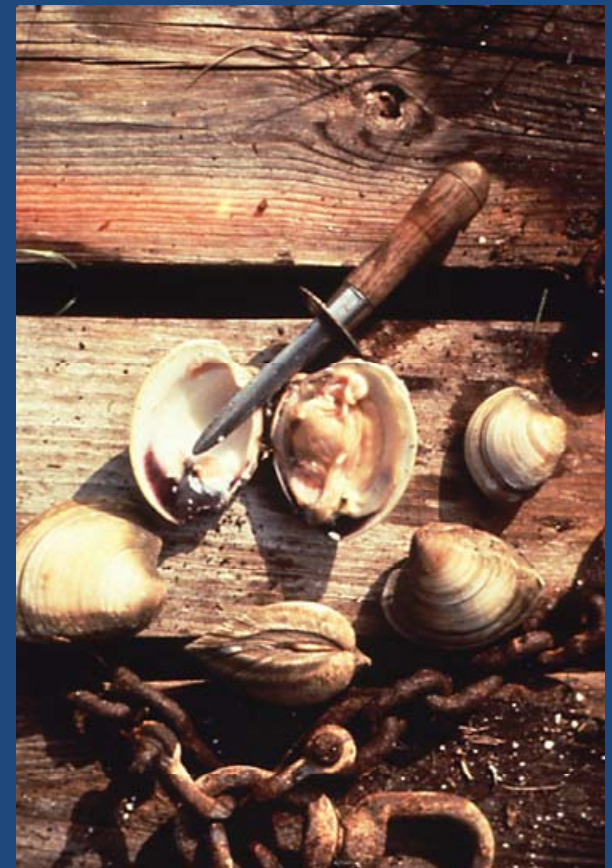


# Clinical Epidemiology

- **Onset:**
  - Minutes to hours (<24)
- **Attack Rate = # Ill/# Exposed:**
  - ??100%
- **Symptoms:**
  - Gastrointestinal; Neurologic; Respiratory; Dermatologic
- **?Fatality: Yes**
- **?Chronic Disease**
  - Ciguatera; ?Aerosolized Florida Red Tide; ?Carcinogenicity
- **Treatment**
  - Mostly supportive; IV Mannitol; ?Brevenal
- **Other**

# Marine & Freshwater Toxin Shellfish Human Diseases

- Paralytic Shellfish Poisoning (PSP)
- **Neurotoxic Shellfish Poisoning (NSP)**
- Diarrheic Shellfish Poisoning (DSP)
- Amnesiac Shellfish Poisoning (ASP)
- Azaspiracid Shellfish Poisoning (AZP)



# Marine & Freshwater Toxin

## Fish Human Diseases

- Pufferfish “Fugu”  
(Tetrodotoxin)/(Saxitoxin)
- **Ciguatera Fish Poisoning**
- ?Brevetoxin Fish  
Poisoning



# Assessment of Saxitoxin in Puffer Fish and other Biota

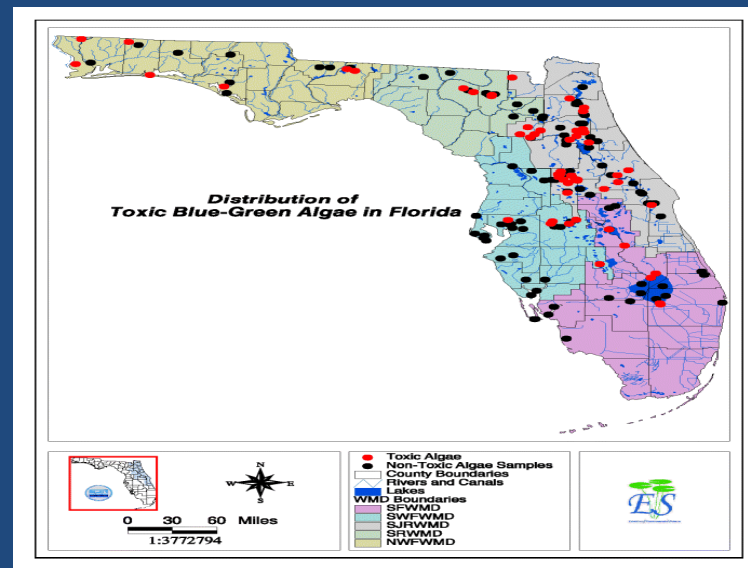


Florida Marine Research  
Institute (FMRI)



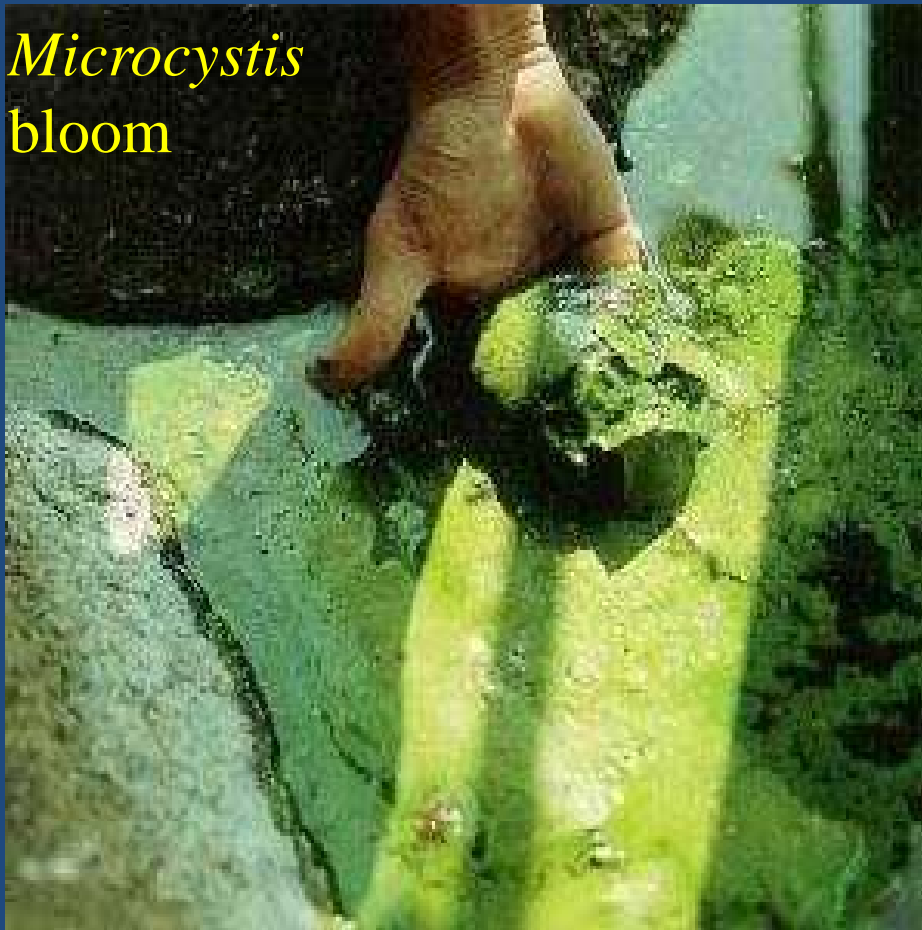
# Marine & Freshwater Toxin Water/Aerosol Human Diseases

- Blue Green Algae/Cyanobacteria
- Aerosolized (Brevetoxin) Red Tide
- ? *Pfiesteria*



# Cyanobacteria

*Microcystis*  
bloom

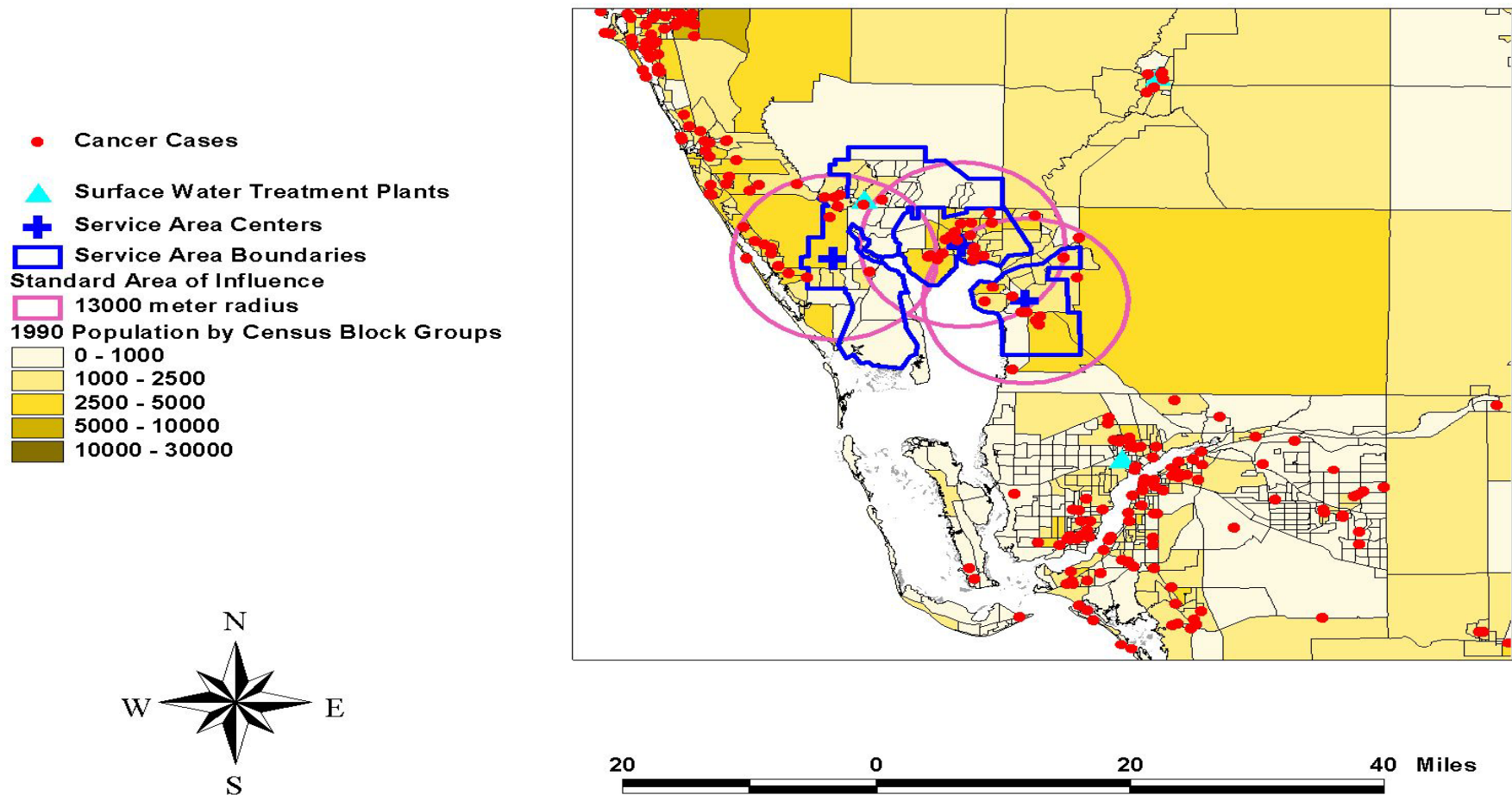


*Anabaena circinalis*  
June 2000



Photos by John Burns

# GIS Methods: HCC Cases & Surface Water Treatment Plants



# Who are the potentially susceptible populations?

- **Underlying lung disease**
  - **Asthma & COPD**
- **Elderly**
- **Pregnant women**
- **?Underlying neurologic disease**
- **?Immunosuppressed**
- **?Children**
- **Pets**

# Marine & Freshwater Toxin Diseases: Current “Prevention”

## Disease

PSP

NSP

DSP

ASP

AZP

Ciguatera

Fugu (Tetrodotoxin/Saxitoxin)

?Brevetoxin Fish

(Brevetoxin) Red Tide

Blue Green Algae

?Pfiesteria/PEAS

## Transvector

*Organism/Toxin*

*Shellfish Bed*

*Monitoring*

*?Fish Monitoring*

*?Water/Air Monitoring*

*??Nutrient Restrictions?*

# Sneezing? Coughing? Watery Eyes?

Your symptoms may be related to Florida Red Tide. People with asthma or respiratory problems should avoid red tide areas especially when winds are blowing on shore.



Solutions To Avoid Red Tide, Inc.

[www.redtideonline.com](http://www.redtideonline.com)

To speak to a health professional anytime,  
call the Florida Red Tide Health Hotline

**1-888-232-8635** toll free

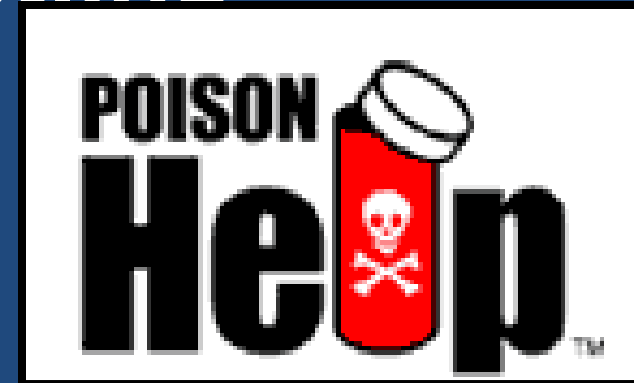
Breathe Easy During a Red Tide

This informational material was funded by the Florida Department of Health.



# Florida Poison Information Center Aquatic Toxins Hotline

- Toll Free: 888 232 8635
- 24/7 in English & Spanish
- Automated Menu of Information
  - Florida Red Tide
  - Other HABs
- Speak with Trained Poison Information Specialist
  - Information
  - Report cases to FI Dept of Health & CDC



# Florida Dept of Health Medical Fact Sheets

Medical Fact Sheet  
Harmful Algae Bloom Series

Neurotoxic Shellfish Poisoning (NSP)



FLORIDA DEPARTMENT OF HEALTH

BUREAU OF  
Environmental Health

**CAUSATIVE AGENT:** Neurotoxic Shellfish Poisoning (NSP) is caused by the consumption of molluscan shellfish (e.g. clams, oysters, coquinas, mussels, and other filter feeders) contaminated with natural toxins known as brevetoxins, which are produced by a marine dinoflagellate called *Karenia brevis*. *K. brevis* is principally distributed throughout the Gulf of Mexico, and occasionally along the mid- and south-Atlantic Coast. Commonly referred to as "Florida red tides," blooms of *K. brevis* most often occur during late summer and fall, but can be present any time of the year.

**SIGNS/SYMPTOMS:** Initial complaints typically include: abdominal pain, nausea, vomiting, and diarrhea accompanied by progressive paresthesias, which can affect areas of the mouth and extremities. Other common symptoms include: ataxia, myalgia, headache, and vertigo. Paradoxical temperature sensation (reversal of hot and cold sensations), as seen in Ciguatera Fish Poisoning, has also been reported in NSP. In more severe cases of NSP, acute respiratory depression and labile blood pressure may also be observed.

**ONSET/DURATION:** Onset of symptoms occurs within minutes to hours, definitely within 24 hours, of consuming brevetoxin-contaminated shellfish. Duration of the illness is generally short, lasting from a few hours to several days.

**DIAGNOSIS:** Diagnosis is generally based on a clinical evaluation of symptoms and recent food history. Mouse bioassay is the only technique accepted by FDA for testing samples for brevetoxin in shellfish; however the use of a brevetoxin ELISA test (to evaluate biological fluids such as urine) is experimental at this time.

**TREATMENT:** No specific antitoxin is available although a new natural antagonist known as brevenol may be useful in the future. Although not well researched, the illness appears to be self-limiting, and therapy is supportive and symptom-driven.

**RISK GROUPS:** All persons are susceptible to NSP. However, young children, the elderly and those individuals with underlying neurologic disease may be at increased risk.

**PREVENTATIVE MEASURES:** The contaminated shellfish are described as tasting delicious and the toxins cannot be removed from the shellfish by different preparation or storage methods. The Florida Department of Agriculture and Consumer Services closes shellfish harvesting areas when *K. brevis* cell counts exceed 5,000 cells per liter. In recent years most NSP cases have been the result of illegal harvesting of shellfish from closed areas. See [www.floridaaquaculture.com/seas/seas\\_statusmap.htm](http://www.floridaaquaculture.com/seas/seas_statusmap.htm) for shellfish harvesting area status.

**REPORTING REQUIREMENTS:** NSP cases must be **immediately** reported to the local county health department pursuant to Section 381.0031 (1), Florida Statutes.

#### ADDITIONAL INFORMATION

Aquatic Toxins Hotline (Florida Poison Information Center): 1-888-232-8635  
The Florida Department of Health's Aquatic Toxins Program at [www.myfloridahh.com](http://www.myfloridahh.com)

#### AQUATIC TOXINS PROGRAM

Protecting Florida's citizens and visitors from Harmful Algal Blooms and related illnesses through  
RESEARCH ◊ SURVEILLANCE ◊ EDUCATION

## Neurotoxic Shellfish Poisoning

Reporting code = 98800

Case Report Form:

1. CDC 52.13 (9/89) *Investigation of Foodborne Illness*

### Clinical case definition

Onset is within a few minutes to a few hours after consumption of epidemiologically implicated shellfish. Symptoms include tingling and numbness of lips, mouth, fingers, and toes; muscular aches; dizziness, reversal of hot and cold sensations; pupil dilation; and usually accompanied by diarrhea, vomiting and ataxia. Illness is self-limited and milder than paralytic shellfish poisoning; paralysis has not been documented. Duration is from a few minutes to a few hours or a few days at most.

### Laboratory criteria for diagnosis

- Detection of toxin in epidemiologically implicated shellfish

### Case classification

**Confirmed:** Clinically compatible illness that is associated with consumption of shellfish from areas where other toxic shellfish have been found.

From:

Surveillance Case Definitions for Select Reportable Diseases in Florida  
Florida Department of Health  
Bureau of Epidemiology  
June 2003



# Posters

## Have you been "slimed"?

Contact with blue-green algae can make you sick.

When blue-green algae (cyanobacteria) form "blooms" in lakes, ponds or rivers, these organisms can release toxins which can make people and animals sick. These large mats of algae can form underwater, rising to the surface overnight, and they sometimes have a bad smell. These "blue-green" algae also can be brown or red in color and can sometimes look like thick paint spilled in the water.

### How To Protect Yourself From Blue-Green Algae Toxins:

- **Avoid contact with large mats of blue-green algae.**
- **NEVER allow children or pets to play in or drink scummy water.**
- **Do not waterski or jet ski over algae mats.**
- **Do not use scummy water for cleaning or irrigation.**
- **If you accidentally come into contact with a blue-green algae bloom, wash thoroughly, paying special attention to the swimsuit area and pets' fur.**

If you think you have symptoms that may be related to contact with blue-green algae, contact your doctor or the Poison Information Hotline at (888)232-8635.

This poster was developed by the Florida Harmful Algal Bloom Task Force in cooperation with the Florida Fish and Wildlife Conservation Commission.

For more information about blue-green algae, visit the Florida Marine Research Institute at [www.floridamarine.org](http://www.floridamarine.org).

*Swimming* in water with a toxic blue-green algae bloom can cause:

- skin rash
- runny nose
- irritated eyes

*Swallowing* such water can:

- cause vomiting or diarrhea
- affect your liver
- poison pets



Attention ER Nurses and Physicians

## Medical Personnel Needed To Assist With Ciguatera Diagnostic Method Study

### Request:

Physicians and nurses to assist with a study on ciguatera fish poisoning (ciguatera)

### Purpose:

Your participation will help study investigators do the following:

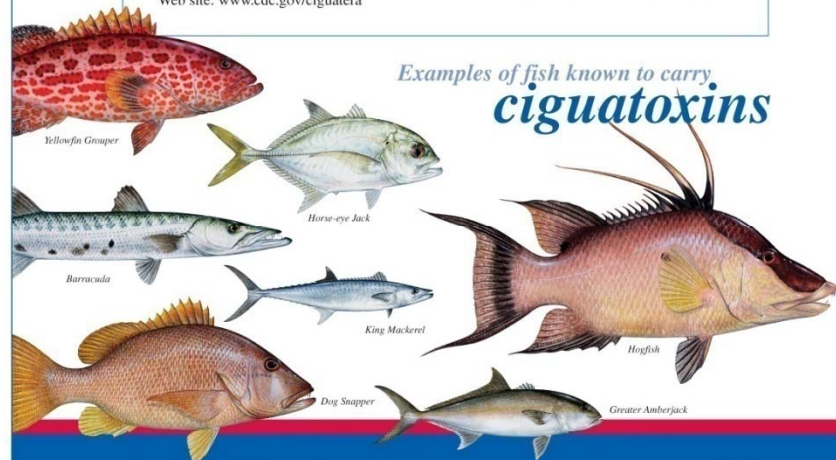
- Identify biomarkers of exposure to ciguatoxins in urine and serum.
- Develop clinical diagnostic tests for exposure.

### What We Would Like You to Do:

- Register to participate.
- If a presumptive ciguatera diagnosis is made, collect clinical specimens and meal remnants from patients and send to investigators.
- Record patient clinical history and conduct limited patient follow up.
- Provide investigators with patient case information.

### For More Information on Ciguatera and to Register for the Study:

Web site: [www.cdc.gov/ciguatera](http://www.cdc.gov/ciguatera)



Examples of fish known to carry *ciguatoxins*

For Additional Information: e-mail: [ciguatera@cdc.gov](mailto:ciguatera@cdc.gov) phone: 404-498-1340

Become part of  
the Solution...

Join



S. T. A. R. T.

Solutions To Avoid Red Tide, Inc.

MONITOR • CONTROL • MITIGATE  
**RED TIDE**

# Hotels, Restaurants, Tourist Venues

## Red Tide Contacts

Florida Red Tide Health Hotline:

1-888-232-8635

Free 24/7 service

Staffed by medical professionals

Report Fish Kills:

1-800-636-0511 (FWRI)

Red Tide Info & Status Reports:

[www.floridamarine.org](http://www.floridamarine.org)

[www.RedTideOnline.com](http://www.RedTideOnline.com)

START:

1-888-757-8278

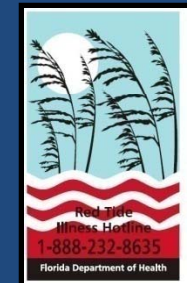


## Key Red Tide Facts:

- Red Tide is a microscopic alga (plant-like organism) in Florida called *Karenia brevis* or *K. brevis*.
- *K. brevis* produces a toxin that can kill fish and can cause respiratory problems in humans. People with severe respiratory problems should avoid red tide areas.
- Red Tide is a type of Harmful Algal bloom that is a world wide problem.
- Red tide can last days, weeks or months but can change daily.
- All seafood from restaurants and hotels is monitored and is safe to eat. Avoid eating clams and oysters taken from red tide waters.
- Red tide symptoms are coughing, sneezing, and watery eyes.

# Outreach Activities: Information, Education and Communication

- ✓ Brochures
- ✓ Trinkets
- ✓ Web Site Development
- ✓ PSAs for Hotels, Public Access Channels
- ✓ Exhibits
- ✓ Professional Enrichment Presentations



# Sarasota County Beach Conditions Report

Sarasota County Beach Reports - Microsoft Internet Explorer

File Edit View Favorites Tools Help

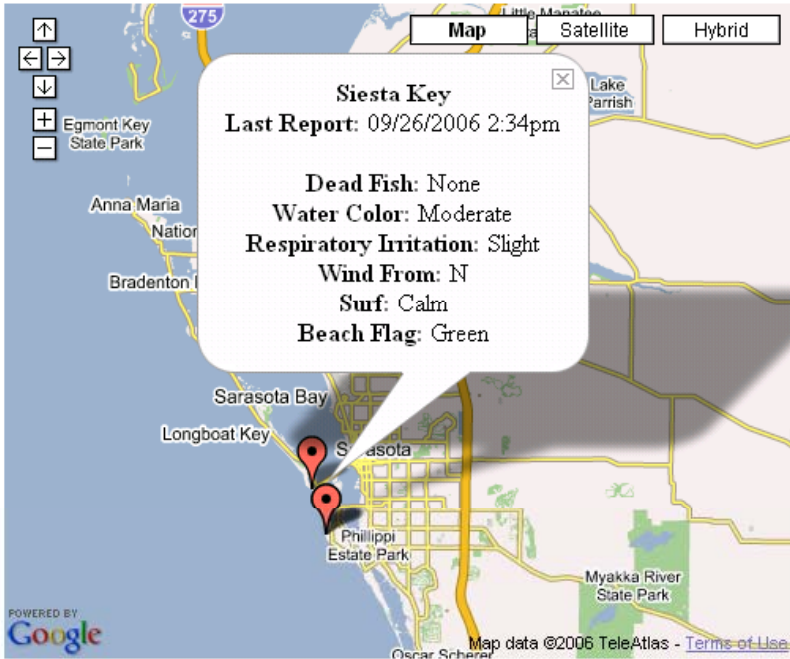
Address <http://coolgate.mote.org/redtide/>

Google

Go

Bookmarks 165 blocked Check AutoLink AutoFill Send to Settings

*yellow flag - bad water*  
*red flag - dangerous swimming conditions*  
*double red flag - beach is closed to swimming*  
*purple flag - hazardous marine life*



**Siesta Key**  
Last Report: 09/26/2006 2:34pm

Dead Fish: None  
Water Color: Moderate  
Respiratory Irritation: Slight  
Wind From: N  
Surf: Calm  
Beach Flag: Green

Links to Red Tide Cell Count/Bloom status reports:

[www.mote.org](http://www.mote.org)  
[www.ourgulfenvironment.net](http://www.ourgulfenvironment.net)  
[research.myfwc.com](http://research.myfwc.com)  
[coastwatch.noaa.gov](http://coastwatch.noaa.gov)

Done Internet

# NOAA HAB Bulletins



## Gulf of Mexico Harmful Algal Bloom Bulletin

5 January 2006  
 NOAA Ocean Service  
 NOAA Satellites and Information Service  
 Last bulletin: January 3, 2006

### Conditions Report

A harmful algal bloom has been identified in Monroe County. Patchy low impacts are possible for the gulfside Lower Keys today and Sunday, with low to moderate impacts possible Friday and Saturday. No impacts are expected elsewhere in SW Florida through Sunday. Dead fish have been reported between Key West and Marathon in the past few days. Dead fish smell, while unpleasant, does not produce the same respiratory irritation as red tide.

### Analysis

The bloom near the Lower Keys remains present. Chlorophyll levels are continually elevated north and south of the Lower Keys, with levels highest north and southeast of Big Mullett Key (24°35'N, 81°54'W and 24°34'N, 81°53'W), inside the Marquesas Keys, and northeast of the Horseshoe Keys (24°48'N, 81°16'W). Elevated chlorophyll extends along the ocean side of the Lower Keys, out to approximately 7 miles from shore. No recent samples are available for this area. A fish kill was reported on 1/3 at Egret Lane west of Marathon. Sampling is highly recommended throughout this area. Continued transport around the Lower Keys is possible throughout the weekend. Also, a slight possibility exists for the transport of additional *K. brevis* through the Lower Keys' larger passages on Friday and Saturday with the appearance of strong north to northwesterly winds.

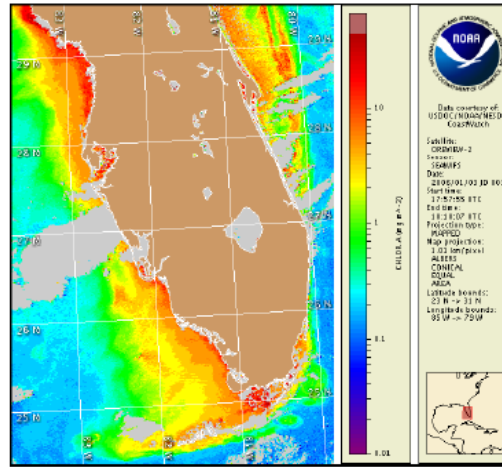
Sampling results indicate the bloom is no longer present at the SW Florida coast, although background levels remain patchy in bay and sound areas of Sarasota and Pinellas County (FWRI, 1/3). Elevated chlorophyll features remain offshore Collier and Monroe Counties near 25°36'N, 82°13'W, and offshore Lee and Collier Counties at 26°16'N, 82°27'W. Sampling, if possible, is recommended. Overall movement has been minimal; the features will likely remain offshore and continue southward migration. ~Fisher, Bronder

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

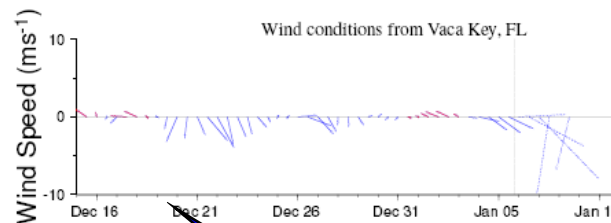
1. Data are restricted to civil marine applications only; i.e. federal, state, and local government use/distribution is permitted.
2. Image products may be published in newspapers. Any other publishing arrangements must receive OrbImage approval via the CoastWatch Program.

Forecast

Detailed Analysis



Satellite chlorophyll image with possible HAB areas shown by red polygon(s).



Wind speed and direction are averaged over 12 hours from buoy measurements. Length of line indicates speed; angle indicates direction. Red indicates that the wind direction favors upwelling near the coast. Values to the left of the dotted vertical line are measured values; values to the right are forecasts.

SW Florida: Westerly winds (5-10kts, 5m/s) today will shift northwesterly, strengthening to 20kts (10m/s) after midnight through Sunday. Continued northwesterlies on Saturday will weaken to 15kts (8m/s) and turn northerly Saturday night at 10kts (5m/s). Mild easterlies expected Sunday and Monday (5-10kts, 5m/s).

FL Keys: Northwest to north winds (10kts, 5m/s) today will shift northwesterly this afternoon into tonight at 15kts (8m/s). Strong northwesterlies on Saturday (15-25kts, 13m/s and gusty) will shift northerly Friday night into Saturday, then to 10kts (5m/s). North to northeast winds near 15kts (8m/s) on Sunday and Monday.

Infrared Satellite Imagery (Chlorophyll a)

Wind Speed Graph

# Acknowledgements

- Florida Dept of Health Aquatic Toxins Program
- CDC
- Florida Poison Information Center
- NSF NIEHS Oceans and Human Health Center
- NIEHS Florida Red Tide PO1



**ollfree 24/7 Aquatic Toxins Hotline: 1-888-232-86**

- [www.doh.state.fl.us/environment/community/aquatic/](http://www.doh.state.fl.us/environment/community/aquatic/)

- [http://coastwatch.noaa.gov/hab/bulletins ns.htm](http://coastwatch.noaa.gov/hab/bulletins_ns.htm)

- [www.Floridamarine.org/](http://www.Floridamarine.org/)

- [www.mote.org/](http://www.mote.org/)

- [www.start1.com/](http://www.start1.com/)

- [www.rsmas.miami.edu/groups/ohh/](http://www.rsmas.miami.edu/groups/ohh/)