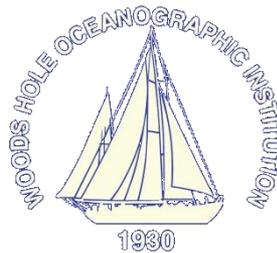


CHANS: MODELING THE DYNAMICS OF HABS, HUMAN COMMUNITIES, AND POLICY CHOICES ALONG THE FLORIDA GULF COAST*

Porter Hoagland *et al.*

Marine Policy Center
Woods Hole Oceanographic Institution



8th Symposium on Harmful Algal Blooms in the US
November 19, 2015

*NSF/CNH No.1009106

et al.:

→ Amo Amaya

Lorrie Backer

Andy Beet

→ Robert Botta

Margaret Byrne

→ Amy Clement

→ Roberto Diaz

→ Jeremy Faris

Lora Fleming

Bruce Garrison

→ Nicholas Hahlbeck

→ Daniel Herrera

Gary Hitchcock

Porter Hoagland

→ Derrick Hudson

Di Jin

→ Andrew Kenney

Barb Kirkpatrick

Gary Kirkpatrick

→ Katie Kubicki

→ Becky Lazensky

→ Cathy Li

→ Stephanie Lavey

Vince Lovko

→ Diana Moanga

→ Tamecia Moore

→ Laura Morse

Andy Reich

Katrin Rudge

→ Karen Scheller

→ Zoe Shoesmith

Jamie Studts

→ Sarah Spiegler

Rick Stumpf

Steve Ullmann

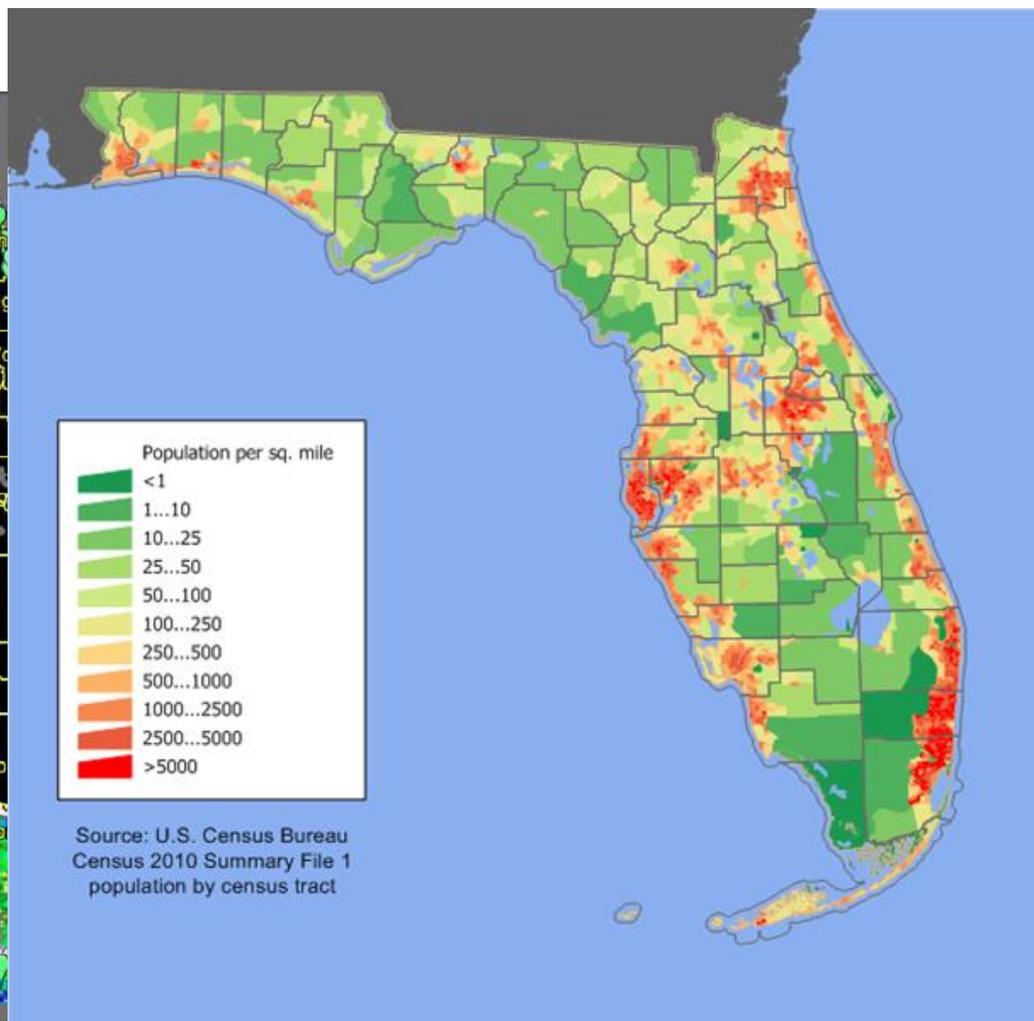
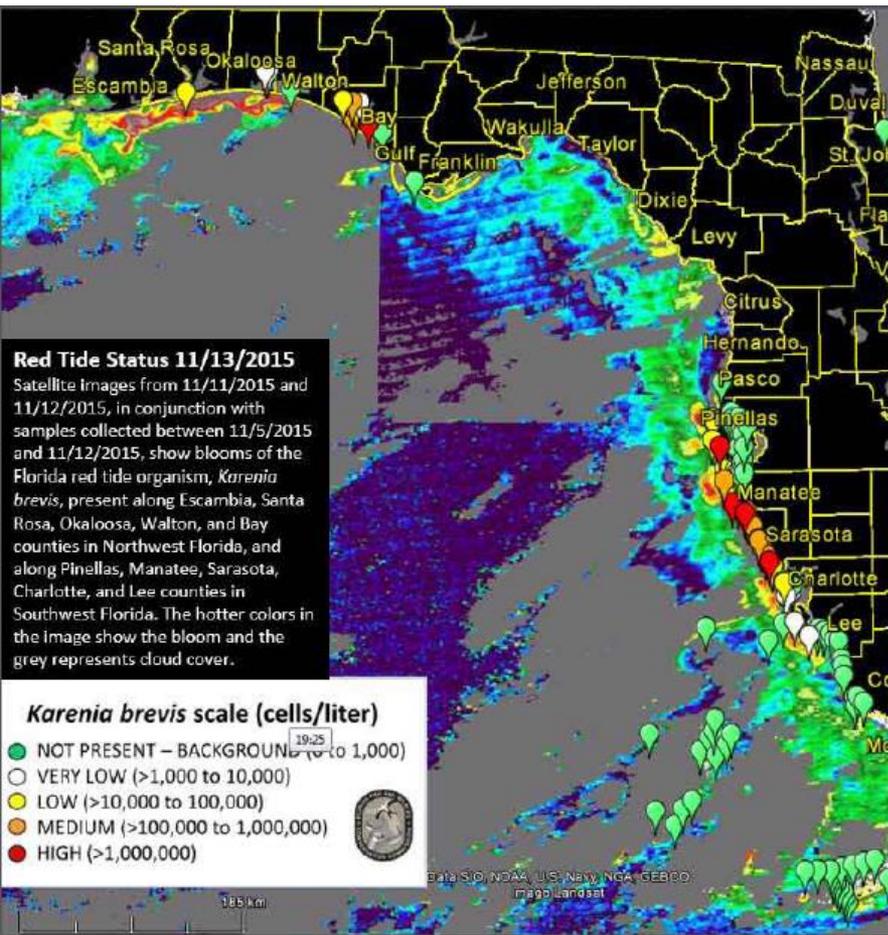
Sharon Watkins

FIELDS

- Public health
- Marine policy
- Oceanography
- Engineering
- Ecology
- Statistics
- Economics
- Medicine
- Remote sensing
- Education
- Communications

SUMMARY

- Florida red tide as a “natural hazard” can be conceptualized as a coupled human and nature system (“CHANS” or “CNH”)
- Dynamics of Florida red tides are a continuing focus of scientific research
- Dynamics of human populations are well understood, but “legends” about human behavior in the face of Florida red tides persist
- Estimates of the public health impacts of Florida red tides (in terms of both illnesses and economic costs) have been developed and refined
- The public remains largely unaware and somewhat unresponsive to the hazard
- It is important to select and scale policies that recognize the nature of the relevant hazard
- Given ongoing uncertainties about the physical properties of Florida red tide blooms, policies that educate the public and increase the flexibility of the public to respond to red tide are likely optimal

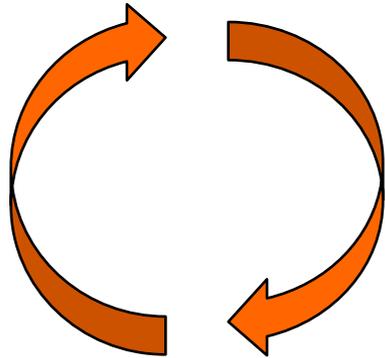


Red tide in **golf** cancels Sarasota **tournament**

Officials are hopeful that the red tide will be blown offshore.

SARASOTA, FL. (WFLA) - Red tide in the gulf has now forced the cancellation of a Sarasota fishing tournament. The **Snook Shindig Fishing Tournament** was supposed to start this weekend. Instead, the participants are out of luck, and scientists are hoping the red tide doesn't get worse.

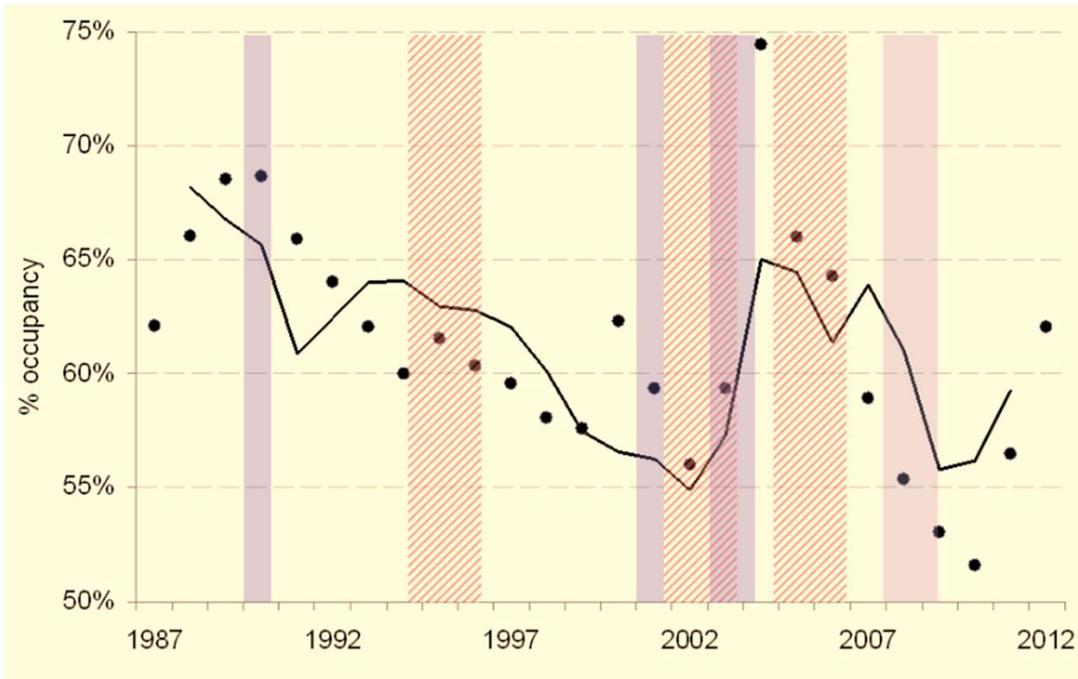
Florida Red Tide Dynamics



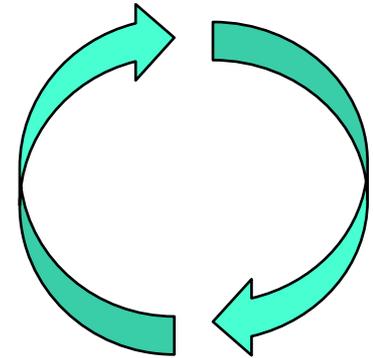
- Concentration (“bloom”)
- Location (velocity)
- Scale
- Duration
- Toxicity

- **Vargo (2009)**
- **~ 24 THOUGHTS AND HYPOTHESES HAVE BEEN PUT FORWARD TO ACCOUNT FOR BLOOMS OF *Kb*** along the west coast of Florida
- *Kb* blooms must be related to a combination of local environmental factors and its physiological ecology
- Background nutrient levels on the West Florida Shelf are insufficient to maintain a high biomass
- *Kb* is capable of using a wide range of available nutrients:
 - **Riverine, estuarine fluxes of N, P**
 - **Submerged groundwater discharges**
 - **Atmospheric N**
 - Benthic fluxes
 - Zooplankton excretion
 - Dead fish

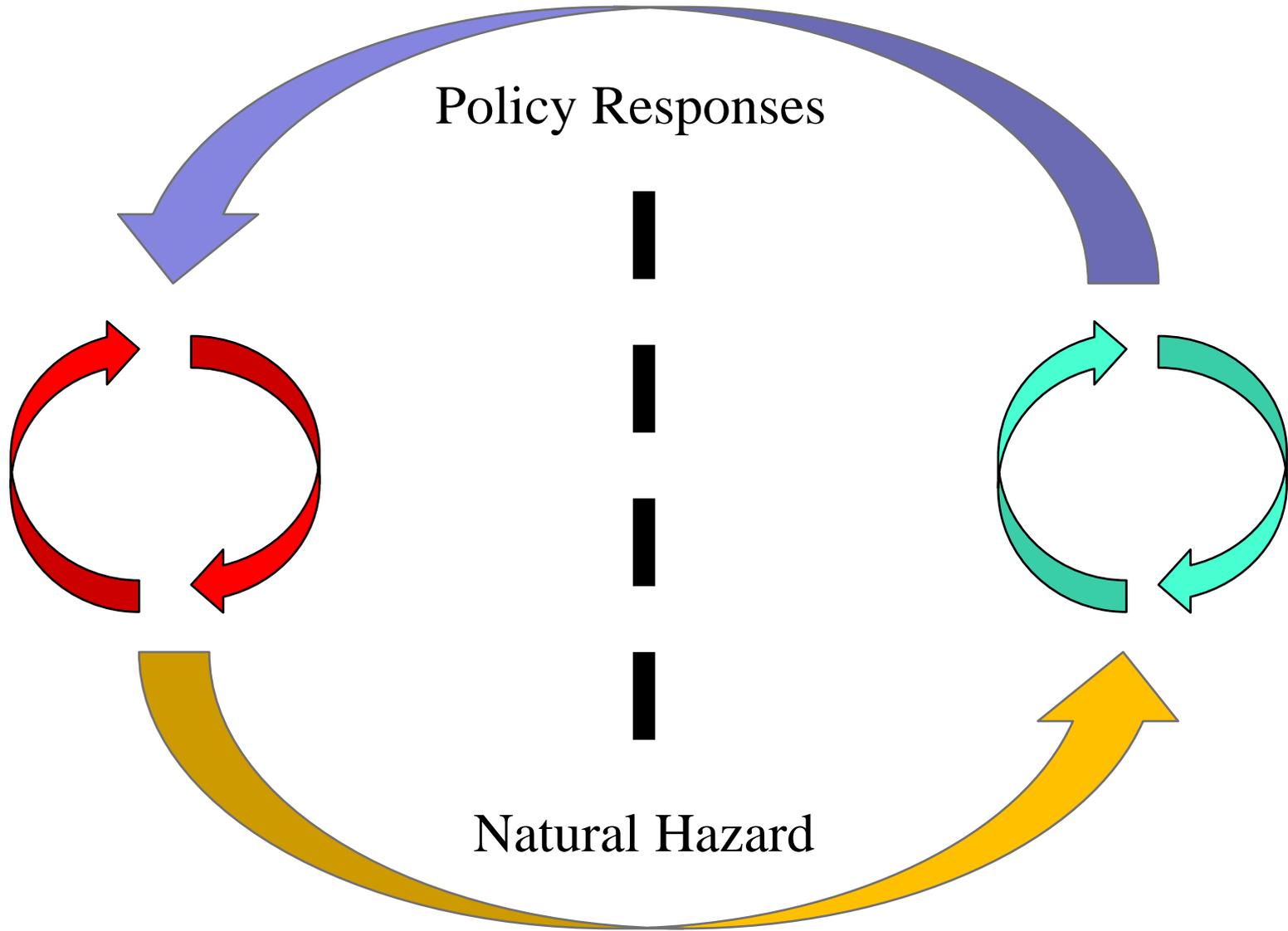
Sarasota Tourism: 1987-2012



Human Coastal Population



- Concentration
- Location
- Trends
- Demographics



UPDATE FROM 7TH SYMPOSIUM:

- Expanded estimates of public health impacts
- SHA closures may be ineffective for recreational shellfishing
- Public's understanding of the effects of red tide has stagnated or declined
- Media tends to treat red tide as an environmental but not a health risk
- Public is largely unaware and therefore possibly unlikely to adhere to policies instituted to mitigate red tide



The human health effects of Florida Red Tide (FRT) blooms:
An expanded analysis



Harmful Algae 43 (2015) 13–19



Assessing the impact of shellfish harvesting area closures on
neurotoxic shellfish poisoning (NSP) incidence during red tide
(*Karenia brevis*) blooms



Harmful Algae 32 (2014) 27–32



Florida red tide knowledge and risk perception: Is there a need for
tailored messaging



Applied Environmental Education & Communication, 14:167–177, 2015
Copyright © Taylor & Francis Group, LLC
ISSN: 1533-015X print / 1533-0389 online
DOI: 10.1080/1533015X.2015.1067579



Risk in Daily Newspaper Coverage of Red Tide Blooms in Southwest Florida

Science of the Total Environment 493 (2014) 898–909



Human responses to Florida red tides: Policy awareness and adherence to
local fertilizer ordinances



Barbara Kirkpatrick^{a,b}, Kate Kohler^a, Margaret Byrne^b, Lora E. Fleming^{b,c,d,*}, Karen Scheller^a, Andrew Reich^c, Gary Hitchcock^c, Gary Kirkpatrick^a, Steven Ullmann^d, Porter Hoagland^e

^a Mate Marine Laboratory, Sarasota, FL, USA

^b Department of Epidemiology and Public Health, Miller School of Medicine, University of Miami, Miami, FL, USA

^c European Centre for Environment and Human Health, University of Exeter Medical School, Truro, Cornwall, UK

^d Rosenstiel School of Marine and Atmospheric Sciences, University of Miami, Miami, FL, USA

IN PROGRESS (AT THIS MEETING)

Author(s)	Response	Predictor(s)
<i>Hahlbeck et al.</i> (16)	<i>Kb</i> bloom “center of mass”	Lagged river discharges
<i>Lovko et al.</i> (25)	Phytoplankton community structure	Water column structure
<i>Kirkpatrick et al.</i> (21)	Qualitative beach conditions	Water temperature (↑) Barometric pressure (↓) Wind direction Relative humidity (↑)
<i>Diaz et al.</i> (8)	Neurological illnesses	<i>Kb</i> nearshore cell counts
<i>Moore et al.</i> (28)	K-12 student percent absent rate	Latent school characteristics

M³

- Visit substitute beaches, restaurants
- Remain indoors
- Travel away from the coast
- Reductions in regional tourist visits

Reduce Population at Risk

RED TIDE BLOOM

POPULATION AT RISK

ILLNESSES

EXPOSURES

Understanding and Notification

Mitigate Illnesses

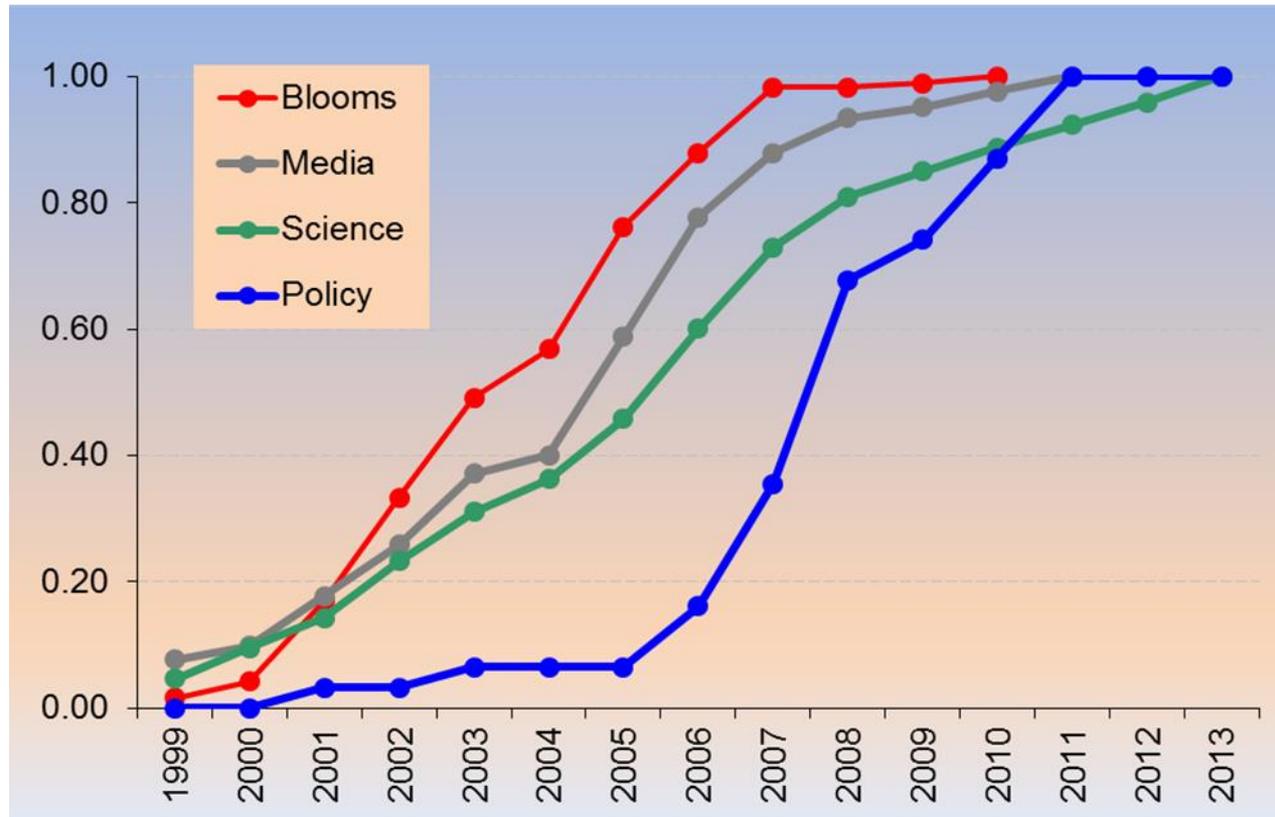
Prevent/Control Blooms

- Fertilizer ordinances
- Other non-point controls
- Wastewater treatments
- Runoff holding ponds
- Septic upgrades
- Other preventive actions:
- Chemical/biological/physical controls

- Monitoring
- Forecasting
- Alerts
- Publications (media, scientific)
- Scientific research
- Education
- Other control actions

- Self-medication
- Physician visits
- Emergency Department visits
- Hospital Stays

Can we shorten the lag between the hazard and responses to mitigate harm?



Is there a policy or a set of policies that is more effective than others in that respect?

Vargo (2009): hypotheses posed for *Kb* bloom initiation, growth, maintenance, and termination

Many potential sources of nutrients **cannot be controlled** (e.g., Trichodesmium N-fixation, zooplankton grazing and excretion, decomposing fish)

Humans (possibly) could control the magnitude of “cultural eutrophication” by **limiting land and fertilizer uses and the release of atmospheric N**

Increased nutrient fluxes to the coastal zone fuel phytoplankton blooms, including HABs or hypoxia, so **reductions in anthropogenic nutrient fluxes are sensible**

HABs should not be used as the sole reason to reduce coastal eutrophication since not all HABs are directly related to estuarine or coastal eutrophication

- Visit substitute beaches, restaurants
- Remain indoors
- Travel away from the coast
- Reductions in regional tourist visits

Reduce Population at Risk

RED TIDE BLOOM

POPULATION AT RISK

ILLNESSES

EXPOSURES

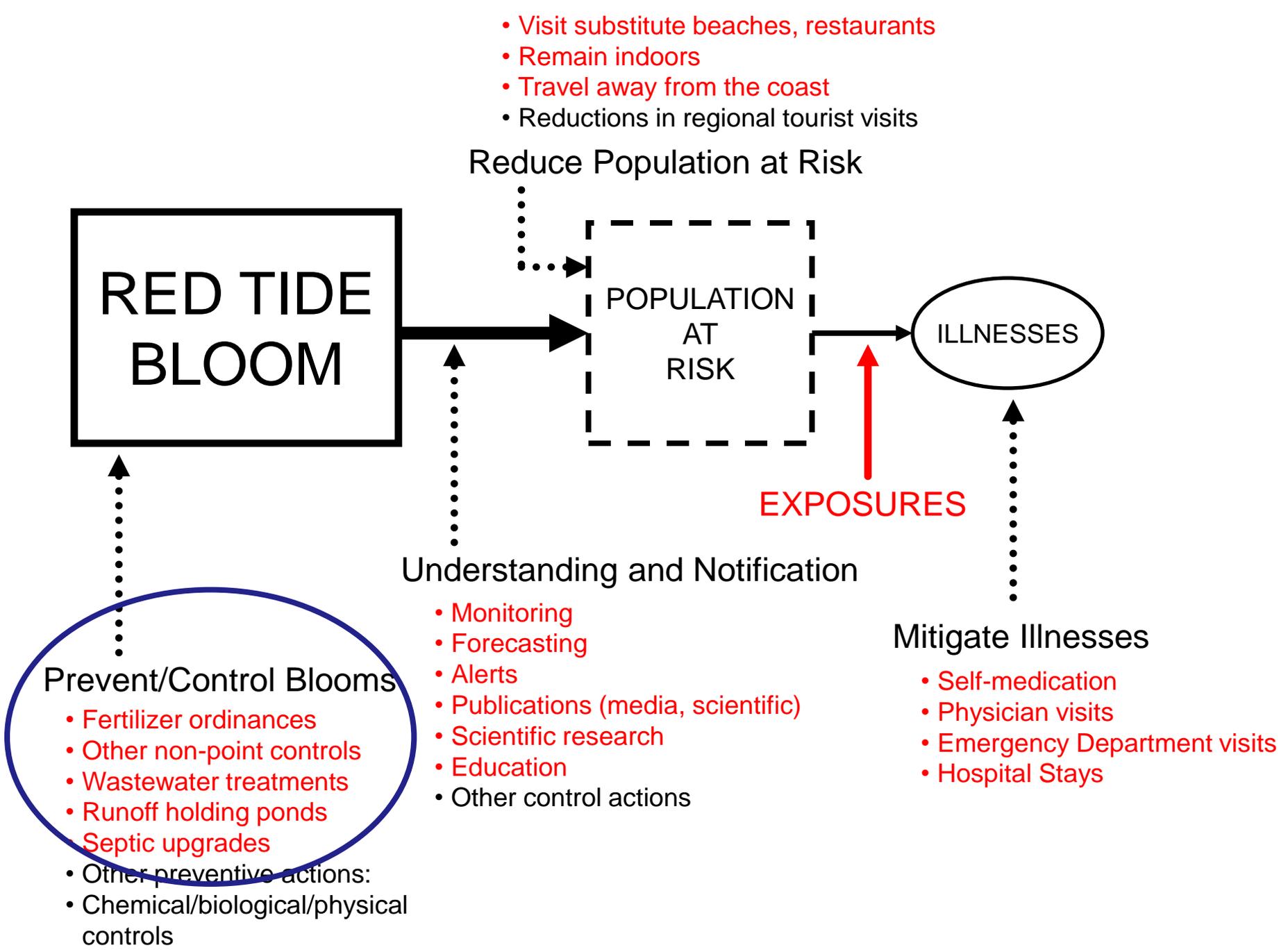
Understanding and Notification

Mitigate Illnesses

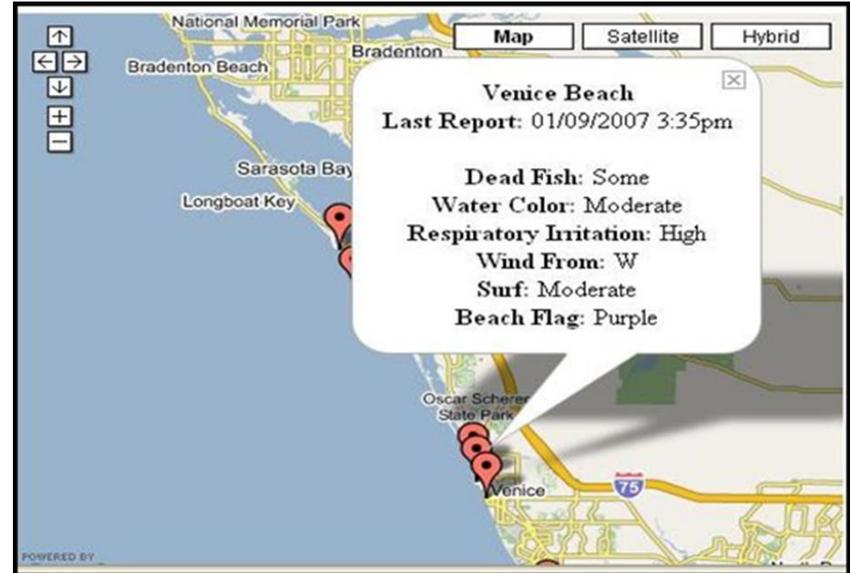
- Prevent/Control Blooms
- Fertilizer ordinances
 - Other non-point controls
 - Wastewater treatments
 - Runoff holding ponds
 - Septic upgrades
 - Other preventive actions:
 - Chemical/biological/physical controls

- Monitoring
- Forecasting
- Alerts
- Publications (media, scientific)
- Scientific research
- Education
- Other control actions

- Self-medication
- Physician visits
- Emergency Department visits
- Hospital Stays



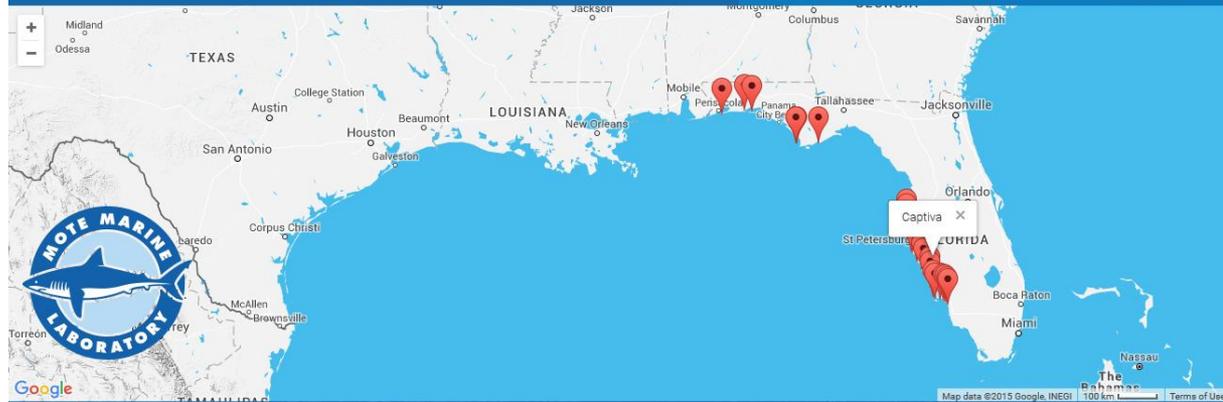
A POLICY ENHANCING FLEXIBILITY: BCRS



From September 2006 to July 2014, the odds that all beaches in Sarasota County experience high respiratory irritation simultaneously:

Morning: ~150:1

Evening: ~100:1



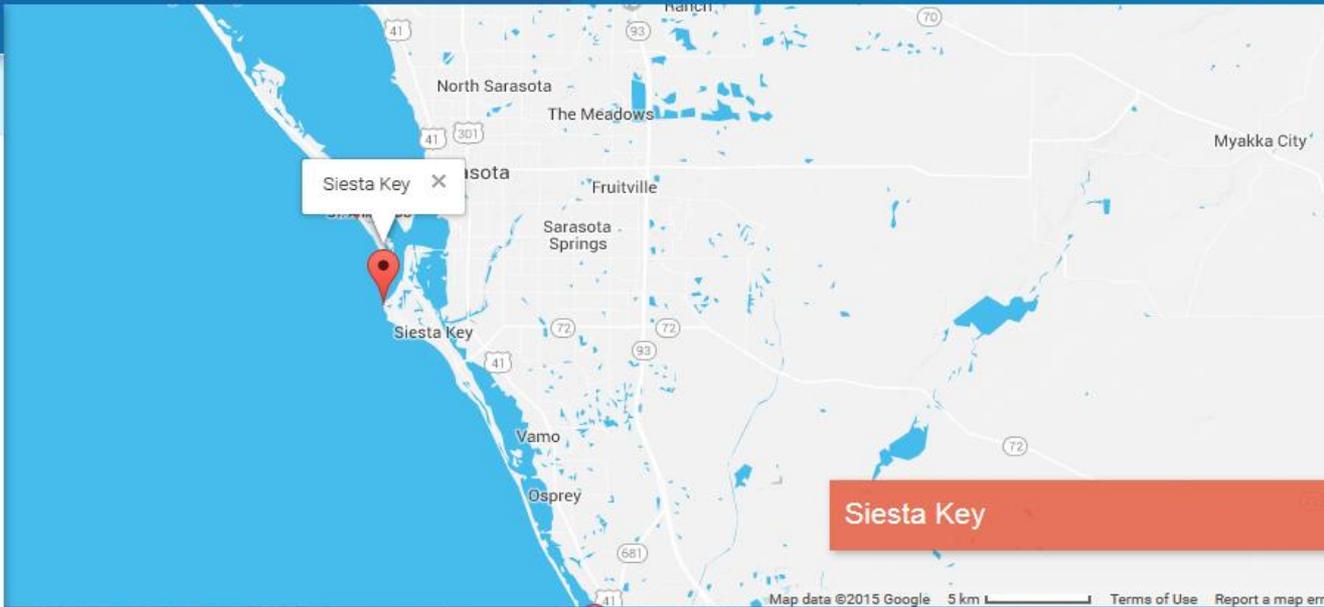
This service provides beach conditions reports from select beaches in the Southwest coast of Florida and the Florida Panhandle. The reports are subjective (no measurements taken, just an estimate) and designed to indicate to the beachgoer which beach may be more preferable to visit at a particular time.

Most reports will be posted at 10 am and 3 pm local time. If a posting is late, please understand that the beach reporters may be involved in more pressing matters.

Siesta Key

Report Amenities Pictures

Date Reported	2015-11-18 15:18:34
Flag	Yellow
Water Color	Moderate
Red Drift	Some
Red Drift Location	Beach
Air Temp	83.38°F
Water Surface Temp	77°F
Weather	Partly Cloudy
Respiratory Irritation	None
Dead Fish	Some
Jellyfish	None
Beach Debris	None
Wind Direction	West
Wind Speed	8.45 MPH
Rip Currents	Present
Surf	Choppy
Surf Type	Wind Chop
Surf Height	1-2FT
Crowds	Many



RELEVANT QUESTIONS FOR THE FUTURE

- What are the set of **feasible policies**?
- What are their levels of **effectiveness** in reducing the hazard?
- What are their **costs**?
- Are there **complementarities** across policies?
- Can we **improve** on the existing set of policies?
 - Especially as we learn more about:
 - **how blooms occur**
 - **how humans behave**