

Impact of climate on dinoflagellates and Ciguatera Fish Poisoning (CFP)

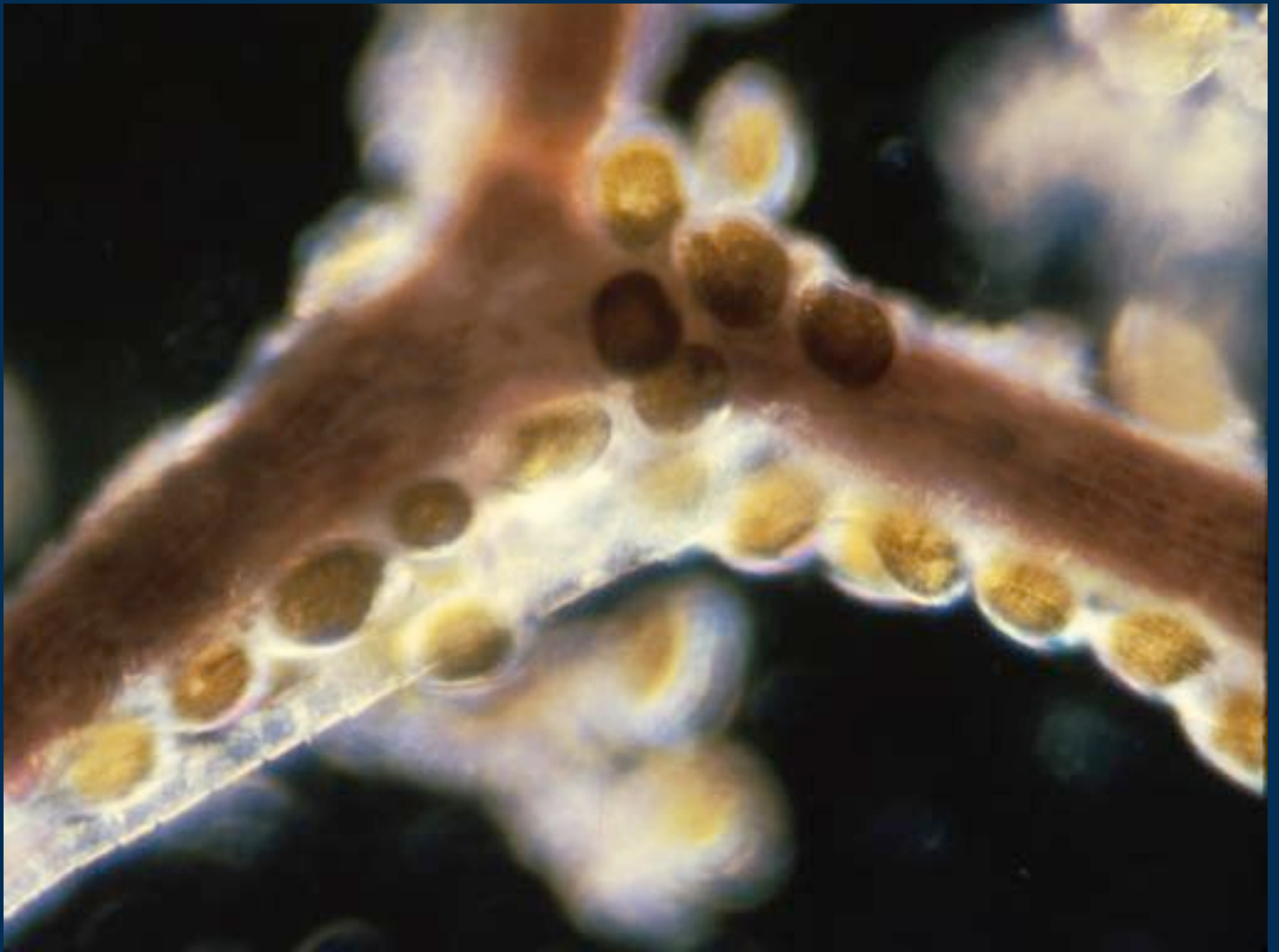
Donald M. Anderson
Senior Scientist
Woods Hole Oceanographic Institution



Ciguatera Fish Poisoning: a few facts

- Ciguatera is caused by the consumption of subtropical and tropical marine fish that have accumulated naturally occurring toxins through their diet. The toxins originate from benthic (bottom-dwelling) dinoflagellates
- It is the most frequently reported marine toxin disease in the world, affecting > 50,000 people per year
- Major constraint on fisheries in many regions







Ciguatoxins,
human illness

herbivorous fish

carnivorous fish

gambiertoxins
(precursor compounds)

Gambiertoxins

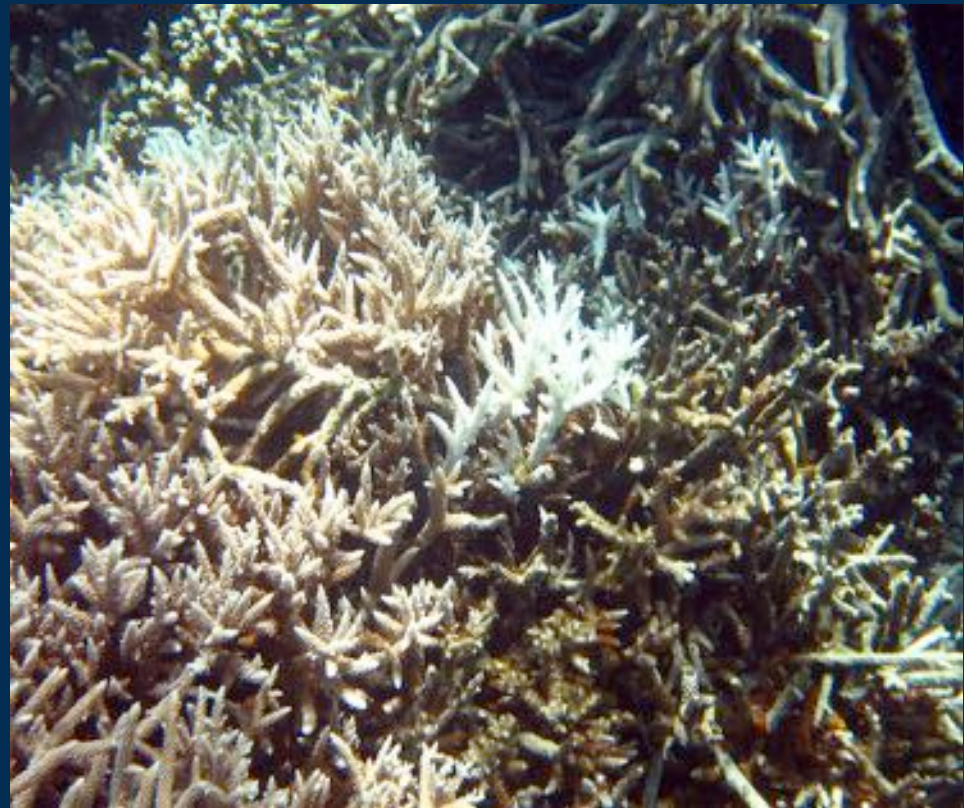
metabolism

Ciguatoxins

- genetic variability
- environmental variability

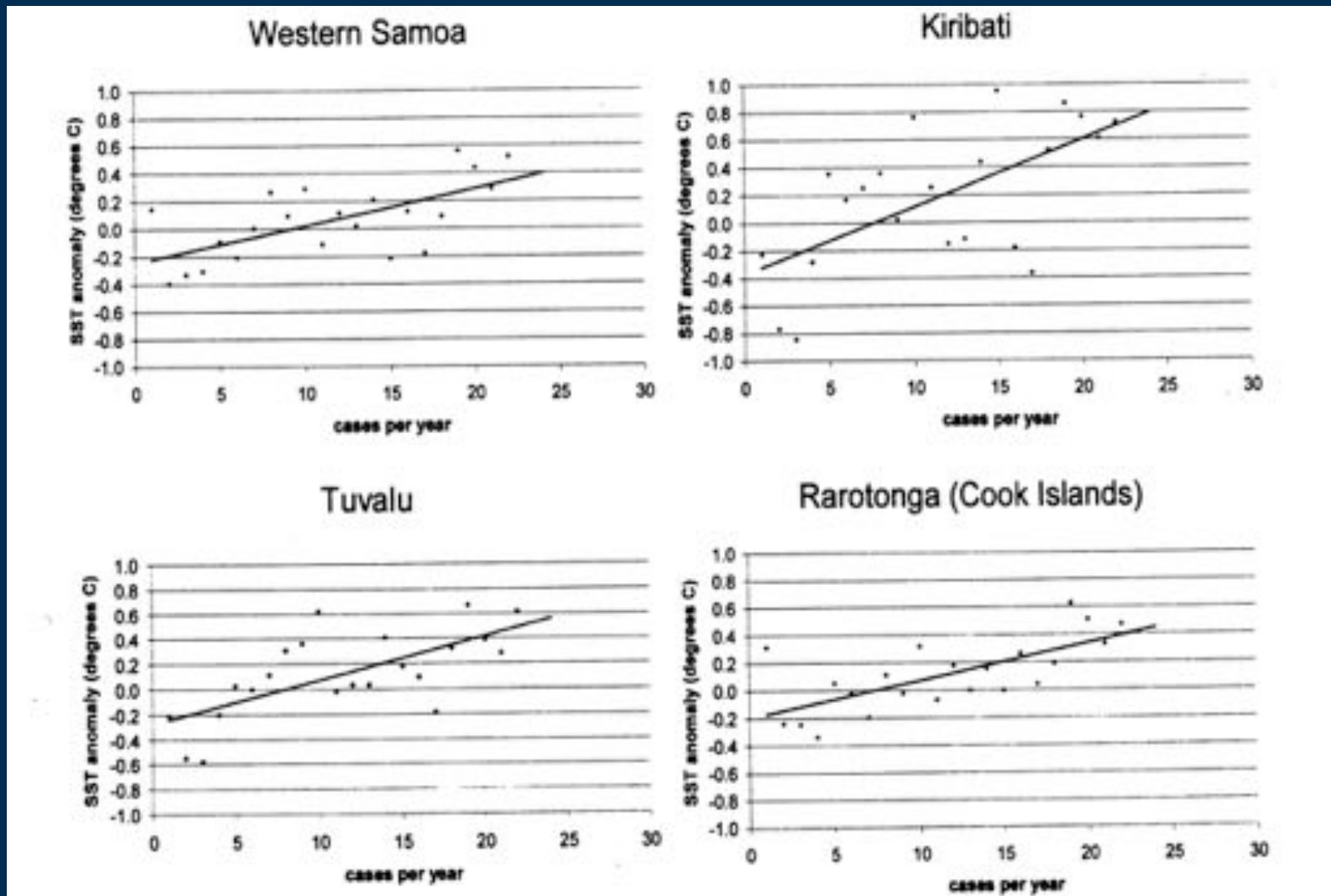
- variability in human symptoms
- variability in timing of outbreaks

Linkages to climate change and coral reef health



- **Ciguatera is regarded by some as a “sentinel” disease, one that can foreshadow the impact of environmental change in coral reef systems.**
- **Despite this, there are very few long-term datasets that include environmental parameters, *Gambierdiscus* abundance, and human poisoning incidence**

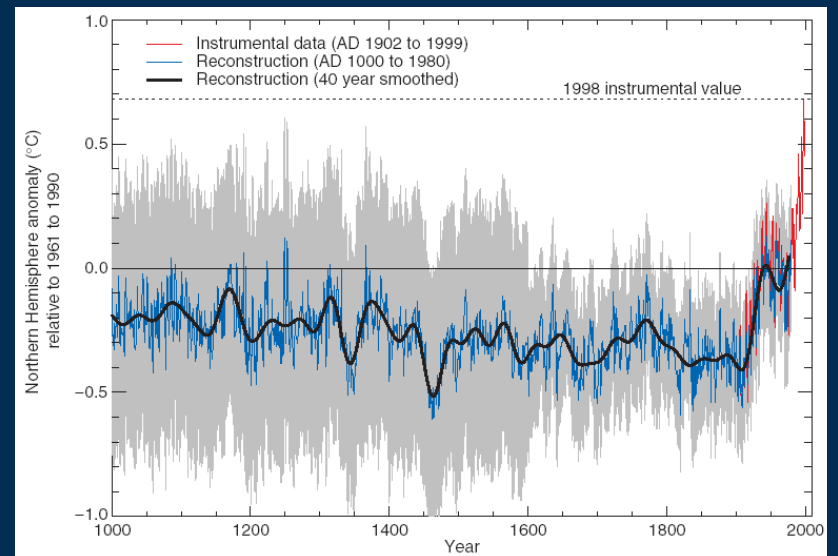
Trends in ciguatera incidence in the tropical Pacific



Relationship between local sea surface temperature anomalies and ciguatera poisonings (Hales et al., 1999)

What are the mechanisms underlying the link between increased sea temperatures and ciguatera disease?

- Stimulation of *Gambierdiscus* growth rates by higher temperatures
- Stimulation of toxin production in *Gambierdiscus* cells;
- Increase in abundance of *Gambierdiscus* due to coral bleaching/disease => opportunistic macroalgal growth



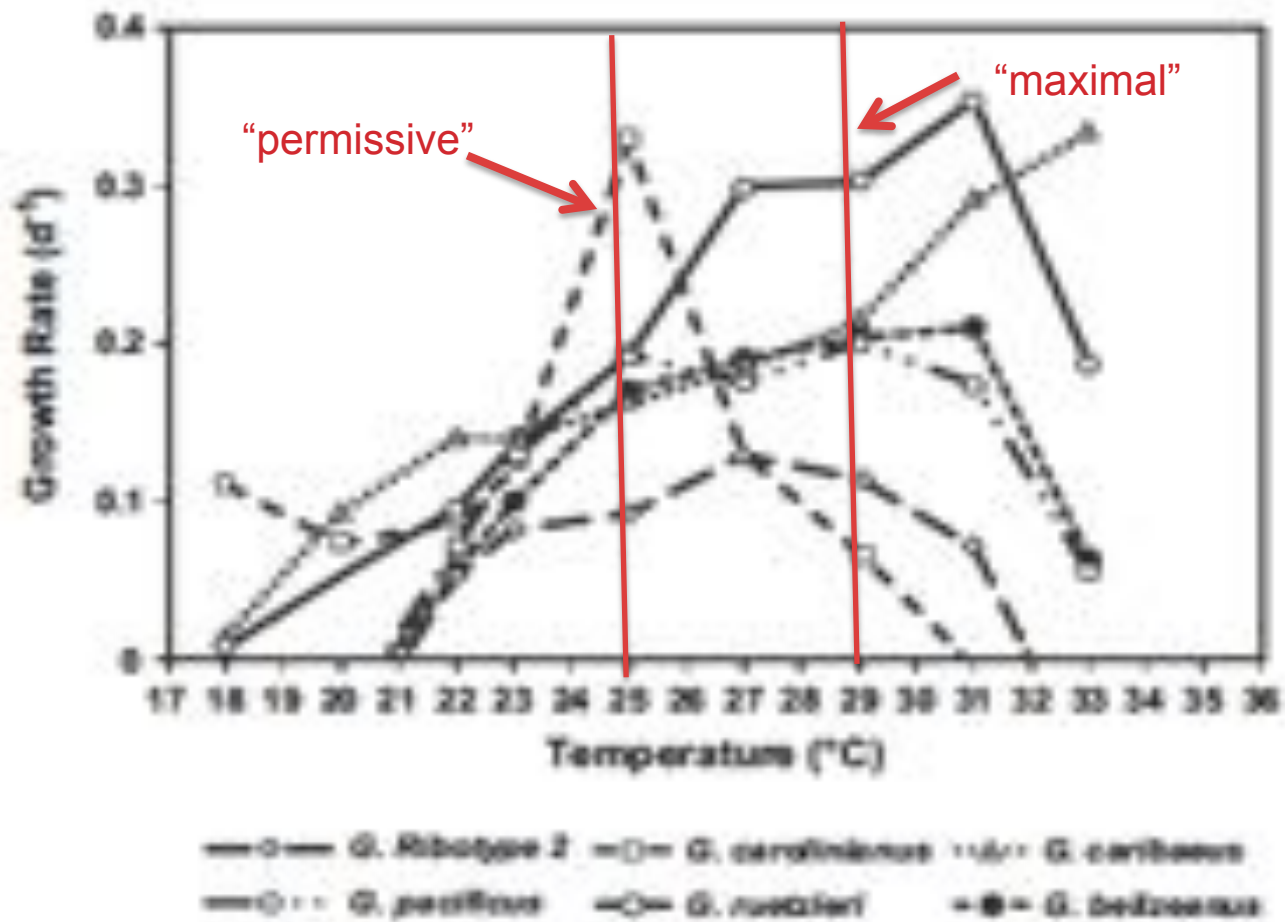


Fig. 5. Growth rates of six species of *Gambiendiscus* measured in the laboratory at temperatures from 18 °C to 33 °C.

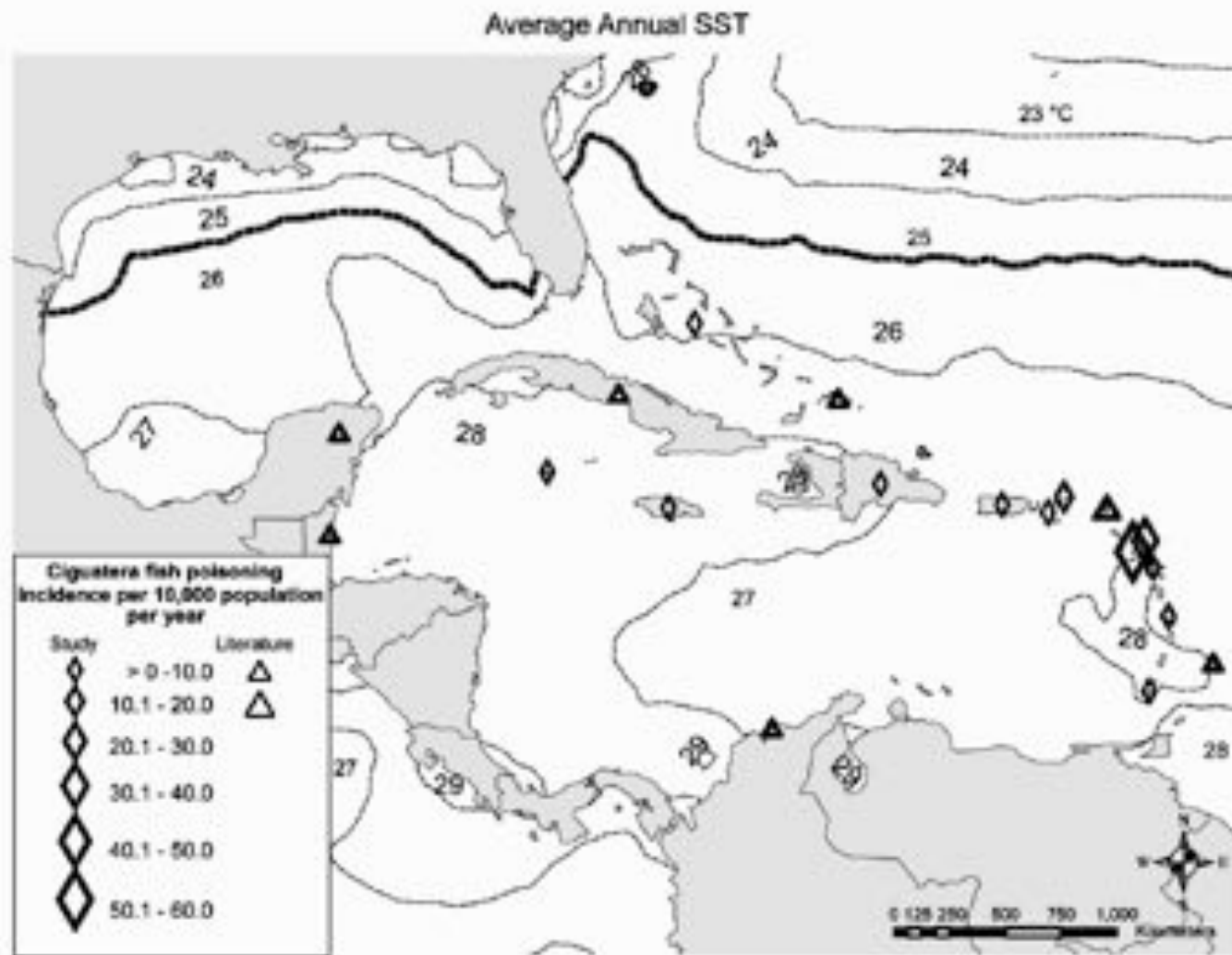
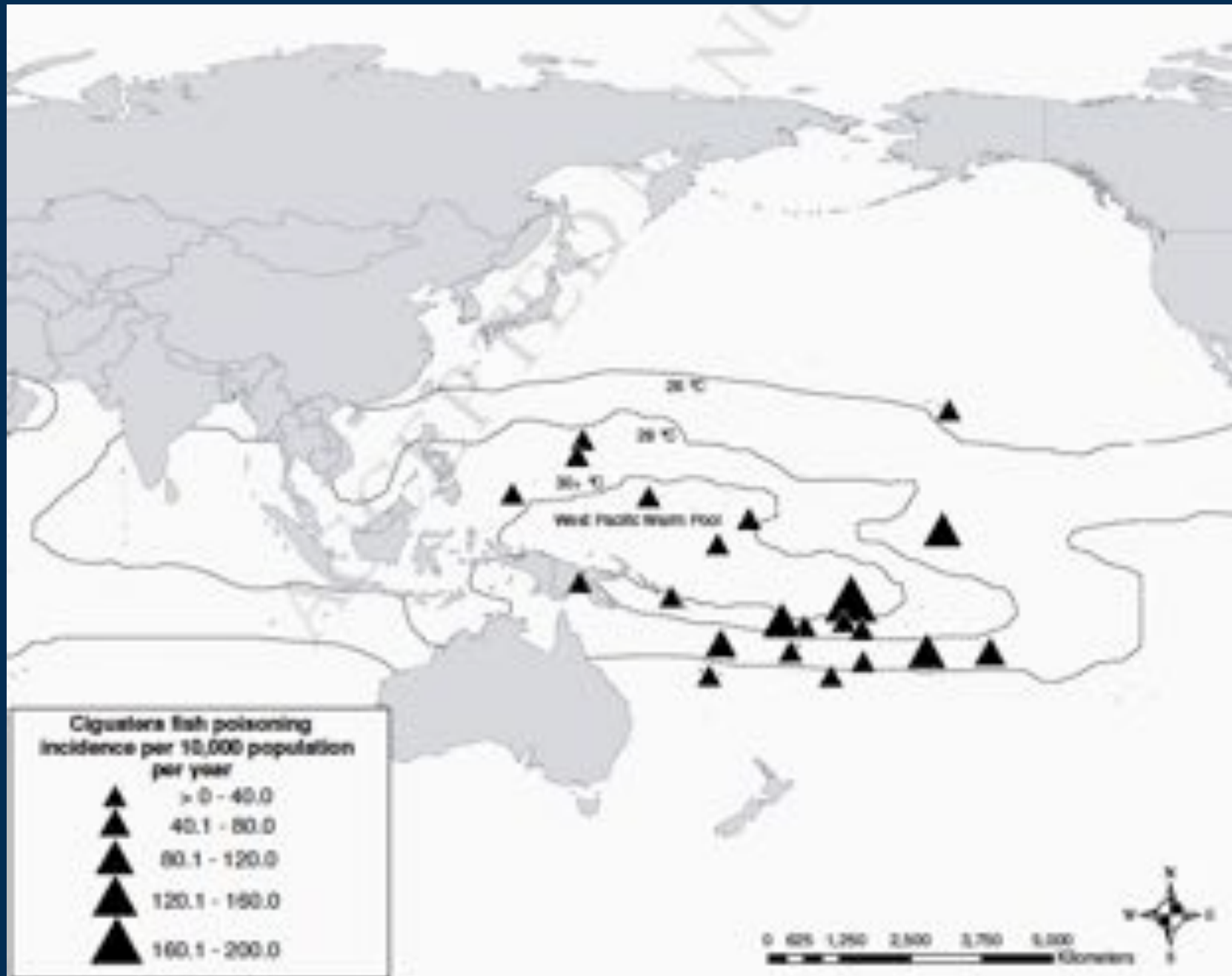
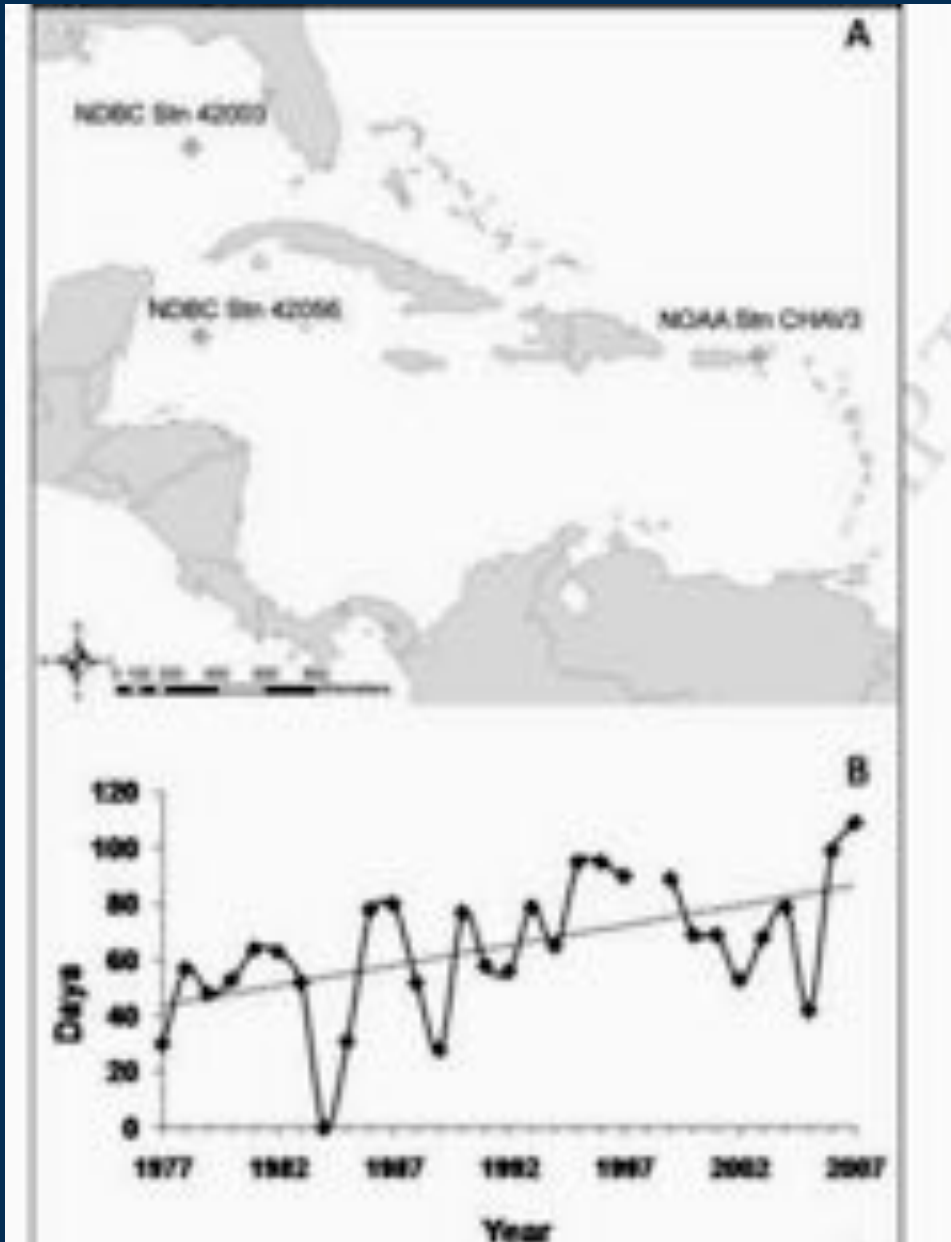


Fig. 2. Average ciguatera fish poisoning incidence rates per 10,000 population per year from 1996–2006 across the Caribbean, plotted with temperature contours (°C) from annual average sea surface temperatures from 2002–2007.



Source: Tester et al. 2010



The number of days with sea surface temperatures > 29 °C has nearly doubled, from 42 to 81, in the last three decades in the southern Gulf of Mexico

Source: Tester et al. 2010

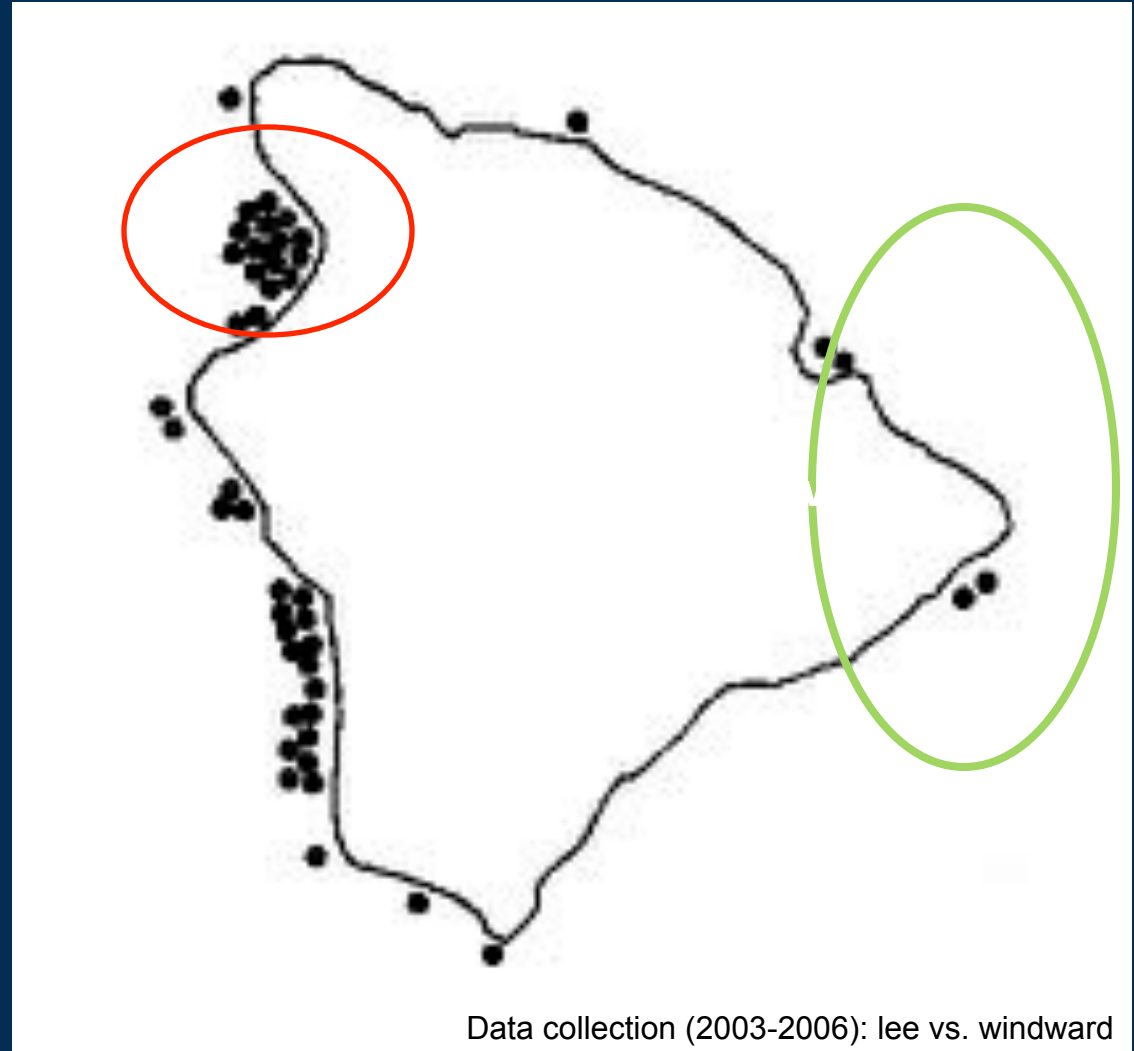
Case Study: modeling *Gambierdiscus* population dynamics in HI (Parsons et al., 2010)



http://www.hawaii.edu/pbcp/images/map/hawaii_map.gif

Purpose:

1. To determine if *Gambierdiscus* population dynamics can be modeled.
2. Ultimate goal – to understand *Gambierdiscus* population dynamics in order to predict/forecast ciguatera outbreaks.



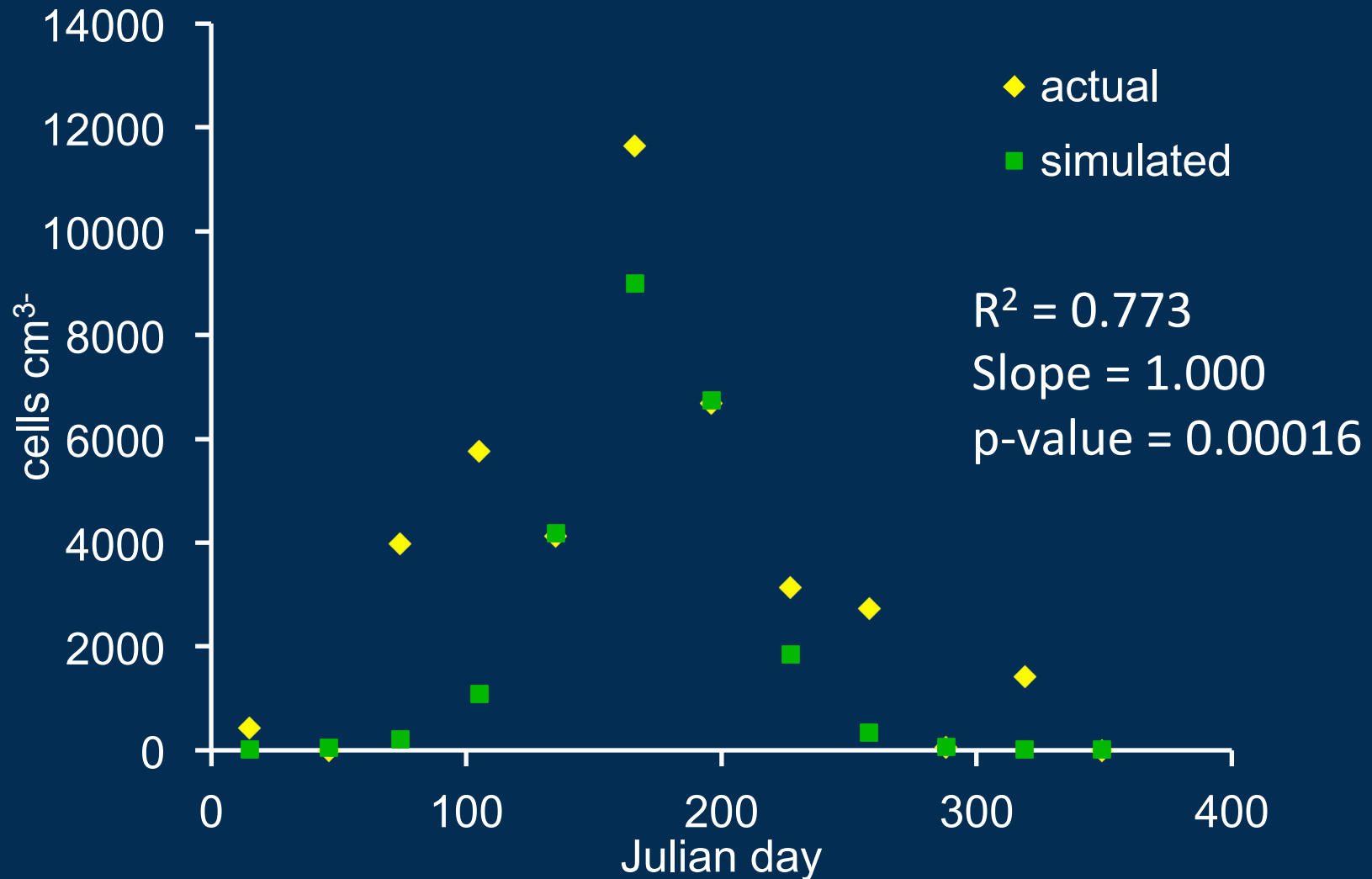
Data collection (2003-2006): lee vs. windward

Model Development

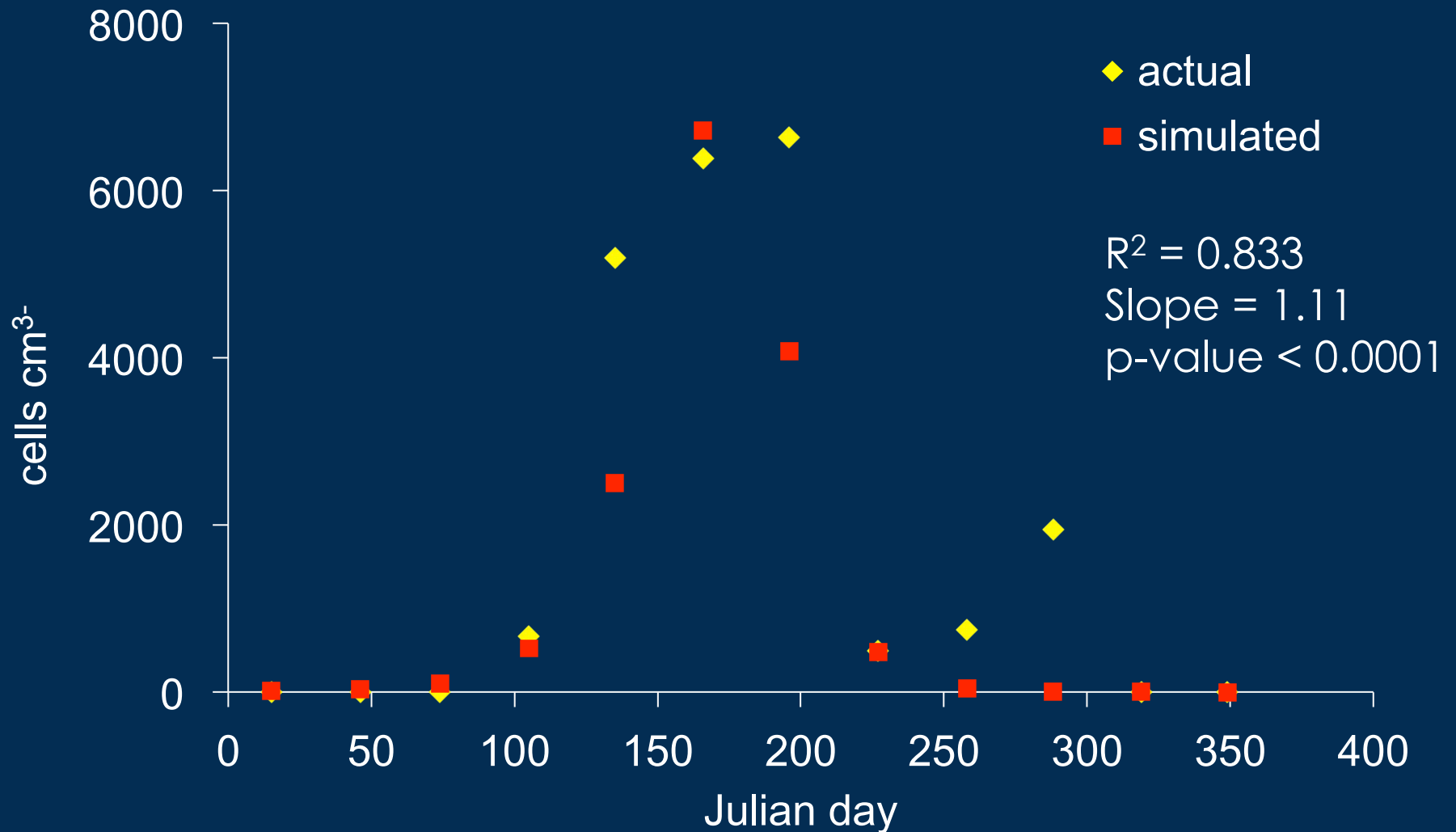
- One box model
 - *Gambierdiscus* growth dependent on T, N, P, light, and salinity
 - Export factor (grazing, disease, transport out of box)



Simulated versus actual *Gambierdiscus* abundance: windward

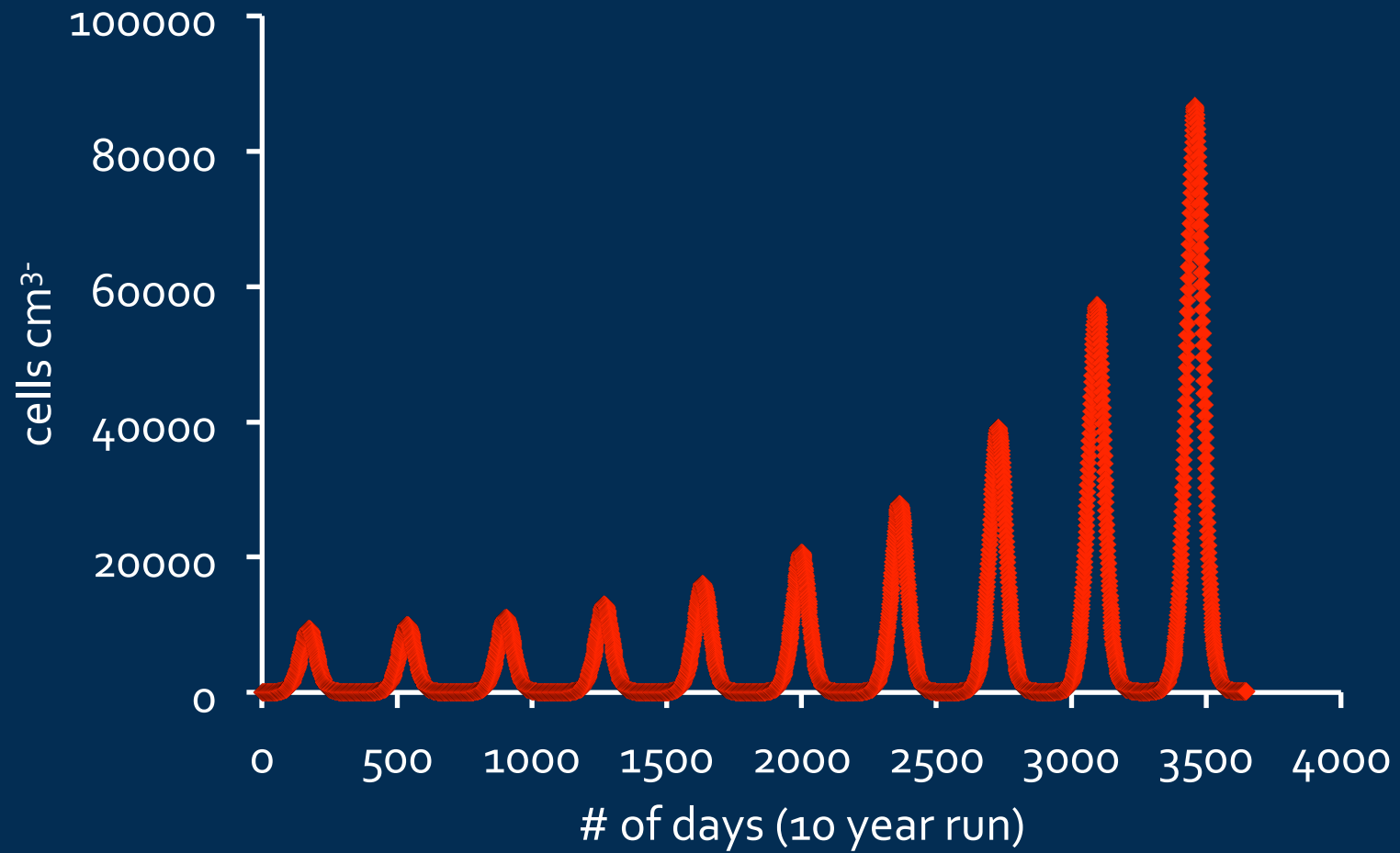


Model confirmation: simulated versus actual *Gambierdiscus* abundance: leeward



Warming scenario

Temperature increase of $+0.028^{\circ}\text{C}$ per year (Cheng et al. 2008)





CDC-funded study: *Gambierdiscus* in the USVI: Towards an Integrated Study of Ciguatera Fish Poisoning

Project is investigating relationships among environmental stresses to coral reefs, population dynamics of *Gambierdiscus*, and associated cases of ciguatera

- Time series data collected on:
 - *Gambierdiscus* abundance and population structure
 - Changes to reef health at these locations (e.g., extent of coral bleaching, coral disease)
 - Toxicity of dinoflagellates and fish
 - Incidence of human poisonings from ciguatera in hospitals and clinics
- Collaboration with UVI, USFDA, UFL

Home · How you get fish poisoning · Ciguatera and Climate · Project Overview · Clinical Symptoms · Partners and Resources · Your Stories · Contact Us

Welcome to Project Carib-CATCH

Project Carib-CATCH seeks to safeguard ocean reef health, local fishing economies, and the public health of people who live in the Caribbean and who eat reef fish.

The Public

Ciguatera is an important clinical and economic problem in parts of the world where reef fish are eaten.

Fishermen

Can we predict when or where fish are more likely to be toxic?

Patients

We are interested in talking with people suffering from ciguatera fish poisoning.

Physicians

For physicians unfamiliar with the syndrome of ciguatera fish poisoning, making the diagnosis may be difficult.

News

Thursday, May 27, 2009
'Reef or Madness': a documentary short about ciguatera

Friday, April 9, 2009
New York Times Magazine: A case study of a healthy 28-year-old man who contracted ciguatera

Friday, December 4, 2009
Slide Set - presented by Dr. Don Anderson, Woods Hole Oceanographic Institution, during press conference on December 4

Friday, December 4, 2009
Press Release - Kick off of ciguatera fish poisoning study

Seminars

Friday, June 18, 2009
Continuing Medical Education Symposium

Friday, June 18, 2009
Topics in General and Emergency Medicine: Ciguatera Fish Poisoning and Procedural Sedation Updates

Project CaribCATCH seeks to safeguard coral reef health, local fishing economies, and the public health of people who live in the Caribbean and who eat reef fish. Healthy ocean reefs are a vital element of life on St. Thomas Island in the U.S. Virgin Islands. Fishermen depend on fish harvests to sustain their livelihoods, and citizens depend on the catches to sustain their health. Scientists and physicians from five major institutions, led by the University of Florida's Emerging Pathogens Institute (EPI) and including the University of the Virgin Islands, the Woods Hole Oceanographic Institution, the University of Maryland, Florida State University, and the U.S. Food and Drug Administration - working together with the Schneider Regional Medical Center and the St. Thomas Fishermen's Association - seek to keep the coral reefs and the food sources they yield safe for the U.S. Virgin Islands.

This project focuses on the study and prevention of the human poisoning syndrome known as ciguatera fish poisoning. Ciguatera is caused by naturally occurring toxins known as ciguatoxins that are produced by certain microscopic algae found on coral reefs. These microalgae are inadvertently consumed by reef fishes and subsequently accumulated in the coral reef food chain. Humans can be poisoned after consuming toxic fish. Ciguatera poisonings occur all over tropical areas of the world, and although this phenomenon has been well studied in the Pacific Ocean, data regarding ciguatera in the Caribbean are lacking.

CaribCATCH is designed to investigate the environmental factors that allow ciguatoxin-producing algae to live in reef communities, and to monitor instances of ciguatera poisonings in people on St. Thomas. We intend to use what we learn to help safeguard the Caribbean's reefs and fresh-caught fish.

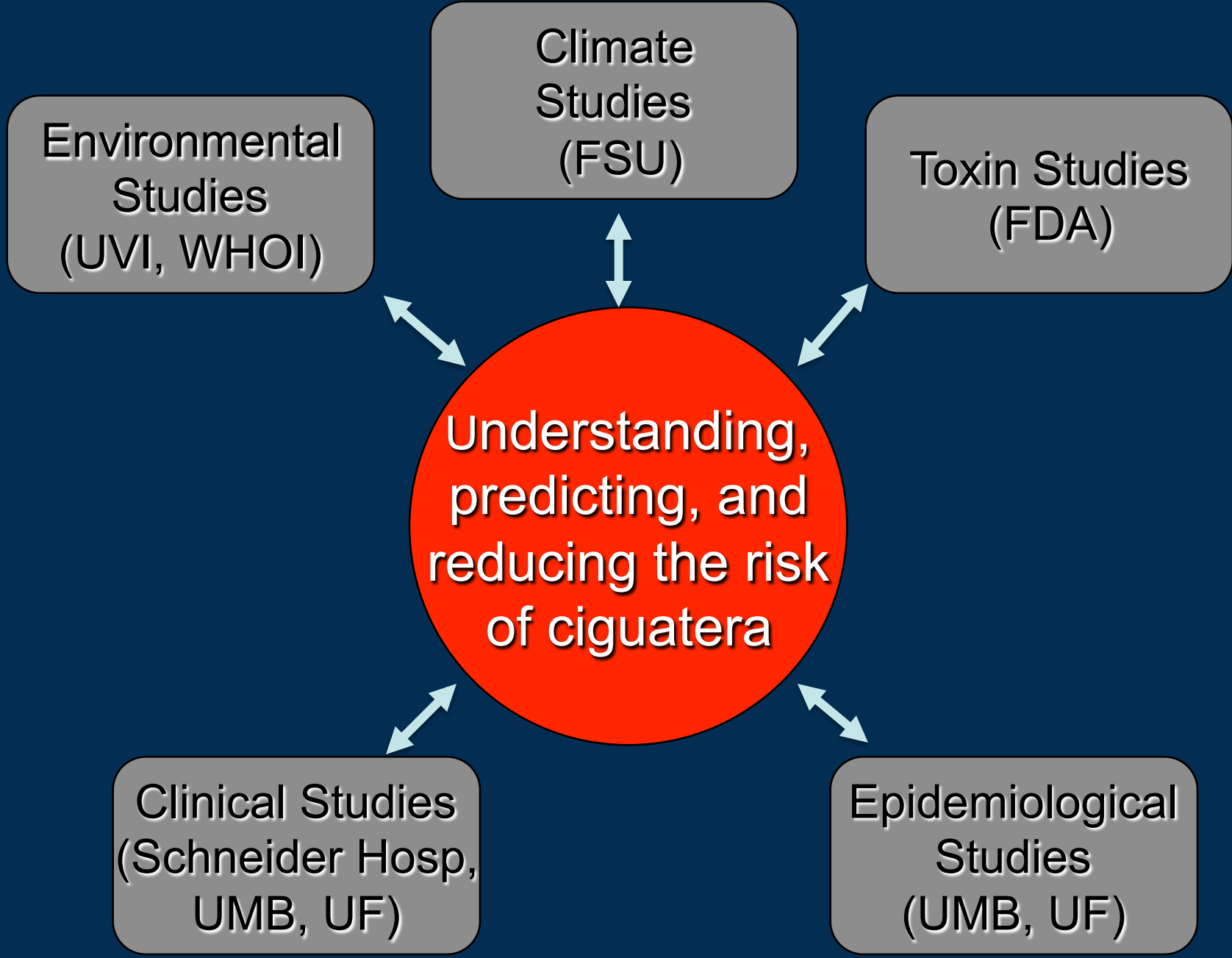
How you get fish poisoning · Ciguatera and Climate · Project Overview · Clinical Symptoms · Partners and Resources · Your Stories · Contact Us

Emerging Pathogens Institute, UF
Woods Hole Oceanographic Institution
University of the Virgin Islands
University of Maryland School of Medicine
Center for Ocean-Atmospheric Prediction Studies, FSU
Gulf Coast Seafood Laboratory, U.S. FDA

Contact: Bealmar
Phone: 352-771-7126
Ciguatera and Poisoned Use
S&N Privacy
©2009 University of Florida

Search Go

UF UNIVERSITY of FLORIDA



Funding source: Centers for Disease Control and Prevention

Coral reef health

Gambierdiscus abundance and toxicity

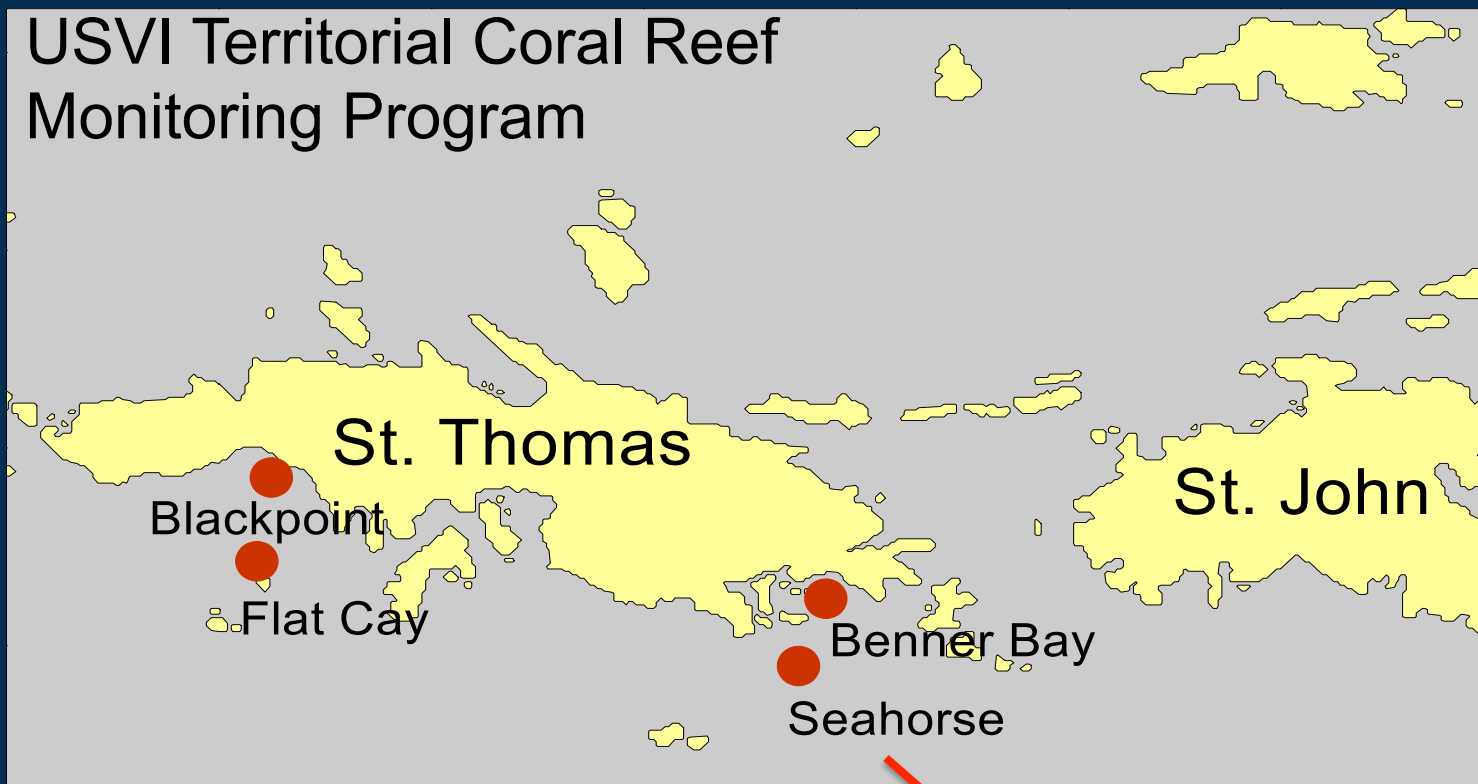
Climate change
Disease
Storms
Pollution
Other stresses

Monitoring programs
Time series

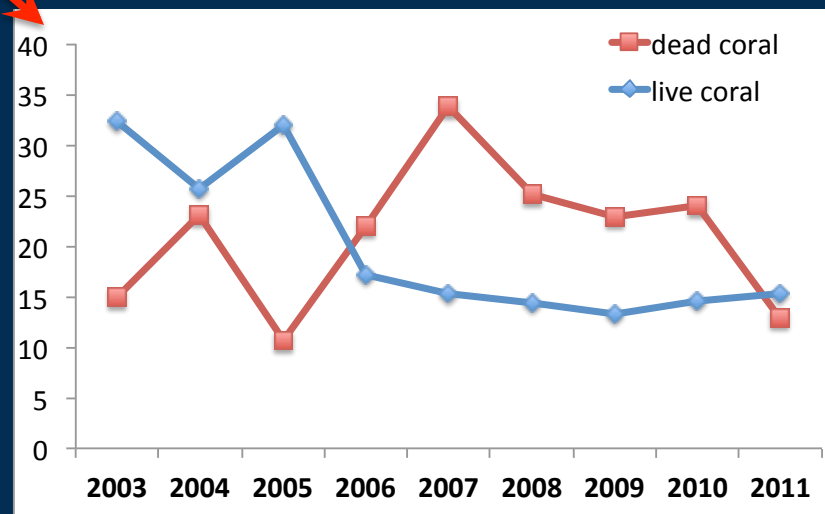
Fish toxicity

Patterns of CFP illness

USVI Territorial Coral Reef Monitoring Program



Ciguatera monitoring added to four locations surveyed by the USVI Territorial Coral Reef Monitoring program: augmenting long-term datasets on reef health, oceanographic properties, and anthropogenic impacts



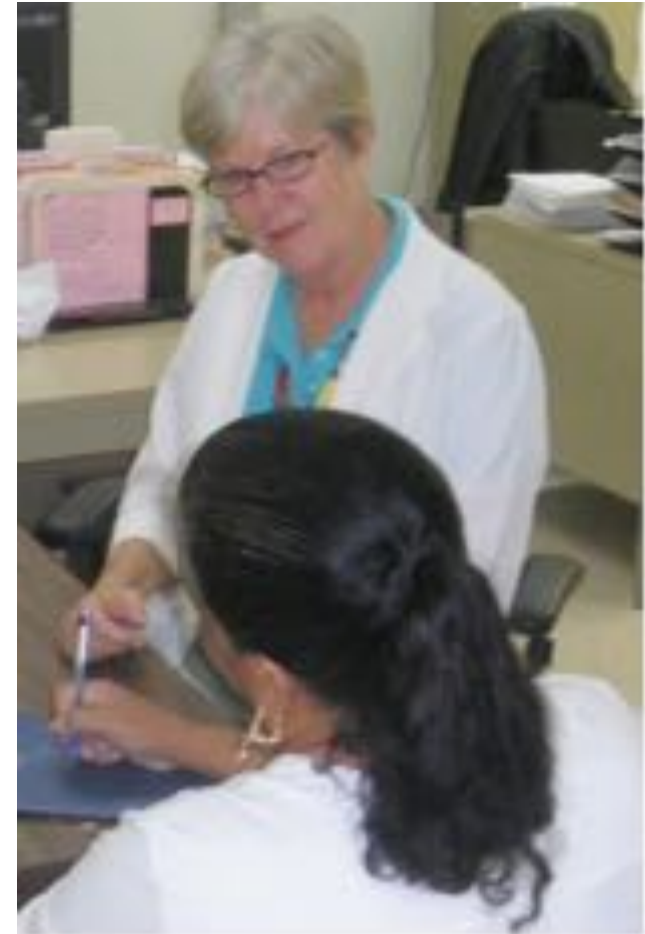
Epidemiological studies

- Medical records review performed at the Roy Schneider Hospital emergency room department to collect data on clinical cases of ciguatera (1995-2011)
- Household surveys collecting estimates of population-based incidence to assess the relationship between numbers of patients who present for medical attention, and number of potential cases in the community, and for identification of risk factors
- Retrospective analysis will develop accurate estimates of the true incidence of ciguatera, for both current and prior years.

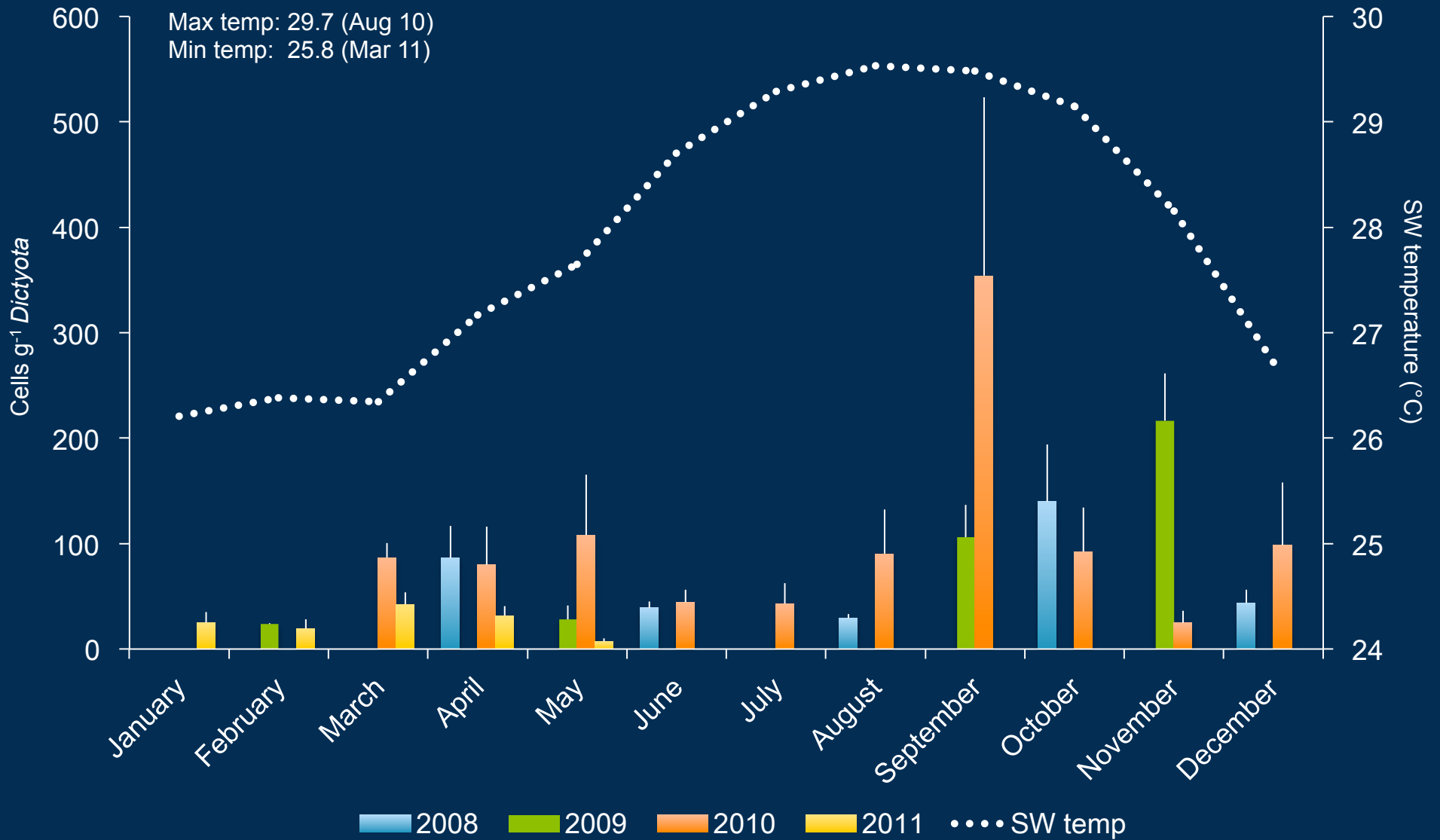


Clinical research in St. Thomas

- Enrolling patients with ciguatera from the emergency room and the community
- Collecting data on symptoms and their severity, sensory perception, cognition, demographics, occupation, fish consumption, medical history, and drug/alcohol use
- Follow up at 3 and 12 months to evaluate chronicity

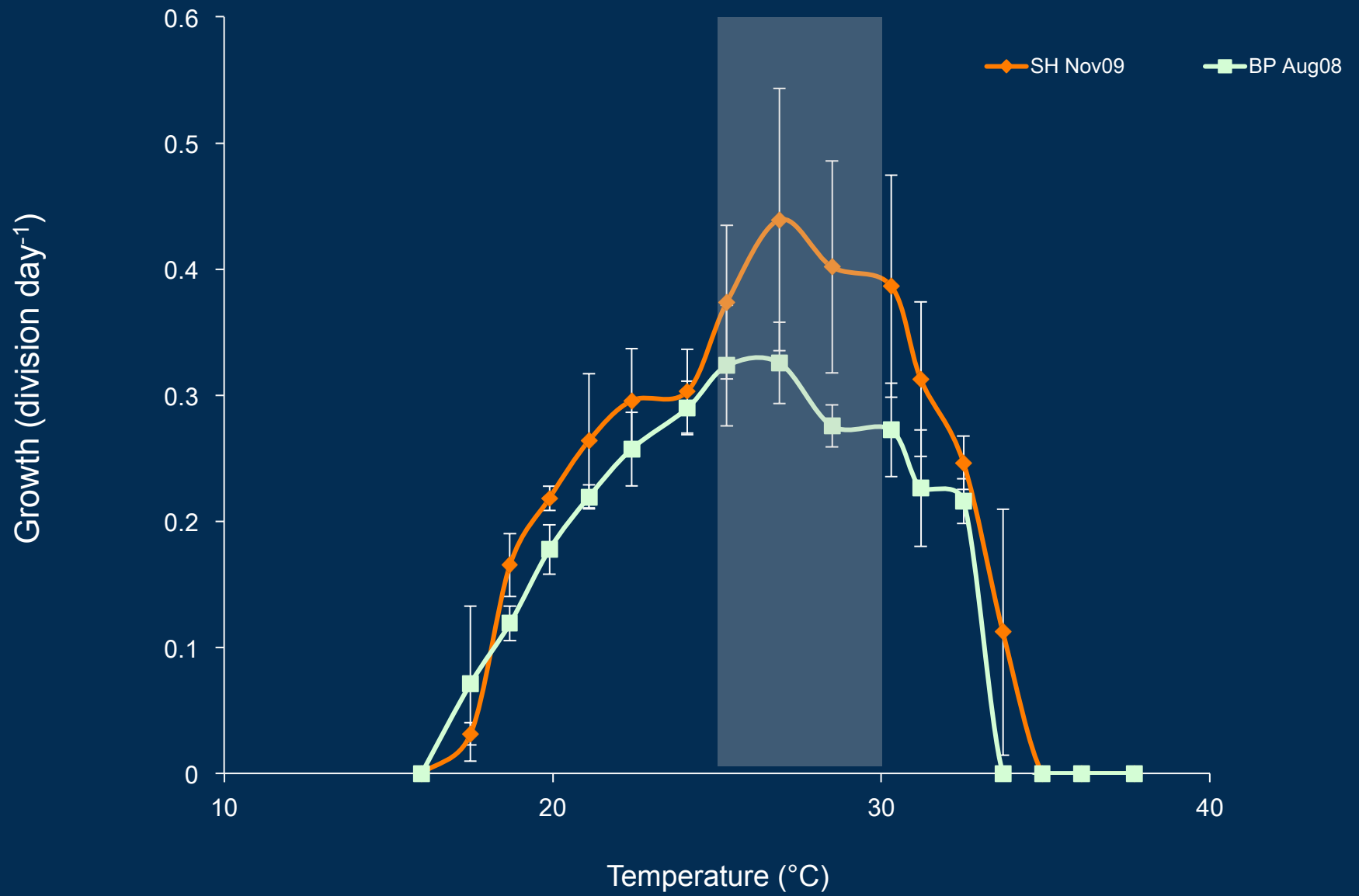


Gambierdiscus spp. abundance, Seahorse

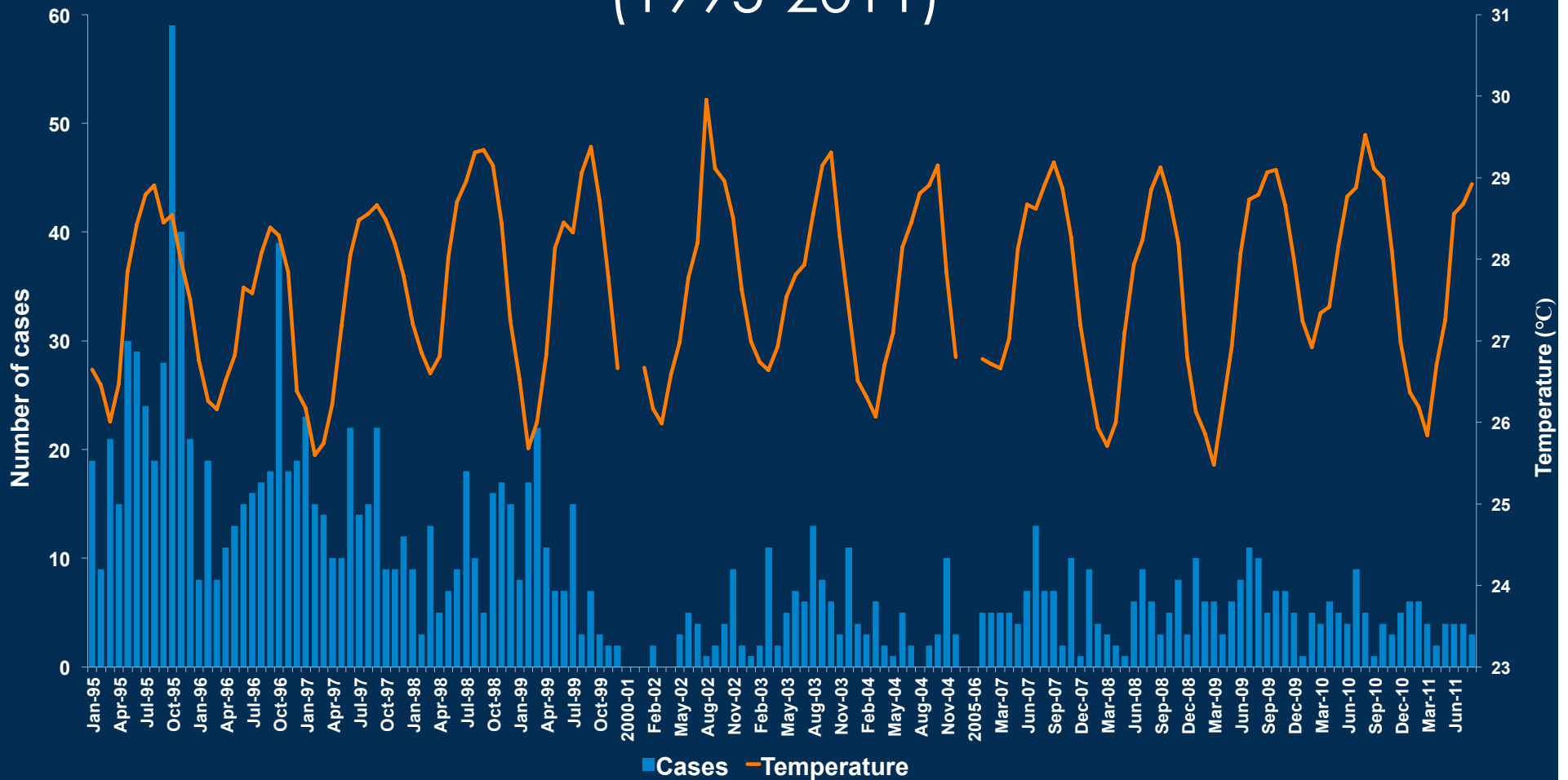


Gambierdiscus spp. abundance positively correlated with SW temperature

G. caribaeus

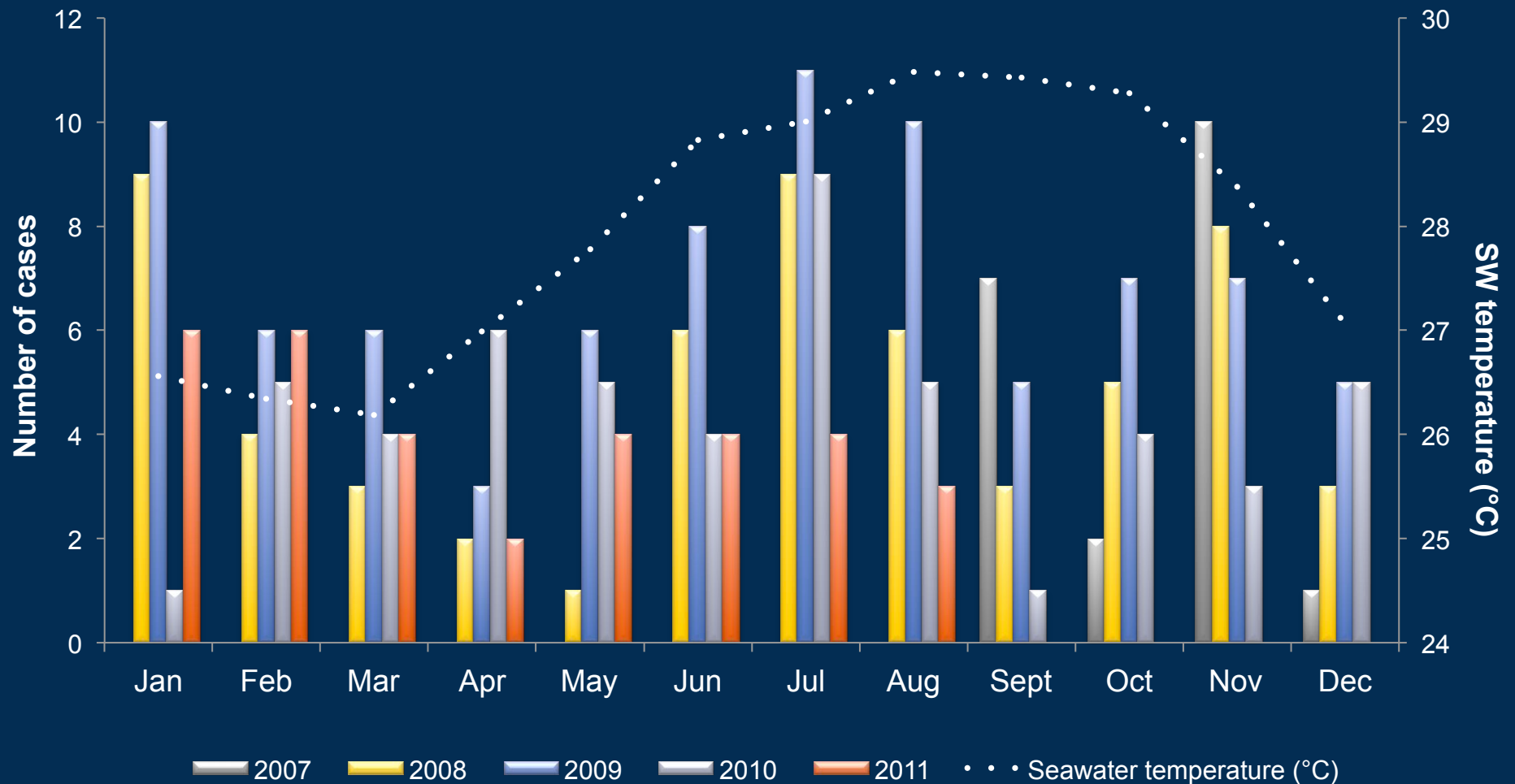


Cases of CFP and mean SST in St. Thomas (1995-2011)



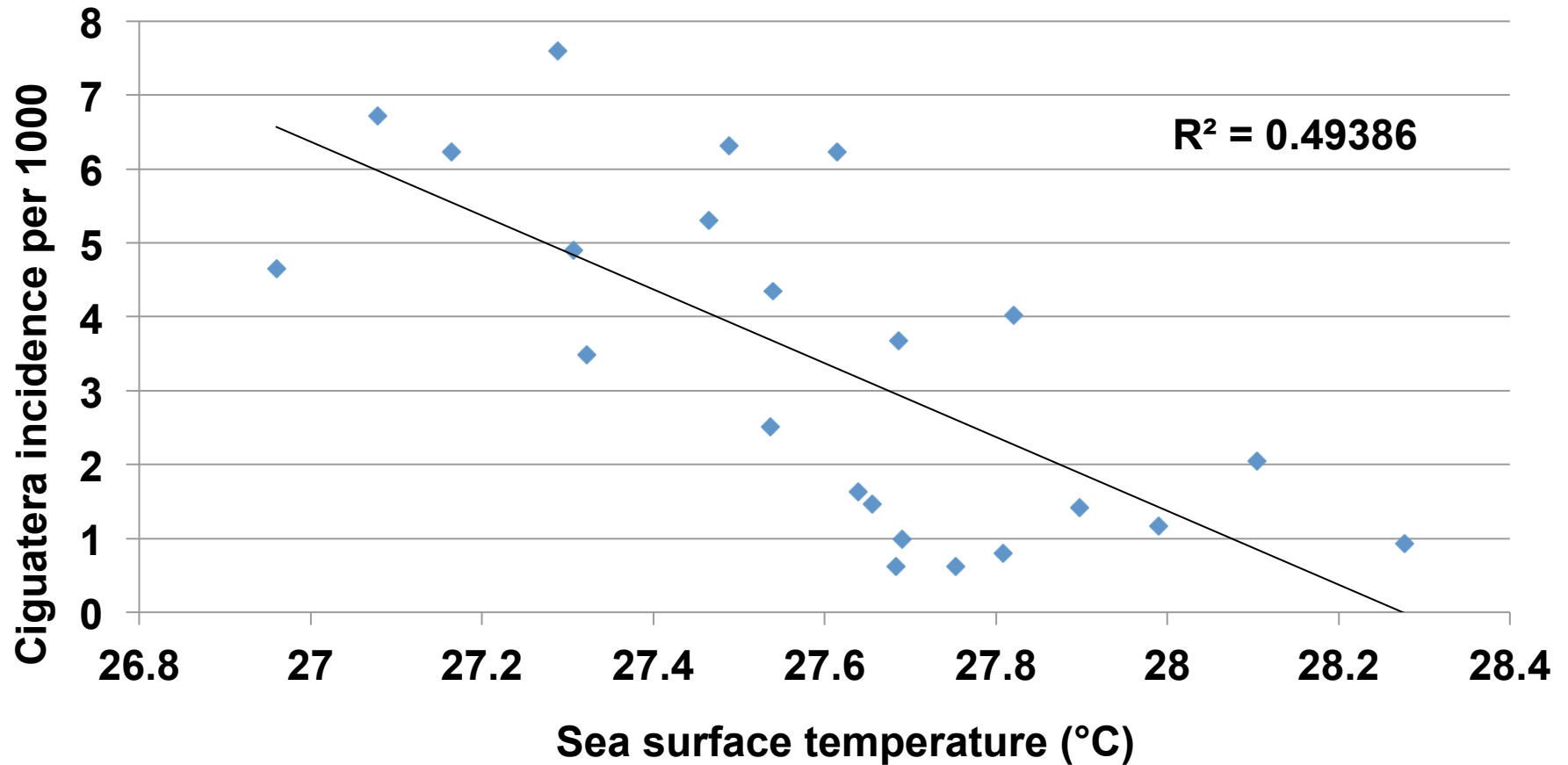
Medical record review: Total of 1335 cases between 1995 and 2010 (gaps from 2000-01 and 2005-06); highest number of ciguatera cases observed in 1995-1996.

Cases of ciguatera fish poisoning and mean seawater temperature (2007-2011)



- Number of ciguatera cases presented to the ER were highest in July 2009.
- No seasonal trend evident during study period; other factors (e.g., “banquet effect”) may affect prevalence of ciguatera cases.

Correlation between annual average SST and incidence of ciguatera ER visits with a one year lag, 1971-2011*



*Data from 1971-1979, 1995-1999, 2002-2005, 2007-2011

Ciguatera incidence estimates among adults in St. Thomas (per 1000 population)

Data source	1980	2011
Emergency room visits*	18	6
Current survey vs. Morris et al. 1982 (age adjusted to nearest Census)	14	12
Current survey vs. Morris et al. 1982 (age adjusted to 1980 survey)	14	8
Current survey vs. McMillan et al. 1980	22% of households	11% of households

*Averaged over 3 years, calculated by dividing the incidence of ER visits by the proportion of survey participants who visited the ER for their most recent ciguatera illness. Assumes 50% of ill individuals visited ER in 1971-71 and 30% visited ER in 2010-11 based on respective surveys.

FLORIDA AGRICULTURAL UNIVERSITY | FLORIDA GULF COAST UNIVERSITY

SEARCH | HOME | ABOUT | CONTACT

CiguaHAB

A regional study of Ciguatera in the Greater Caribbean



Quickstart

Home

About CiguaHAB

Ciguatera Fish Poisoning

Research Team

Research Activities

Funding / Sponsors

Applications for Management

Student Involvement

Study Sites

Photos

External Links

Welcome

What is CiguaHAB?

An international team of researchers headed by Michael Parsons of Florida Gulf Coast University aims to better understand the factors that influence the occurrence of Ciguatera Fish Poisoning (CFP), the most common form of phytoplankton-borne seafood poisoning in the world. The source of these toxins is the berthing dinoflagellate, *Gambierdiscus*, which commonly associates with macroalgae (seaweeds). Herbivores (fish and invertebrates) feed upon the macroalgae, thereby ingesting the *Gambierdiscus* cells and their toxins. *Gambierdiscus* fish consume the herbivores, causing the toxins to move into the foodweb. People can be exposed to the toxins by consuming these herbivores and carnivores, leading to CFP. CiguaHAB is an anticipated 3 year project funded by NOAA's Ecology and Oceanography of Harmful Algal Blooms (EOHAB) Program designed to investigate the conditions that lead to higher toxin production in order to better predict CFP outbreaks.

CiguaHAB will produce a comprehensive understanding of the diversity, phenology and ecology of *Gambierdiscus*

Future work – CiguaHAB (funded by NOAA CSCOR) – 2011-2015

- Study will characterize *Gambierdiscus* population diversity and connectivity in the greater Caribbean
- Determine effects of environmental factors on the growth and toxicity of *Gambierdiscus*.
- Investigate *Gambierdiscus* population dynamics and the environmental conditions that contribute to blooms.
- Investigate the fate of ciguatera precursors, toxins and metabolites in the coral reef food web.
- Model the population dynamics and toxin production of *Gambierdiscus* under different environmental forcings, including climate change.
- Communicate project results to stakeholders and discuss applications to resource management
- **No epidemiological component**

Summary

- Ciguatera is a serious threat to human health in many tropical and sub-tropical countries. In many areas, it causes underutilization of much-needed fisheries resources.
- There is a positive correlation between ciguatera incidence and seawater temperature in some regions. There are multiple reasons to expect higher ciguatera incidence as temperatures rise.
- In other areas (e.g., USVI) a negative correlation is emerging between temperature and ciguatera poisoning incidence. This may reflect multiple factors (e.g., education, over fishing, excessive temperatures for *Gambierdiscus* growth, etc.) and argues that simplistic climate forecasts based on temperature alone can be misleading.
- The establishment and maintenance of long term datasets are essential for detecting trends in *Gambierdiscus* populations and ciguatera cases, and unraveling the complex linkages between ciguatera fish poisoning, reef health, and climate change.

Acknowledgements

Centers for Disease Control and Prevention Grant
1U01EH000421-01

National Oceanic and Atmospheric Administration, National
Ocean Service (Cooperative Agreement NA11NOS4780060)

National Science Foundation Small Grant for Exploratory
Research OCE-0743993

Woods Hole Oceanographic Institution, Ocean Life Institute,
Tropical Research Initiative Grant

