



# **Ciguatera and Climate Change: New Evidence for a Blunting of Effect by Population Changes**

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# Study Partners

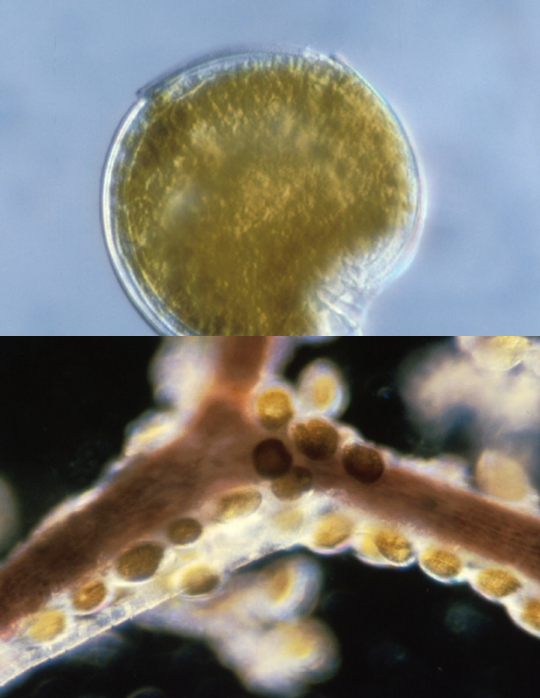
**Centers for Disease Control and Prevention {U01} :  
Impact of climate on dinoflagellates and ciguatera fish poisoning**

- **Emerging Pathogens Institute,**
- **J. Glenn Morris**
  - **Elizabeth Radke**
- **Woods Hole Oceanographic Institution**
  - **Don Anderson**
  - **Mindy Richlen**
  - **Katie Pitz**
- **University of the Virgin Islands**
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  - **Vasu Misra**
- **Gulf Coast Seafood Laboratory, Food and Drug Administration**
  - **Alison Robertson**
  - **Robert Dickey**
  - **Steven Plakas**
- **St. Thomas Fishermen's Association**
  - **David Olsen**
- **On island Study Coordinator**
  - **Margaret Abbott**



## Ciguatera

- Results from eating tropical reef fish that carry “ciguatoxin”
- Causes clinical syndrome marked initially by GI symptoms, followed by neurologic and cardiac symptoms



gambiertoxins  
(precursor compounds)

herbivorous fish



carnivorous fish



Ciguateroxins, human  
illness

- **Most frequently reported marine toxin disease in the world, affecting > 50,000 people per year**
- **Major constraint on fisheries in many regions (tourism, recreational economies)**

# Ciguatera Fish Poisoning - Fish

- Fish are unaffected by toxin
- Fish look and taste normal
- Toxin is not affected by cooking
- Internal organs more likely to be toxic
- Larger fish more likely to be toxic
  - St. Thomas study: toxicity increased for larger fish in any given species
- May be geographic localization of toxicity
- *No good method currently available for identifying toxic fish*





# Ciguatera: Incidence

- **U.S. Virgin Islands:**  
**7.3 cases/1,000 population/year\***
- **Miami:**  
**0.05 cases/1,000 population/year**
- **South Pacific:**  
**0.97-2.19 cases/1,000 population/year**
- **Reunion Island:**  
**0.08 cases/1,000 population/year**

\*population-based survey



**Environmental  
Studies  
(UVI, WHOI)**

**Climate  
Studies  
(FSU)**

**Toxin Studies  
(FDA)**

**Understanding  
*Ciguatera*  
And how to  
Prevent it**

**Clinical Studies  
(Schneider Hosp,  
UMB, UF)**

**Epidemiologic  
Studies  
(UMB, UF)**



# Changing Caribbean Climate and Threats to Reefs

OPEN ACCESS Freely available online

PLoS one

## Caribbean Corals in Crisis: Record Thermal Stress, Bleaching, and Mortality in 2005

C. Mark Eakin<sup>1\*</sup>, Jessica A. Morgan<sup>2</sup>, Scott F. Heron<sup>3,4</sup>, Tyler B. Smith<sup>5</sup>, Gang Liu<sup>2</sup>, Lorenzo Alvarez-Filip<sup>6,7</sup>, Bart Baca<sup>8</sup>, Erich Bartels<sup>9</sup>, Carolina Bastidas<sup>10</sup>, Claude Bouchon<sup>11</sup>, Marilyn Brandt<sup>3</sup>, Andrew W. Bruckner<sup>12</sup>, Lucy Bunkley-Williams<sup>13</sup>, Andrew Cameron<sup>14</sup>, Billy D. Causey<sup>15</sup>, Mark Chiappone<sup>16</sup>, Tyler R. L. Christensen<sup>2</sup>, M. James C. Crabbe<sup>17</sup>, Owen Day<sup>18</sup>, Elena de la Guardia<sup>19</sup>, Guillermo Díaz-Pulido<sup>20,21</sup>, Daniel DiResta<sup>22</sup>, Diego L. Gil-Agudelo<sup>23</sup>, David S. Gilliam<sup>24</sup>, Robert N. Ginsburg<sup>25</sup>, Shannon Gore<sup>26</sup>, Héctor M. Guzmán<sup>27</sup>, James C. Hendee<sup>28</sup>, Edwin A. Hernández-Delgado<sup>29</sup>, Ellen Husain<sup>30</sup>, Christopher F. G. Jeffrey<sup>31</sup>, Ross J. Jones<sup>32</sup>, Eric Jordán-Dahlgren<sup>33</sup>, Les S. Kaufman<sup>34</sup>, David I. Kline<sup>35,37</sup>, Philip A. Kramer<sup>36</sup>, Judith C. Lang<sup>37</sup>, Diego Lirman<sup>25</sup>, Jennie Mallela<sup>38,39</sup>, Carrie Manfrino<sup>40</sup>, Jean-Philippe Maréchal<sup>41</sup>, Ken Marks<sup>37</sup>, Jennifer Mihaly<sup>42</sup>, W. Jeff Miller<sup>43</sup>, Erich M. Mueller<sup>44</sup>, Erinn M. Muller<sup>45</sup>, Carlos A. Orozco Toro<sup>46</sup>, Hazel A. Oxenford<sup>47</sup>, Daniel Ponce-Taylor<sup>16</sup>, Norman Quinn<sup>48</sup>, Kim B. Ritchie<sup>9</sup>, Sebastián Rodríguez<sup>10</sup>, Alberto Rodríguez Ramírez<sup>23</sup>, Sandra Romano<sup>5</sup>, Jameal F. Samhoury<sup>49</sup>, Juan A. Sánchez<sup>50</sup>, George P. Schmahl<sup>51</sup>, Burton V. Shank<sup>52</sup>, William J. Skirving<sup>3</sup>, Sascha C. C. Steiner<sup>53</sup>, Estrella Villamizar<sup>54</sup>, Sheila M. Walsh<sup>55</sup>, Cory Walter<sup>9</sup>, Ernesto Weil<sup>13</sup>, Ernest H. Williams<sup>13</sup>, Kimberly Woody Roberson<sup>31</sup>, Yusri Yusuf<sup>56</sup>

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## LETTERS

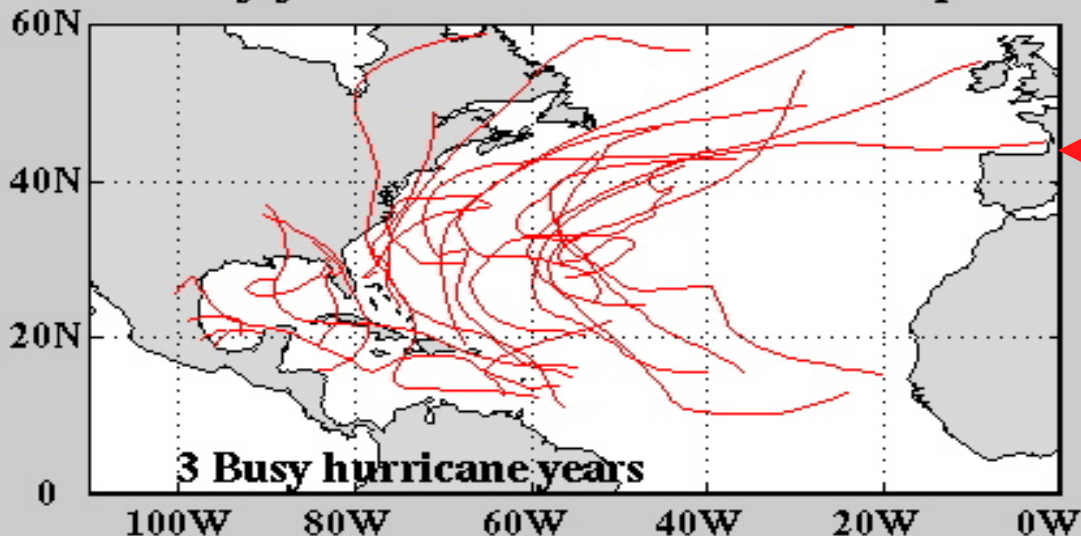
### Large contribution of sea surface warming to recent increase in Atlantic hurricane activity

Mark A. Saunders<sup>1</sup> & Adam S. Lea<sup>1</sup>



# 54 Years of Atlantic Hurricanes (1950-2003)

23 Busy-year hurricanes for small warm pools



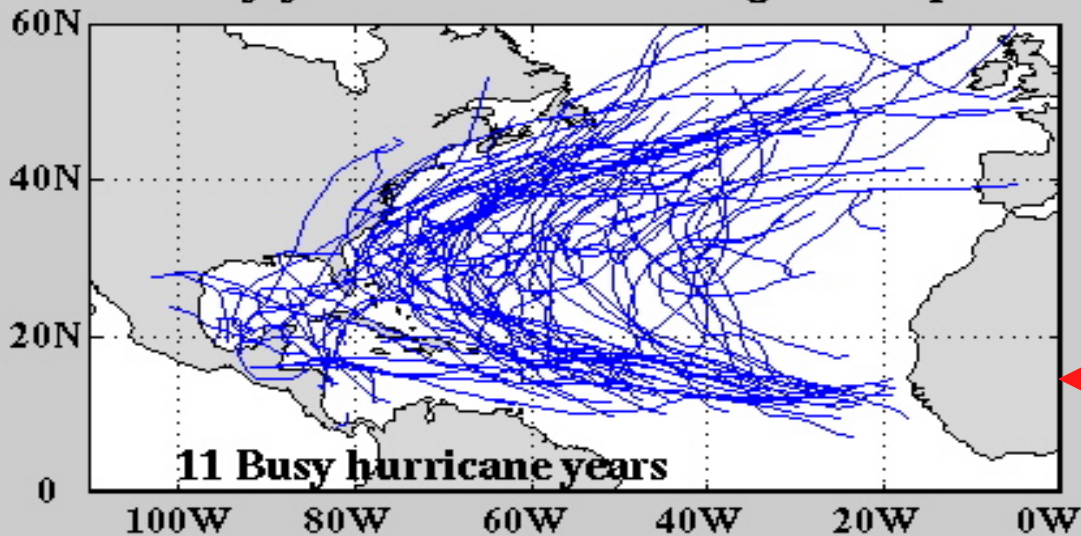
*Of the 18 years with small warm pools*

3 busy years, 23 storms

*Busy hurricane years*

= years for which the number of late-season hurricanes fall within the top tercile of all years

82 Busy-year hurricanes for large warm pools

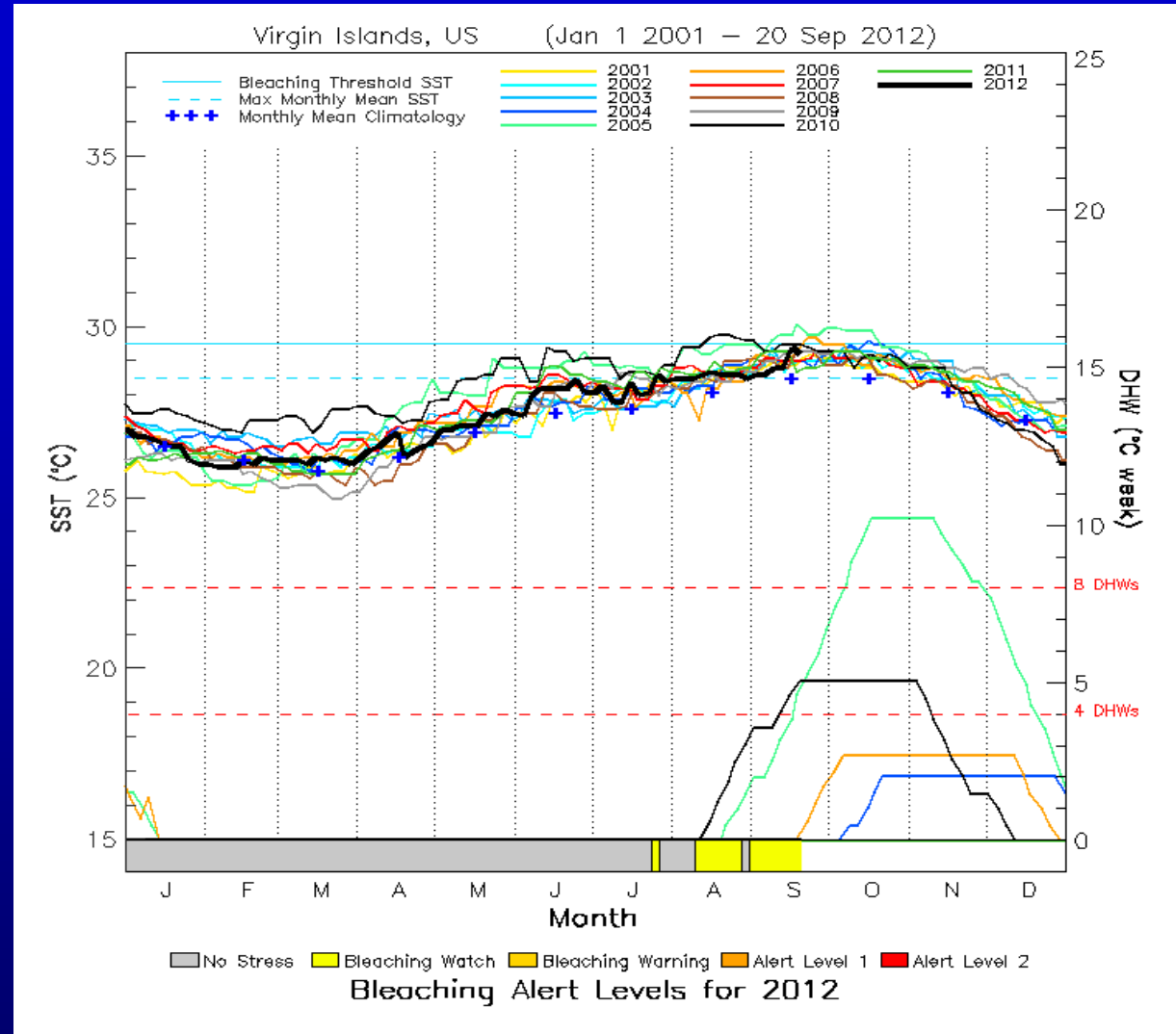


*Of the 18 years with large warm pools*

11 busy years, 82 storms

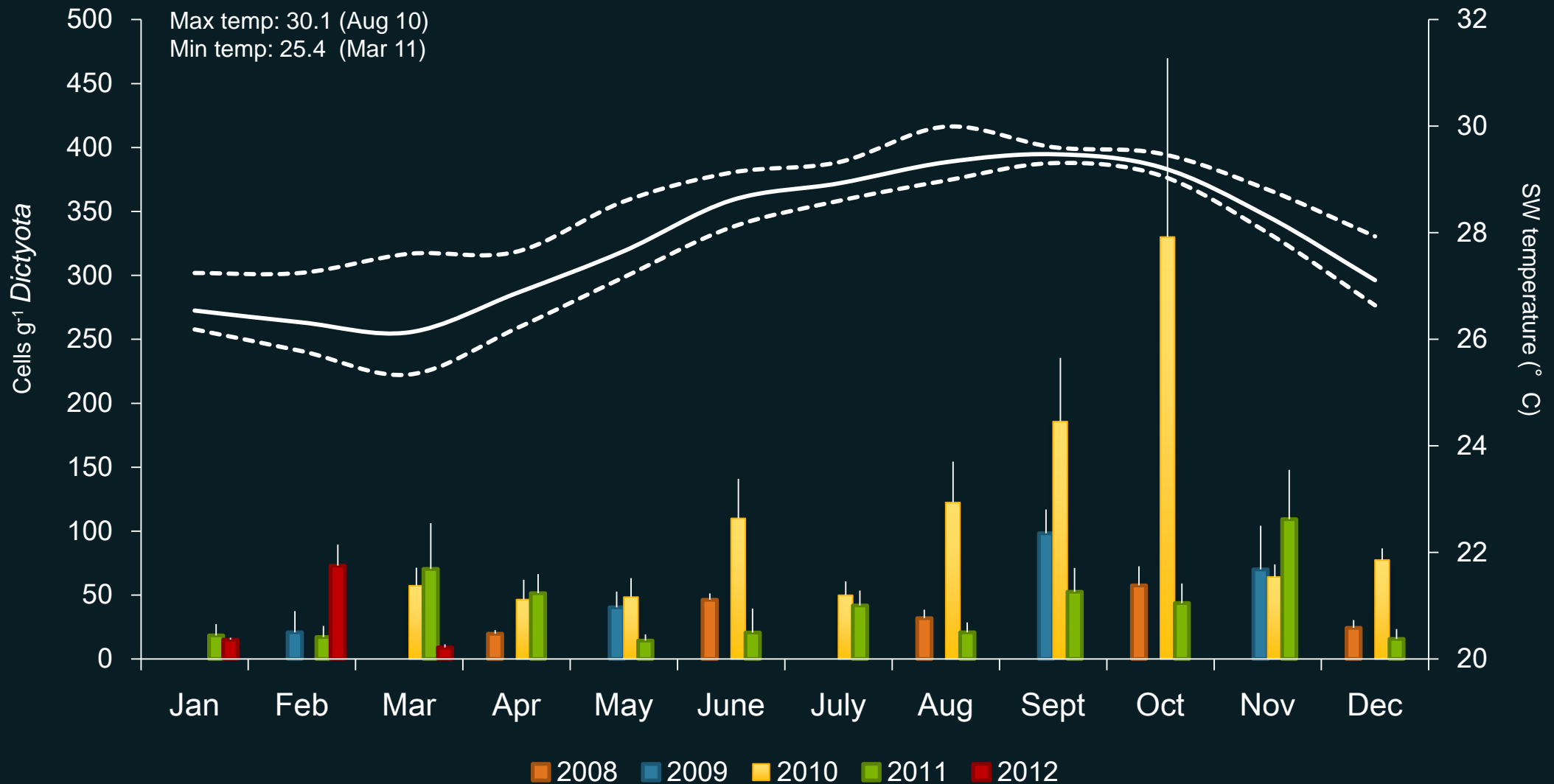
## Increasing Sea Surface Temperatures

- Sea surfaces temperature  $1^{\circ}\text{C}$  above the maximum monthly mean can cause mass coral bleaching
- In USVI, every year of the last decade has seen warmer summers than our climate mean



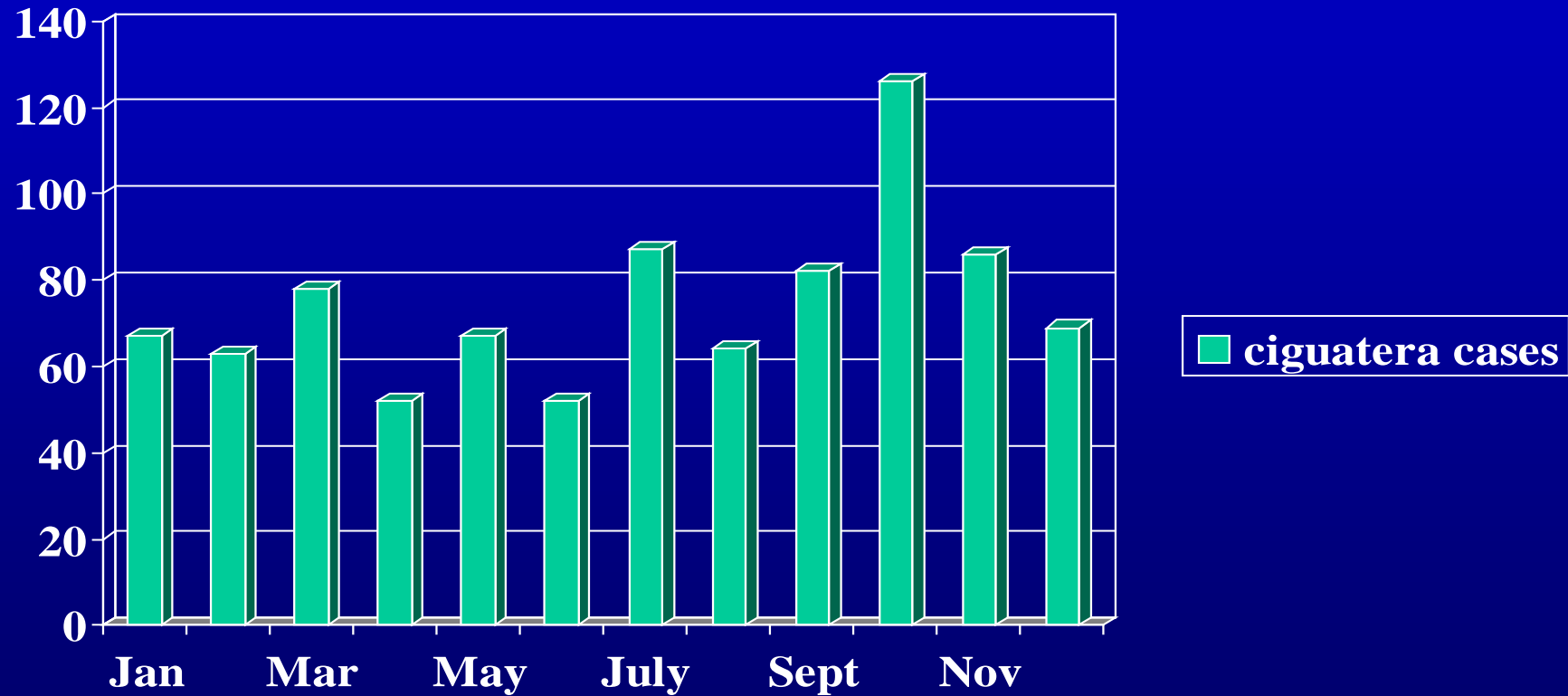


## *Gambierdiscus* spp. abundance, Benner Bay



*Gambierdiscus* spp. abundance **positively correlated with SW temperature, precipitation**; negatively correlated with wind velocity (Spearman's rank correlation,  $p < 0.05$ )

# Ciguatera Cases, Emergency Department, Schneider Hospital, St. Thomas, by Month, 1995-1999



# Background

- **Incidence surveys performed in St. Thomas in 1980**
  - **7 per 1000 (approximately 14 per 1000 among adults)**
    - **In person survey, Morris, et al.**
  - **22% of households affected in a five year period**
    - **Telephone survey, McMillan, et al.**
- **Since this time, seawater temperatures have risen.**
  - **Has been suggested that increasing seawater temperature, in the context of global warming, will lead to an increase in ciguatera incidence**



# Research Questions

- **Has ciguatera incidence in St. Thomas changed from 1980 to 2010/2011?**
  - We hypothesized that incidence would have increased due to the rise in seawater temperatures
- **What demographic and behavioral factors are associated with ciguatera illness in St. Thomas?**

# Telephone Survey

**Two island-wide random digit dial telephone surveys in St. Thomas (November 2010 and October 2011) - Landline and cellular telephones**

**Eligibility criteria: adult residents of St. Thomas**

# Telephone Survey Questionnaire

- 1. Demographics**
- 2. Recent fish consumption (frequency, type of fish, how obtained)**
- 3. History of ciguatera episodes in the participant and their household members**
- 4. Ciguatera awareness**

# Survey population

- **807 individuals participated in the telephone surveys**
  - 400 in 2011 provided information about ciguatera in the past five years
- **186 (23%) had ever had ciguatera**
  - 339 total episodes
- **43 households (11%, 95% CI=8-14%) had a ciguatera episode in the previous five years**
- **56 (30%, 95% CI=21-39%) visited the emergency department for their most recent ciguatera illness**

# Emergency Department Visits

- Medical record review of emergency department at Roy Schneider Hospital
- All available records with discharge diagnosis of ciguatera were identified and reviewed
- Data from pre 1980 were obtained from past research
- Collected annual counts for 1971-79 and 1995-2011, with gaps from 2000-01 and 2006.



# Incidence estimates

## ➤ Telephone survey:

- 12 per 1000 (95% CI=10-21) 2010/2011
- 14 per 1000 in 1970's survey

## ➤ Emergency department visits:

- - 18 per 1000 in 1970s
- - 6 per 1000 (95% CI=5-8) in 2007-11

# Survey Results

- **22% of households were affected in in 1970's over 5 years**
- **11% of households were affected in 2010/2011 over the same time period.**

# Population Differences

- **Between 1980 and 2010/2011, we found significant differences in education (higher), age (older), and fish consumption (lower).**
- **Combined risk difference of -2.7 per 1000**

# Conclusion

- We observed a *decline* in ciguatera incidence in St. Thomas from 1980 to 2010/2011
- This may be due to a population shift: Higher socioeconomic status, aging and lower fish consumption

Radke et al. (2013) *American Journal of Tropical Medicine and Hygiene*, In Press

# Alternatively

- **St. Thomas may have reached an upper temperature threshold that is limiting *Gambierdiscus* growth**
- **A positive association with seawater temperature may exist but the effect of temperature is obscured by other factors (change in toxin profiles, primary dinoflagellate, or fish populations).**
- **Despite the decline in incidence in STX over the past 30 years, Ciguatera remains a major public health problem, affecting about 1% of the US population each year.**



