Biotechnology: Contributions to Coral Reef Science

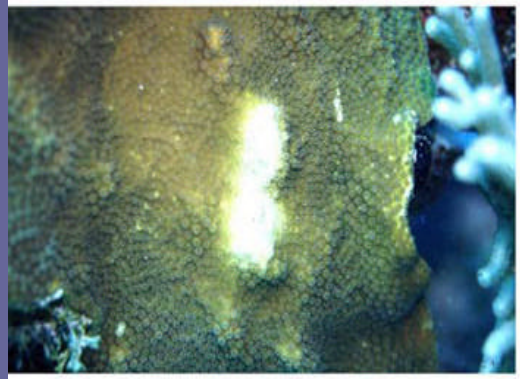
EnVirtue
Biotechnologies, Inc.

The Problem

- Coral reefs are declining worldwide, with 58-70% adversely affected by human activities.
- Declines likely caused by local, regional, and global stresses; latter two most widely reported in media:
  - Global warming (El Nino)
  - African dust
  - Emerging infectious diseases
- Local impacts relatively unknown.
- Resource managers uncertain whether or how to ameliorate adverse impacts.

Agaricia agaricites: healthy (2)

Agaricia agaricites: bleached (8)



Montastrea annularis: bleached (8)

Diploria labyrinthiformis: bleached (8)

The REAL PROBLEM

- Developing ‘useful’ understanding of the causes and mechanisms of coral reef declines
  - Scientists
  - Resource Managers

The REAL PROBLEM

- **Developing tools to diagnose and mitigate the *causes* of coral reef declines**

  TECHNOLOGY = The ability to *perceive* reality and to *alter* conditions and effects

Current monitoring methods ignore important links in the biological hierarchy

Ecosystem

Communities

Populations

Individuals

Organs

Tissues

Cells & Molecules

Stress

Ü Infer

Ü Monitor

Ü Monitor

Biotechnology Industry

Tools: ***Genomics and Proteomics and Cell Biology***

Methodology & Philosophy: ***Biomedical Sciences***

- ***Cellular Diagnostics and Therapeutics***

Environmental Cellular Diagnostics

- All life is based on the cell

- Cellular diagnostics is the ability to measure “cellular health”

» Diagnose the health of any species on the planet . . .

Cellular Diagnostics and Coral Reef Decline

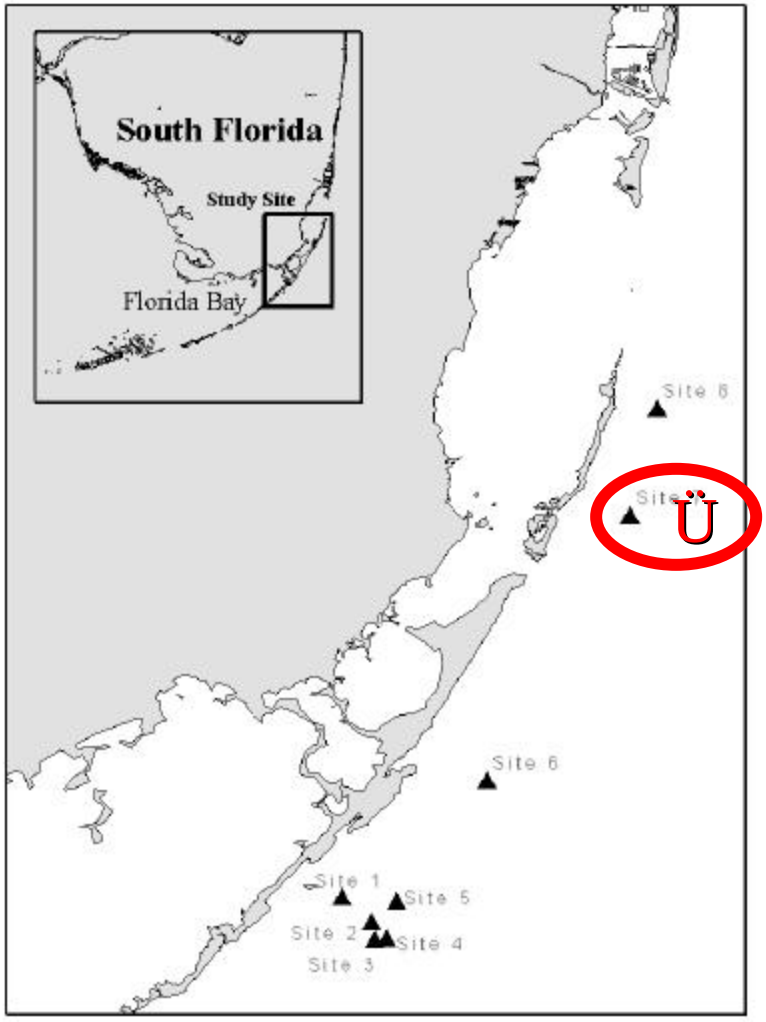
Mechanisms of Coral Bleaching (Global and Regional)

Oxidative Stress

- **Same Process in Corals that is associated with Parkinson's Disease, Alzheimer's Disease, and Aging**

- **U.S. NOAA, U.S. NPS, Australian Institute of Marine Science**
- **College of Charleston, Univ. California-Berkeley, Med. Univ. South Carolina,**
  Univ. Newcastle Upon Tyne (UK)
- **Cousteau Society, Mote Marine Laboratory**
- **Environmental Moorings, Intl., IIDEXO**

Sampling Locations

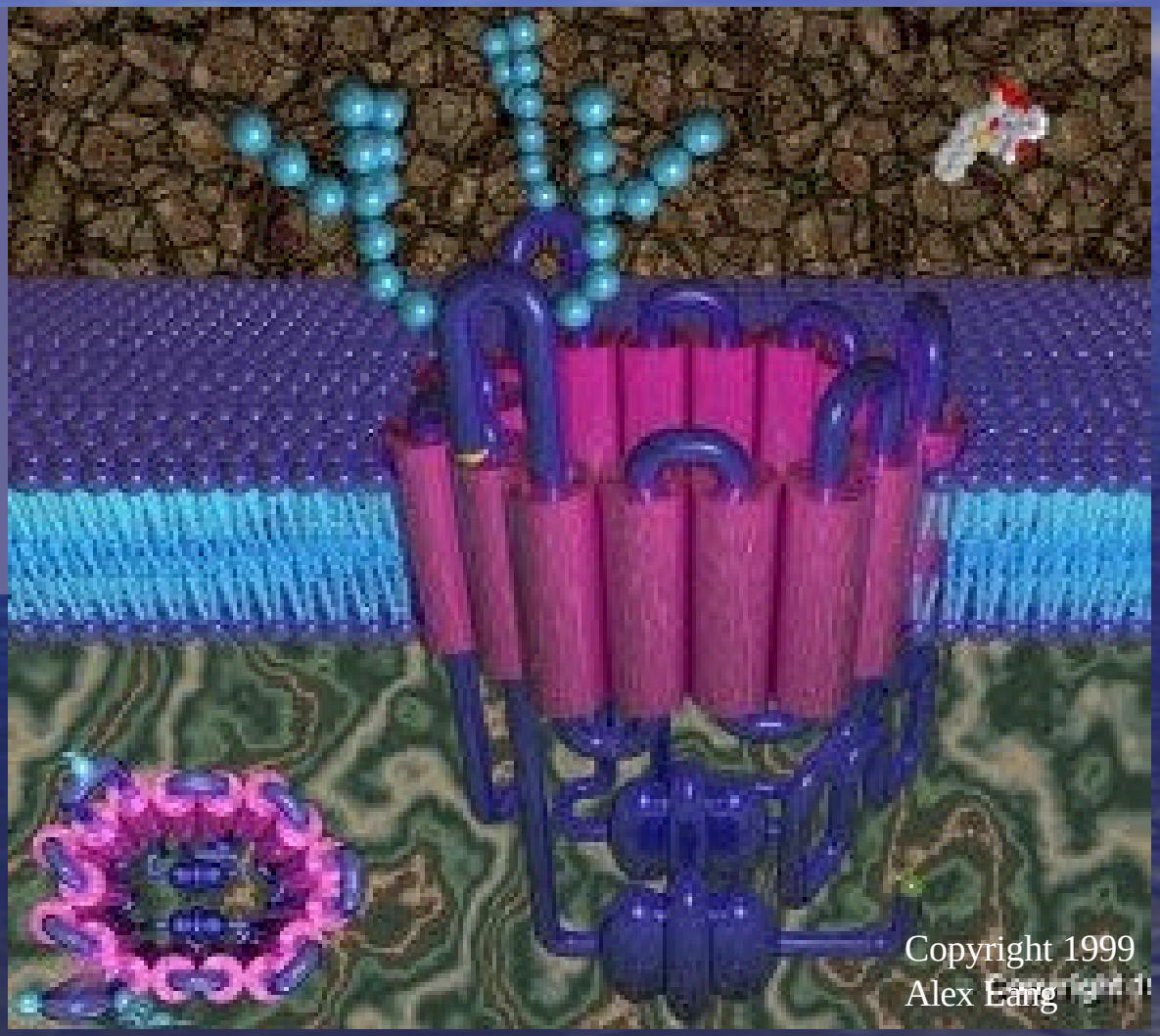


Map by Mike Callahan

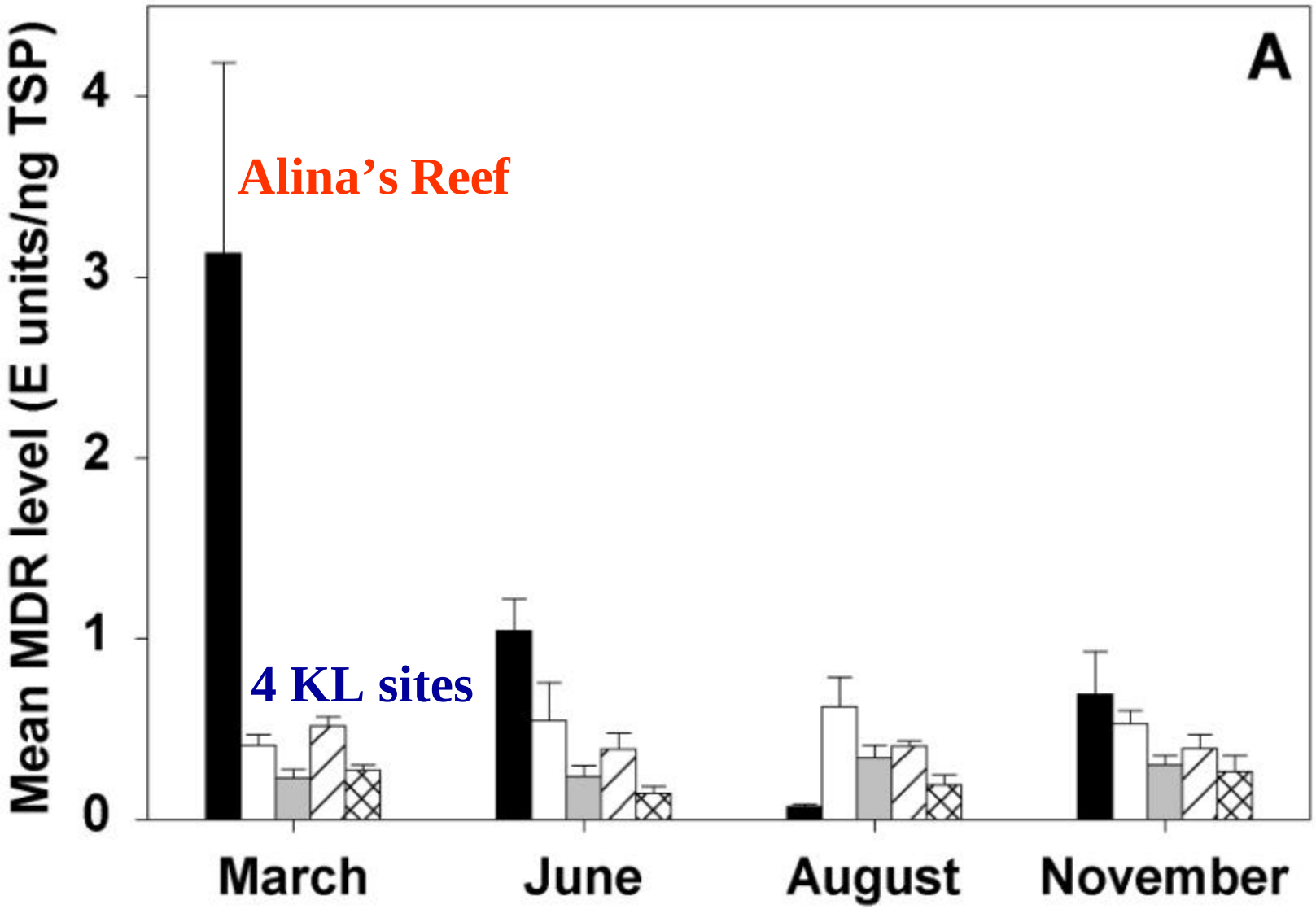
	Site Name	Depth
1	Rodriguez Key	3 m
2	SW Three Sisters	6 m
3	Between Molasses and Pickels	10 m
4	SW Molasses	18 m
5	White Bank	6 m
6	Algae reef	6 m
7	**Alina's reef**	6 m
8	East Bache Shoal	6m

MDR function

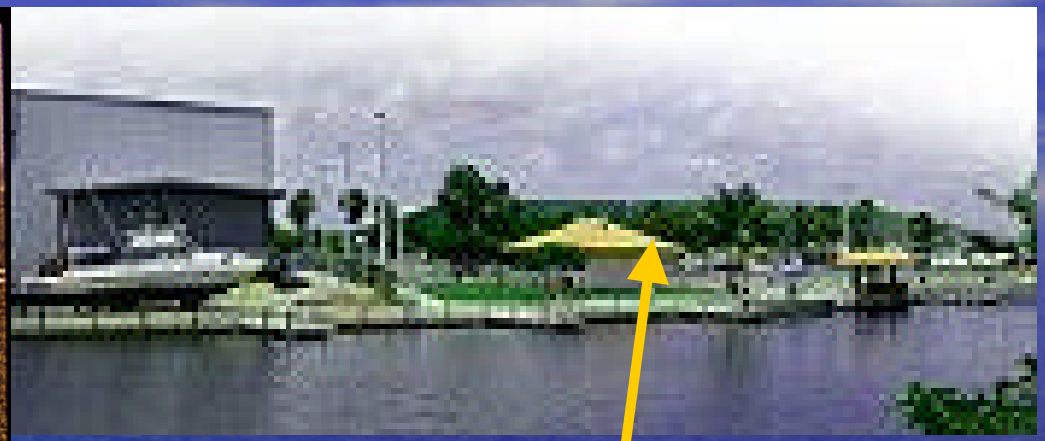
- Protein complex that detoxifies xenobiotics
- Suggests fertilizer, pesticide or chemical contamination.



Evidence of xenobiotic: MDR



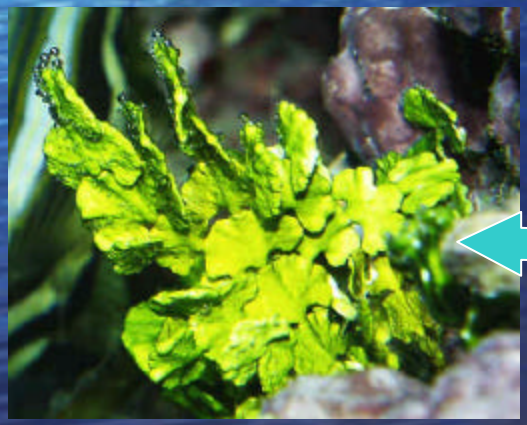
Possible Sources



"Mount Trashmore"
Dade County landfill

Several drainage canals

Ongoing Research: Coral Reef Ecosystems



Most Forecasting Methods Ignore Important Links in the Biological Hierarchy

Ecosystem

Communities

Populations

Individuals

Organs

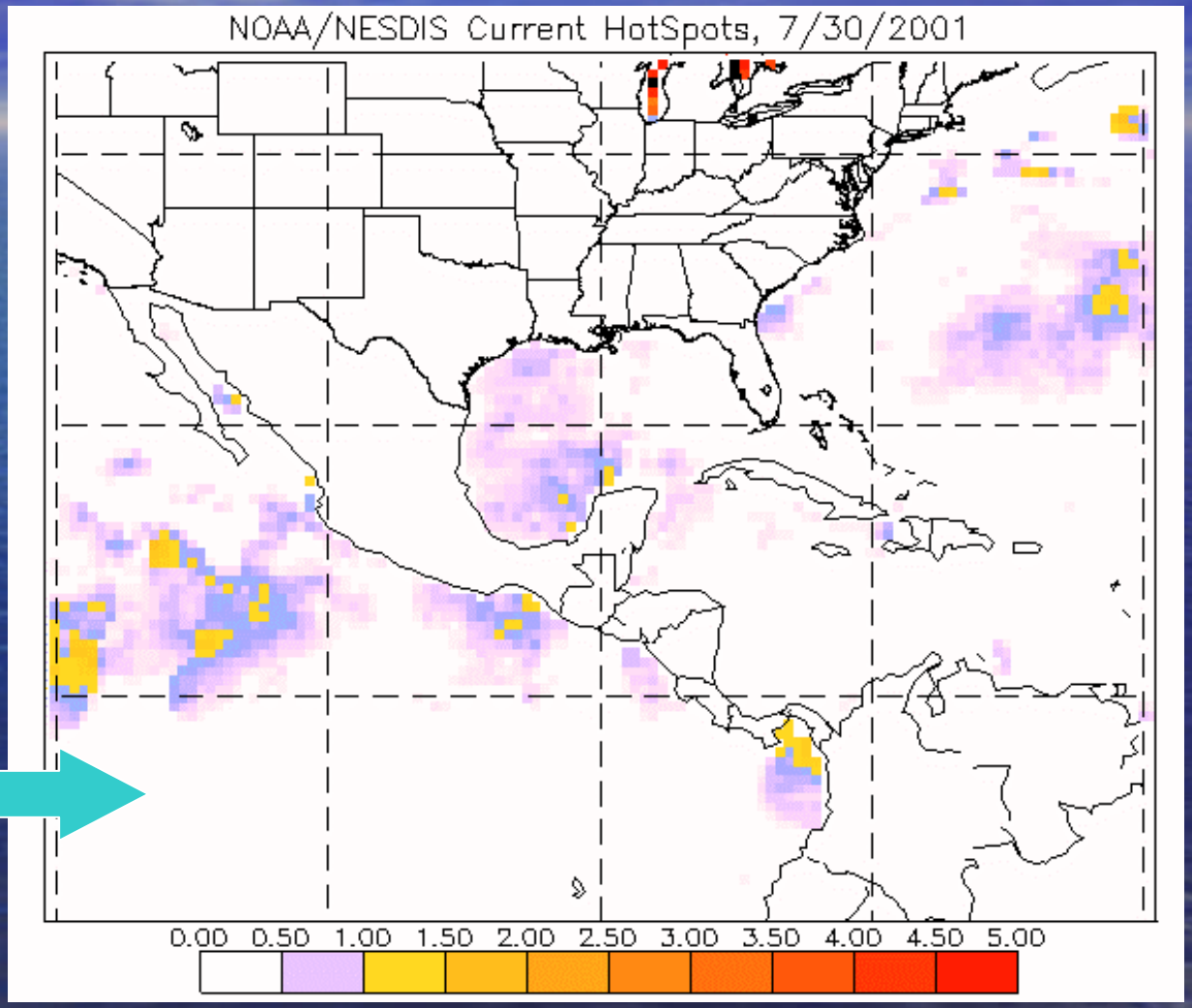
Tissues

Cells & Molecules

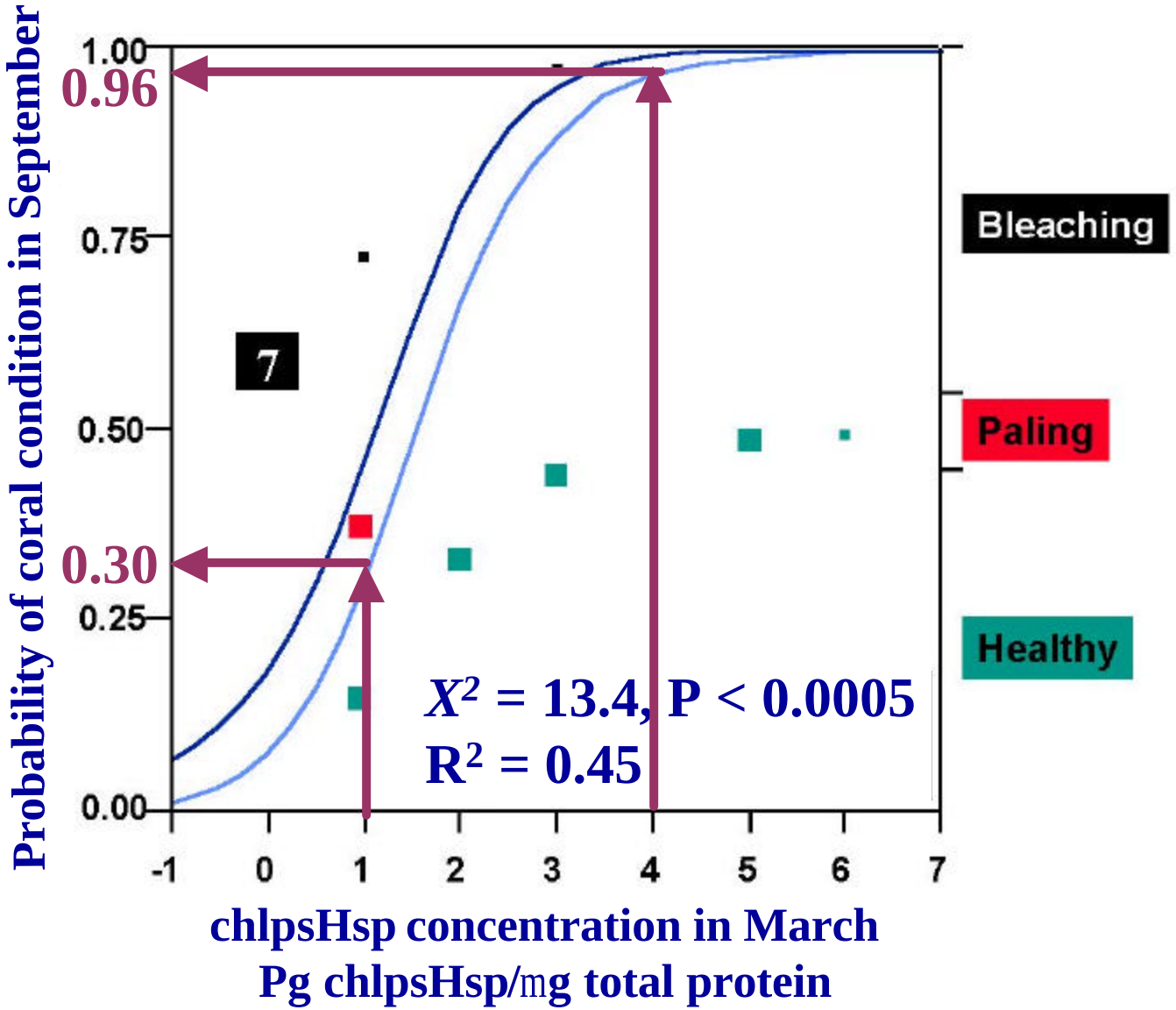
Stress

Significant Regressors

- **March water temperature** ($R^2 = 0.37$, $P < 0.002$).
- **NOAA currently uses water temperature to predict coral bleaching hot spots.**



A Better Regressor: Chloroplast Small Heat Shock Protein



Prognosis: How long will a coral reef live if stresses remain unabated?

Resource Managers = Clinicians/Caregivers

Biotechnologies

- "Dipsticks" to diagnose disease
- Topical antibiotic creams for coral diseases

- Long-term: Cellular and genetic markers to select "stress-tolerant corals" for coral reef restoration

Acknowledgments

- U.S. NOAA
- Florida Keys NMS
- NPS (Biscayne)
- Flower Gardens NMS
- U.S. Geological Survey
- Aust. Instit. Mar. Sci

- Environmental Moorings Intl.
- Oxis Research, Inc.

- College of Charleston
- Univ. S. Florida
- Medical Univ. S. Carolina

- The Cousteau Society
- Mote Marine Laboratory
- IIDEXO
- Bermuda Biol. Station

Ecological Forecasting

- **Genomic Integrity**

Stress Causes Genetic Damage

How fit will offspring be?

Down's Syndrome = Oxidative Stress = ß Recruitment

Spina Bifida = Nutritional deficiency = Planula deformations

Miscarriage = Toxin exposure = No spawning

Differences in stress responses: 2000 vs. 2001