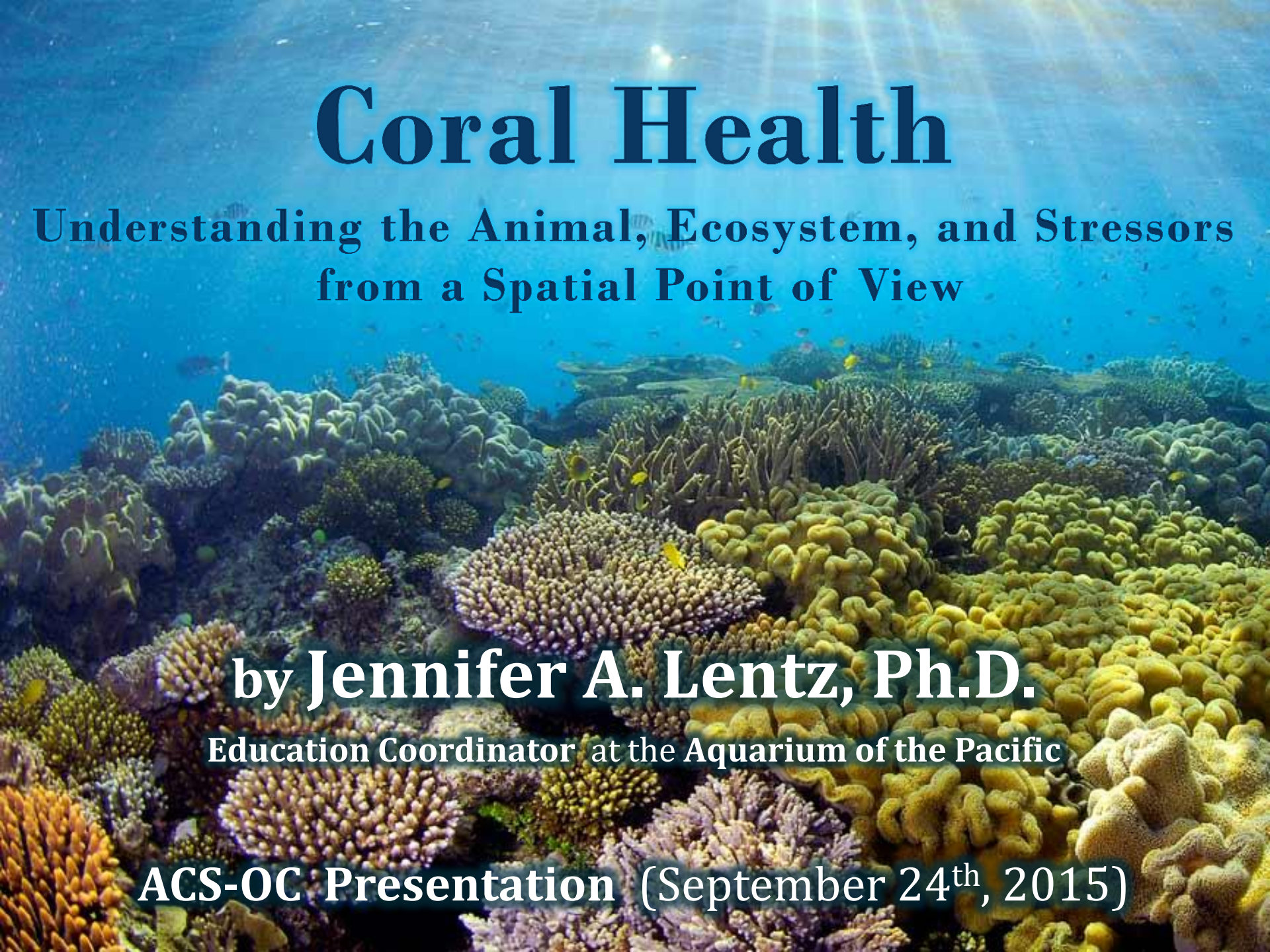


Coral Health

Understanding the Animal, Ecosystem, and Stressors from a Spatial Point of View

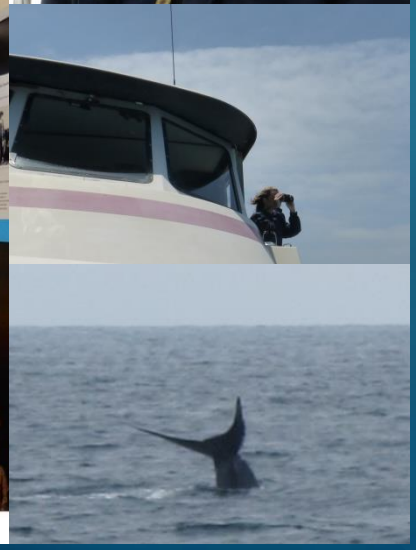
by **Jennifer A. Lentz, Ph.D.**

Education Coordinator at the **Aquarium of the Pacific**

ACS-OC Presentation (September 24th, 2015)

My Background

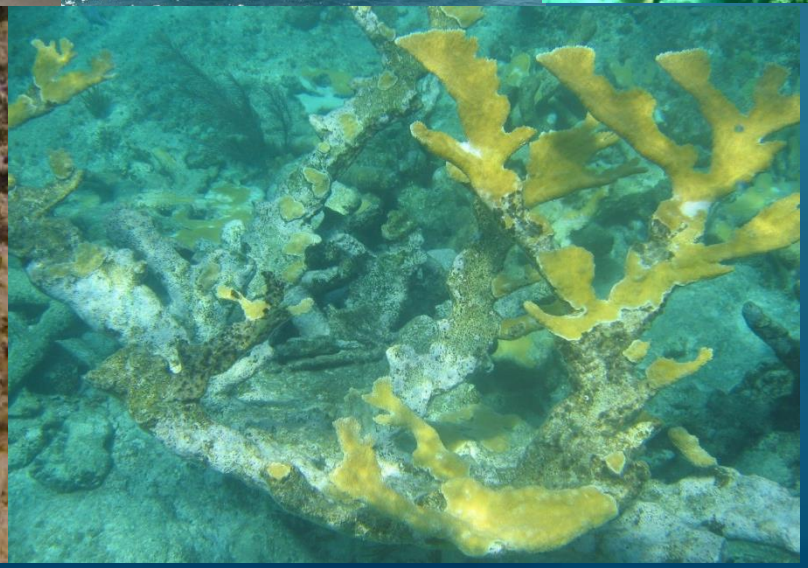
"Education Coordinator" at the Aquarium of the Pacific



My Background

Bachelor of Arts (BA) degree from **Hamilton College**
with an Interdisciplinary Concentration in **Environmental Studies**

SFS THE SCHOOL FOR FIELD STUDIES
Marine Resource Studies
Turks and Caicos Islands

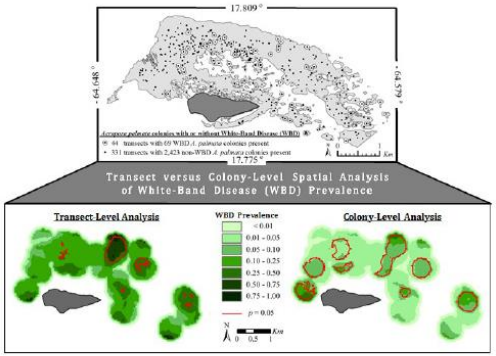


My Background

Ph.D. from **LSU's** Department of **Oceanography and Coastal Sciences** with a **GIS** Minor

A Dissertation Defense
Department of Oceanography and Coastal Sciences

Developing a Geospatial Protocol For Coral Epizootiology



by

Jennifer Anne Lentz

B.A., Hamilton College, 2005

Thursday, March 29th, 2012 at 1:00pm

Dalton J. Woods Auditorium
Energy, Coast, and Environment Building
Louisiana State University, Baton Rouge, Louisiana

What are Corals?

and Why are they Important?

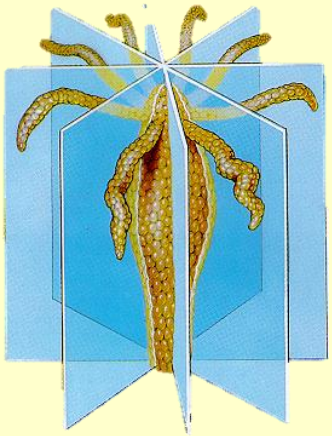
(Toby Hudson's 2010 photo of Great Barrier Reef corals)

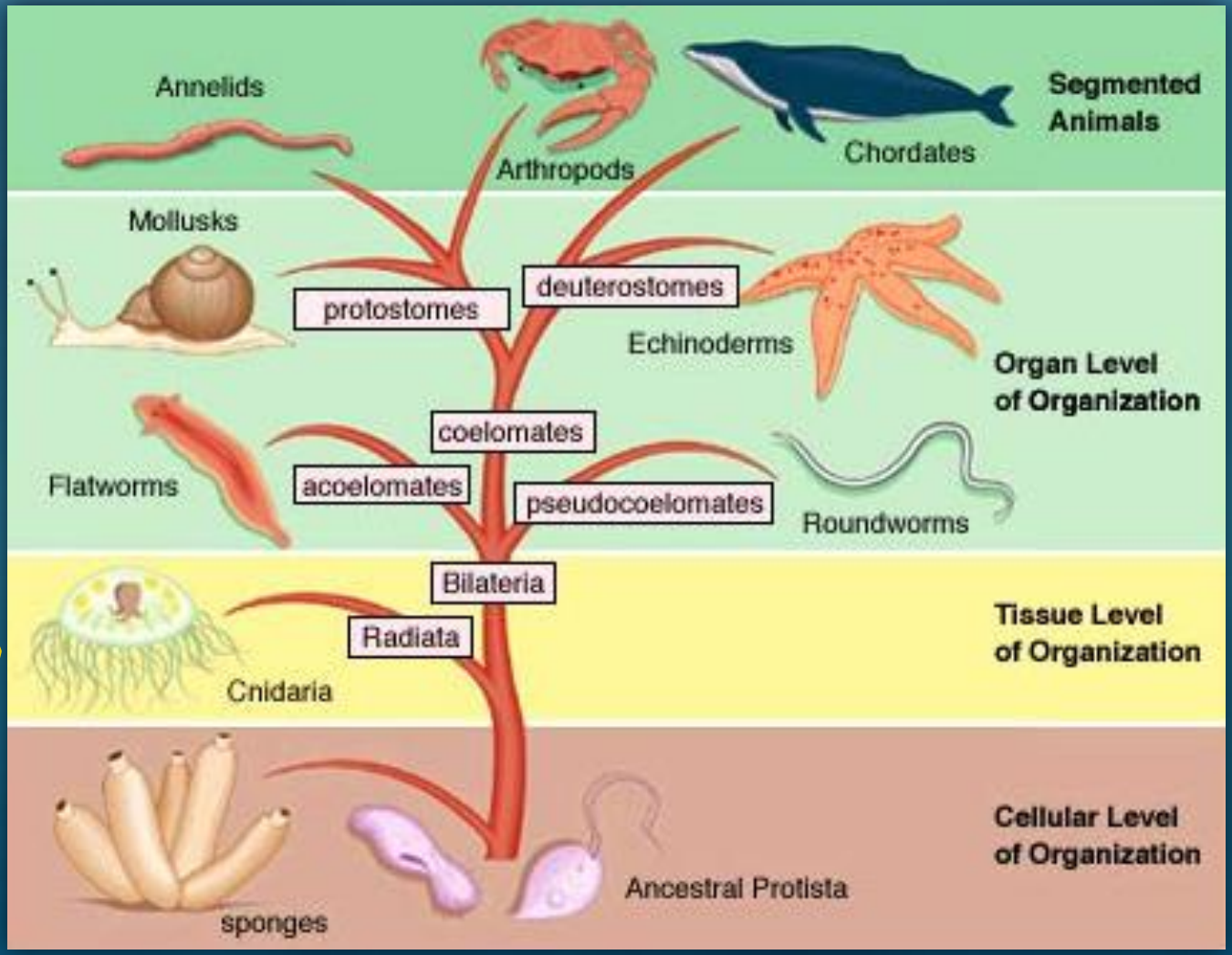
Coral Classification

Kingdom **Animalia**

Phylum **Cnidaria**

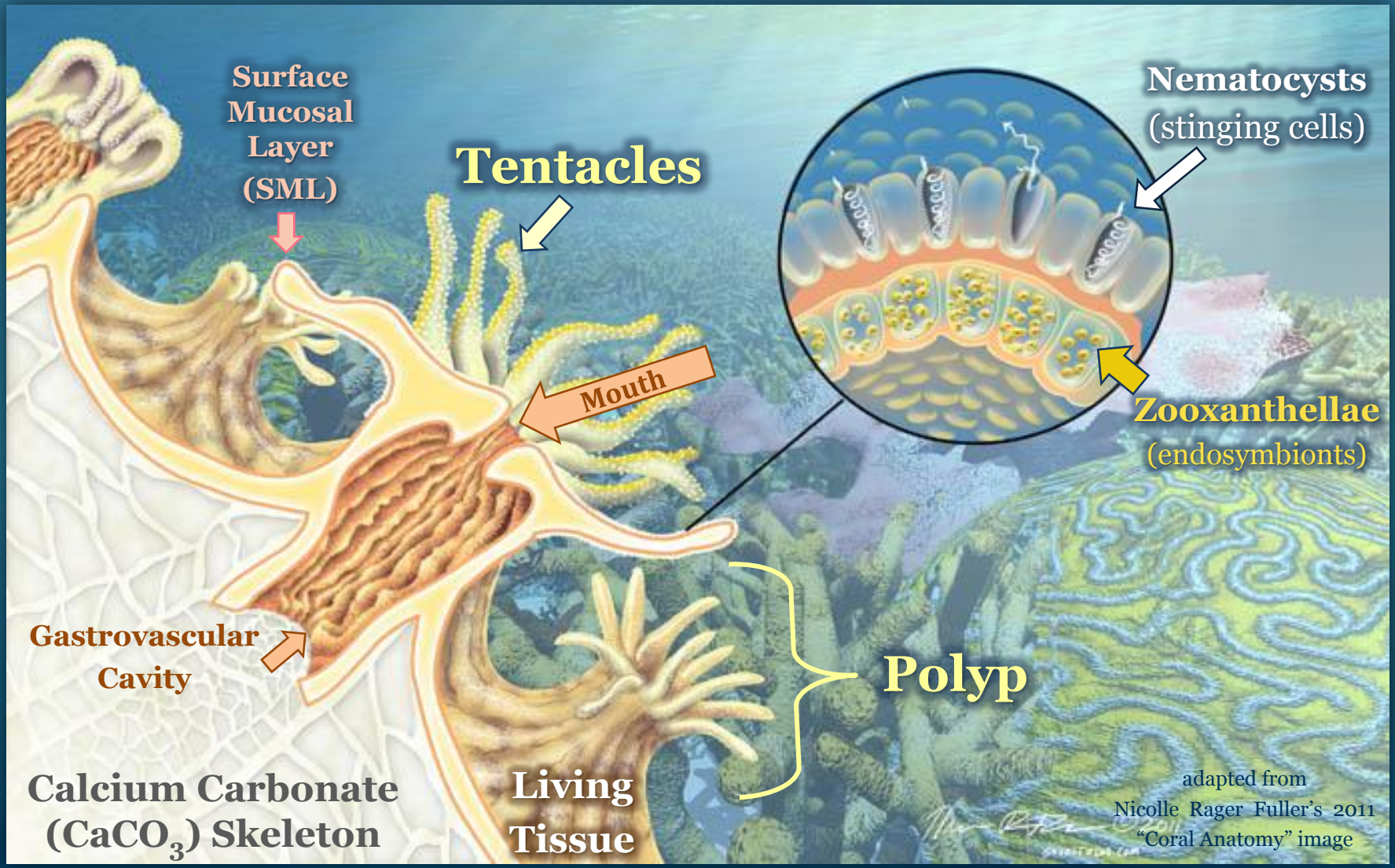
- **Multi-cellular**
- **Invertebrates**
- **Stinging Cells** (Nematocysts)
- **Radially symmetry**



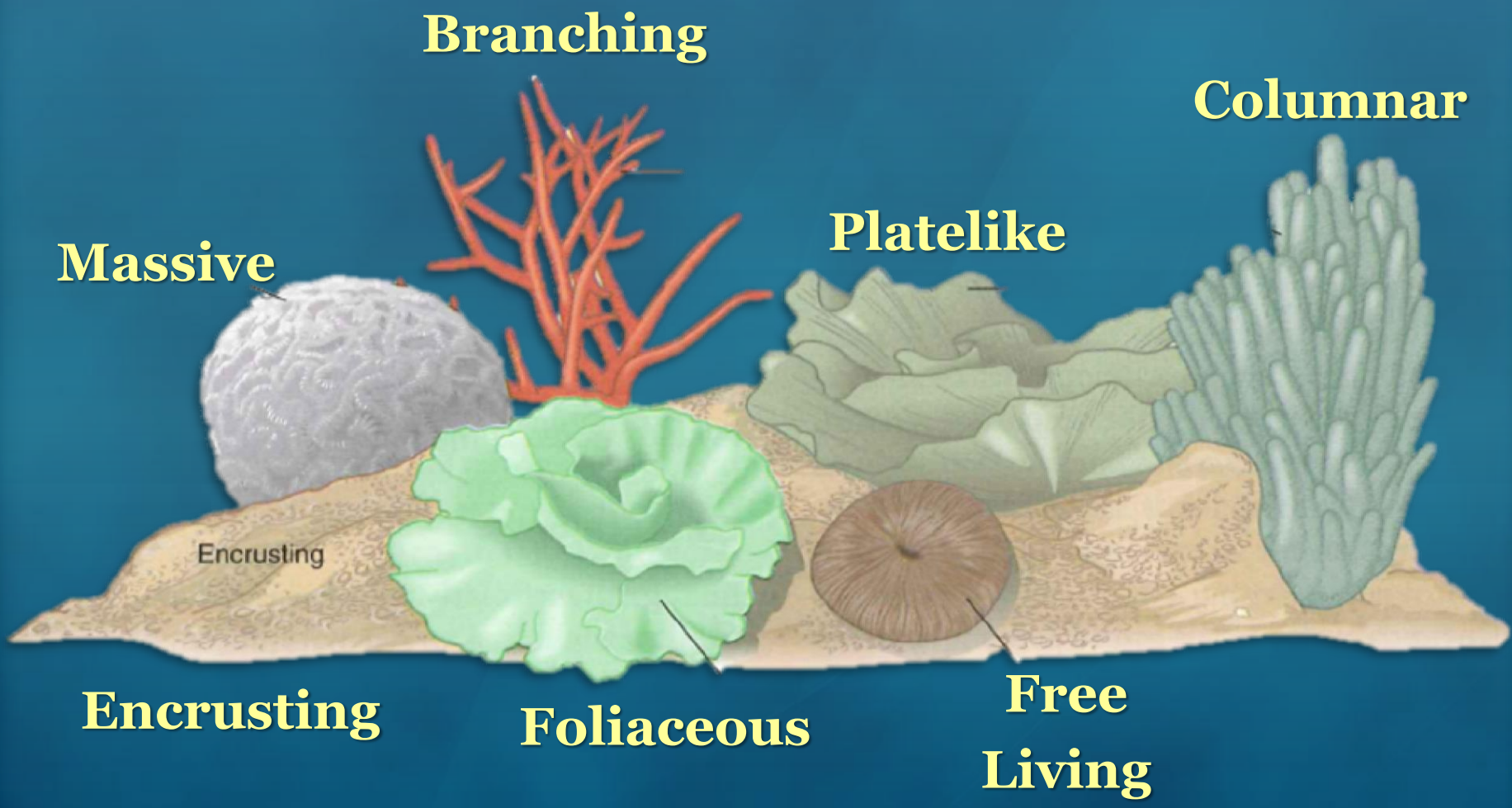


(Phylogenetic Tree graphic by the McGraw-Hill Company)

Coral Anatomy

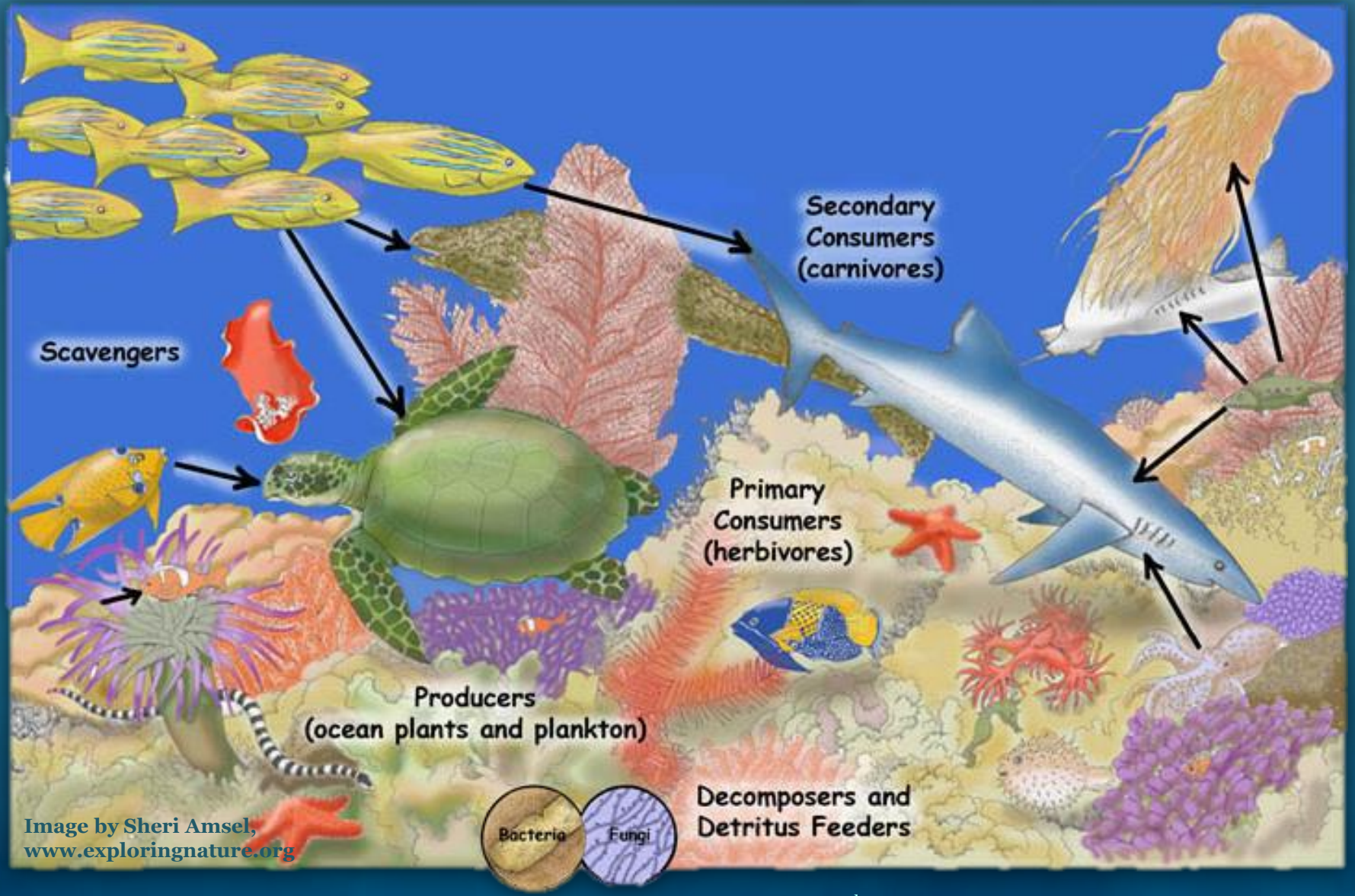


Coral Morphologies

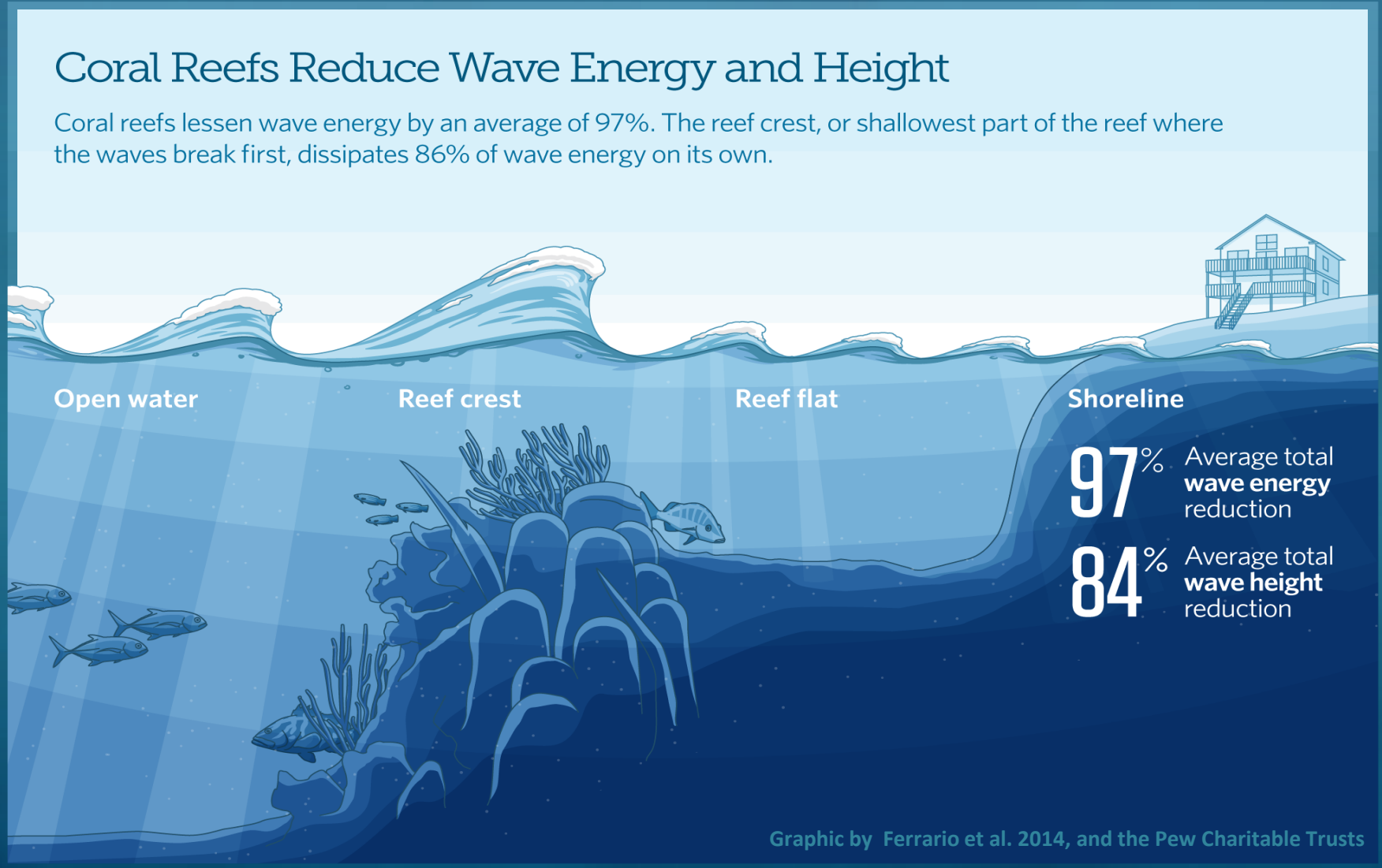


(adapted from Sumich & Morrissey 2004's Fig. 9.3)

Importance of Coral Reefs



Importance of Coral Reefs



Importance of Coral Reefs

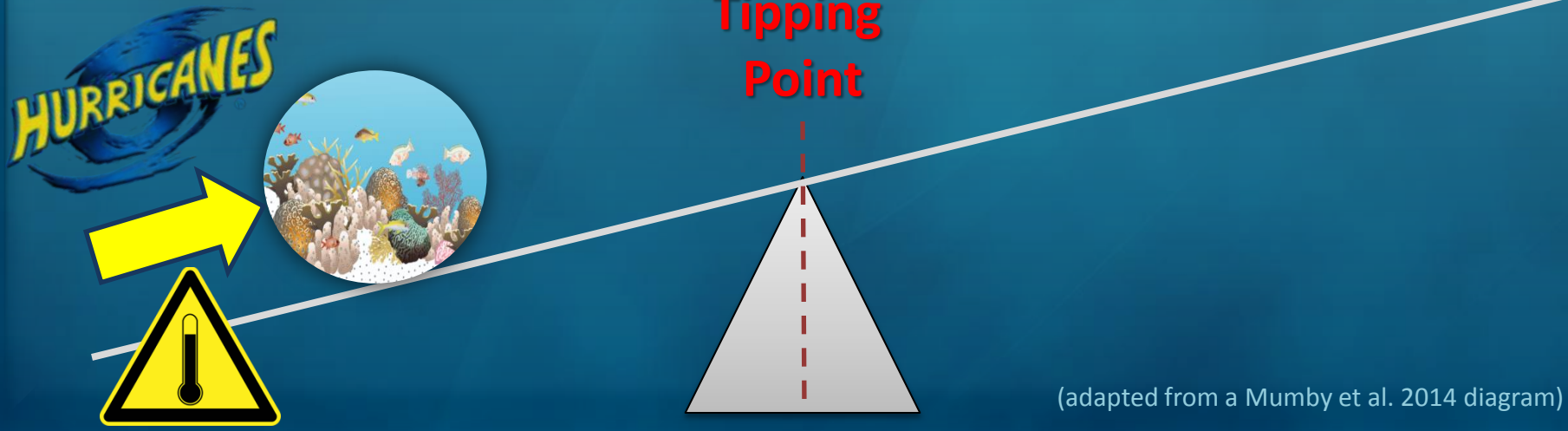
Phase Shifts

Tipping Point

(adapted from a Mumby et al. 2014 diagram)

Phase Shifts

Tipping Point

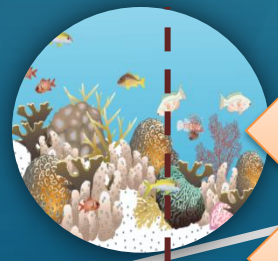


(adapted from a Mumby et al. 2014 diagram)

Phase Shifts

New
Tipping Point

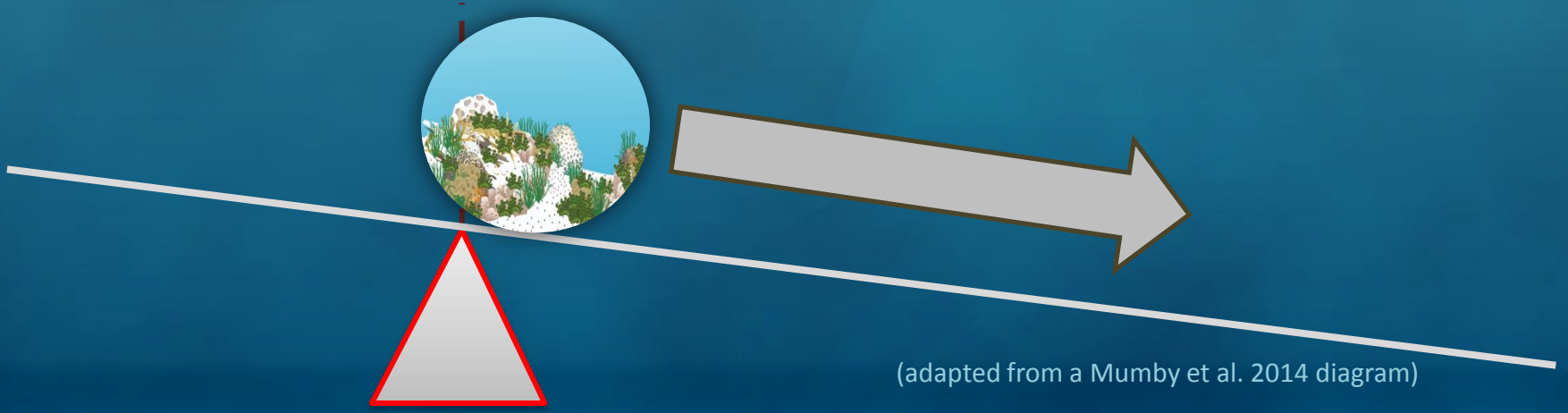
Tipping
Point



(adapted from a Mumby et al. 2014 diagram)

Phase Shifts

New
Tipping Point



(adapted from a Mumby et al. 2014 diagram)

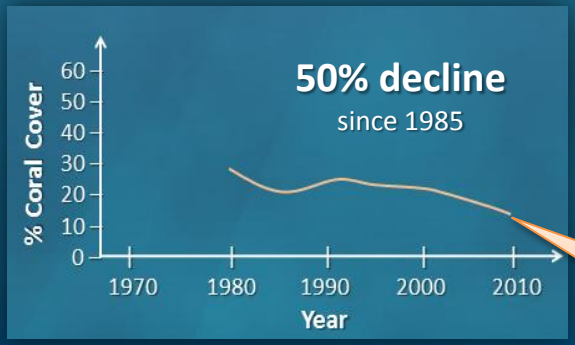
Phase Shifts

Declines in Coral Reefs

Healthy Reef

40-75% Live Coral Cover

Great Barrier Reef

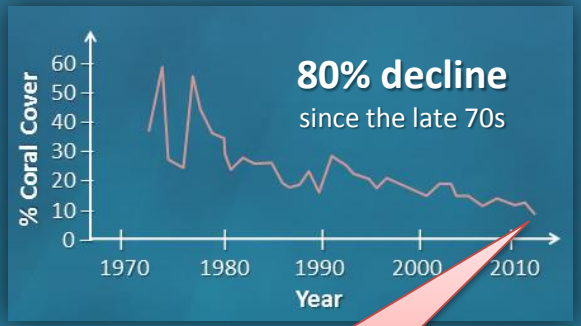


Severely Degraded Reef

10-25% Live Coral Cover

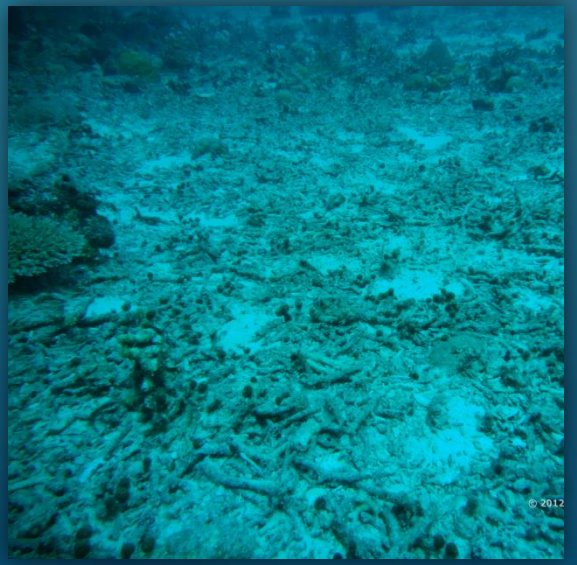
"Severely Degraded"
~ **13** % Cover in 2010

Caribbean Reefs



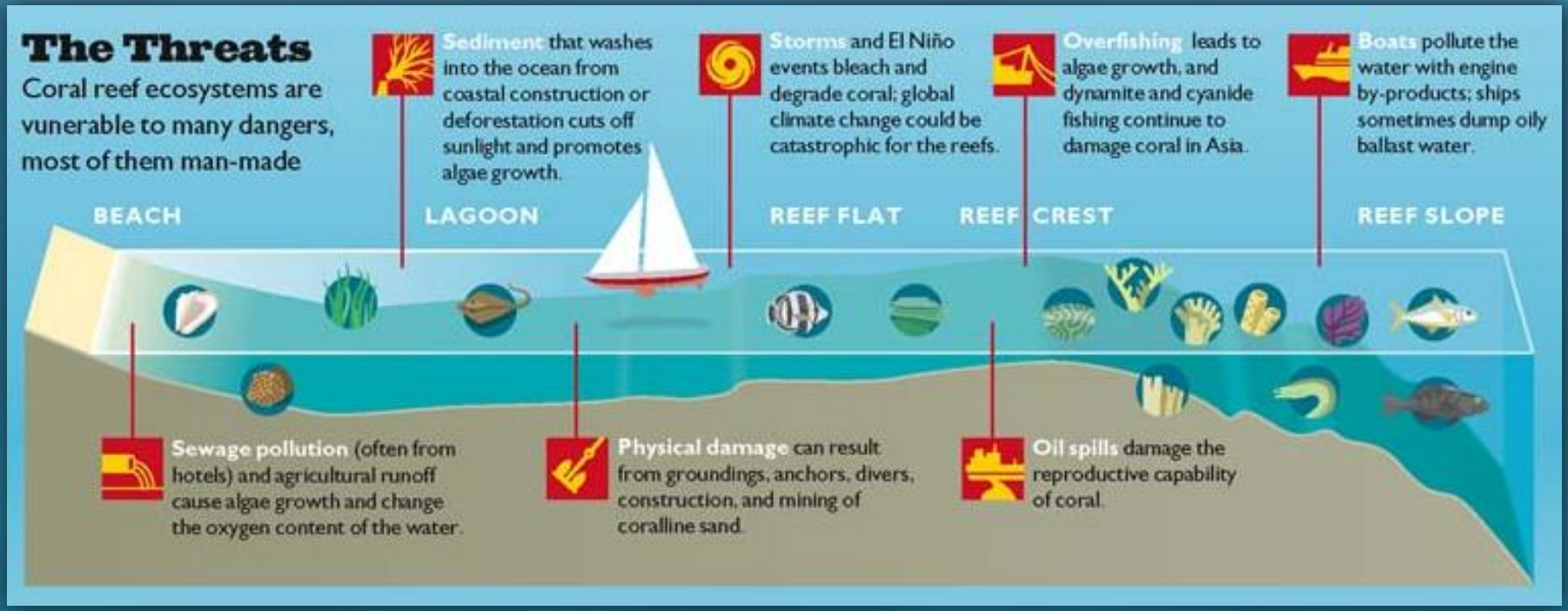
"Nearly Dead"
~ **9** % Cover in 2010

Nearly Dead Reef



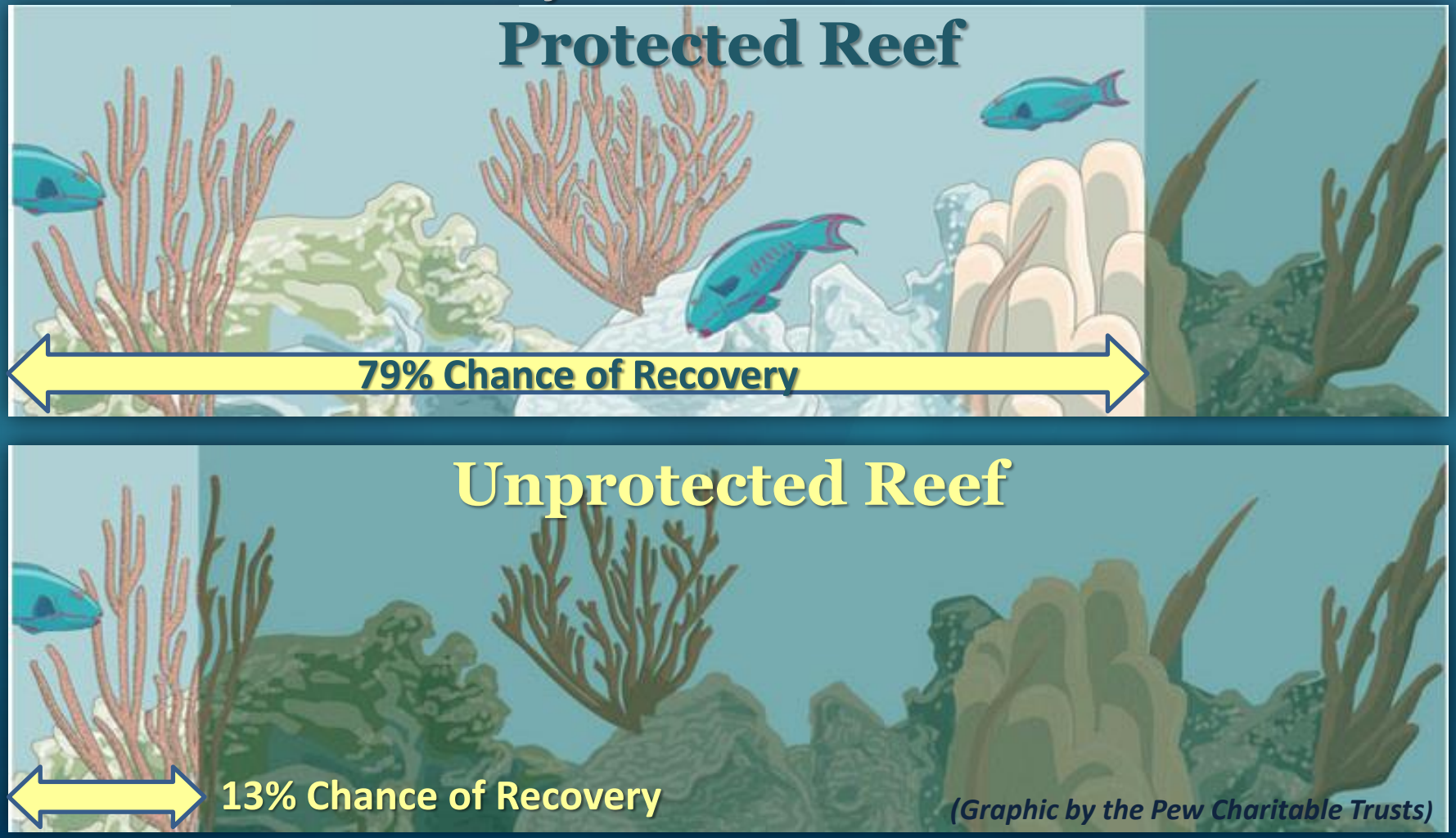
< 10% Live Coral Cover

Coral Stressors & Threats



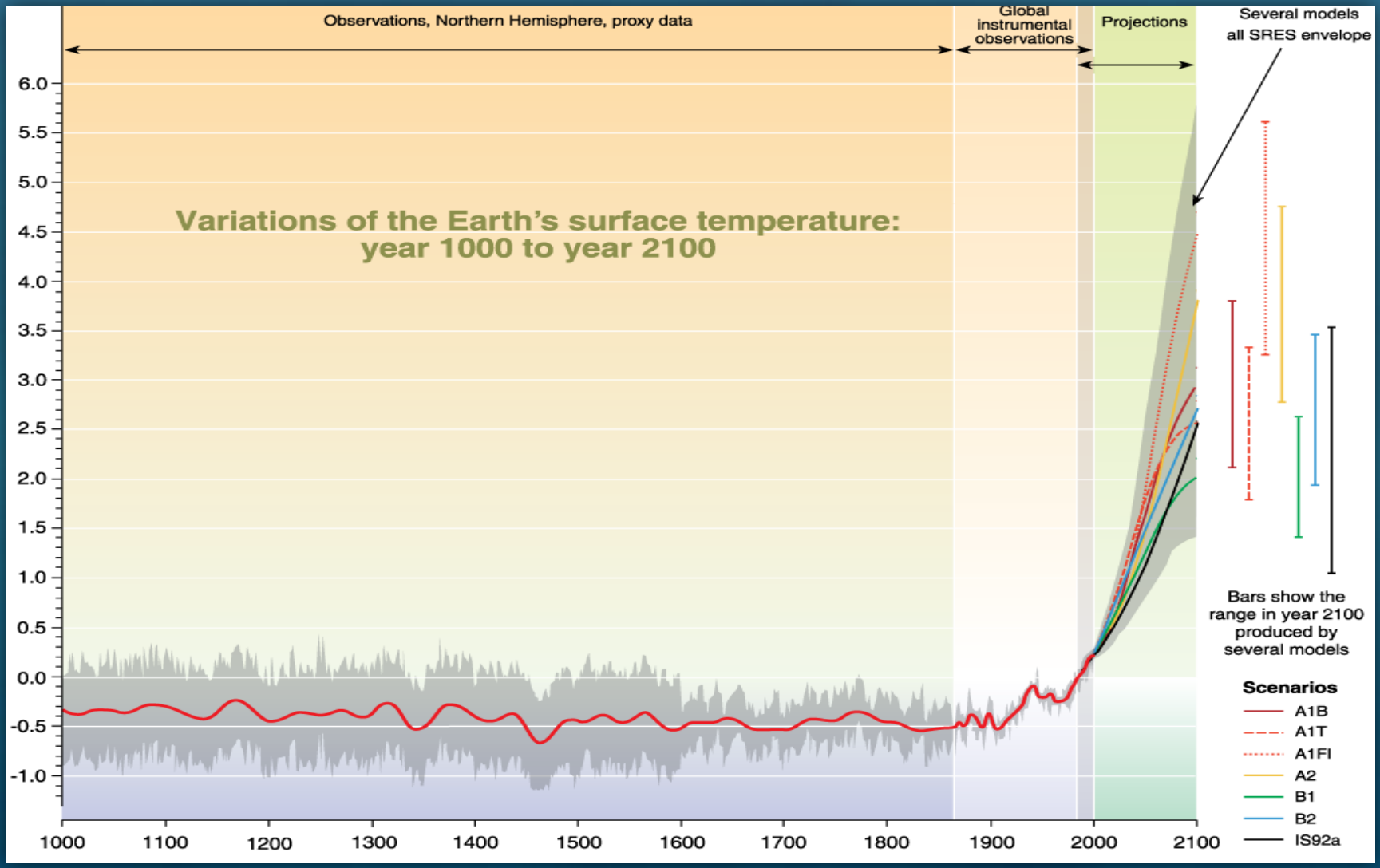
Coral Stressors – Overfishing

Corals in no-take reserves are 6x more likely to recover after a disturbance

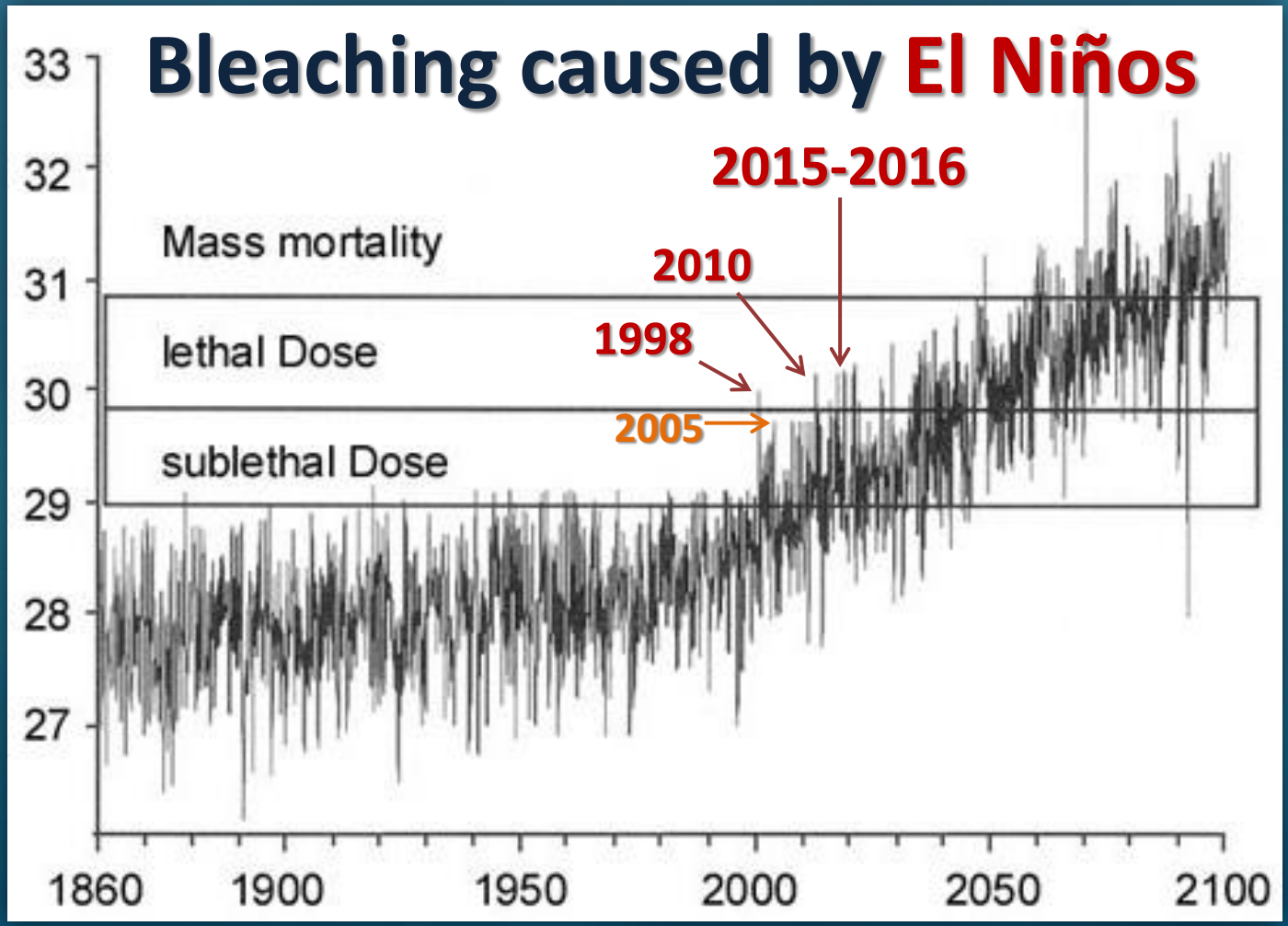


Coral Stressors – Destructive Fishing

Coral Stressors – Climate Change

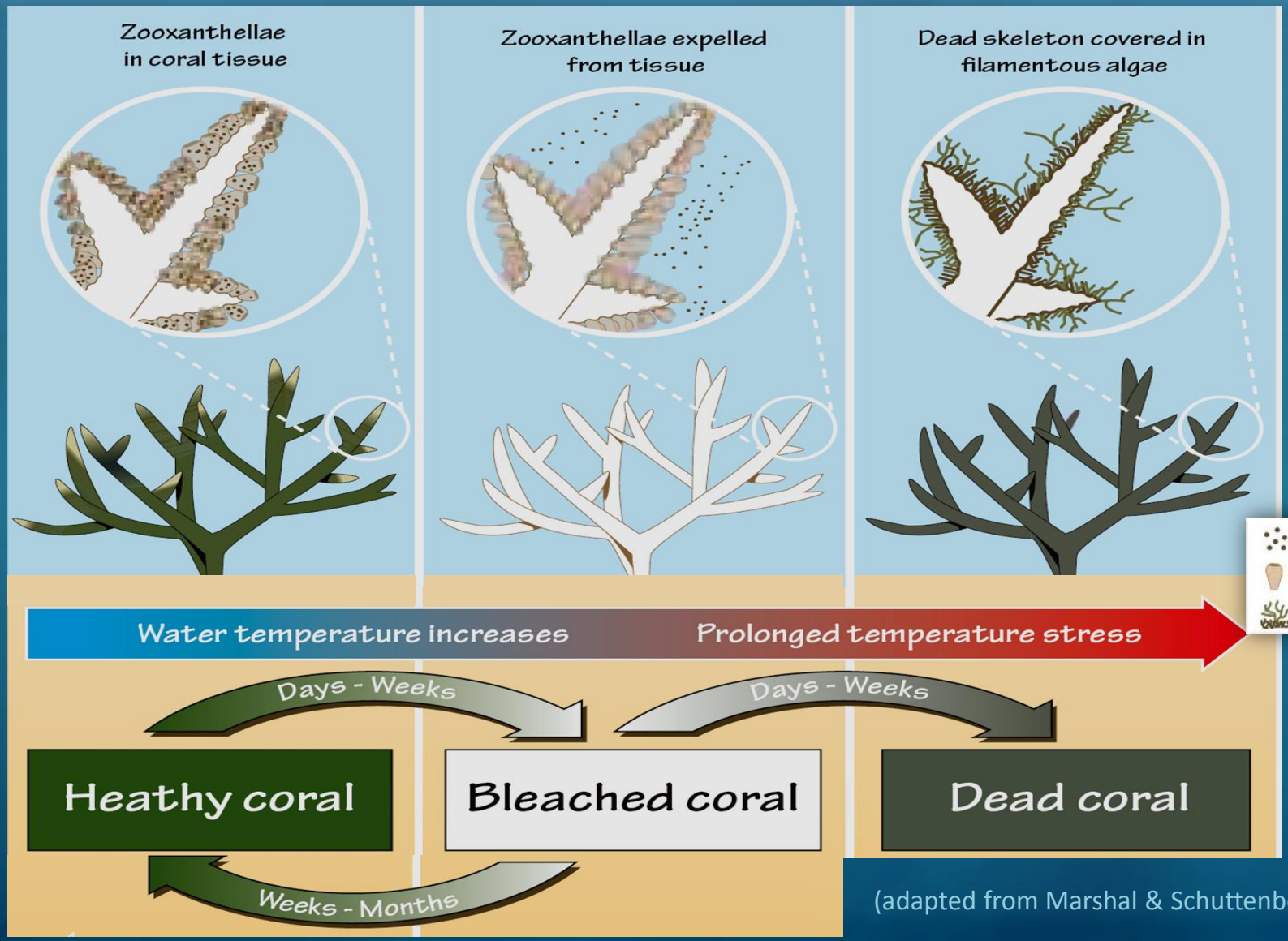


Coral Stressors – Coral Bleaching



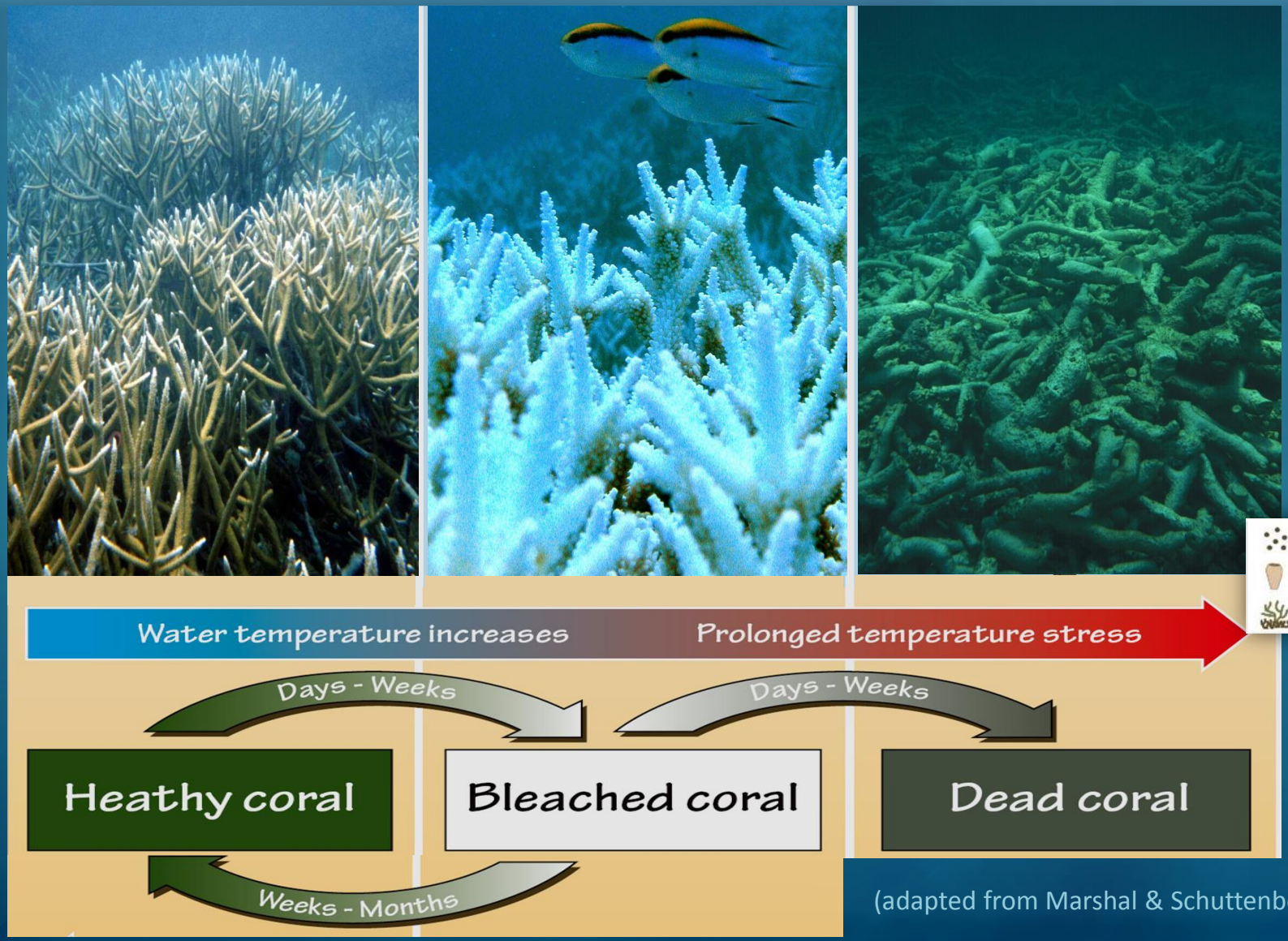
(adapted from Hoegh-Guldberg 2004)

Coral Stressors – Coral Bleaching



(adapted from Marshal & Schuttenberg 2006)

Coral Stressors – Coral Bleaching



(adapted from Marshal & Schuttenberg 2006)

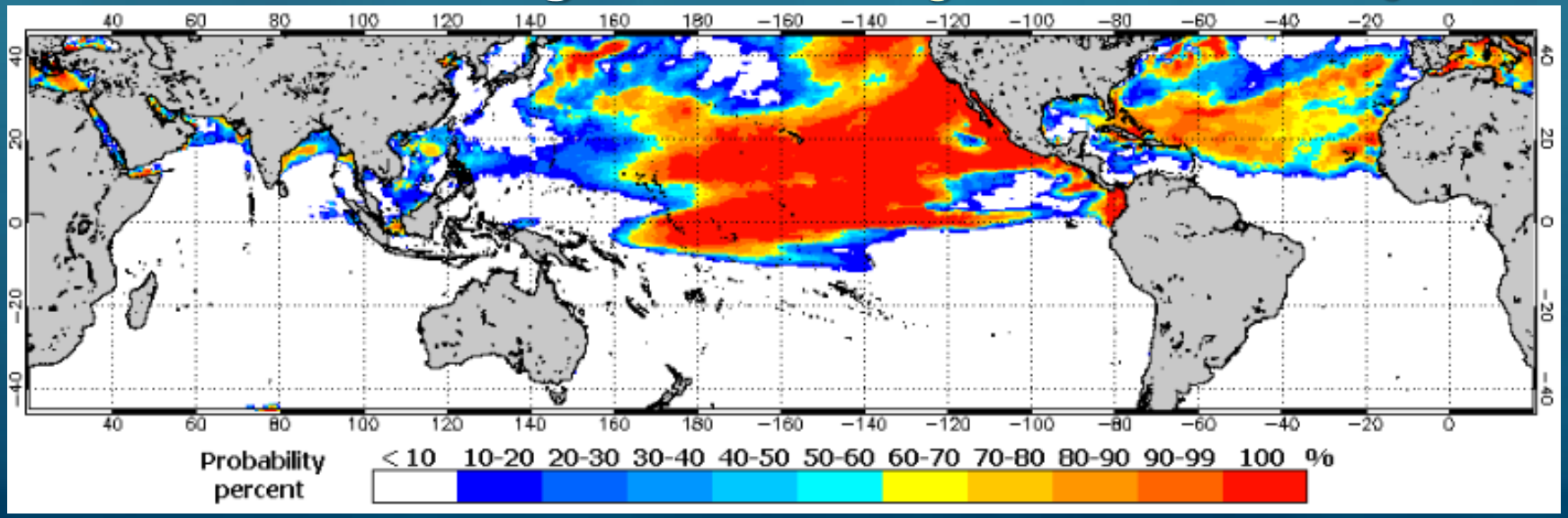
Coral Stressors – Coral Bleaching

Coral Rubble following the **1997-1998 El Niño**

Coral Stressors – Coral Bleaching

Areas affected by Coral Bleaching in 1998

Coral Bleaching Outlook for August – November 2015

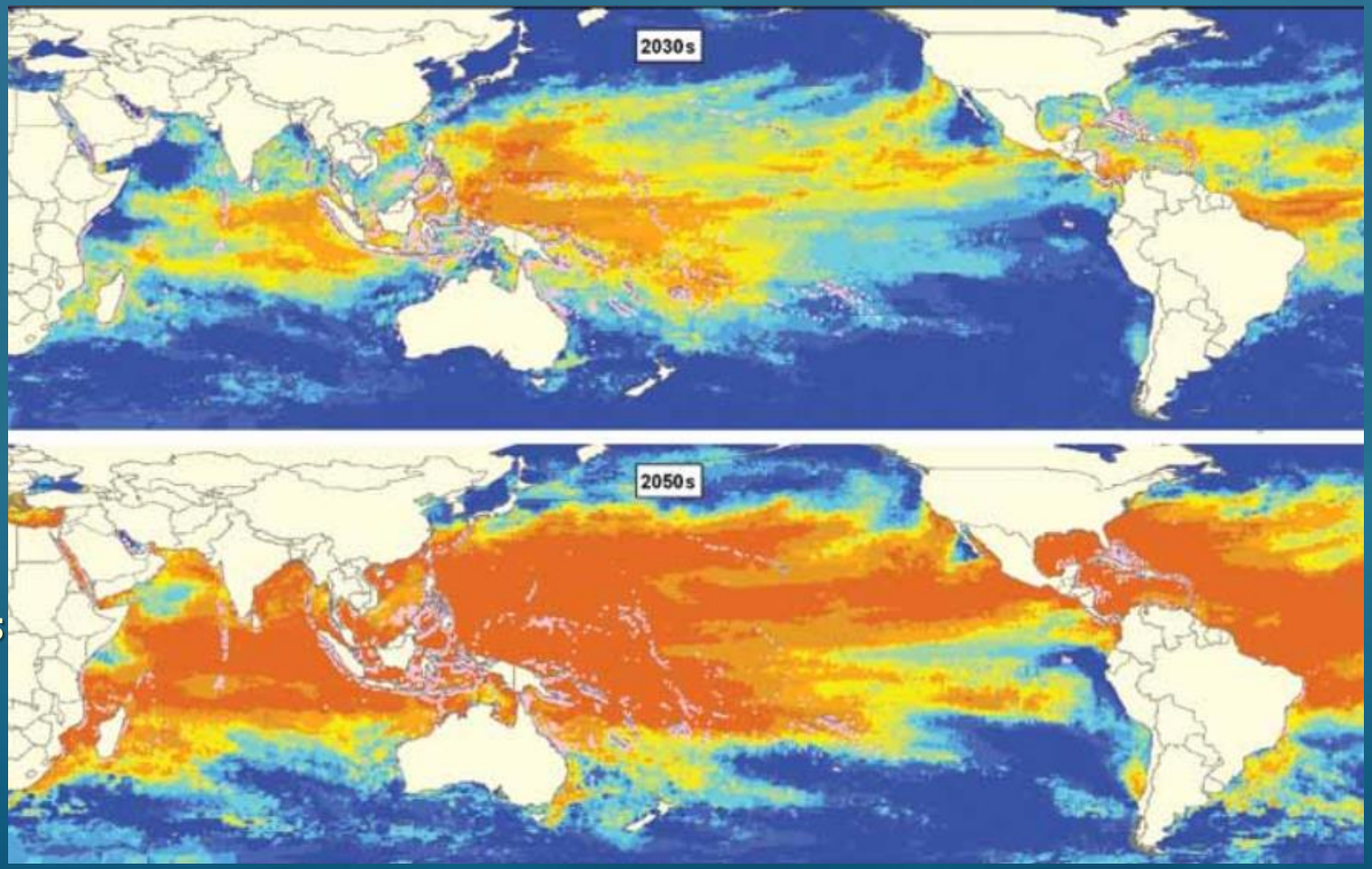


Coral Stressors – Coral Bleaching

Frequency of Future Bleaching events

2030s

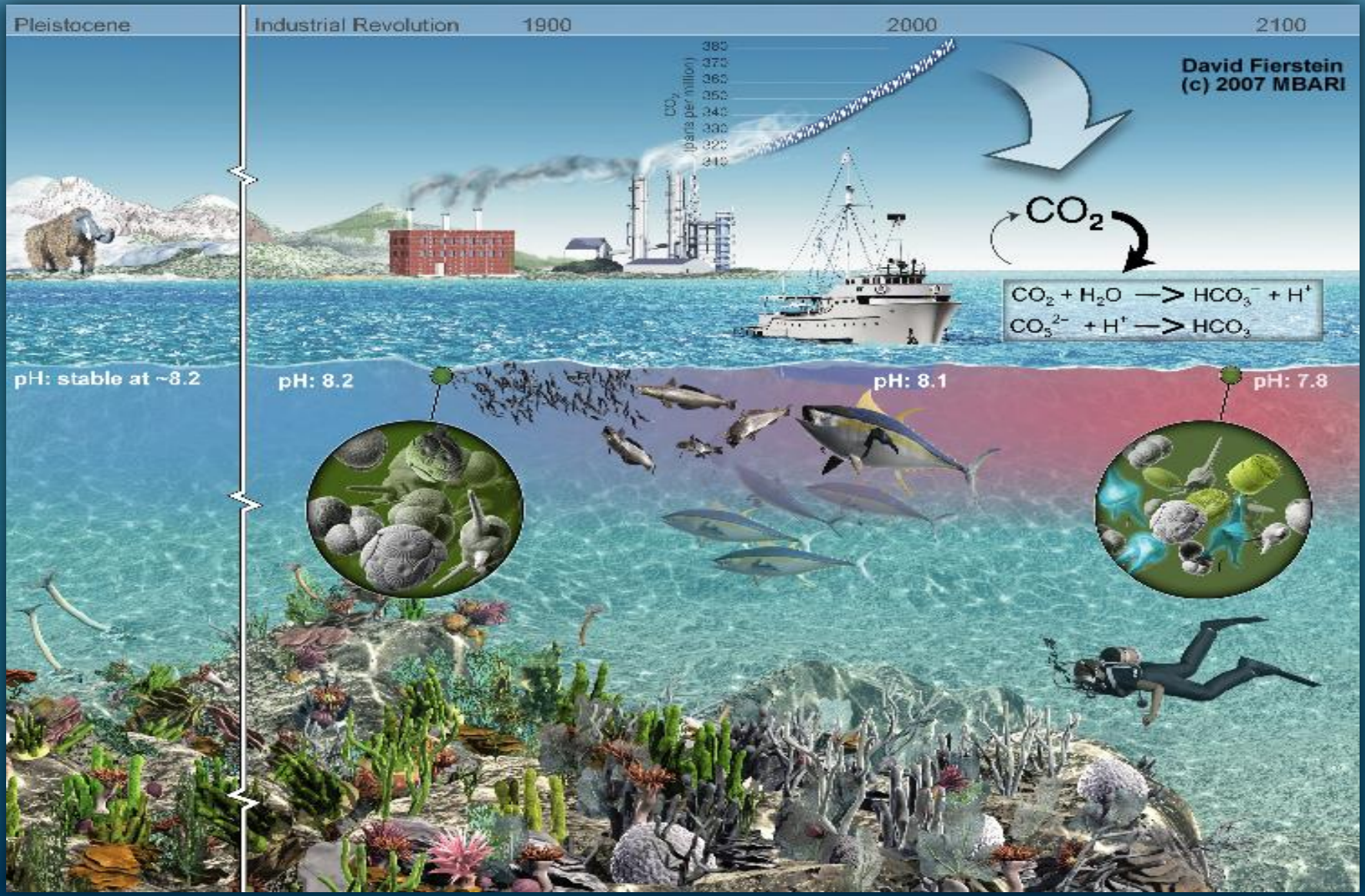
2050s



Frequency (Percent of Years) of NOAA Bleaching Alert Level 2 Events

0 -10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100

Coral Stressors – Ocean Acidification

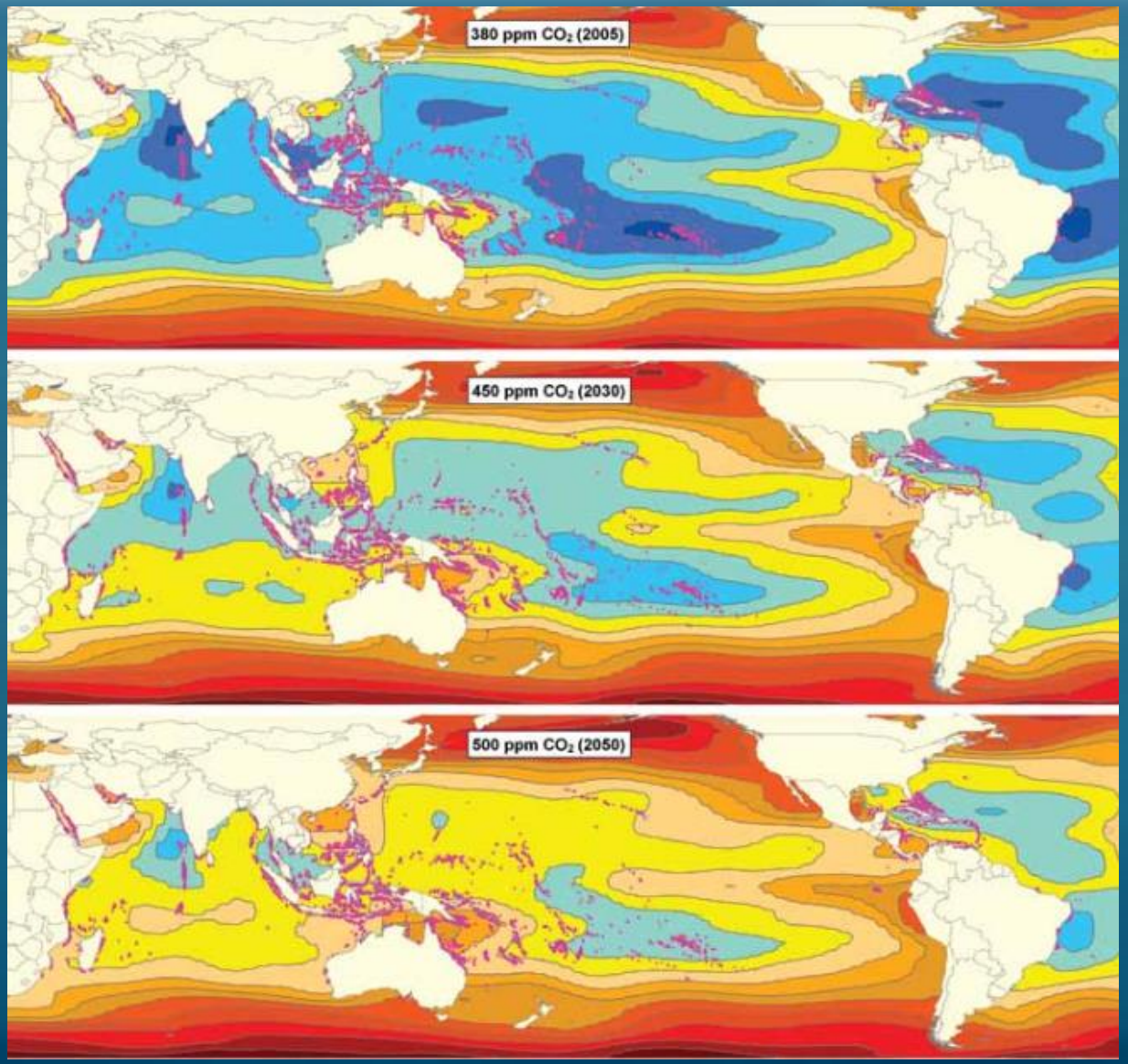


Coral Stressors – Ocean Acidification

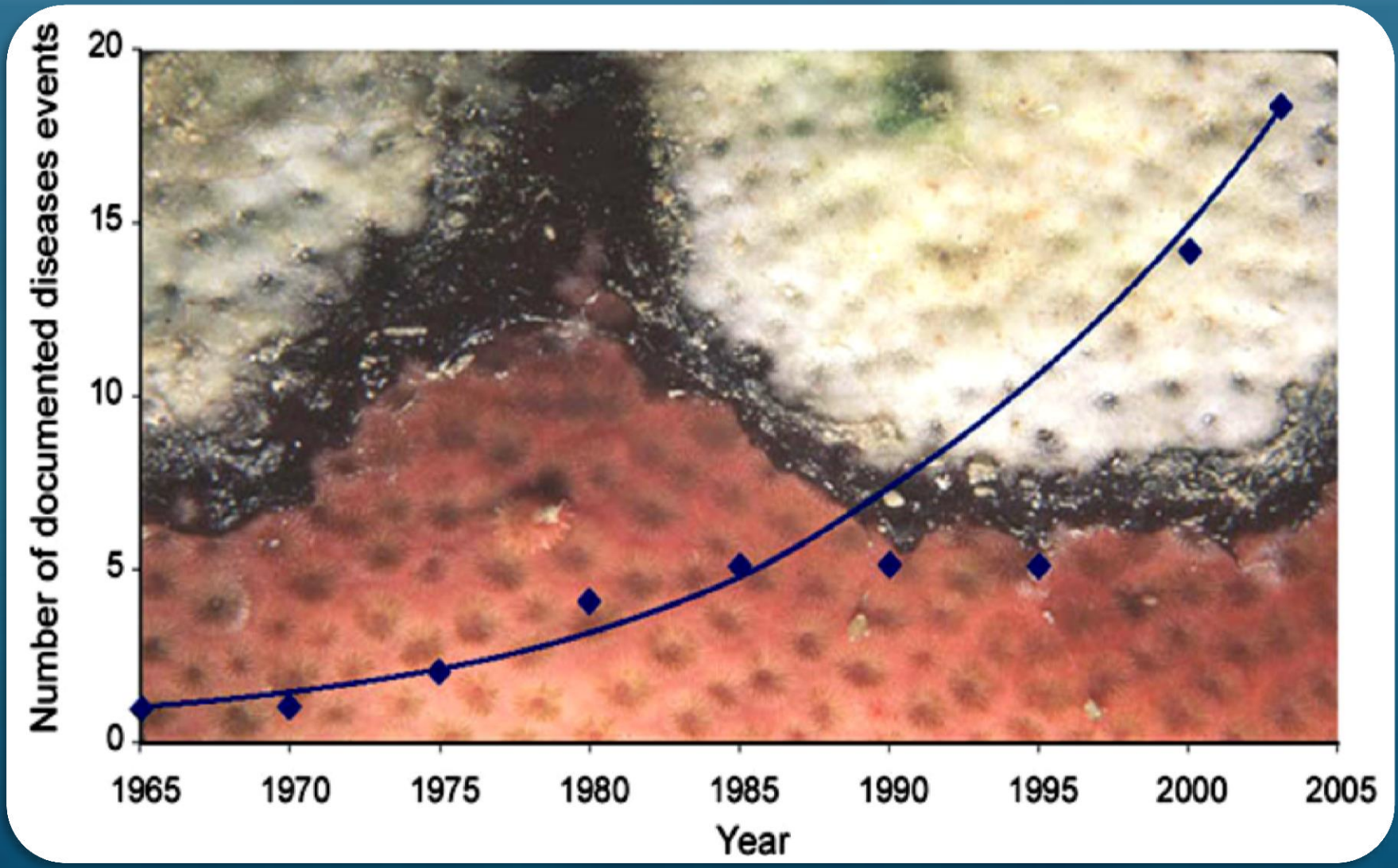
2005
380 ppm CO_2

2030
450 ppm CO_2

2050
500 ppm CO_2



Coral Stressors – Coral Diseases



(Madl's 2005 Fig. 4.5, adapted from Sutherland et al. 2004)

Coral Stressors – Coral Diseases

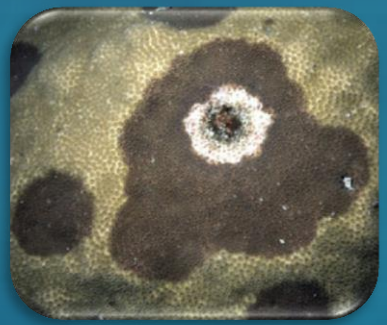
Black Band Disease (BBD)

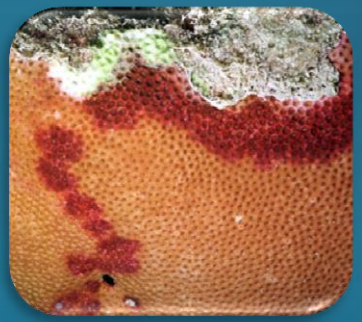
White Band Disease

White Pox Disease

White Syndrome

White Plague Disease (WPL)





Dark Spots Disease/Syndrome (DSD/S)

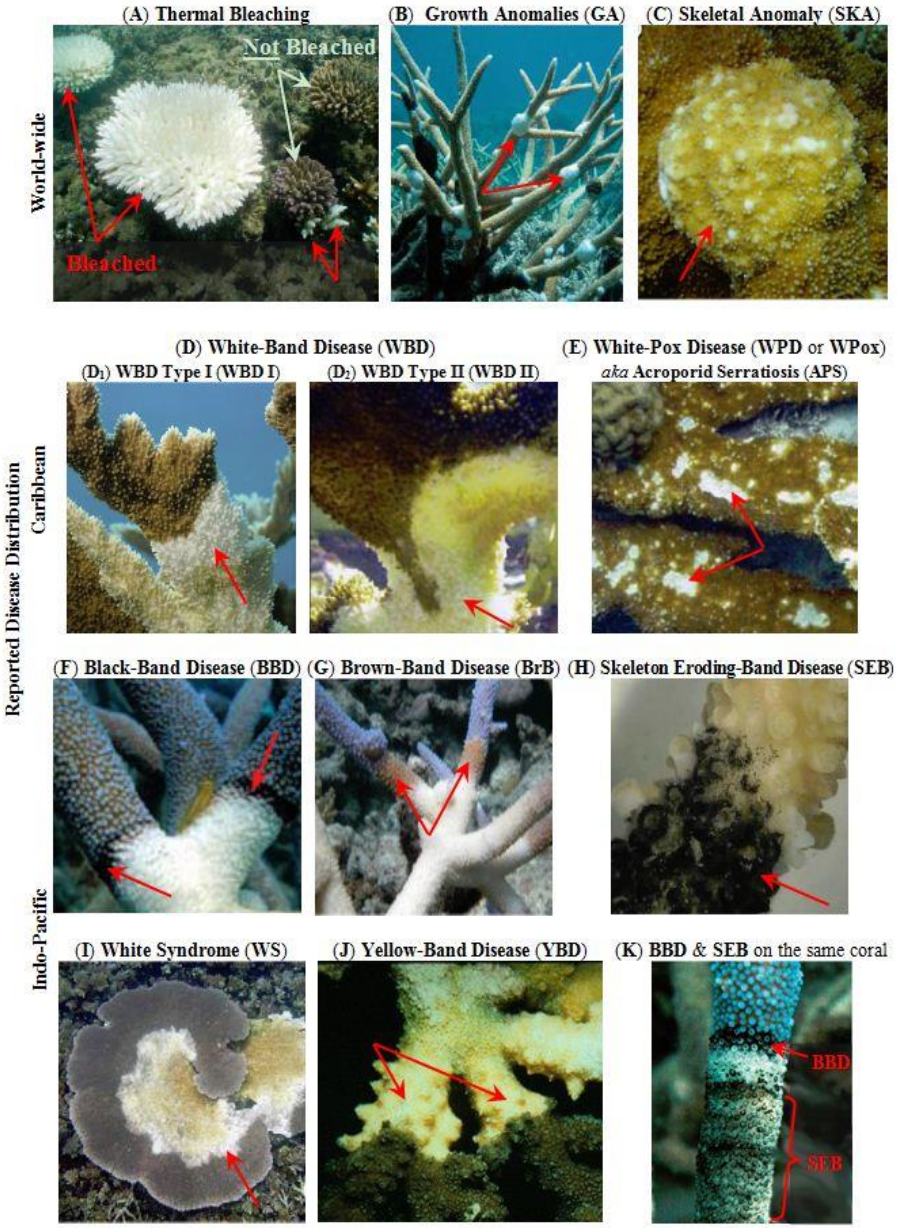
Coralline Lethal Orange Disease

Yellow Blotch Disease

Rapid Wasting Disease

Red Band Syndrome

Coral Disease Identification



1. Describe what Type of Coral is the lesion found on

Identify the general colony type according to its overall structure & if possible specify the *Genus* and *species*

(a) Massive (b) Encrusting (c) Laminar/Explanate (d) Corymbose (e) Branching/Foliaceous/Arborescent (f) Free-Living

2. Describe Where the lesions are located on the colony

(a) Apical (b) Medial (c) Basal (d) Central (e) Peripheral (f) Colony-wide

3. Describe the how the lesions are Distributed across the surface of the colony

(a) Focal (b) Multifocal (c) Multifocal to Coalescing (d) Diffuse

4. Describe the appearance of the lesion Edges

(a) Distinct (b) Indistinct (c) Annular

5. Describe the appearance of the lesion Margins

(a) Smooth (b) Serrated (c) Undulating (d) Serpiginous

6. Describe the Shape of the lesions

(a) Circular (b) Oblong (c) Pyriform (d) Cruciform (e) Linear (f) Lanceolate (g) Irregular

7. Describe any three-dimensional structure associated with the lesion (i.e. the Relief of the lesion)

(a) Umbonate (b) Bosselated (c) Nodular (d) Exophytic (e) Fimbriated

8. Describe the Color of the lesion

(a) White (b) Black (c) Tan (d) Brown (e) Red (f) Orange (g) Yellow (h) Green (i) Blue (j) Purple (k) Pink

9. Describe the Size of the lesions

(a) Small (b) Medium (c) Large (d) Physical Measurement

10. Describe the Number of lesions on the colony

(a) Small (b) Medium (c) Large (d) Actual Count

11. Lesion Texture

(a) Rugose
(b) Smooth

12. Lesion Extent (% of Surface Area Covered)

(a) Mild (< 20%)
(b) Moderate (21-50%)
(c) Severe (> 50%)

13. Time (Rate of Lesion Onset)

(a) Acute (hours – days)
(b) Sub-Acut (weeks)
(c) Chronic (months – years)

14. Tentative Categorization of Lesion

(a) Tissue Loss (b) Discoloration (c) Growth Anomaly

15. Structures of the Coral Affected by the Lesion

(a) Polyp (b) Coenosarc (c) Skeleton

White-Band Disease (WBD)

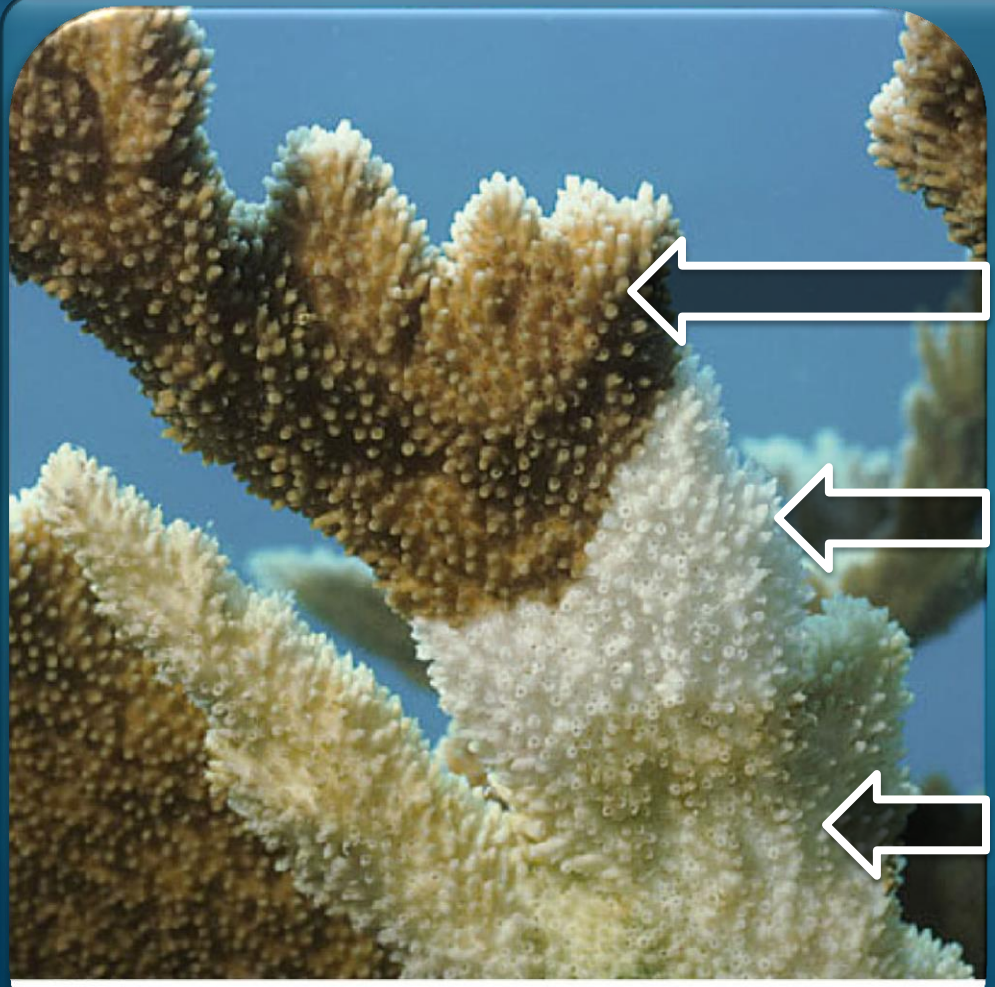


Fig.4.19: WBD; Caribbean *Acropora palmata* infected with WBD-I.
Sutherland et al, 2004

Healthy Tissue

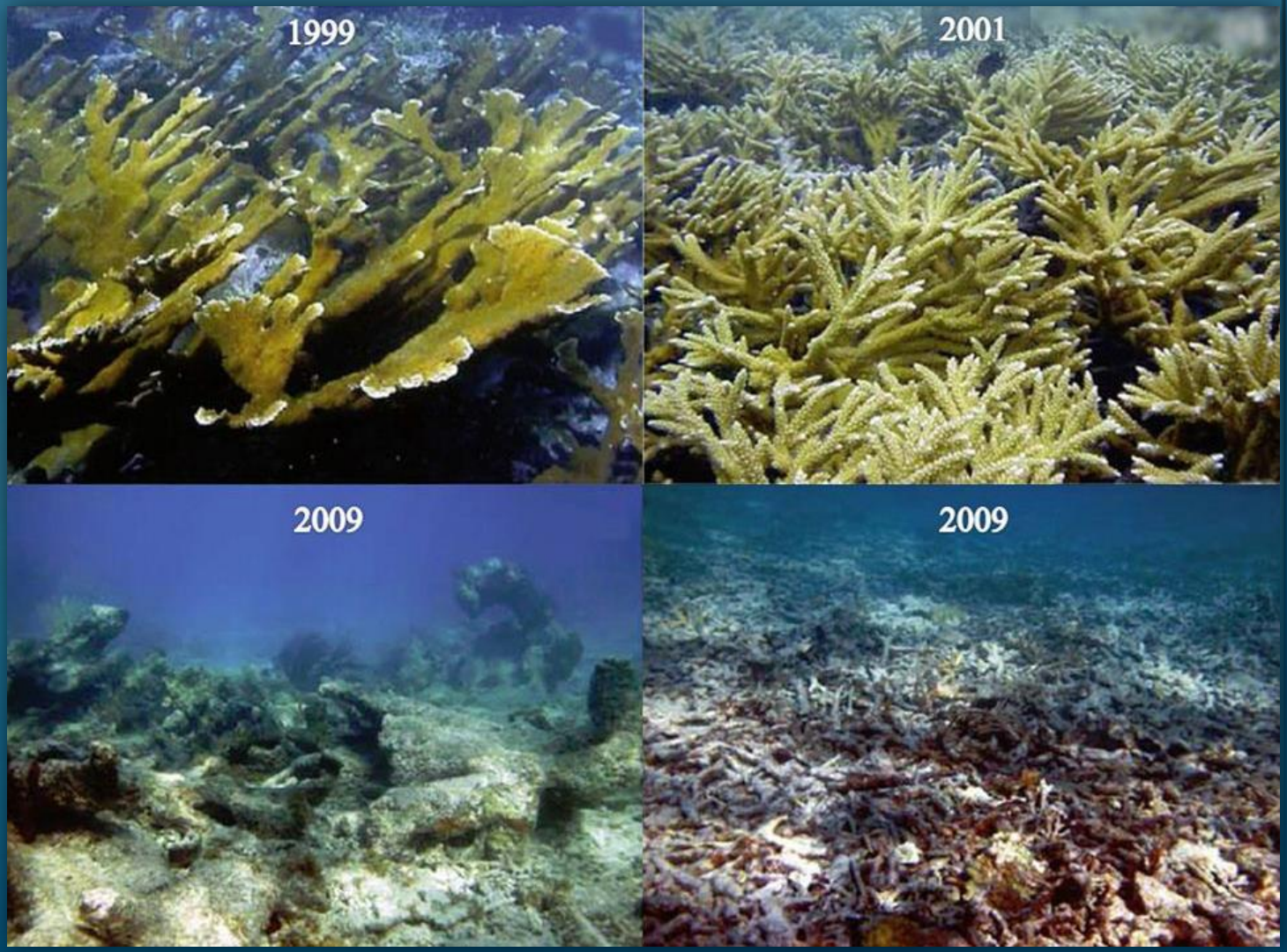
Active WBD

Recently Dead tissue
killed by WBD

95% decline in Caribbean *Acropora*

Healthy Coral Thickets

Algal Dominated Reef Ruble



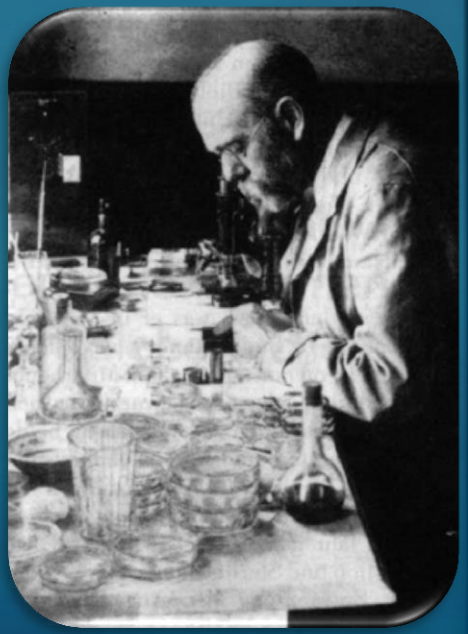
Epidemiologic Models & Etiologic Diagnoses

Assume the **Etiology** (cause of disease) involves a **microbes**

Koch's Postulates

To definitively state the cause of a disease as a specific microbe, the following rules must be adhered to:

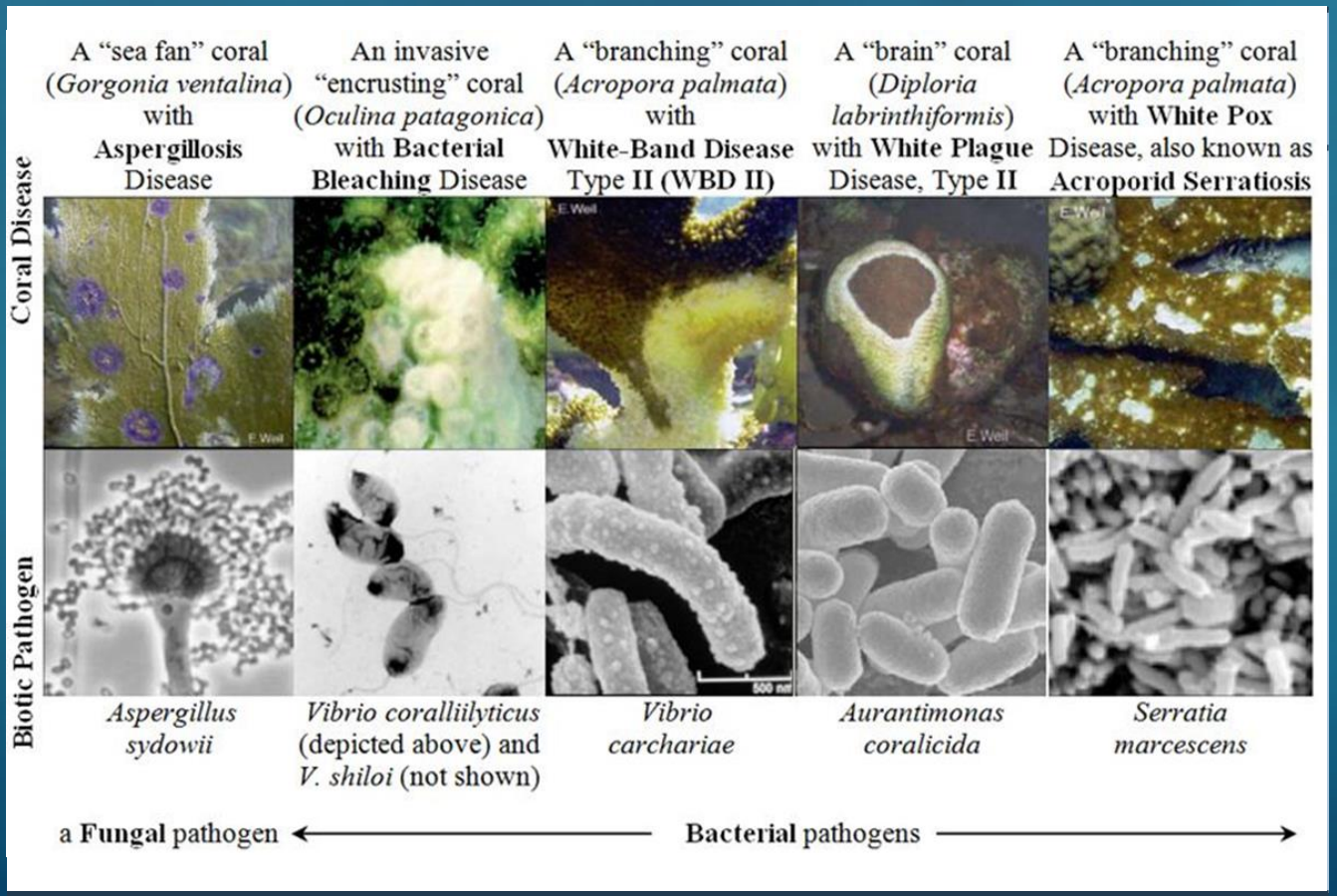
1) The microbe must be present in all known cases of the disease, but not present in healthy (non-diseased) organisms
2) The microbe must be able to be isolated from the diseased organism & grown in pure culture in the lab
3) Experimental Infection: This lab grown microbe must cause the same disease when instilled in a healthy organism
4) The microbe must then be able to be isolated from the diseased organism & grown in pure culture from the experimental infection in the lab

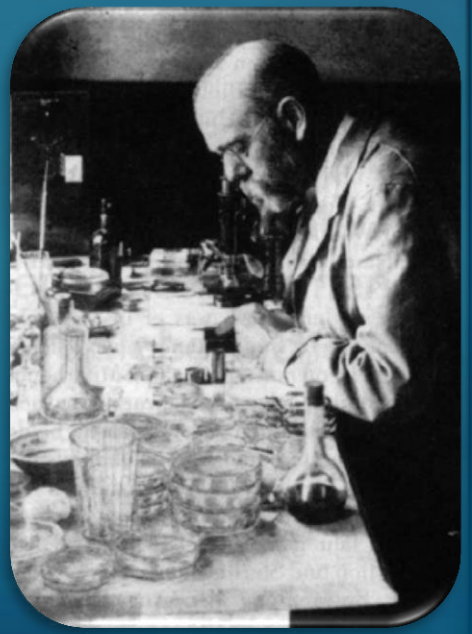


Epidemiologic Models & Etiologic Diagnoses

Assume the **Etiology** (cause of disease) involves a **microbes**

Koch's Postulates



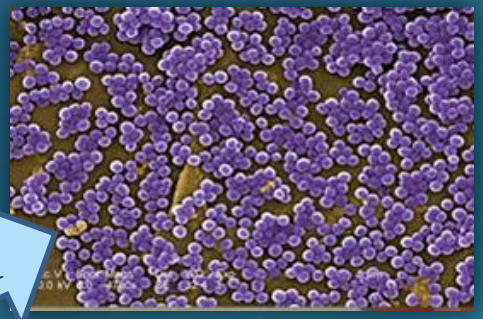


Epidemiologic Models & Etiologic Diagnoses

Assume the **Etiology** (cause of disease) involves a **microbes**

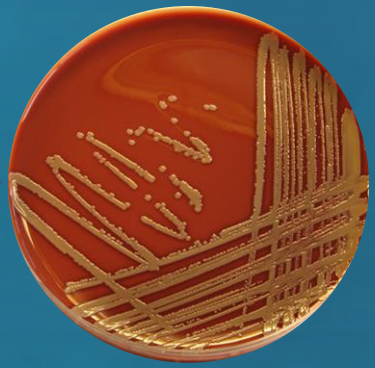
Patient's Injury

Gram Stain



Gram-positive

culture



Staphyloccus aureus

Diagnosis: **Staph Infection**

Treatment: **Antibiotics**

Epidemiologic Models & Etiologic Diagnoses

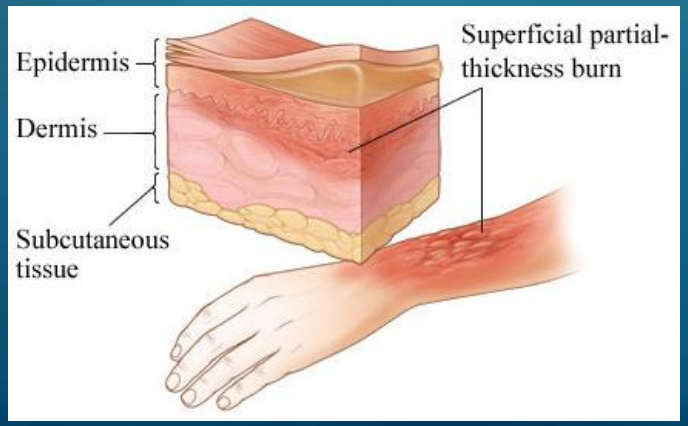
Assume the **Etiology** (cause of disease) involves a **microbes**

Patient's Injury

Background

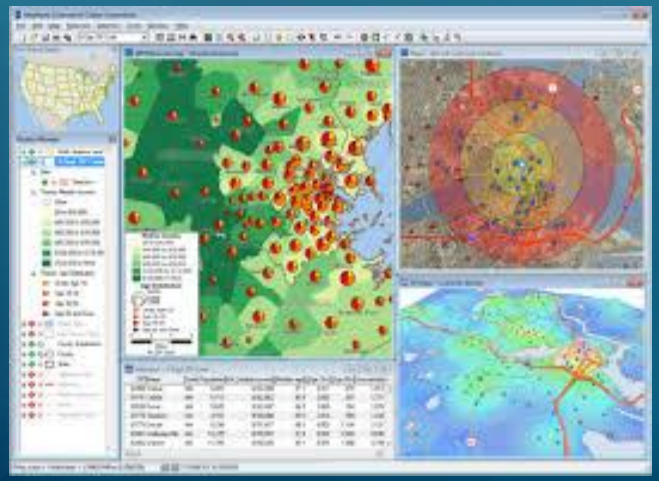
Patient History

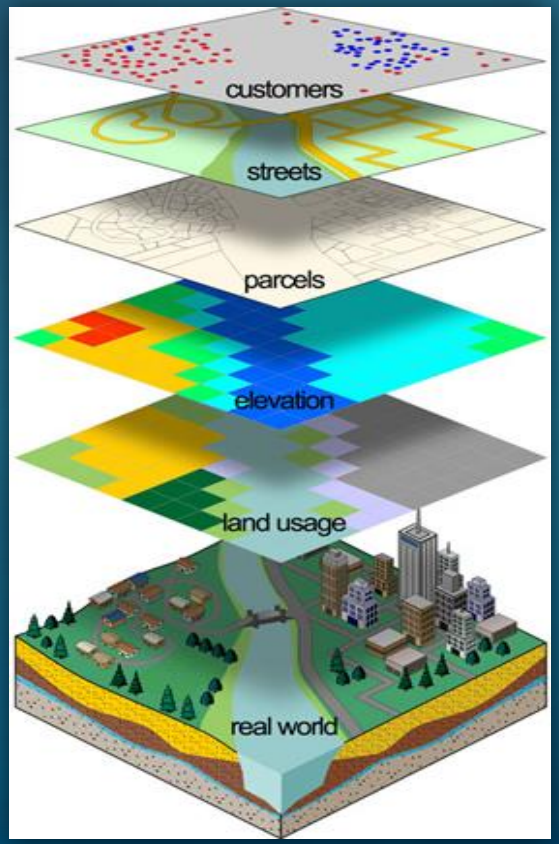
Diagnosis: **2nd Degree Burn**

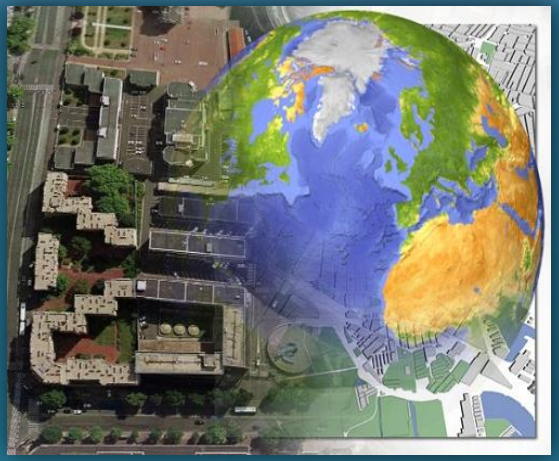


Geographic Information Systems

Spatial Analysis



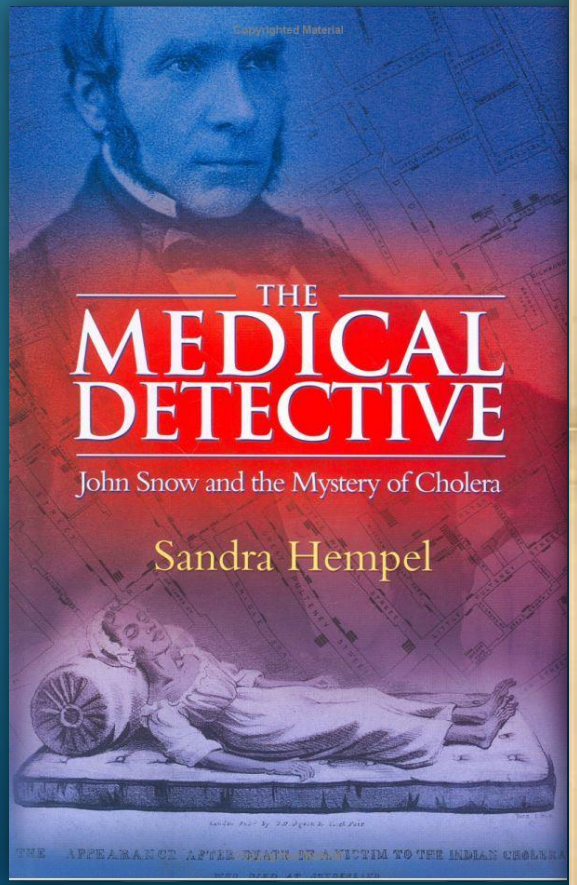


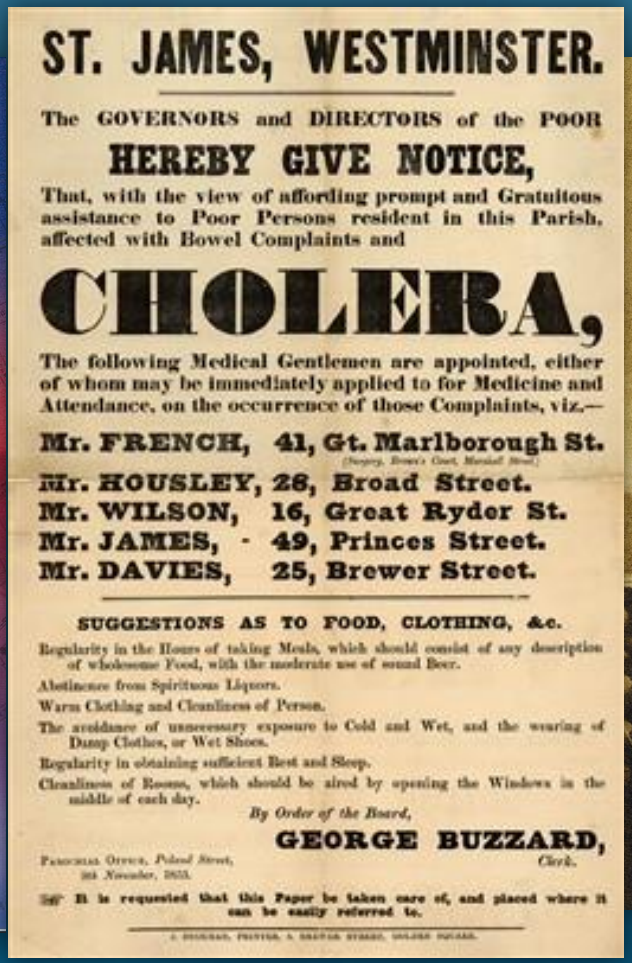


Remote Sensing

Dr. John Snow (1813-1858)

"Father of Modern Epidemiology"





ST. JAMES, WESTMINSTER.

The GOVERNORS and DIRECTORS of the POOR

HEREBY GIVE NOTICE,

That, with the view of affording prompt and Gratuitous assistance to Poor Persons resident in this Parish, affected with Bowel Complaints and

CHOLERA,

The following Medical Gentlemen are appointed, either of whom may be immediately applied to for Medicine and Attendance, on the occurrence of those Complaints, viz.—

Mr. FRENCH, 41, Gt. Marlborough St.
(Surgery, Brewer's Court, Marshall Street)
Mr. HOUSLEY, 26, Broad Street.
Mr. WILSON, 16, Great Ryder St.
Mr. JAMES, 49, Princes Street.
Mr. DAVIES, 25, Brewer Street.

SUGGESTIONS AS TO FOOD, CLOTHING, &c.

Regularity in the Hours of taking Meals, which should consist of any description of wholesome Food, with the moderate use of sound Beer.

Abstinence from Spirituous Liquors.

Warm Clothing and Cleanliness of Person.

The avoidance of unnecessary exposure to Cold and Wet, and the wearing of Damp Clothes, or Wet Shoes.

Regularity in obtaining sufficient Rest and Sleep.

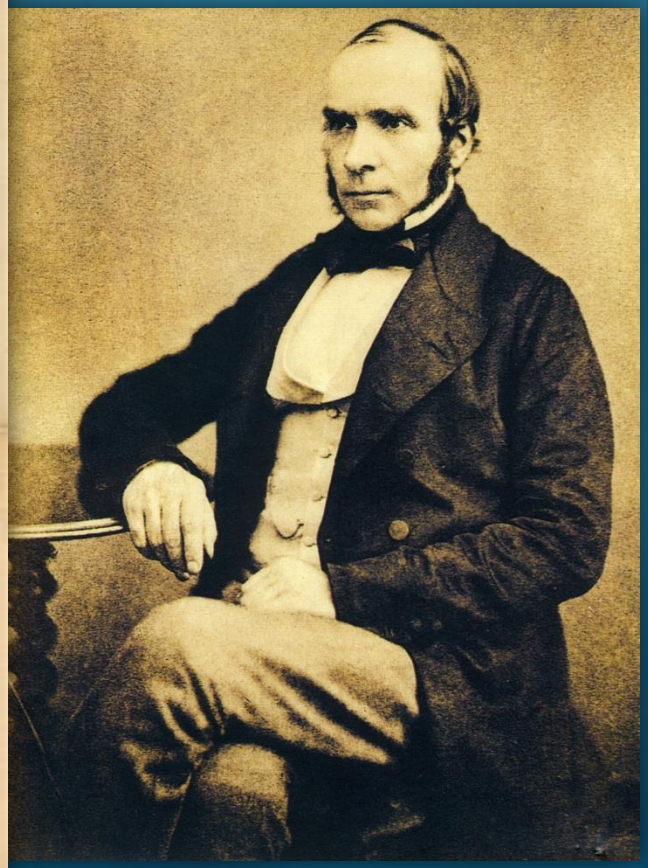
Cleanliness of Rooms, which should be aired by opening the Windows in the middle of each day.

By Order of the Board,

GEORGE BUZZARD,
Clerk.

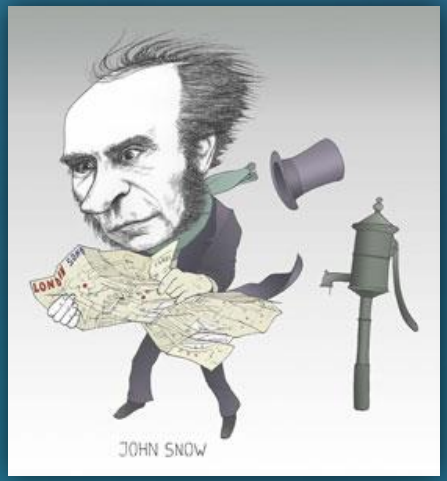
PAROCHIAL OFFICE, *Poland Street,*
8th November, 1853.

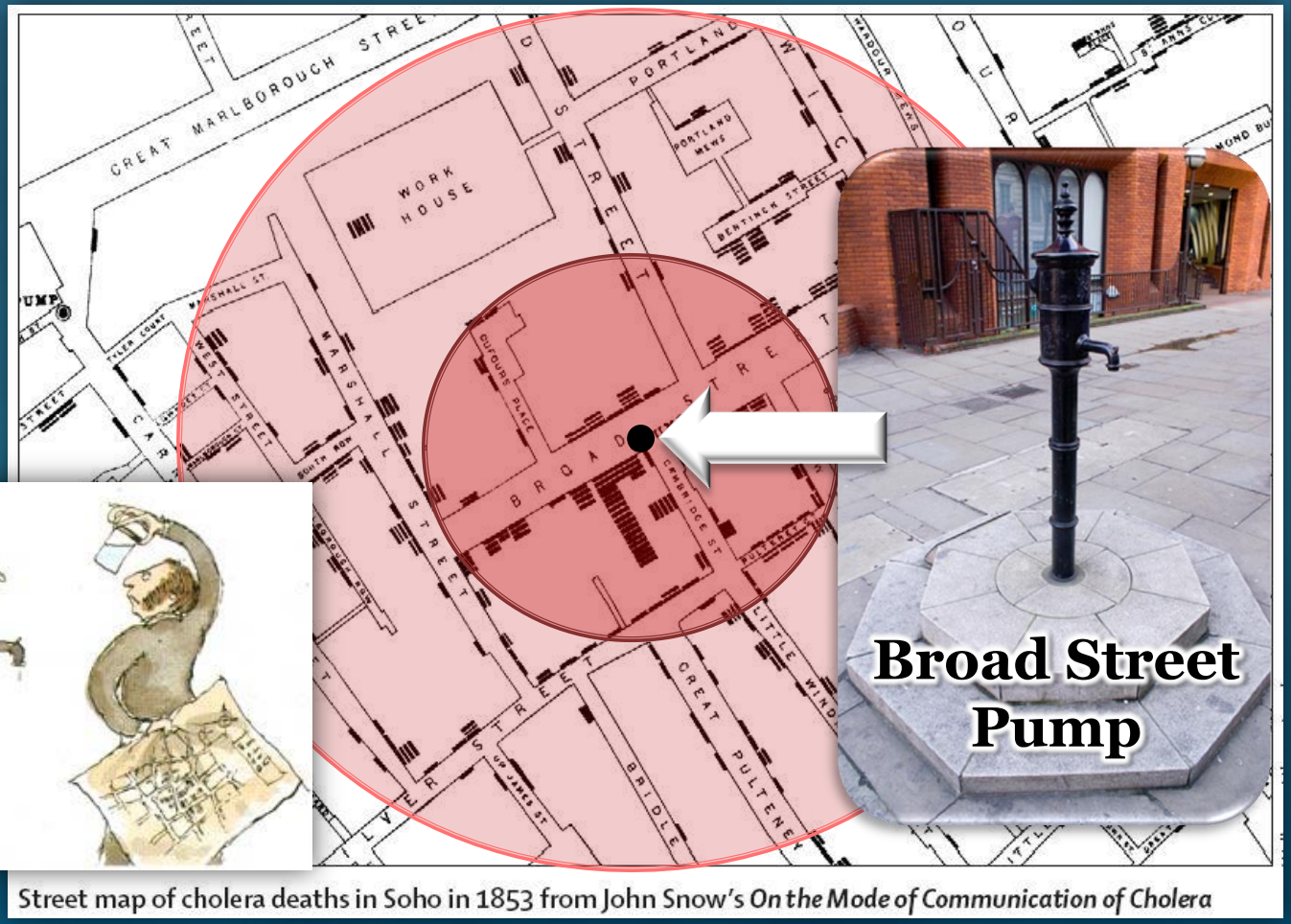
☞ It is requested that this Paper be taken care of, and placed where it can be easily referred to.



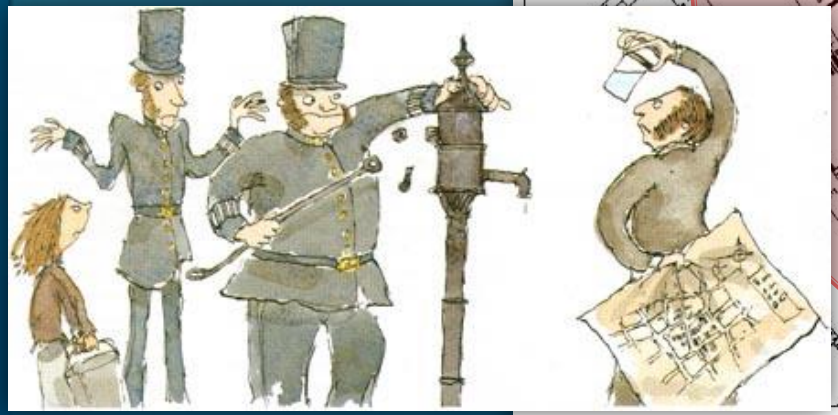
Dr. John Snow (1813-1858)

"Father of Medical Geography"

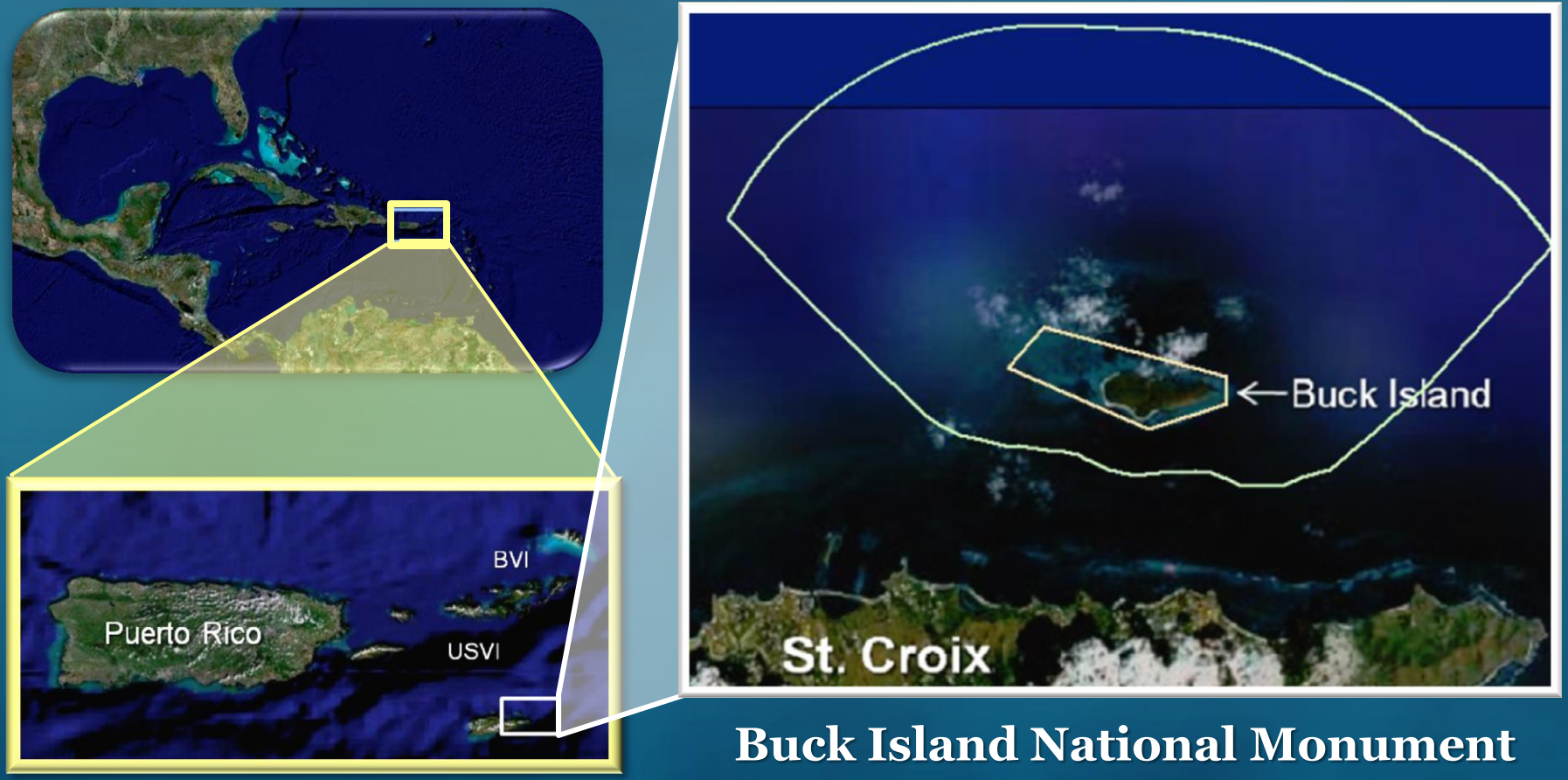




Street map of cholera deaths in Soho in 1853 from John Snow's *On the Mode of Communication of Cholera*

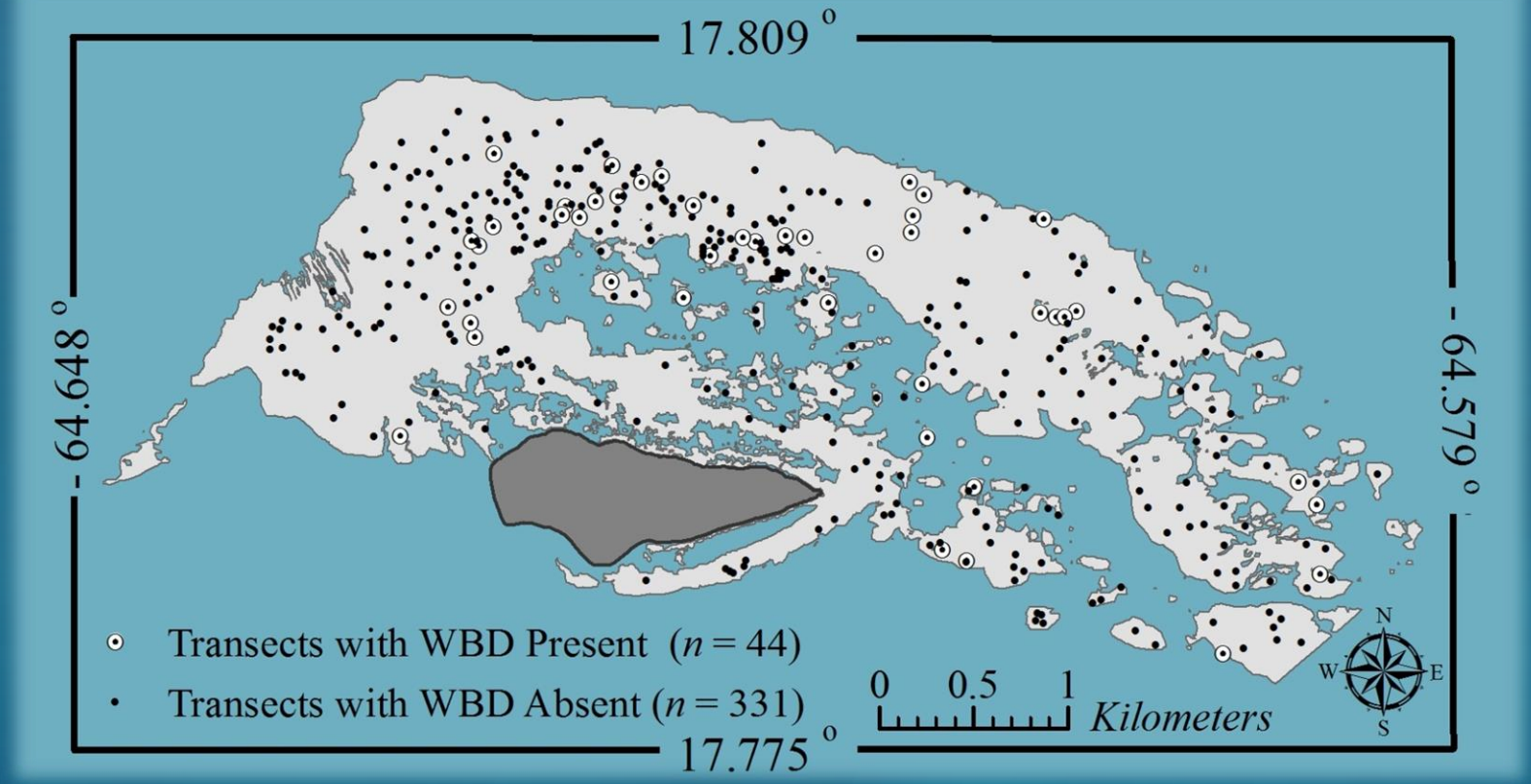


Study Site



Buck Island National Monument

WBD Outbreak at Buck Island



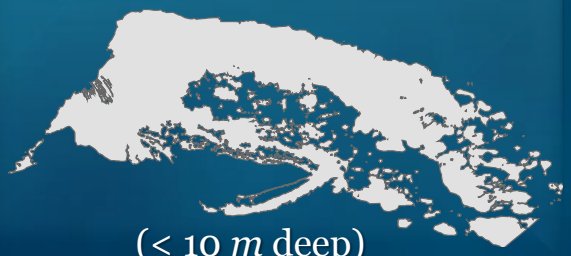
Buck Island Reef
National Monument

US Virgin Islands

Colony-Level Data

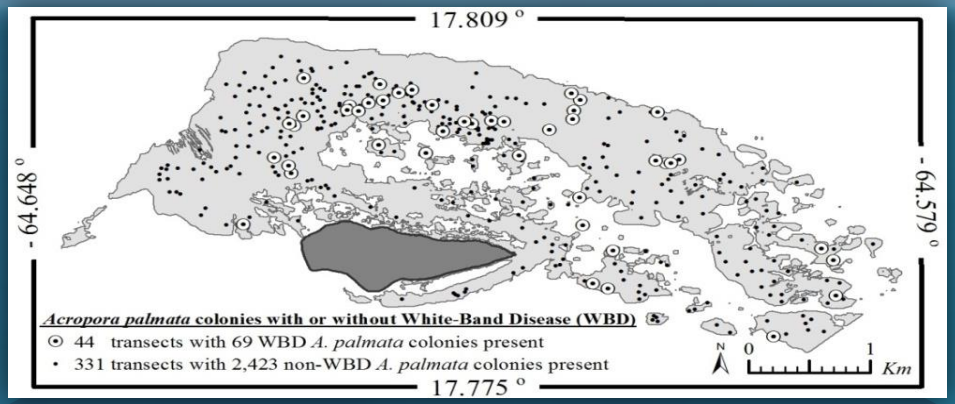
A. palmata	Min	Max	Mean	S.D.	Total
with WBD	1	6	1.57	1.16	69
without WBD	1	40	6.48	5.87	2,423
Total	1	40	6.65	5.99	2,492

Surveyed Habitat



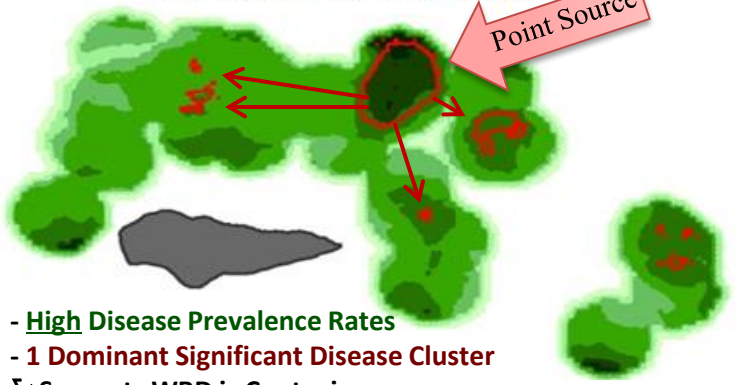
(< 10 *m* deep)

WBD Outbreak at Buck Island

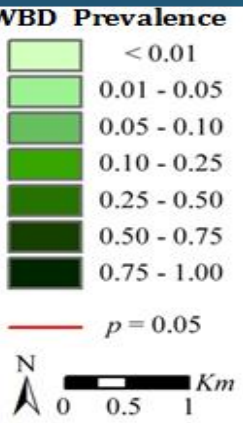


Transect versus Colony-Level Spatial Analysis of White-Band Disease (WBD) Prevalence

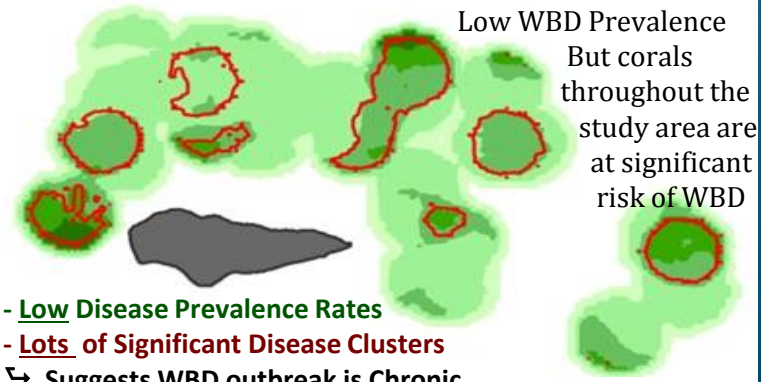
Transect-Level Analysis



- High Disease Prevalence Rates
- 1 Dominant Significant Disease Cluster
  ↳ Suggests WBD is Contagious
  & spreading out from Point source location



Colony-Level Analysis

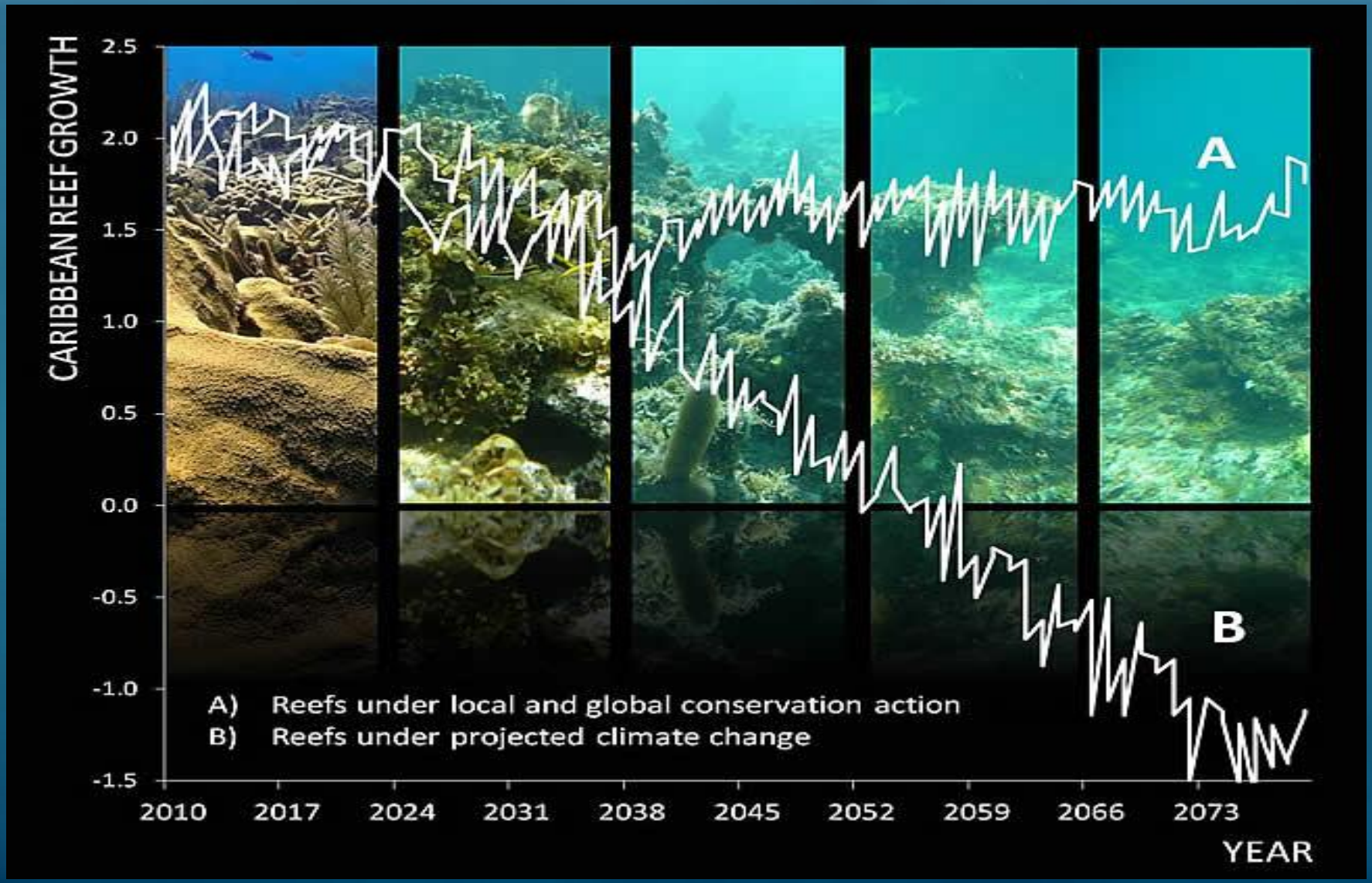


Low WBD Prevalence
But corals throughout the study area are at significant risk of WBD

- Low Disease Prevalence Rates
- Lots of Significant Disease Clusters
  ↳ Suggests WBD outbreak is Chronic
  & likely caused by a ubiquitous stressor

What Can Be Done to Help Corals?

What Can Be Done to Help Corals?



What Can Be Done to Help Corals?