

Doomsday versus Hope

Research and messaging for coral reef response to climate change

(15-20 minutes)

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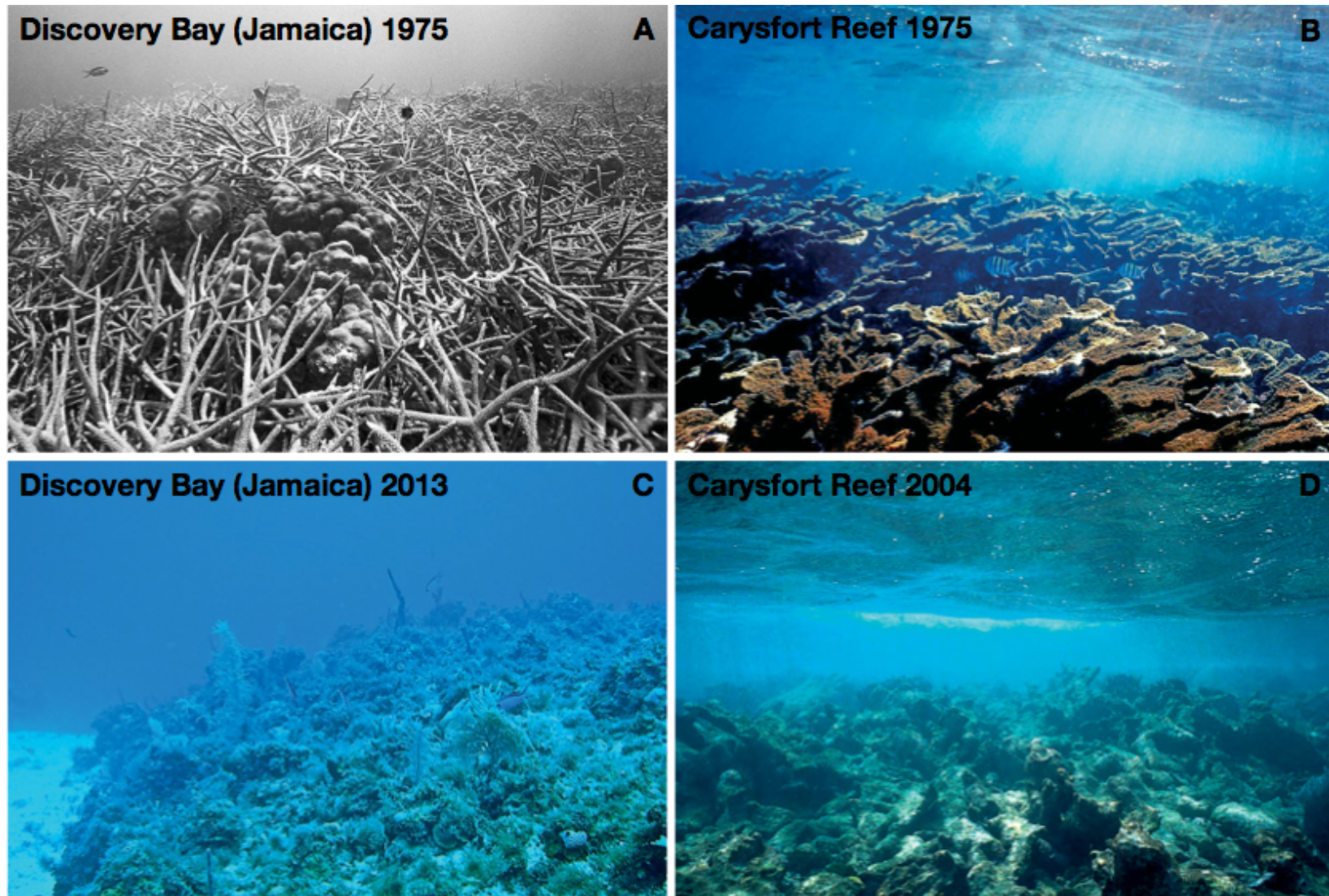
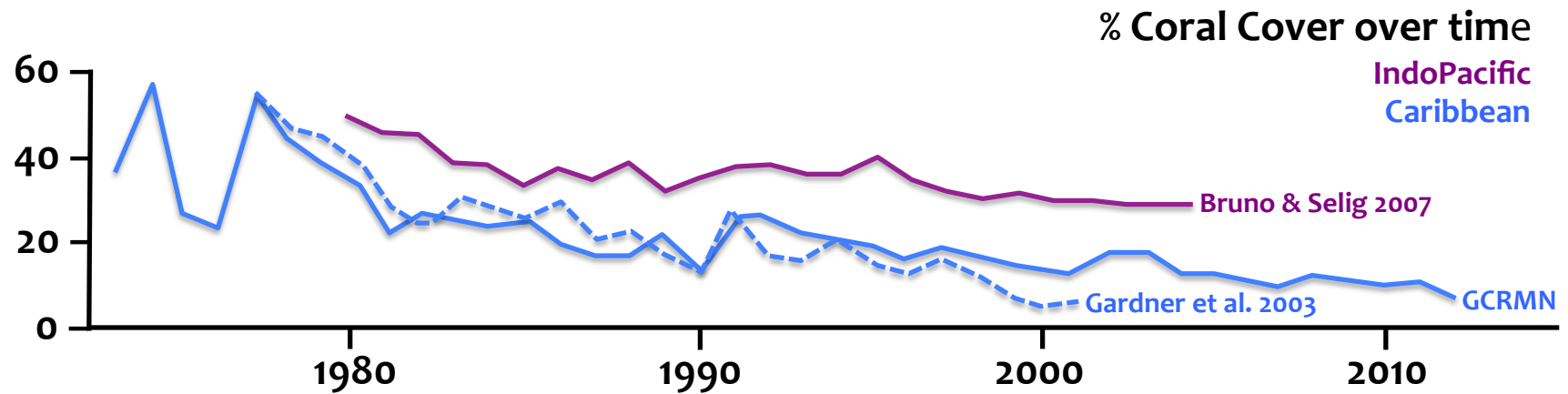
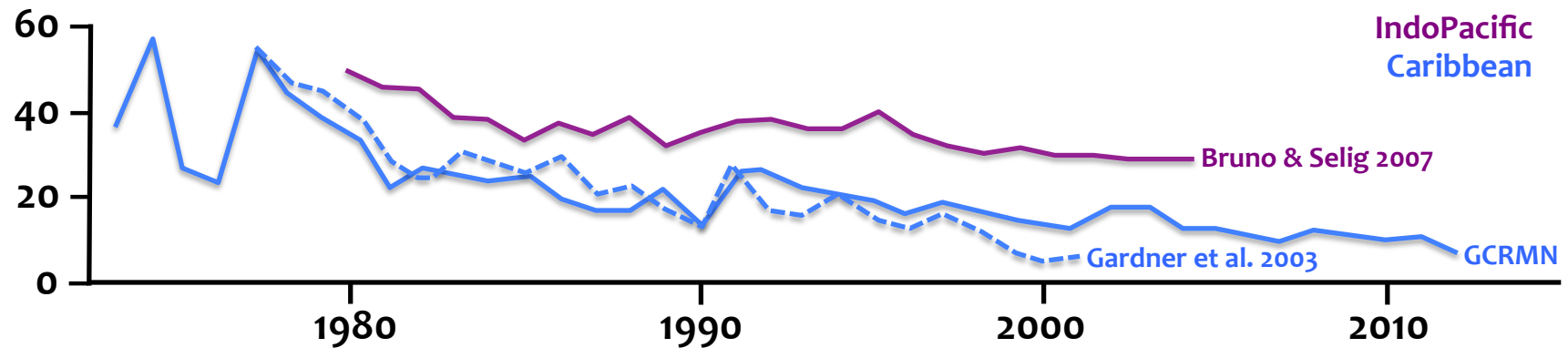


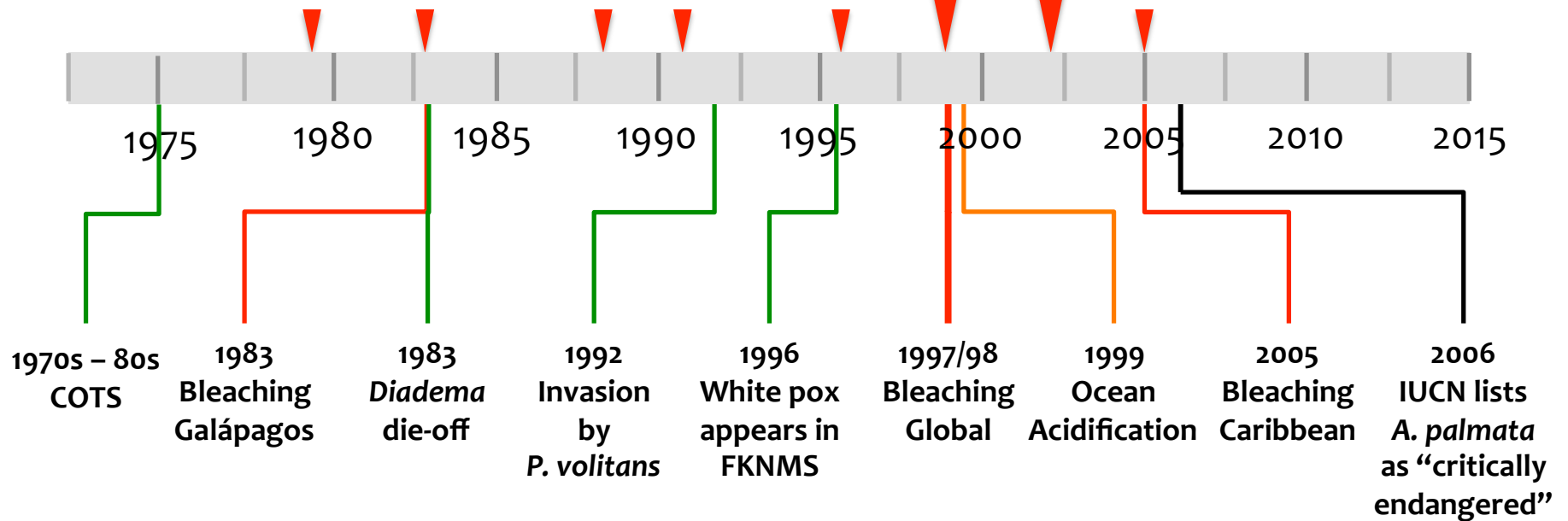
FIGURE 2. Phase shift from dominance by corals to dominance by macroalgae on the shallow fore-reefs in the northern Florida Keys and north coast of Jamaica. (A) Discovery Bay, Jamaica in 1975 and (C) the same location in 2013. (B) Carysfort Reef within the Florida Keys National Marine Sanctuary in 1975 and (D) in 2004 ((A, B, D by Phillip Dustan, and C by Robert Steneck).

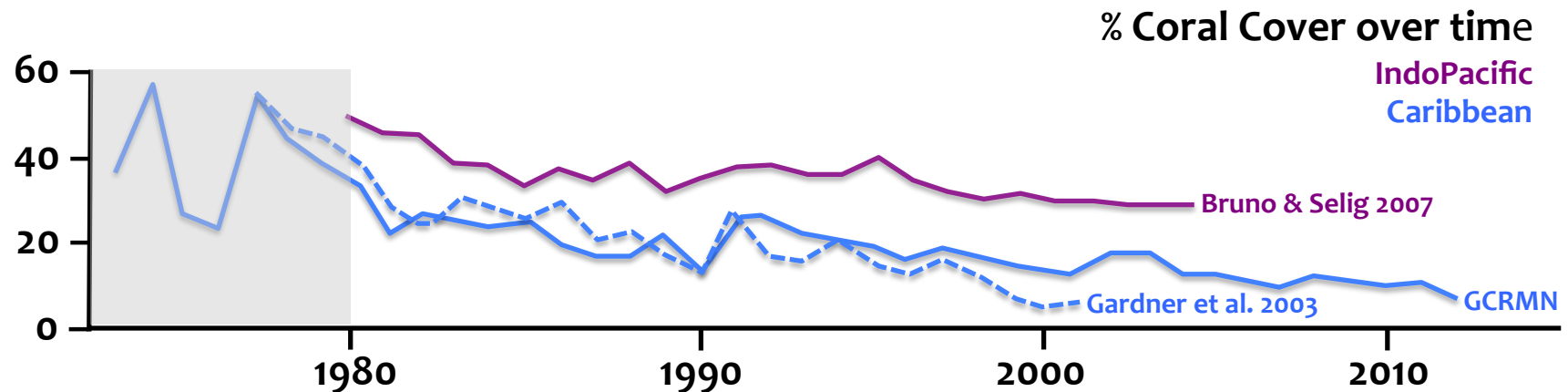


% Coral Cover over time



Severe decline in Caribbean

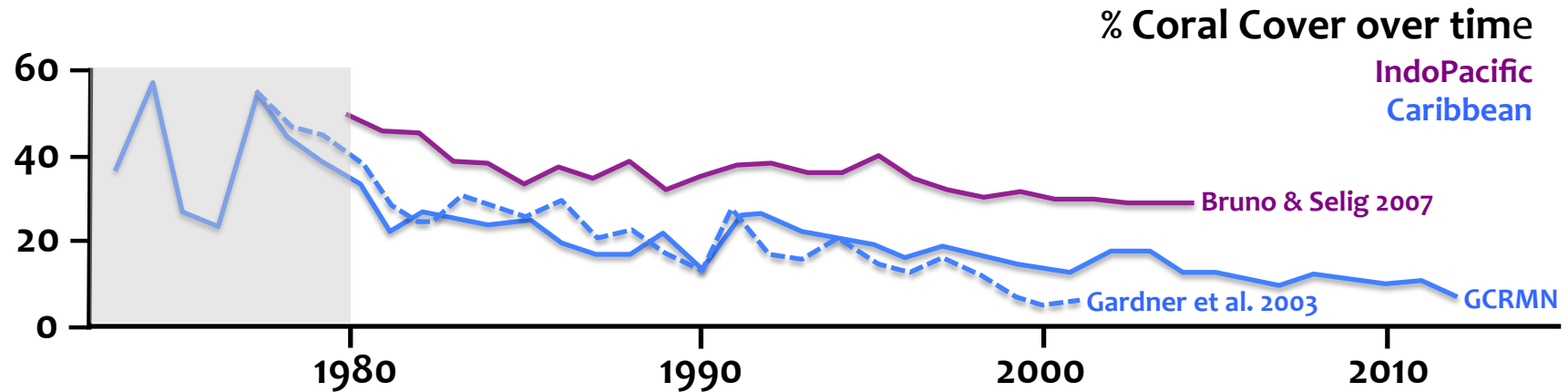




Resilience

Predominant thinking during early phases of reef research:

- Coral reefs are **RESILIENT**
- Major causes of coral loss were cyclones or biological invasions, but most reefs bounced back
- Reef ecosystems thrive in warm water, so they are likely to expand poleward with climate change



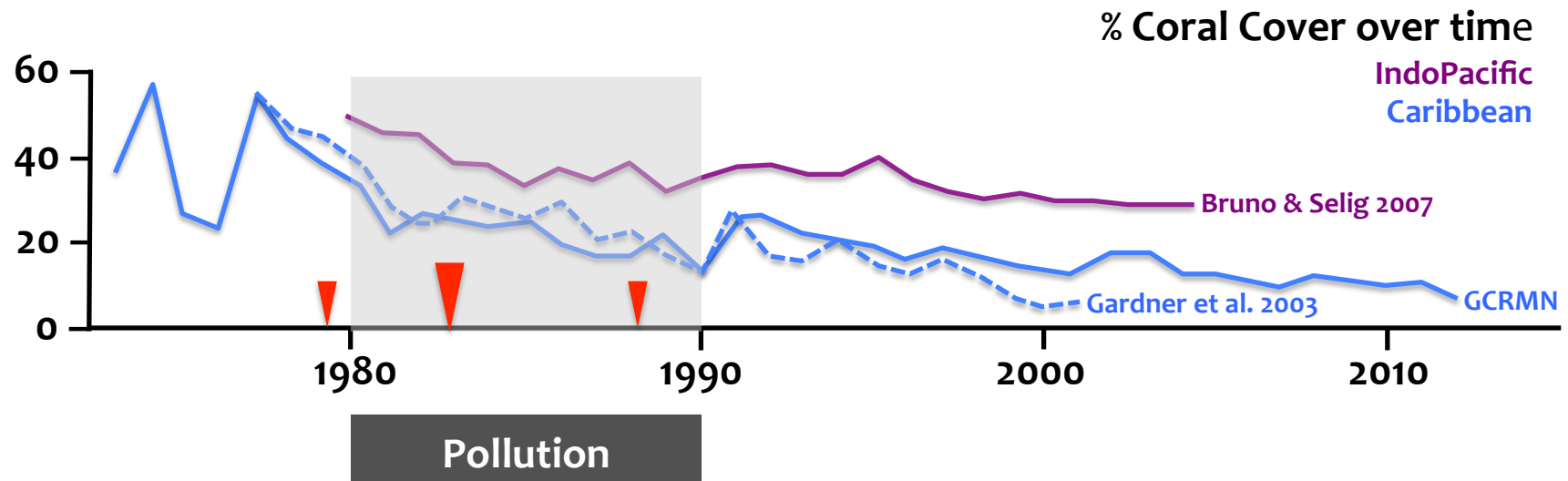
Corallivore: *Acanthaster planci*

Crown-of-thorns starfish

Population explosions and dramatic predation on live corals

Indo-Pacific, especially the Great Barrier Reef

Huge debates about causes – the outbreaks continue

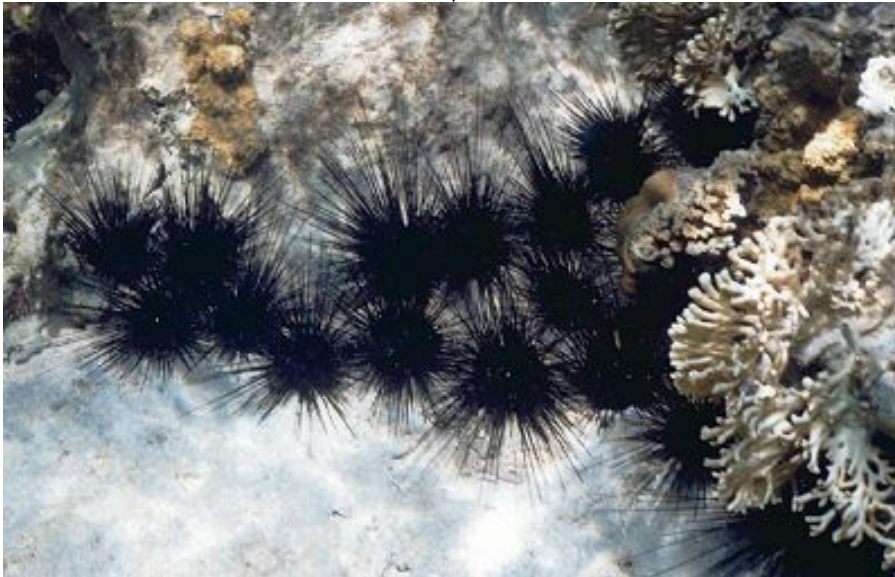
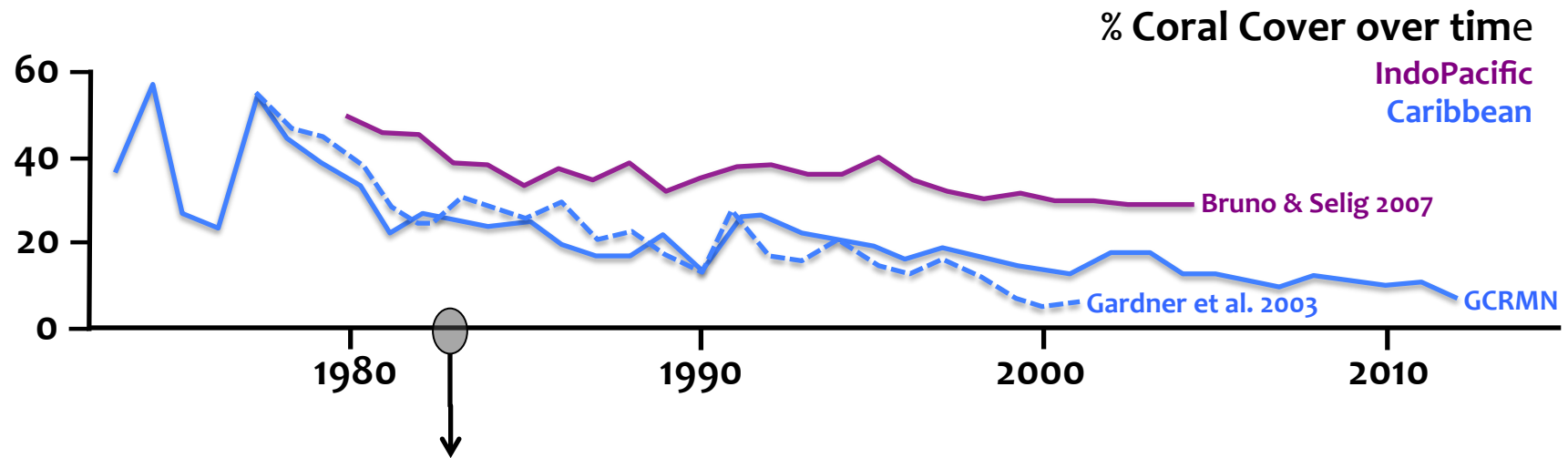


Reef degradation is occurring

Land-based sources of pollution are most commonly
blamed

Key species (sea urchin) is nearly wiped out

Coral bleaching comes on the radar – El Niño becomes a
lab-hold word



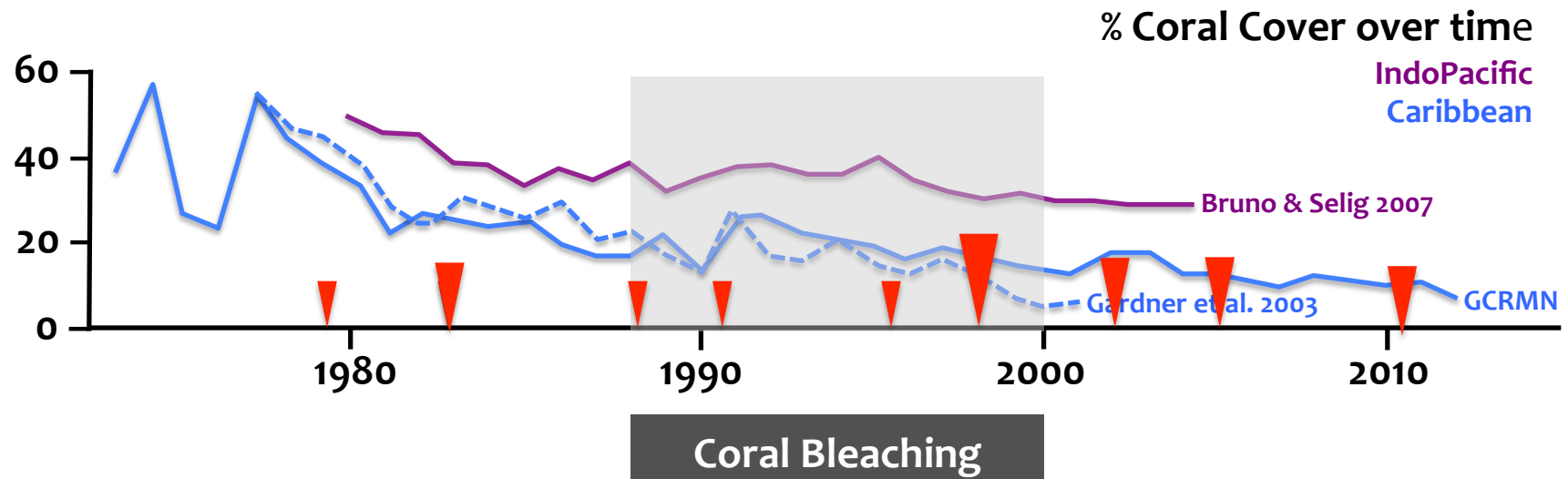
Key herbivore: *Diadema antillarum*

Long-spined sea-urchin

97% mortality of urchins from disease – surprisingly slow recovery

Caribbean only

Led to algal overgrowth of many reefs, and ecological phase shifts

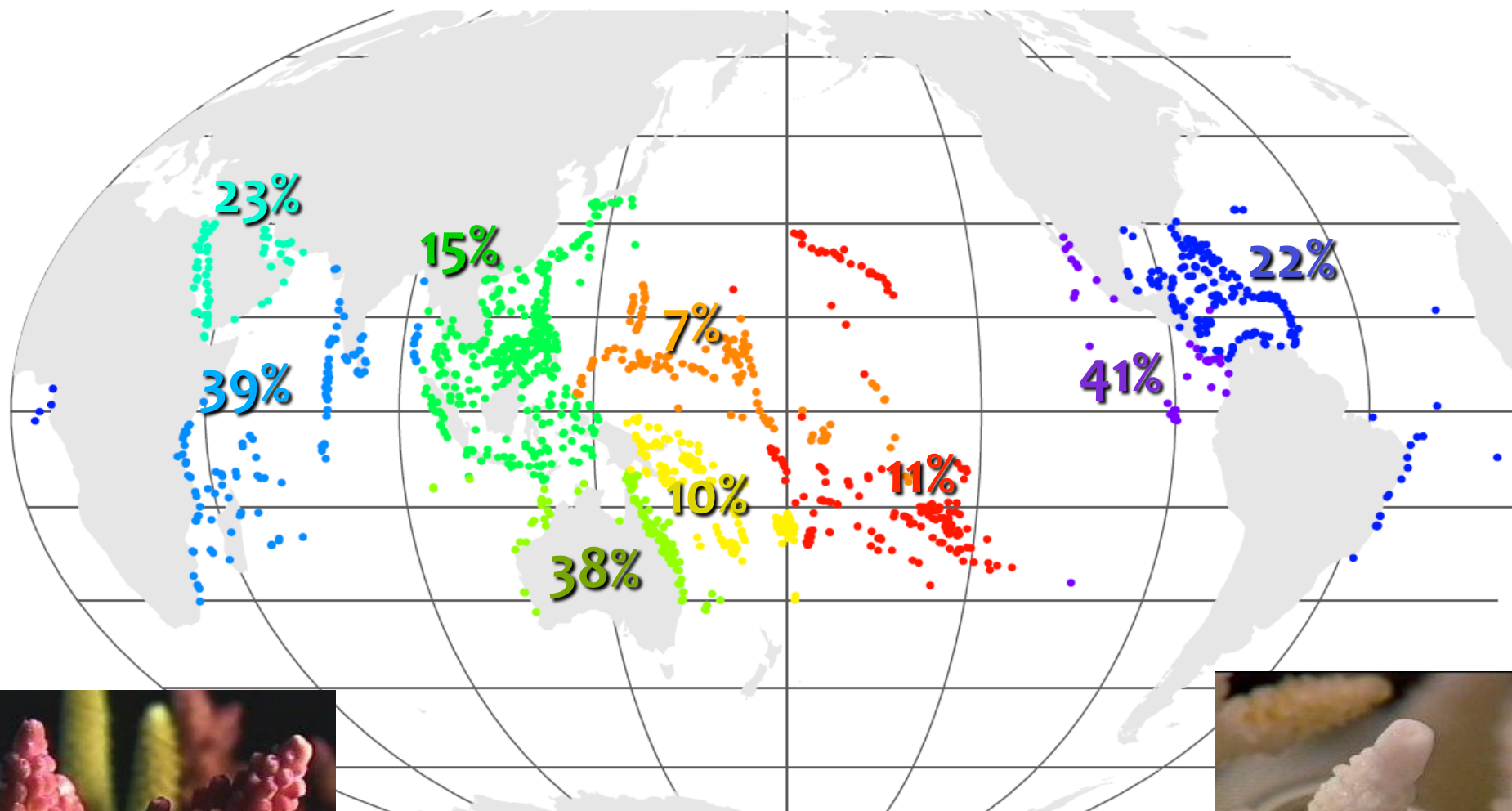


Increasing and more widespread coral bleaching events

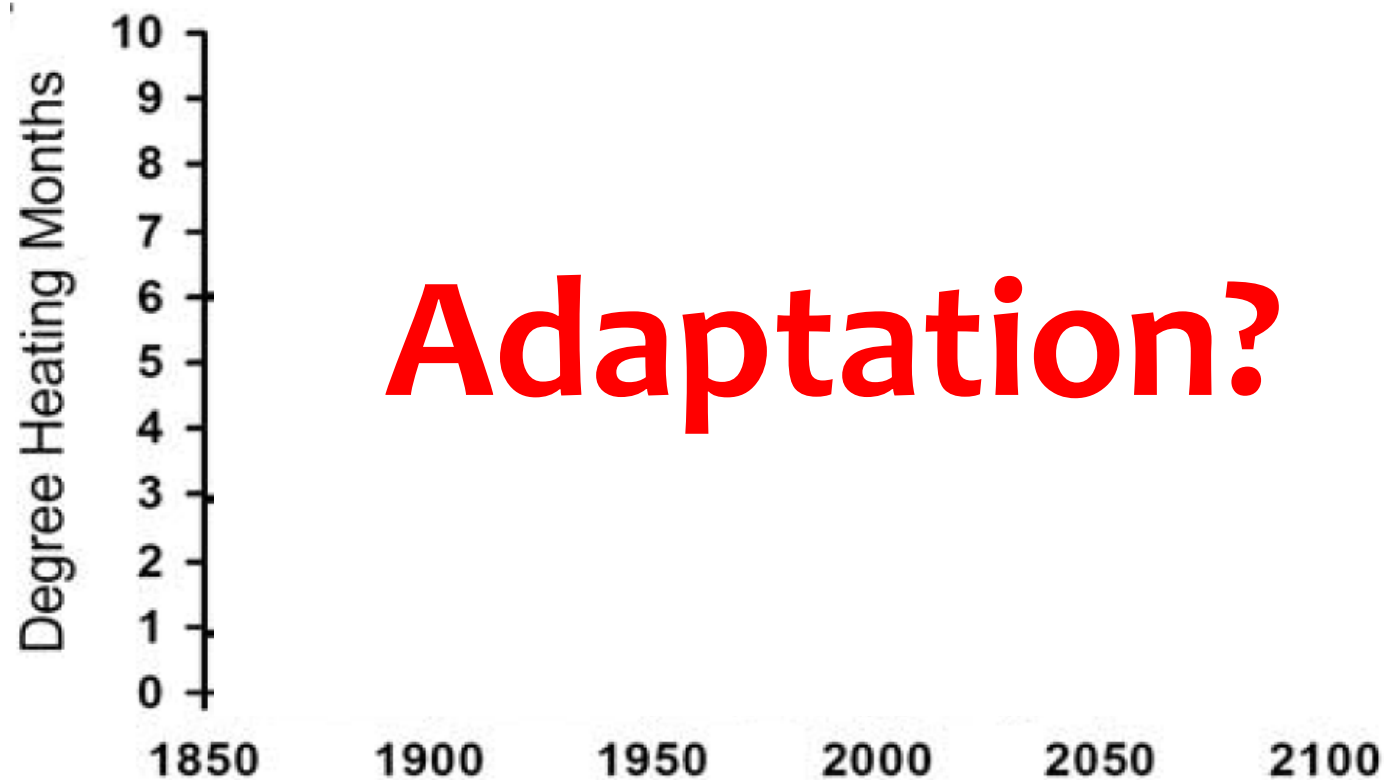
- Almost all events linked to warming temperatures
- Widespread mortality on many reefs worldwide during **1997-98 ENSO**

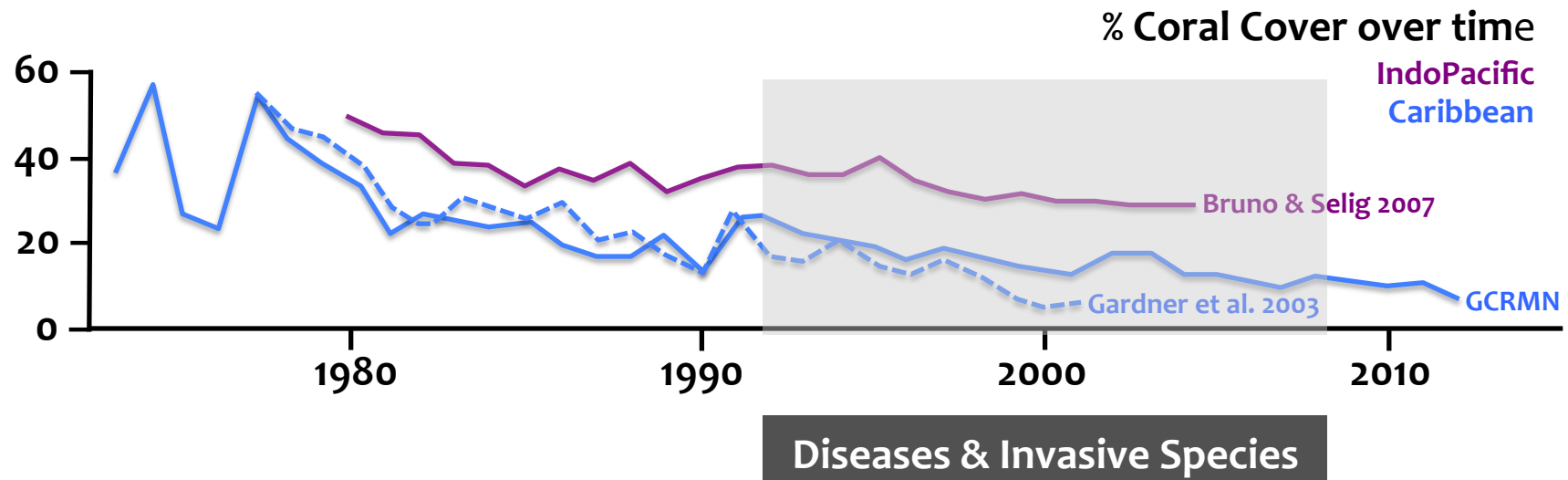
A BIG EVENT BRINGS CLIMATE CHANGE TO THE FOREFRONT

% of Reefs That Have Experienced Severe Bleaching



Future Projections of Coral Bleaching





Caribbean is hit hard by a sudden onset of diseases
Most important reef-building species is nearly wiped out

Debate on causes:

- Links to human sources (e.g. septic tanks)
- Climate seems to play a role:
 - warm waters cause greater virulence
 - heat stress weakens the host



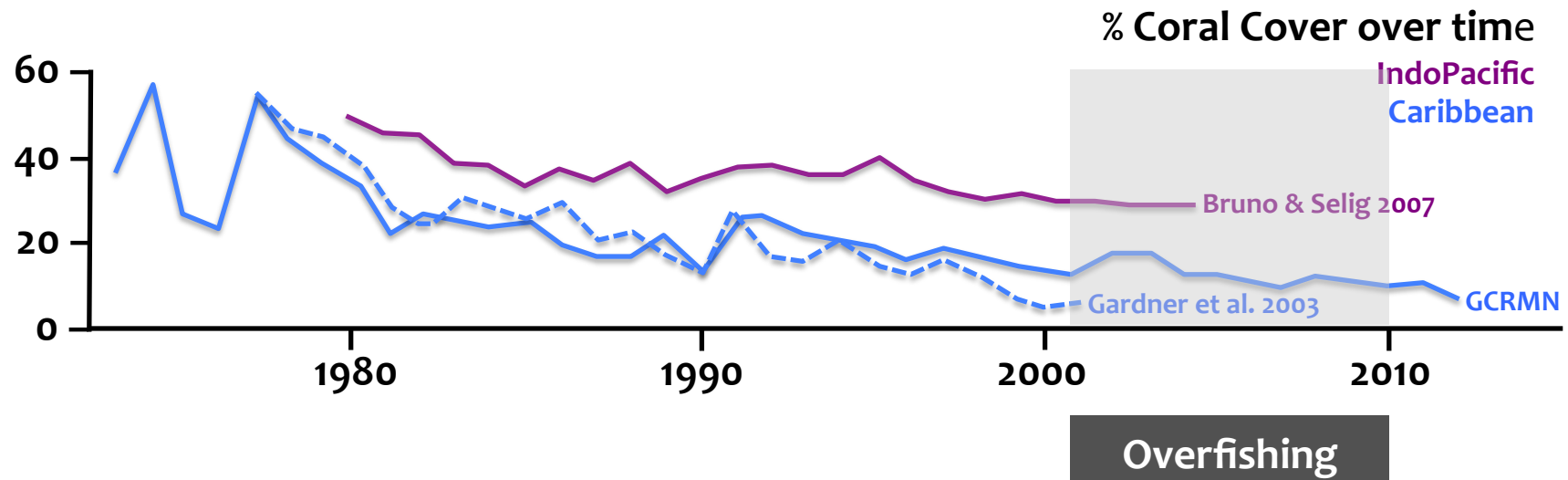
Acropora palmata
without and with white pox disease

Coral Diseases

A. palmata was the key coral species of Caribbean reefs.

It is now reduced to 5-10% of its original abundance

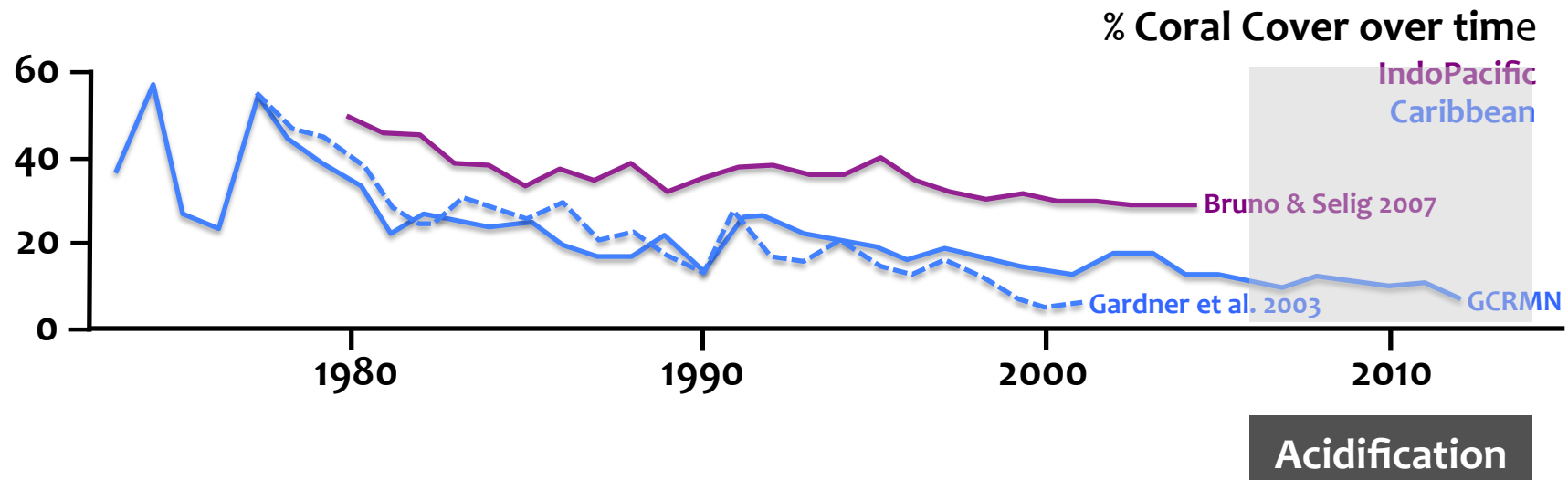




Jackson highlights overfishing as most important problem

“Ecological extinction caused by overfishing precedes all other pervasive human disturbance to coastal ecosystems, including pollution, degradation of water quality, and anthropogenic climate change.” – Jackson et al. Science 2001

Paper intended to return attention to a local impact, but lead to perception that climate change was over-trumped

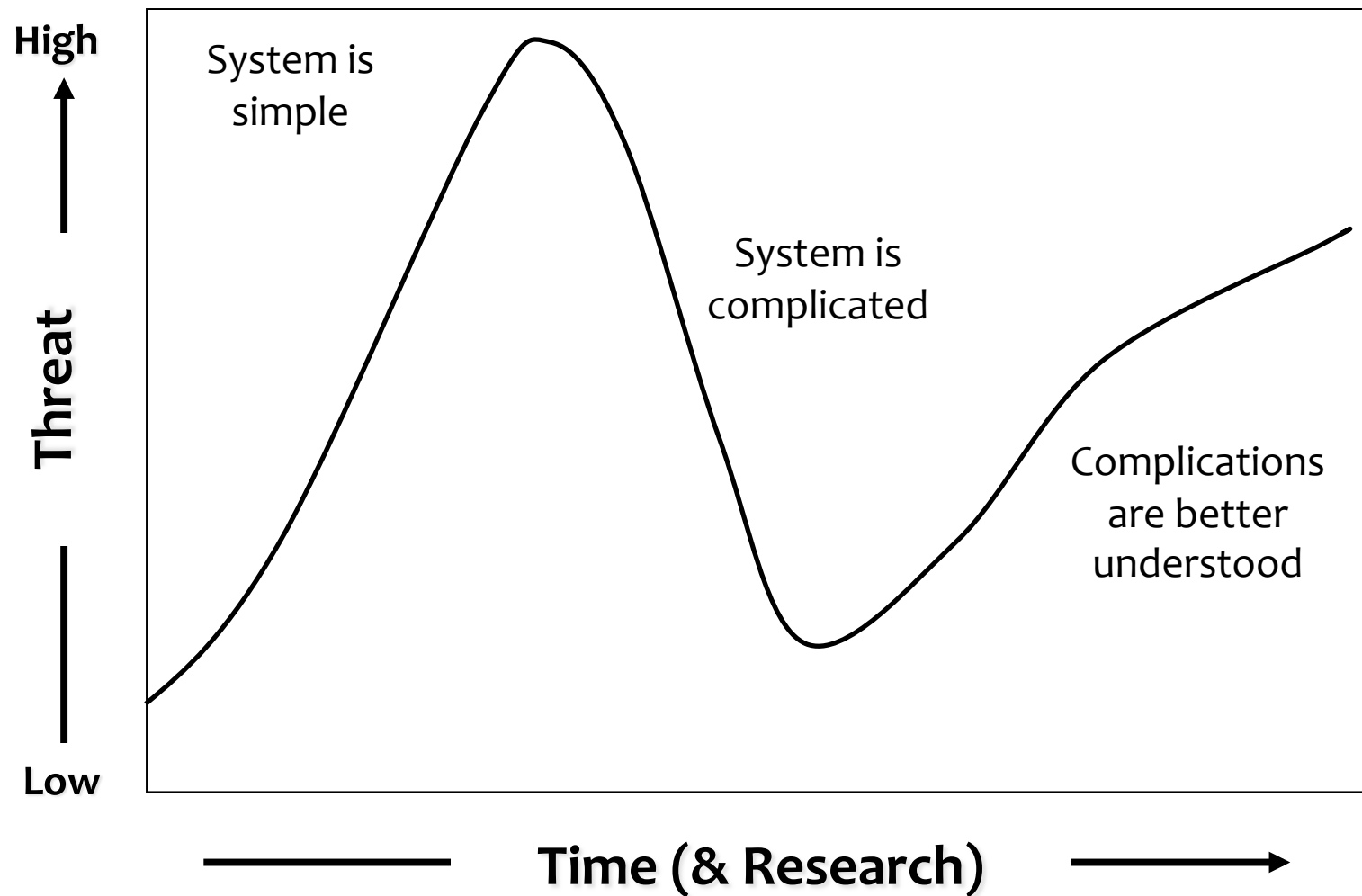


Ocean acidification and its impacts on reefs was proposed in 1999, but did not receive acceptance until 2005

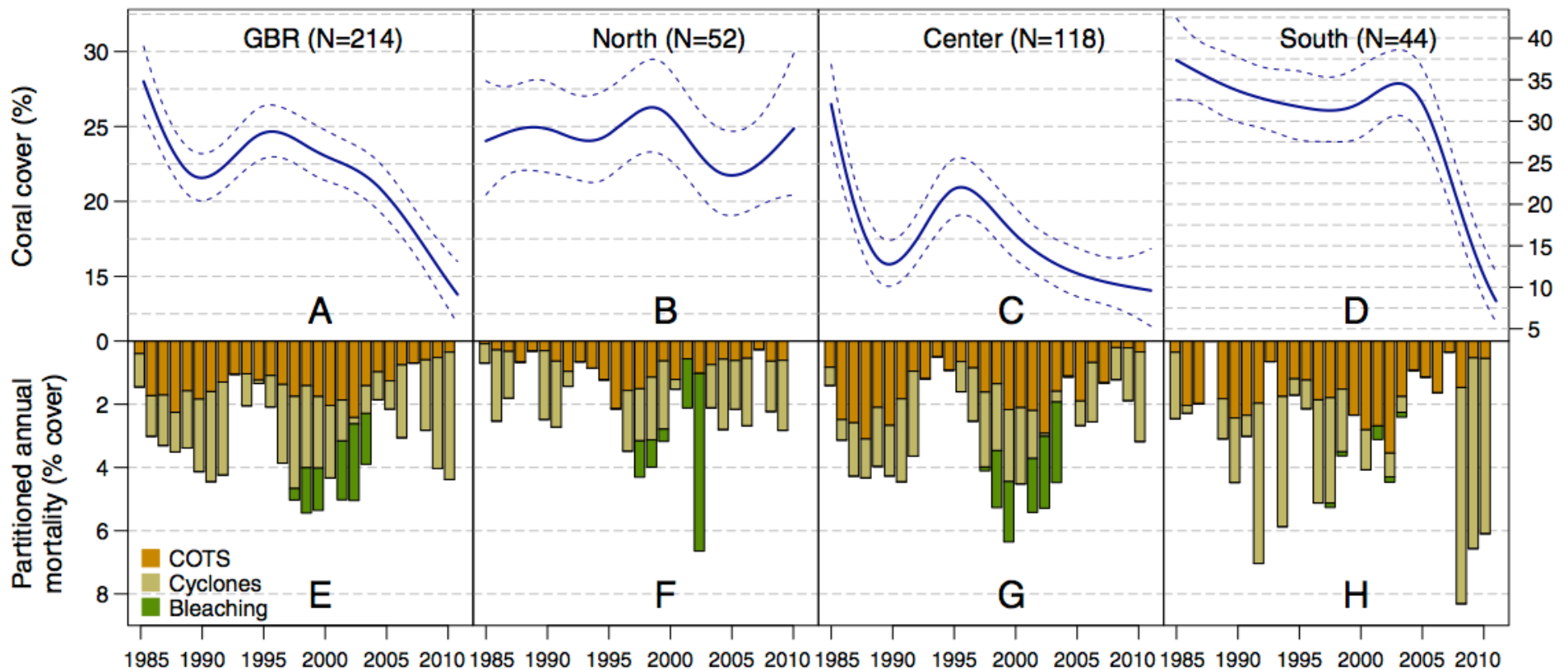
A direct consequence of rising CO₂, the process of ocean acidification is well accepted

However, many consider OA to be a non-lethal problem of the future - **a creeping environmental problem**

Perception of the threat of Ocean Acidification over time



Great Barrier Reef Analysis (2012)



Doomsdayer or Prophet?

“Doomsdayer” / Alarmist / Chicken Little

Merriam-Webster:

def: one who warns of or predicts calamity especially without justification

ex.: <some called him *Chicken Little*, but the climatologist had the data to back up his warning on global warming>

Motivations:

1. To call attention to a legitimate issue
2. To invoke a needed action
3. To gain personal attention or benefit
4. To waste others' time

Quote: “Co-author [redacted], director of [redacted], told Guardian Australia that current climate trends signal ‘game over’ for the Great Barrier Reef.” - March 2014



PollyAnna or Optimist?

“PollyAnna”

Merriam-Webster:

def: a person characterized by irrepressible optimism

ex.: <I'm no *Pollyanna*, but I do think some good will come out of this.>

Motivations:

1. To avoid the gravity of a problem
2. To motivate others to keep trying
3. To gain personal attention or benefit
4. To waste others' time

Quote: “While there are many concerns about the future of corals reefs in the face of climate change,

there are still many reasons for optimism about the future of coral reefs particularly if we manage other local stressors such as pollution and development.”

- 2014



The evolution of reef research in context of climate change:

- Unexpected or dramatic events drive research directions (the more visual the better)
- For creeping problems, a few individuals drive research directions
- Even if we Think Globally – we Act Locally:
 - Global climate change is recognized as an imminent problem, but local/regional issues are still considered more important
- Doomsday messages get more attention from the media; Optimistic messages are more stimulating to those impacted by climate change (TNC)

Lessons

What has enabled progress:

Visible impacts: bleaching (unfortunately)

Better models, observations, and interdisciplinarity
(young researchers)

Strong leadership and proactive communication

What has slowed progress:

Globally: Increasing Population, Declining Economy

Nationally: Political climate; “Ocean who?”

Scientifically: Lack of roadmaps toward solutions (e.g. AGCI products); Pessimism about the future

Moving toward solutions for the future

Moving along:

- From slowing climate change to living with it
- “Feeding a growing population” has replaced “Maintain reef biodiversity”

Engaging first hand with “on the ground” practitioners

Understanding the thresholds of ecosystem collapse

Reef Restoration



Photo credits: The Nature Conservancy, Carey Wagner

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Abstract

Coral reefs have been a poster child ecosystem for climate change impacts, but there is a wide range of scientific opinion regarding the fate of this ecosystem. Some scientists feel the ecosystem is doomed, and others feel there is considerable hope. This talk will present a short history of how projections of coral reef state have shifted in response to contemporary changes in reef state and to research findings.

Facts

Coral reefs in general are in decline

Coral bleaching events have increased

Diseases in reef organisms have increased

Acidification is an increasing problem for both corals and reef-building

Need for greater protection

Debates

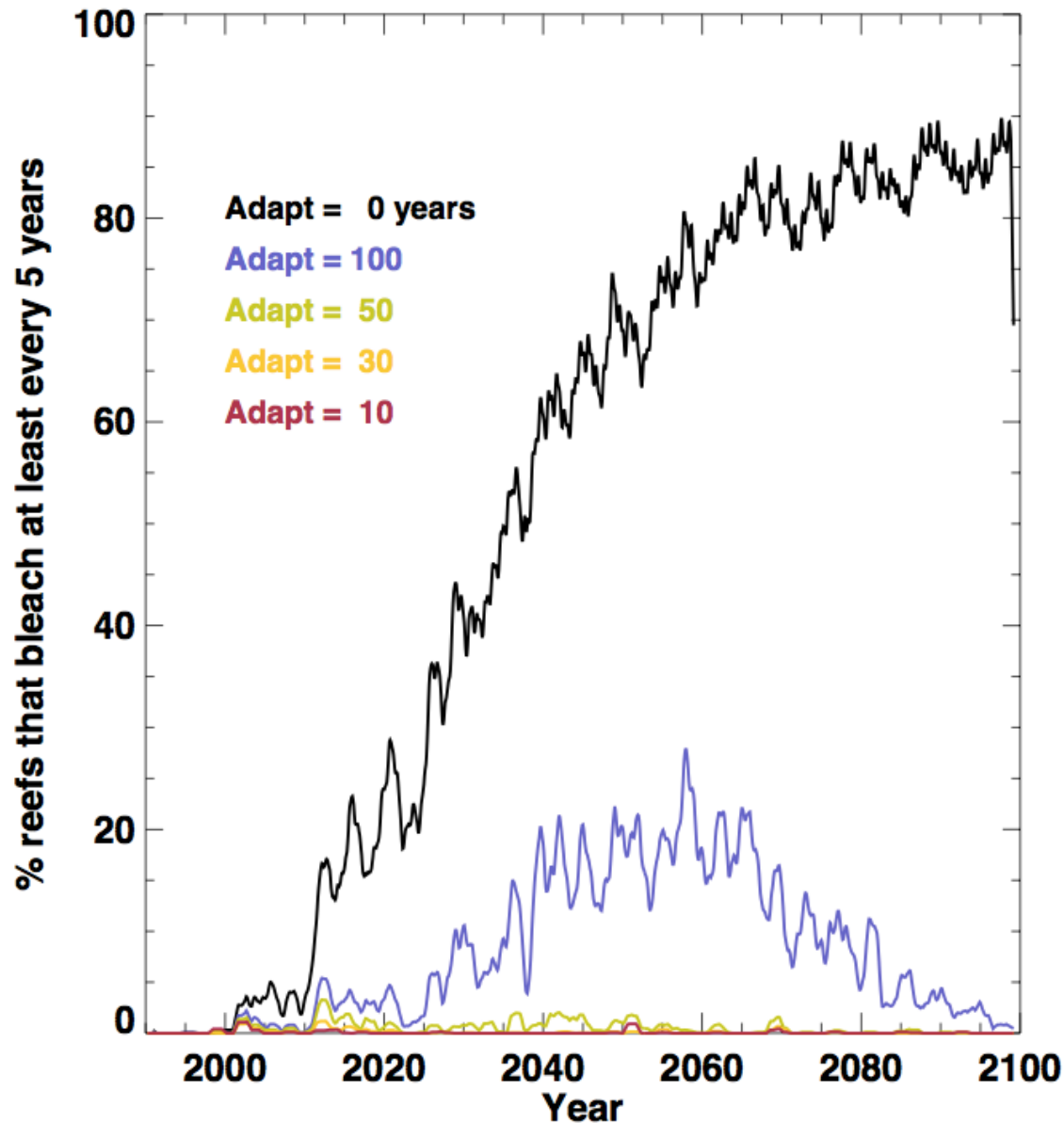
The most important drivers of the decline – natural, climate, overfishing, pollution?

**The speed of coral adaptation
The nature of ocean warming: gradual or episodic?**

The causes of disease: pollution or climate change

**The speed of coral adaptation
When will reefs become net erosional**

The approach to reef protection: passive versus active



But corals have
SOME capacity to
adapt

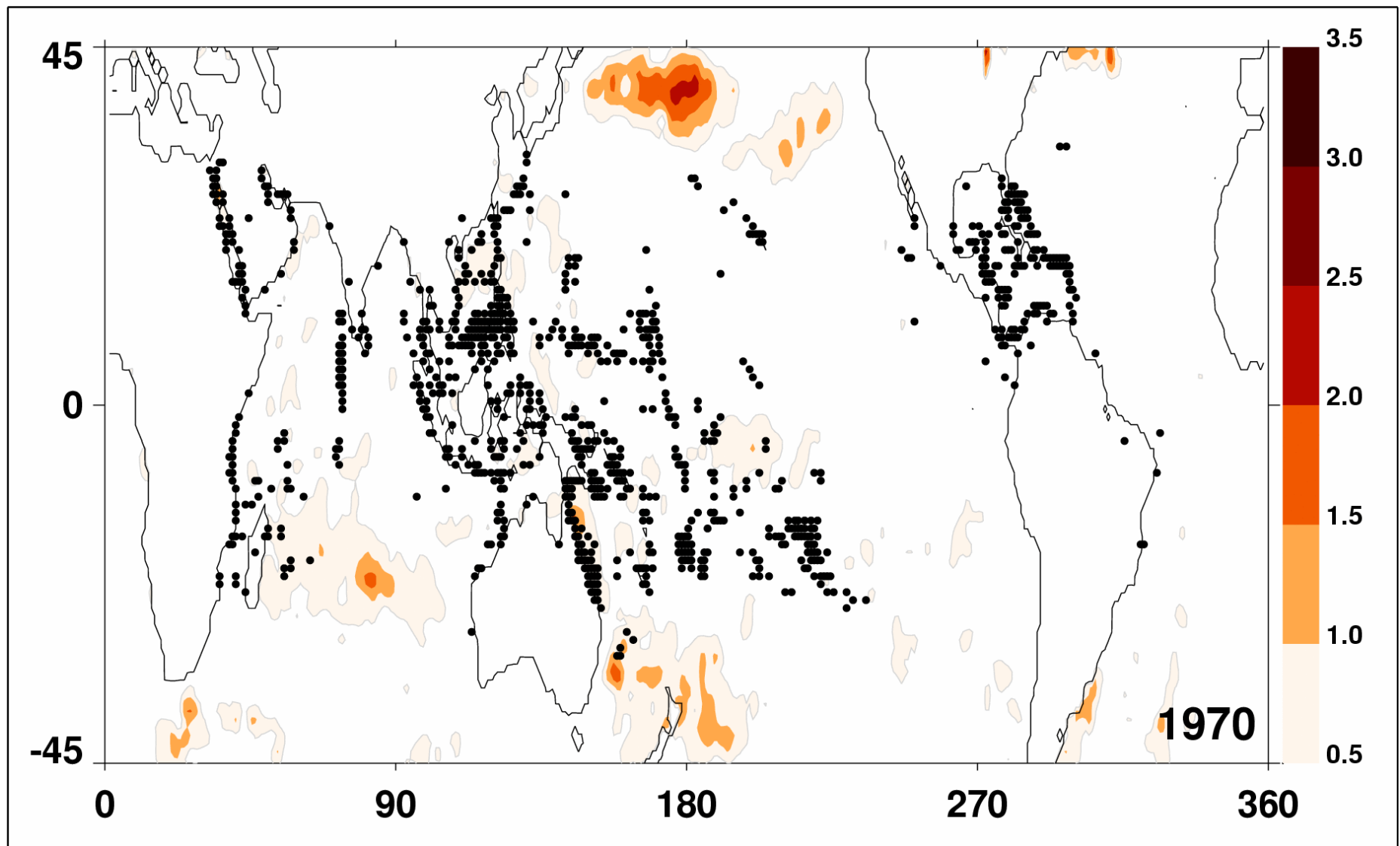
- Acclimation
- Natural selection

Wide range of opinions on reef future

Reef state is declining This can motivate action

Adaptation happens

Rates of change are too fast



● mild

● moderate

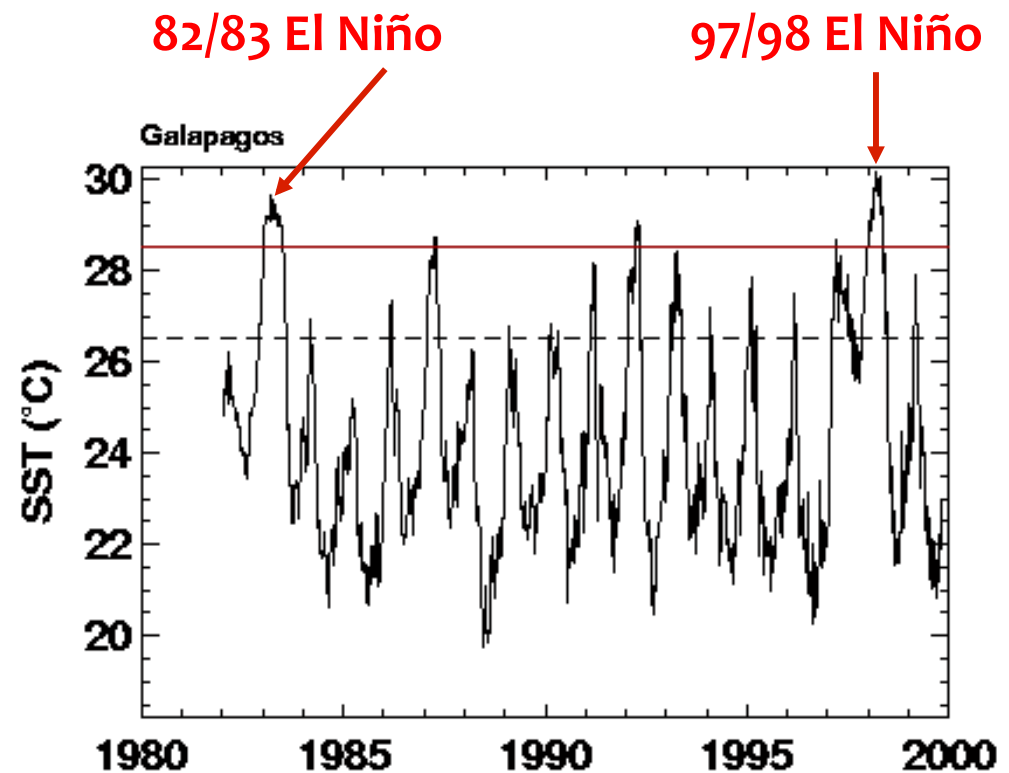
● severe

Doomsday versus Hope

- 1. History of coral reef state and causes of decline
(with key factors that influenced reef research:
events, people, media)**
- 2. Lessons from the past**
- 3. Moving toward solutions for the future**

Coral Bleaching

A breakdown of coral-algal symbiosis



Scientists' Rankings of Threats to Coral Reefs (2005)

THREAT		THREAT	
Overfishing	2.36	Sedimentation (natural)	1.46
Coastal development	2.32	Global warming not bleaching	1.46
Laws/enforcement	2.27	Oil pollution	1.34
Sedimentation (unnatural)	2.26	Scientific research	1.29
Lack of education	2.22	Increases in storms	1.23
Nutrient enrichment	2.19	Sea-urchin die-off	1.23
Algal competition	2.19	Alien or invasive species	1.21
Bleaching	2.14	Live-rock collection	1.16
Habitat destruction	2.06	Increases in UV	1.13
Tourism	2.03	Sea-urchin grazing	1.07
Industrial/urban pollution	1.94	Atmos. transport of materials	1.05
Mangrove destruction	1.85	Salinity changes (natural)	1.04
Diseases not bleaching	1.71	<i>Acanthaster</i> predation	1.01
El Niño	1.68	Salinity changes (unnatural)	1.03
Herbicides & Pesticides	1.67	Sea level rise	0.98
Cyclones/Storms	1.55	Decreases in ocean pH	0.95
Destructive fishing	1.52	Cold water exposure	0.69
Vessel Groundings	1.51	<i>Drupella</i> predation	0.58
Aquarium Trade	1.48	Volcanoes/Earthquakes	0.53
		AVERAGE SCORE	1.49



pH 8.05
Today



pH 7.95
~ year 2050



pH 7.8
~ year 2100

Fabricius et al. 2010 NCC

Ocean Acidification

Acidification does not kill reef organisms directly

It does reduce their ability to grow and build/maintain reef structures

Coral recruitment is likely to decrease

- Reef resilience decreases
- Reef habitat decreases

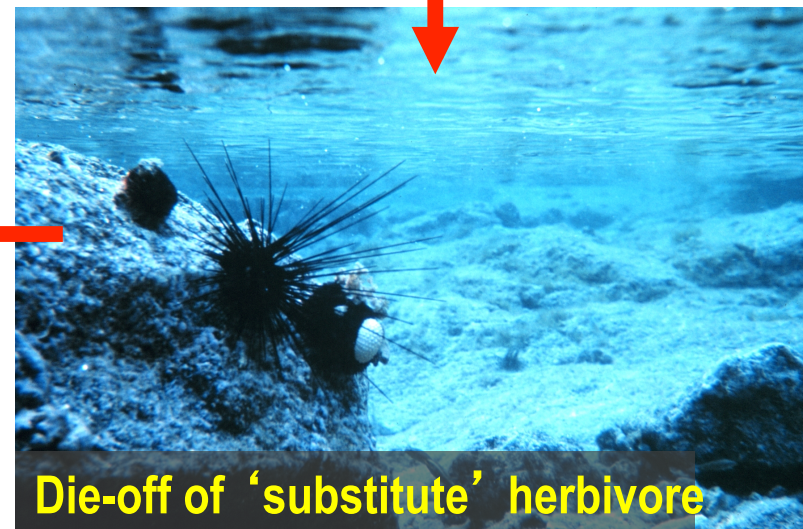
Coral-dominated



Main herbivores overfished



Algal-dominated



Die-off of 'substitute' herbivore