Biodiversity and Climate Change In the Caribbean: Coral Reefs of the Future

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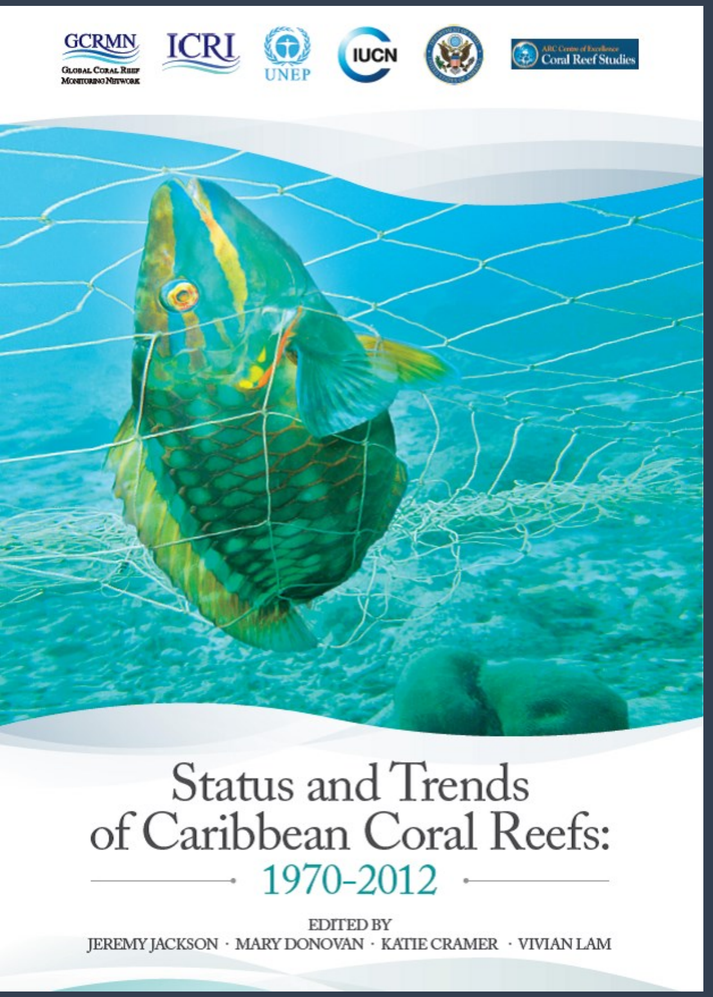
http://reefresearch.org

Little Cayman Island

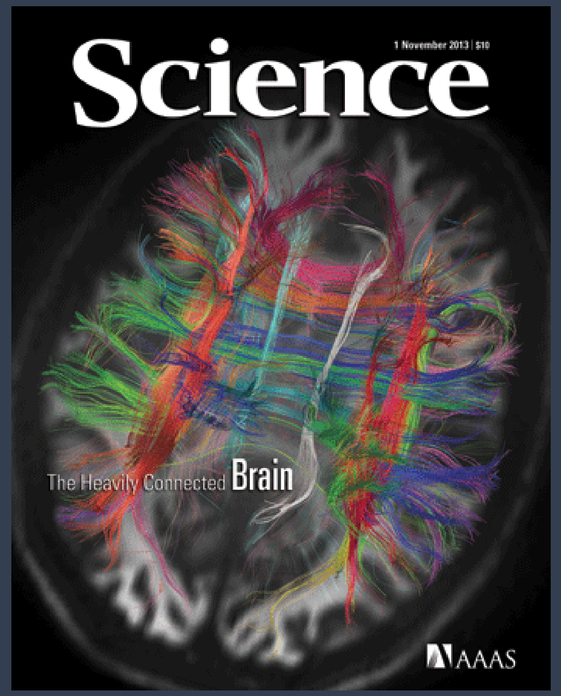
Climate Change and coral reefs

Caribbean Reef trajectories 1970-2012 Jackson et al. 2012



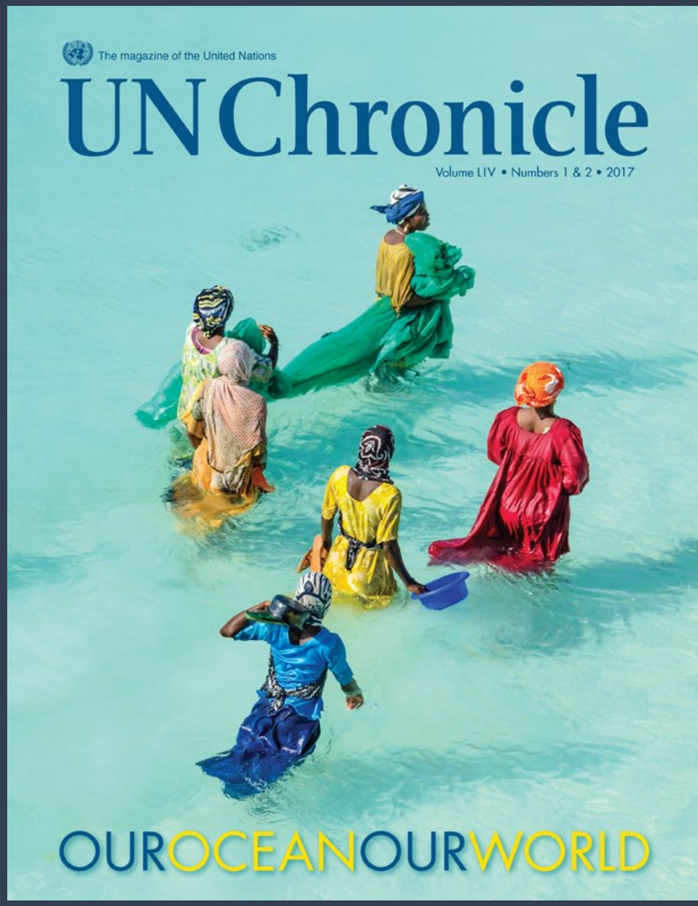
Editors' Choice SCIENCE
Volume 342, Number 6158, Issue of 1 November 2013

A Positive Trajectory for Corals at Little Cayman Island Carrie Manfrino, Charles A. Jacoby, Emma Camp, Thomas K. Frazer. *PLOS ONE* 8, e75432 (2013)



Coral reefs today and reef of the future. Can we save coral reefs?

Manfrino, 2017, UN Chronicle)



Assist, Support, Restore Natural Processes

Identify & protecting species critical to reef health:

Reef building species

Fleshy algae controlling species

Scrapers & bioeroders

Assisting Natural Processes to boost resistence and resilience

Spatial Planning
- Promote habitat and larval connectivity
(mangroves, seagrasses and reefs)

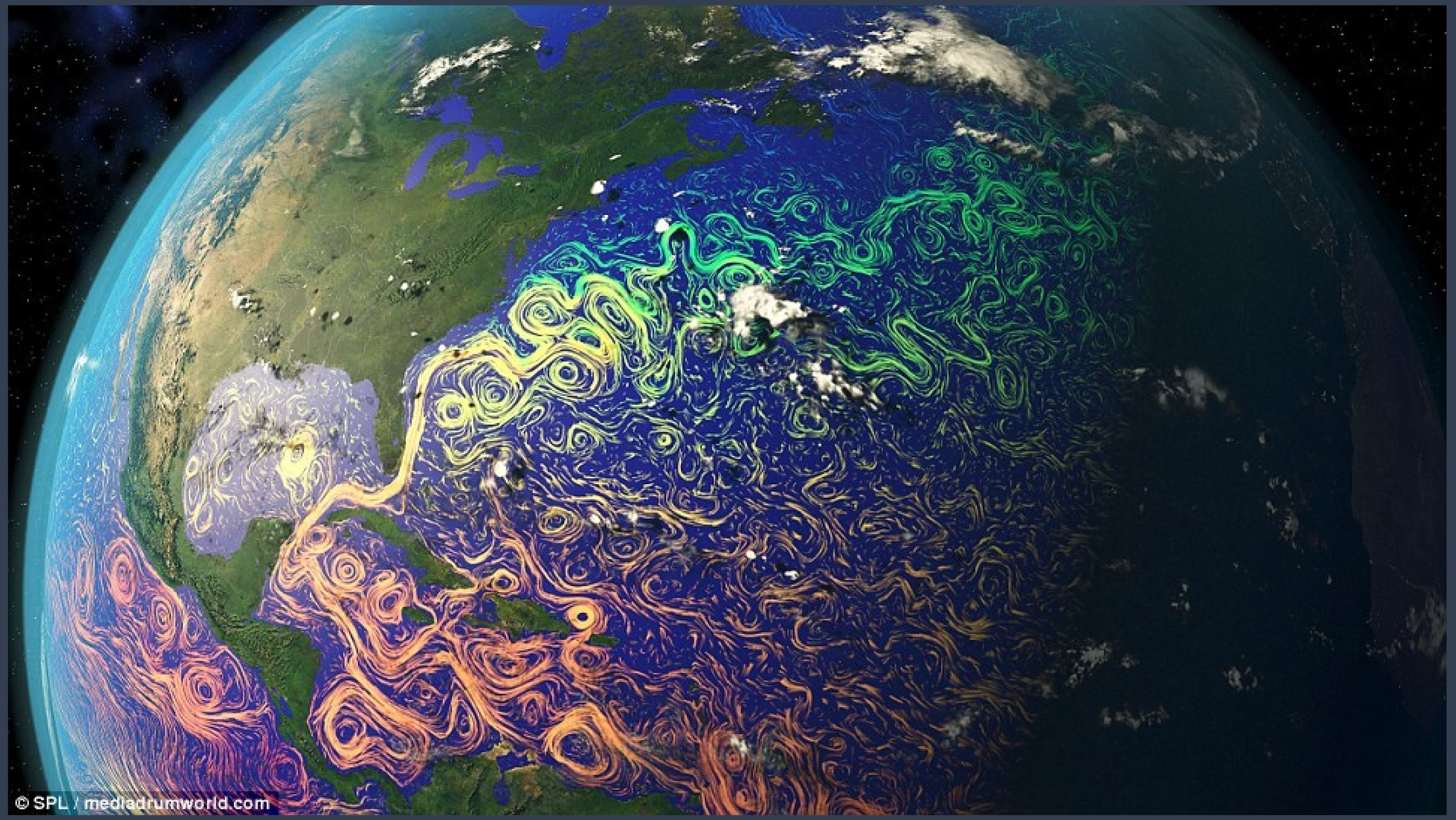
Strategic Reef Restoration:

Nurseries and outplanting

OTHER SOLUTIONS ?

The Multiple Stressors due to climate change

Rising Sea Level
Ocean Acidification
Increasing Temperatures
Altering Ocean Circulation
Storm Patterns



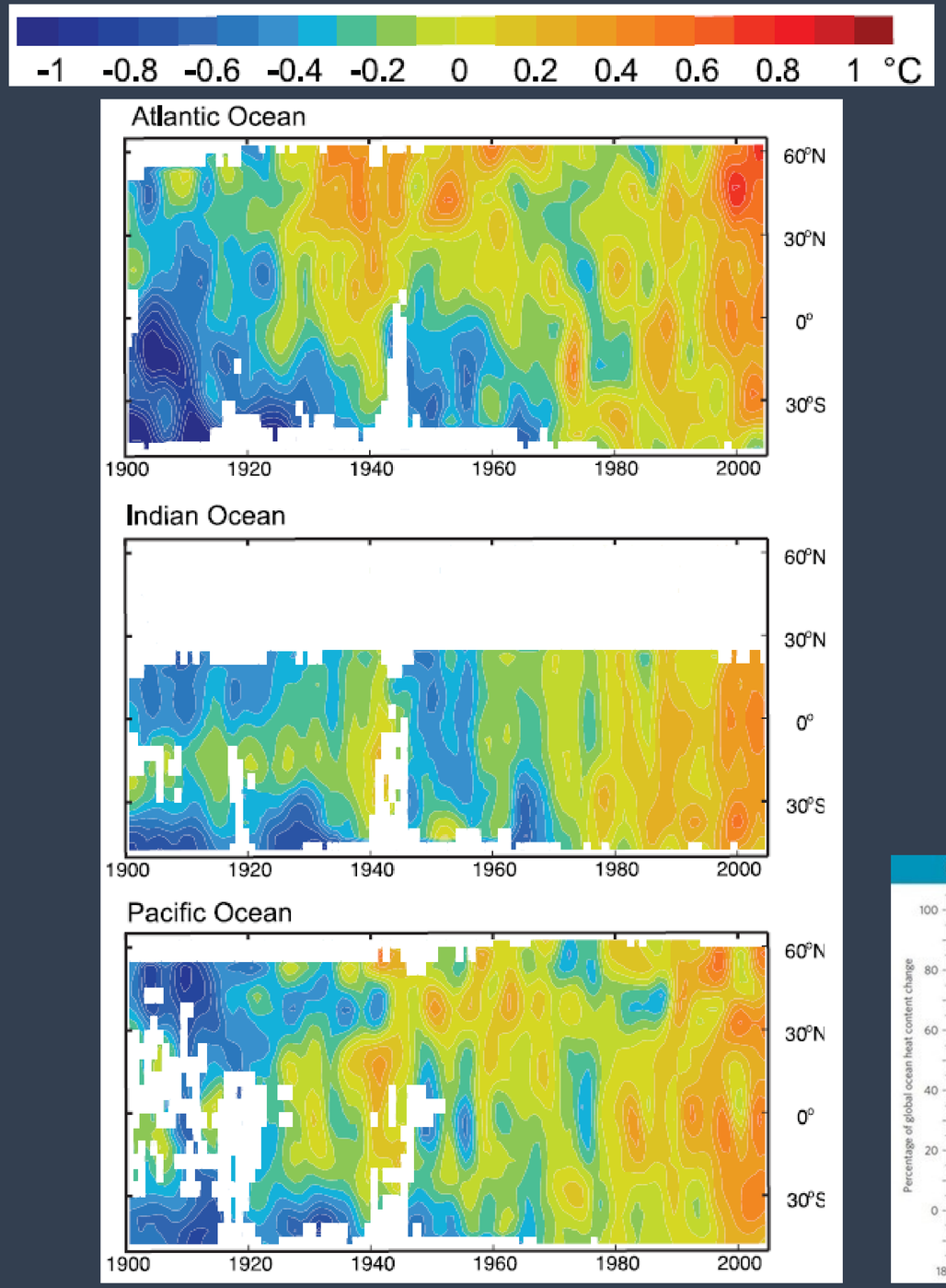
Climate Change and Coral Reefs

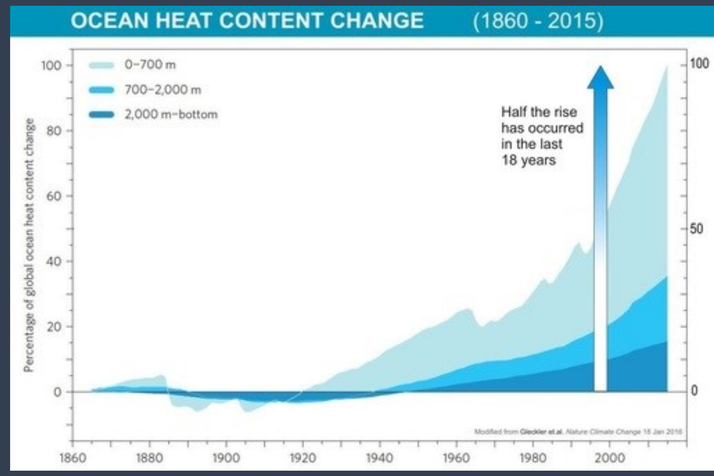
RISING SEA LEVEL
1 – 4 Feet by 2100

Climate Change and Coral Reefs

Climate Change and Coral Reefs

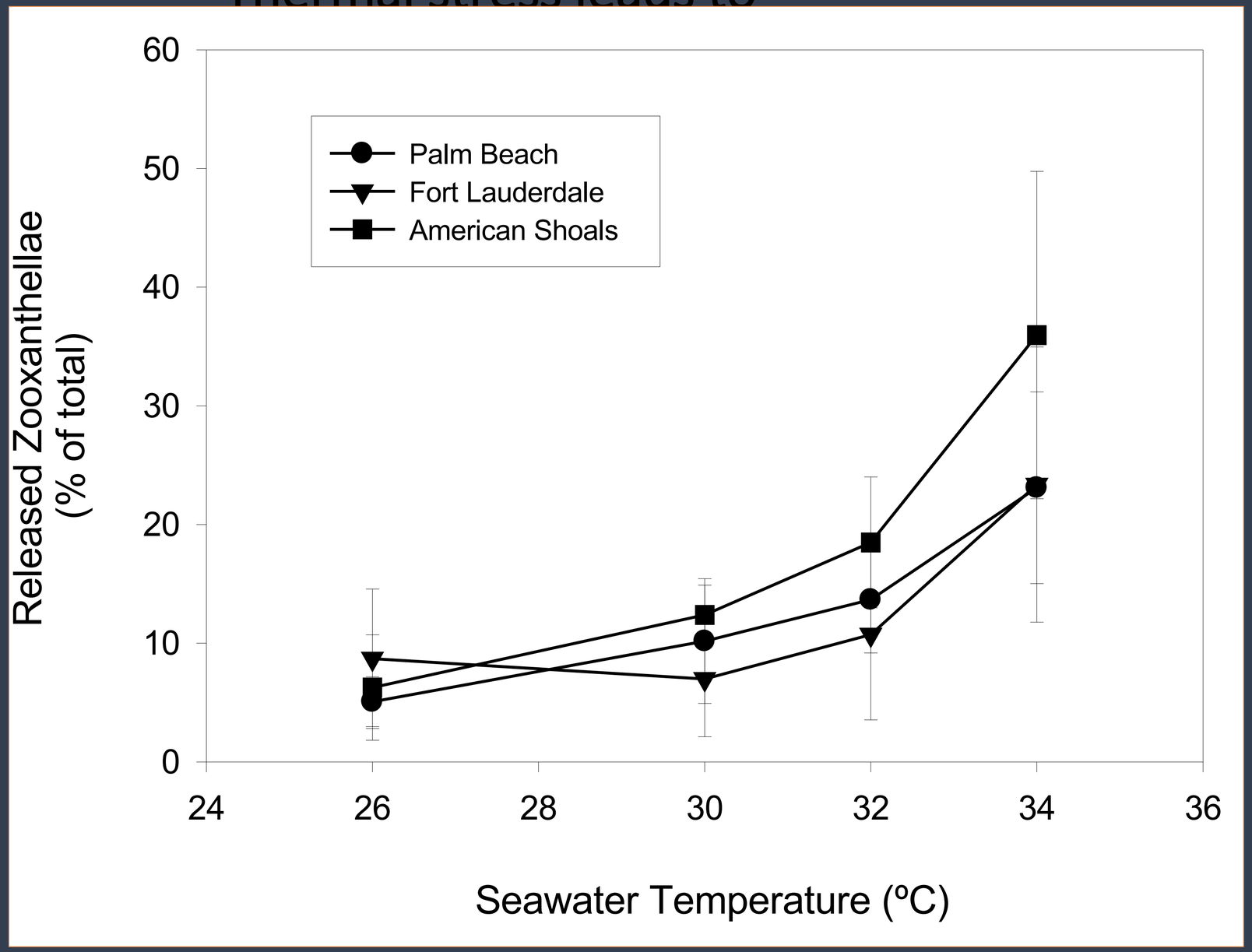
Temperature Stress





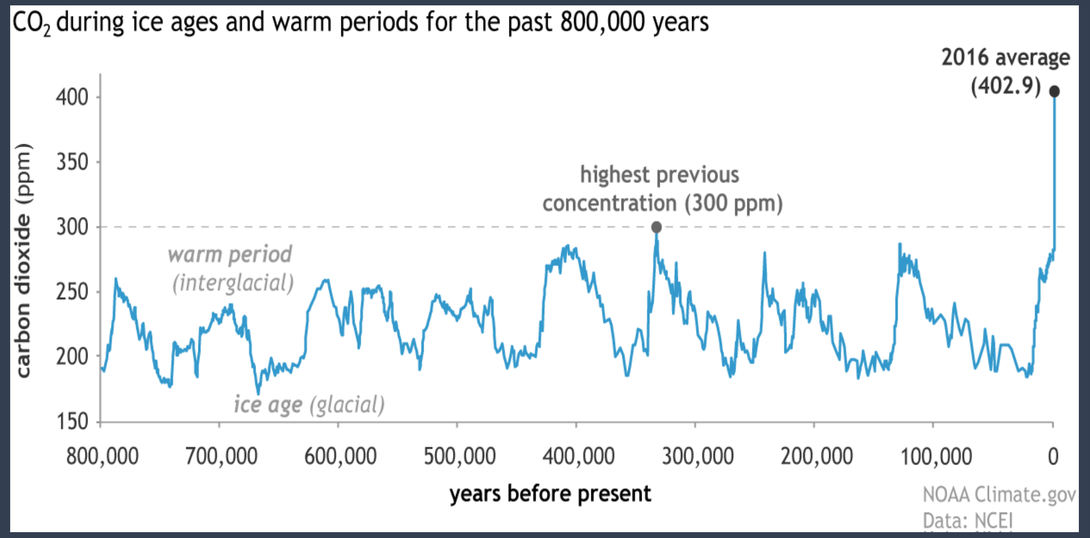
Climate Change and Coral Reefs

Thermal stress leads to



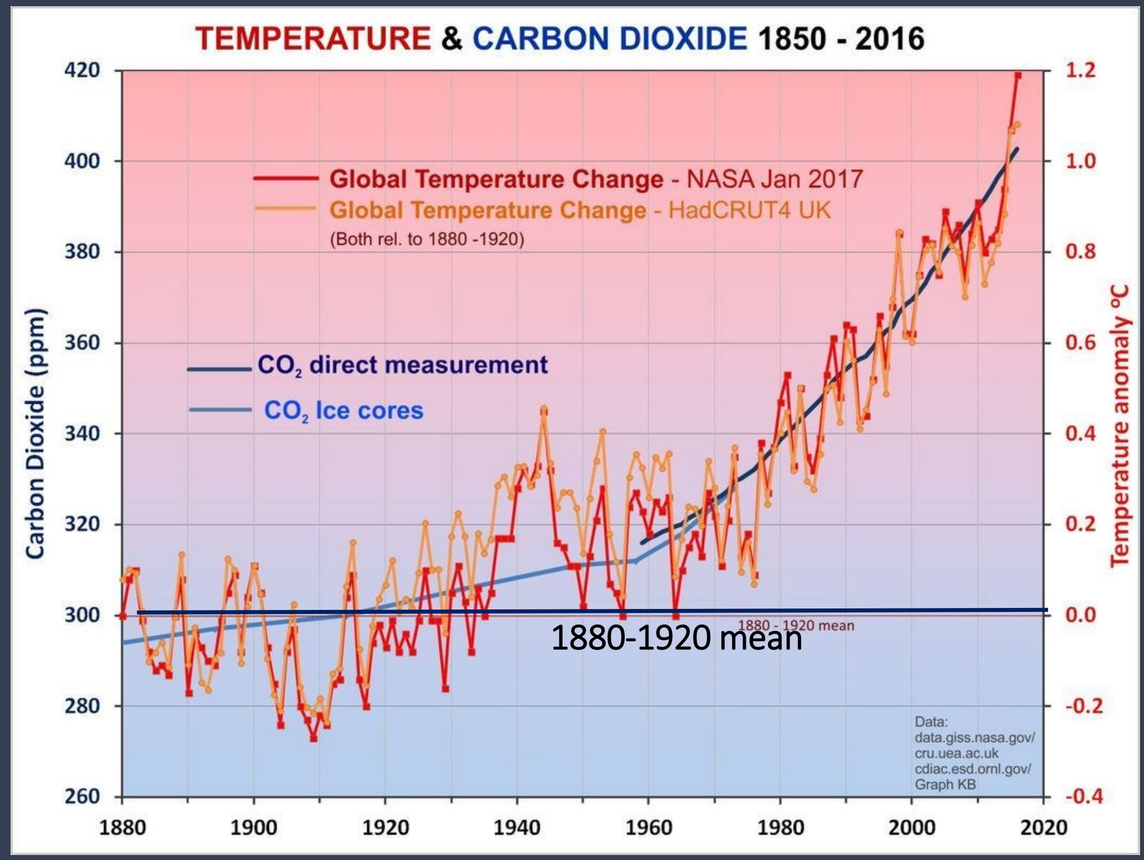
Climate Change and Coral Reefs

Climate Change and Coral Reefs

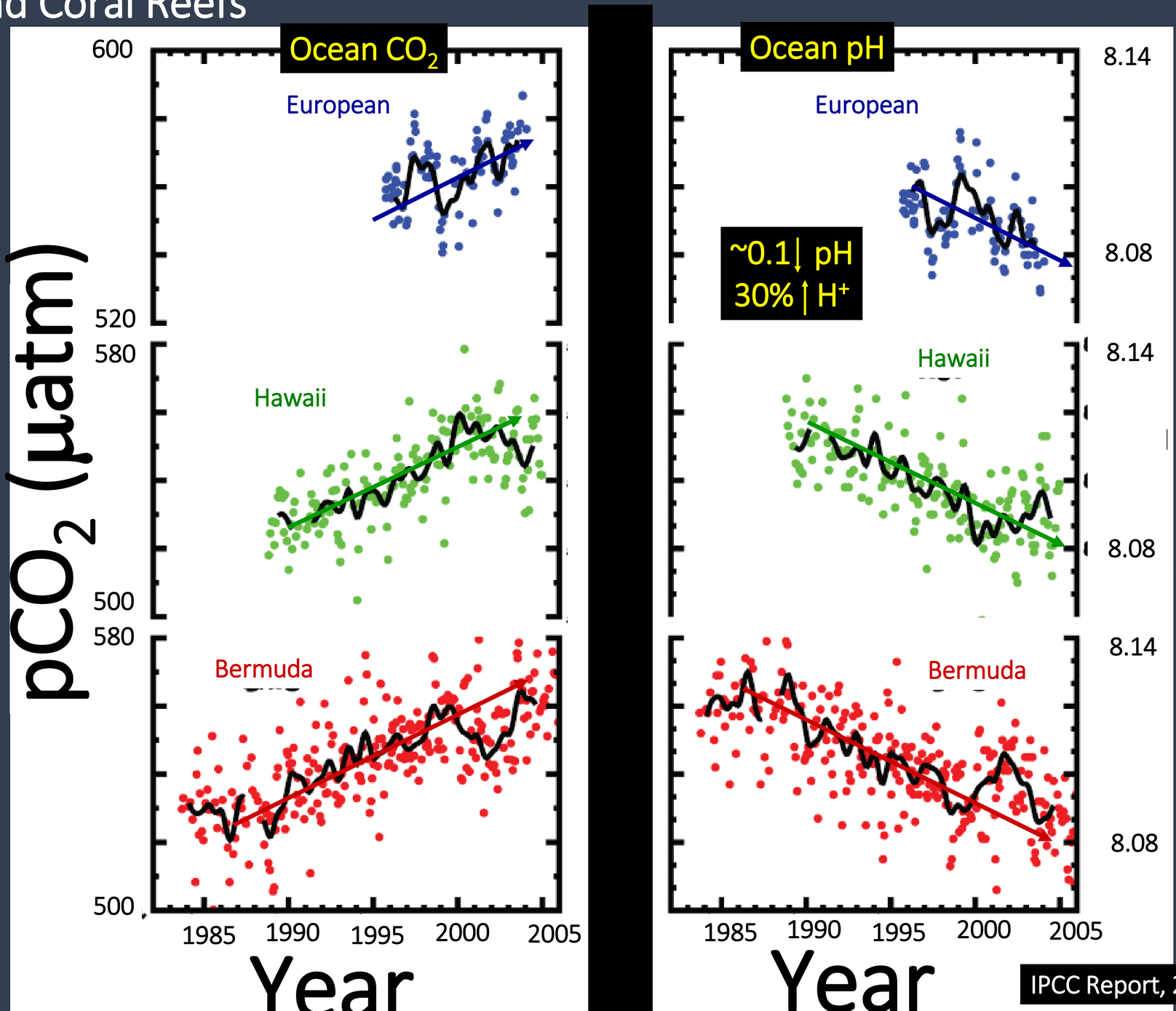


1) Mid- Pliocene, SL + 20—40m, coral reefs, CO2 @400ppm
2) Late Pleistocene, SL +6-+10m, coral reefs, CO2 <300ppm
3) The rate of change in C02 in the last 50-100 years is more rapid than previous rates.

Rates of Change in CO2

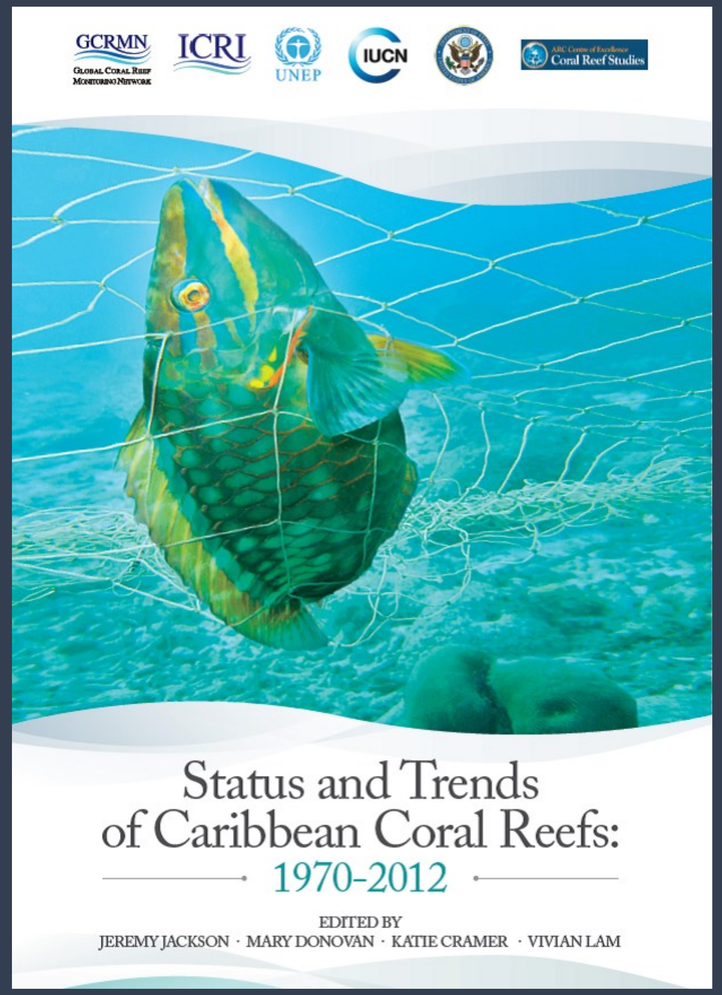


Climate Change and Coral Reefs



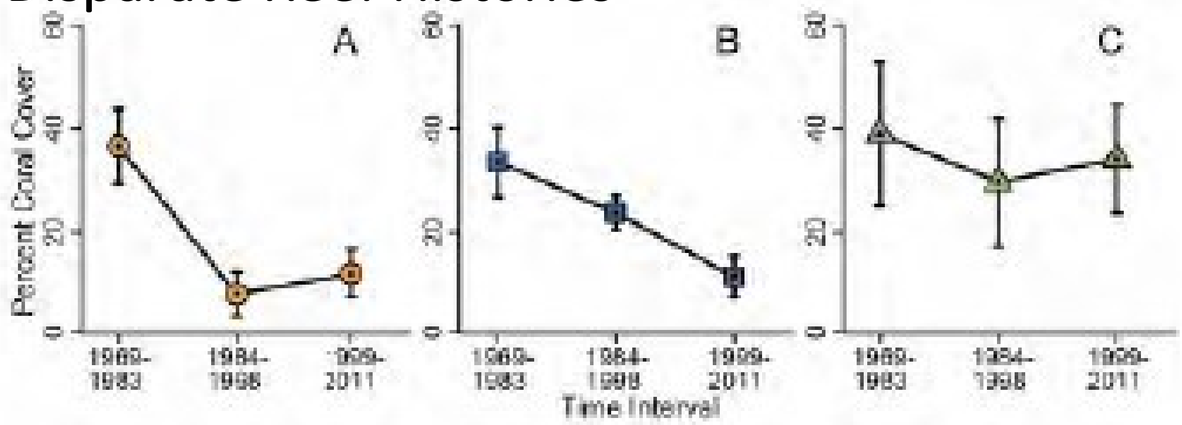
IPCC Report, 2007

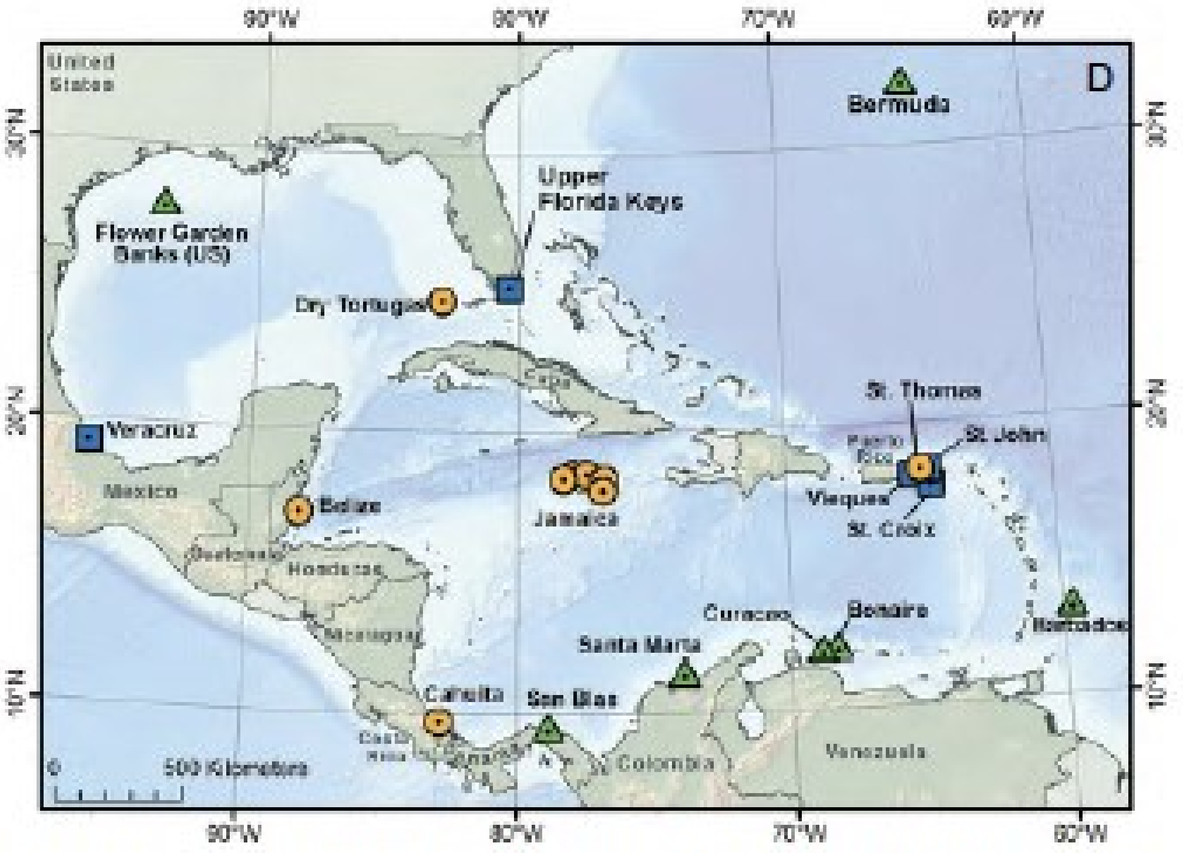
Coral Reef Trajectories



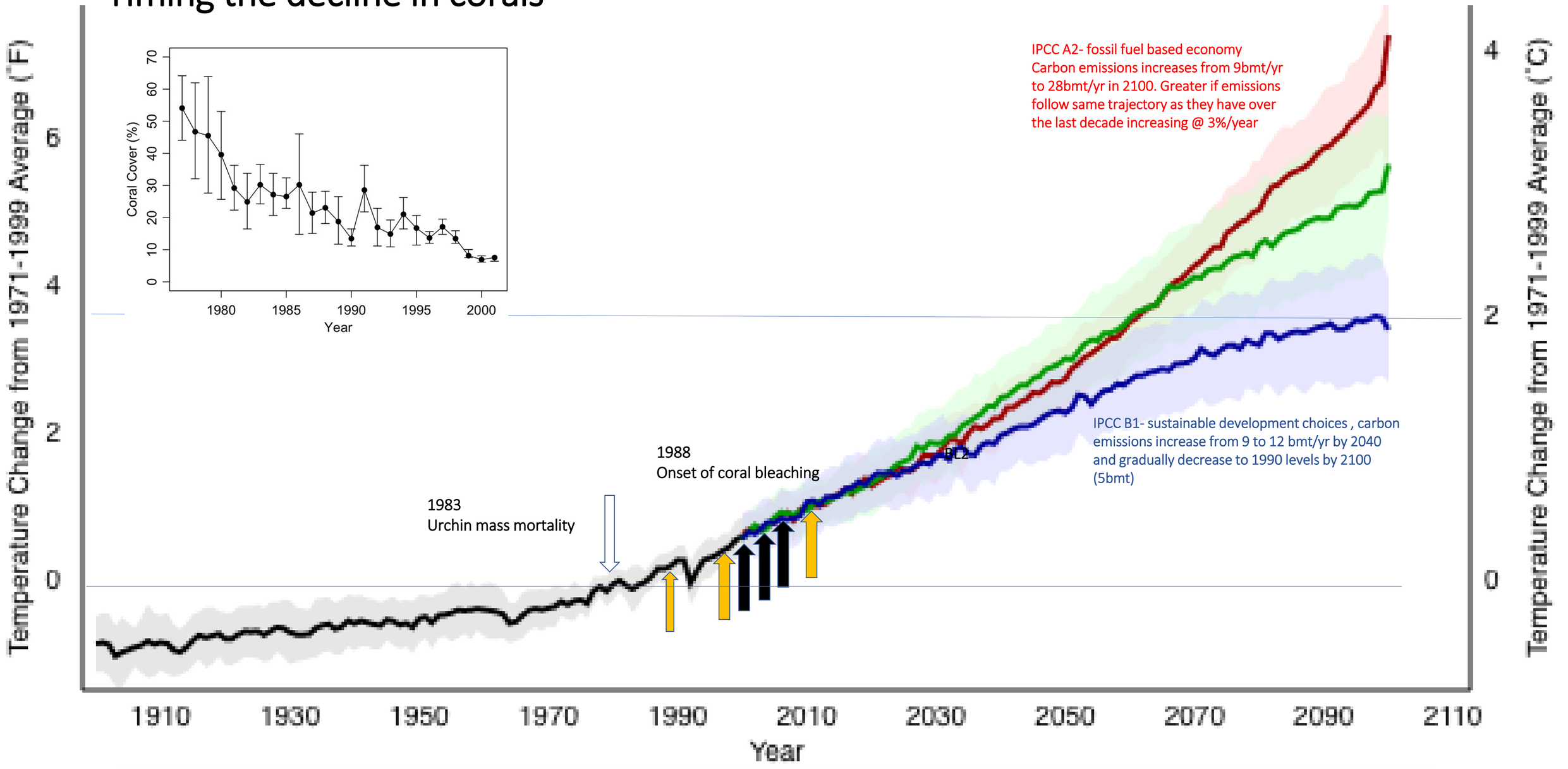
34 countries, 90 locations, 35,000+ individual surveys;
21 locations have data from before 1984

Disparate Reef Histories

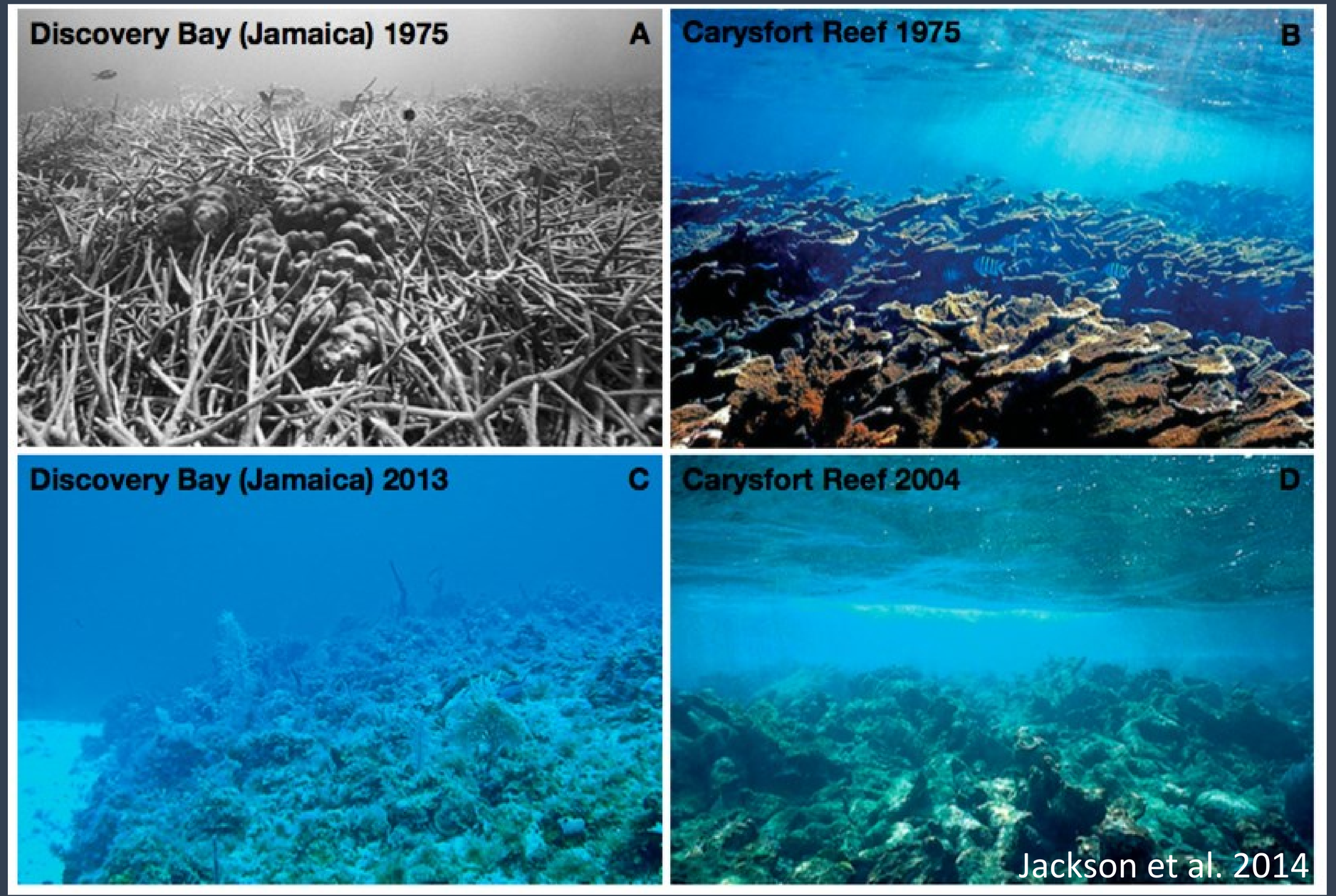




Timing the decline in corals



Drivers of Change



Corals listed under the Endangered Species Act

There are 2 coral species listed as ‘endangered’ in 2006

& 5 as ‘ threatened’ in 2014

Acropora palmata – Elkhorn (2006)

Acropora cervicornis – Staghorn (2006)

- *Dendrogyra cylindrus* - Pillar coral
- *Mycetophyllia ferox* - Rough cactus coral
- *Orbicella annularis* - Lobed star coral
- *Orbicella faveolata* - Mountainous star coral
- *Orbicella franksi* - Boulder star coral

Winners and Loosers
Coral adaptation?
Assisted Evolution

P. divaricata
P. porites

Drivers of Change

Overfishing

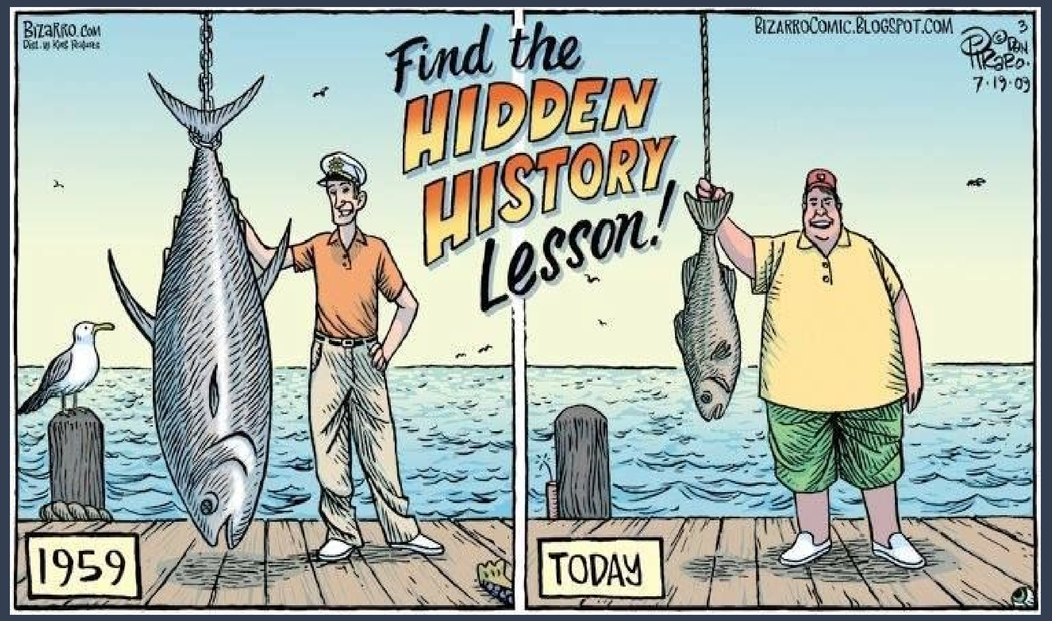
Destructive Fishing

Fishing in Nurseries

Fishing Spawning Aggregations

Fishing too many large fish

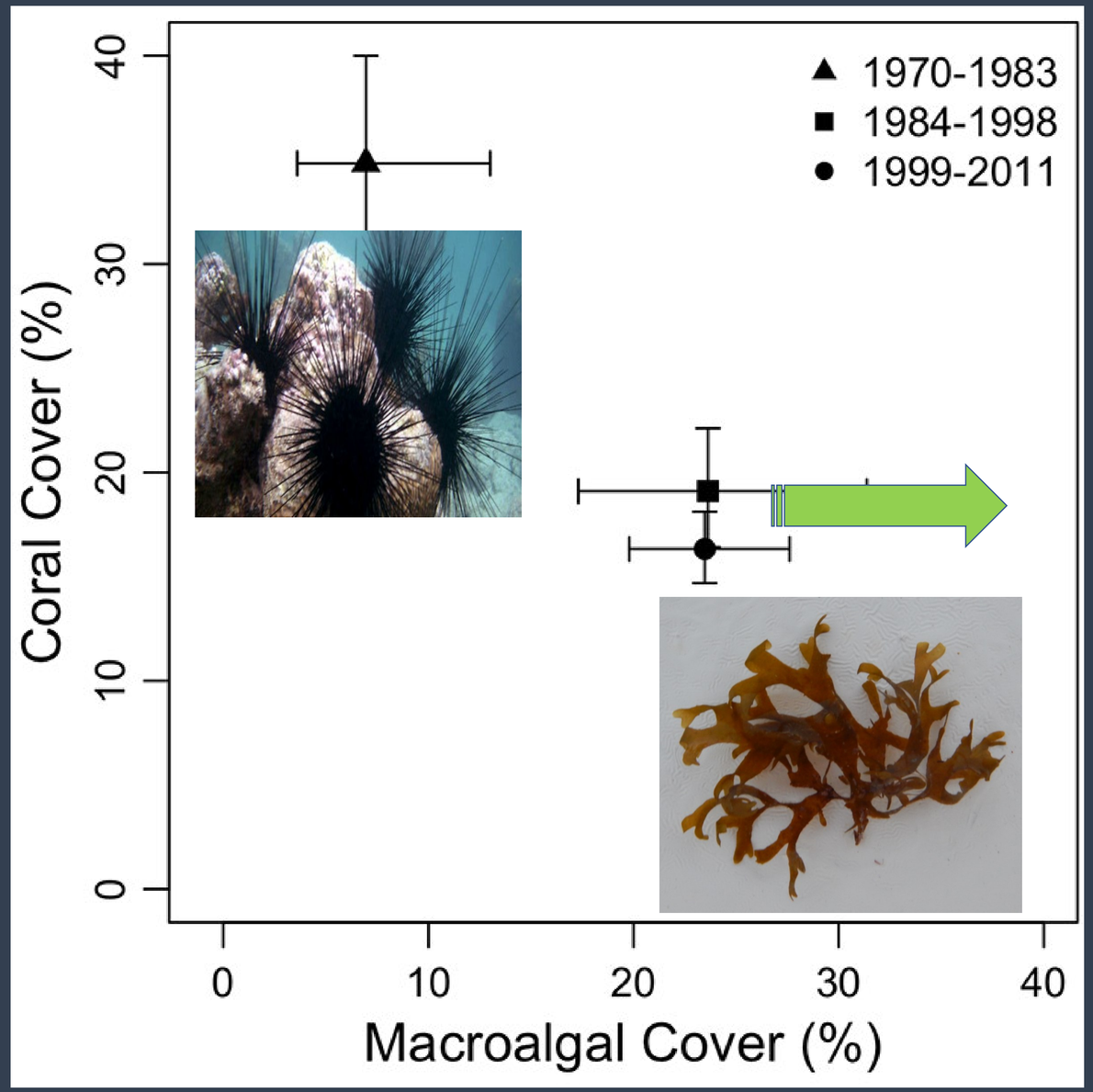
Debris (nets, line, traps)



1957

1980-85

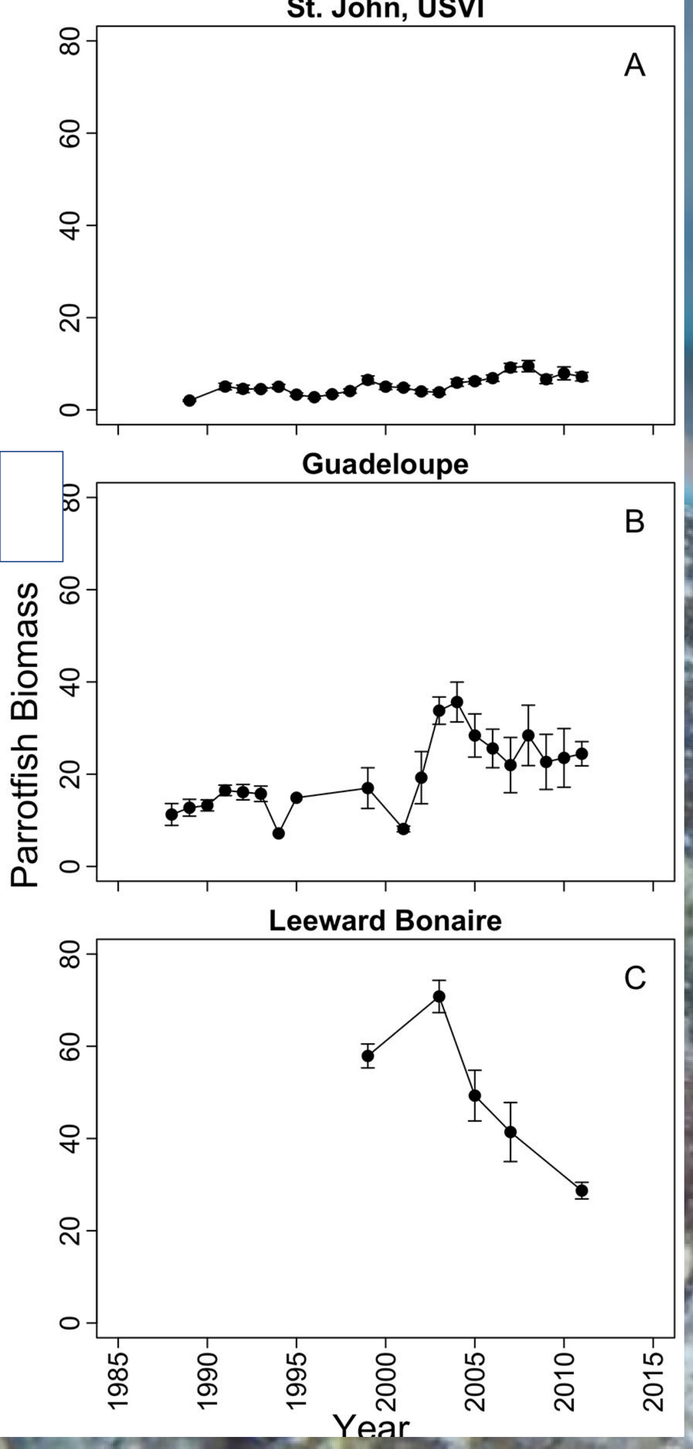
2007



Summary: Drivers of change

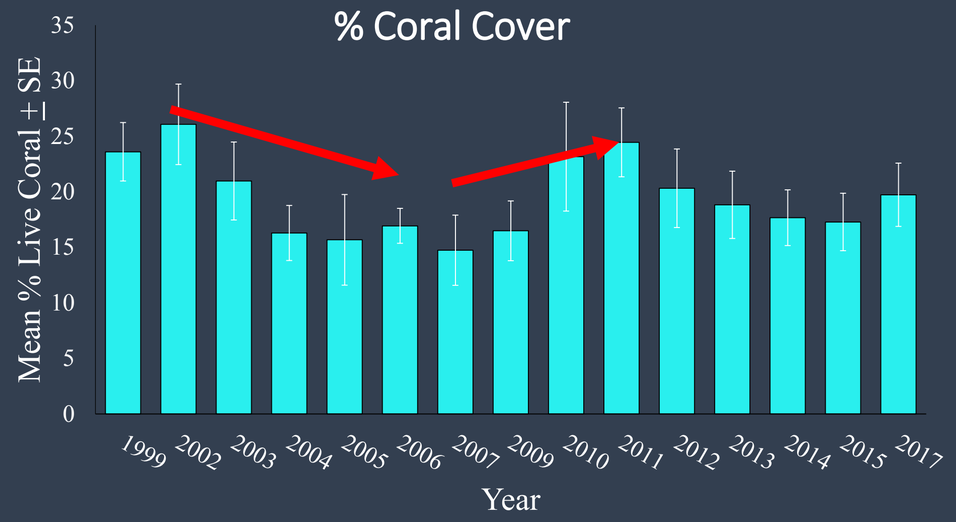
- Disease – (Diadema mortality (80's), Elkhorn and Staghorn coral)
- Ocean warming
- Pollution
- Overfishing
- Alien species

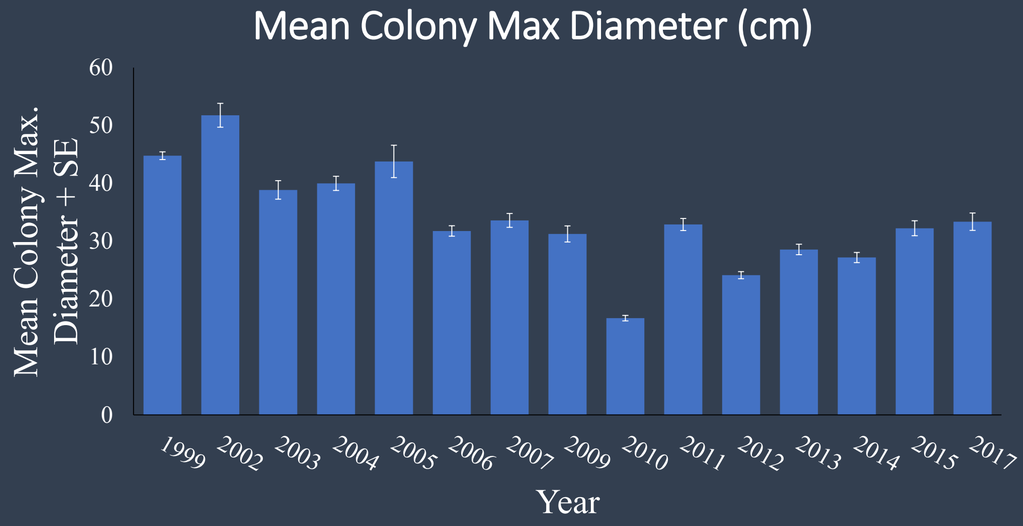
Phase Shift
Coral cover declines
Macroalgae dominates

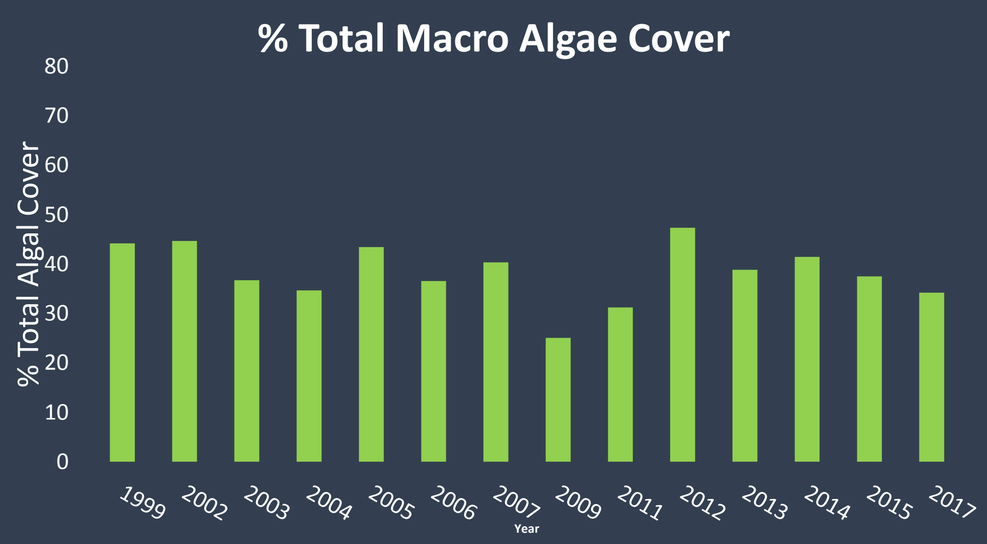

St. John, USVI
A
Guadeloupe
B
Leeward Bonaire
C
Parrotfish Biomass
0
20
40
60
80
1985
1990
1995
2000
2005
2010
2015
Year

scraper

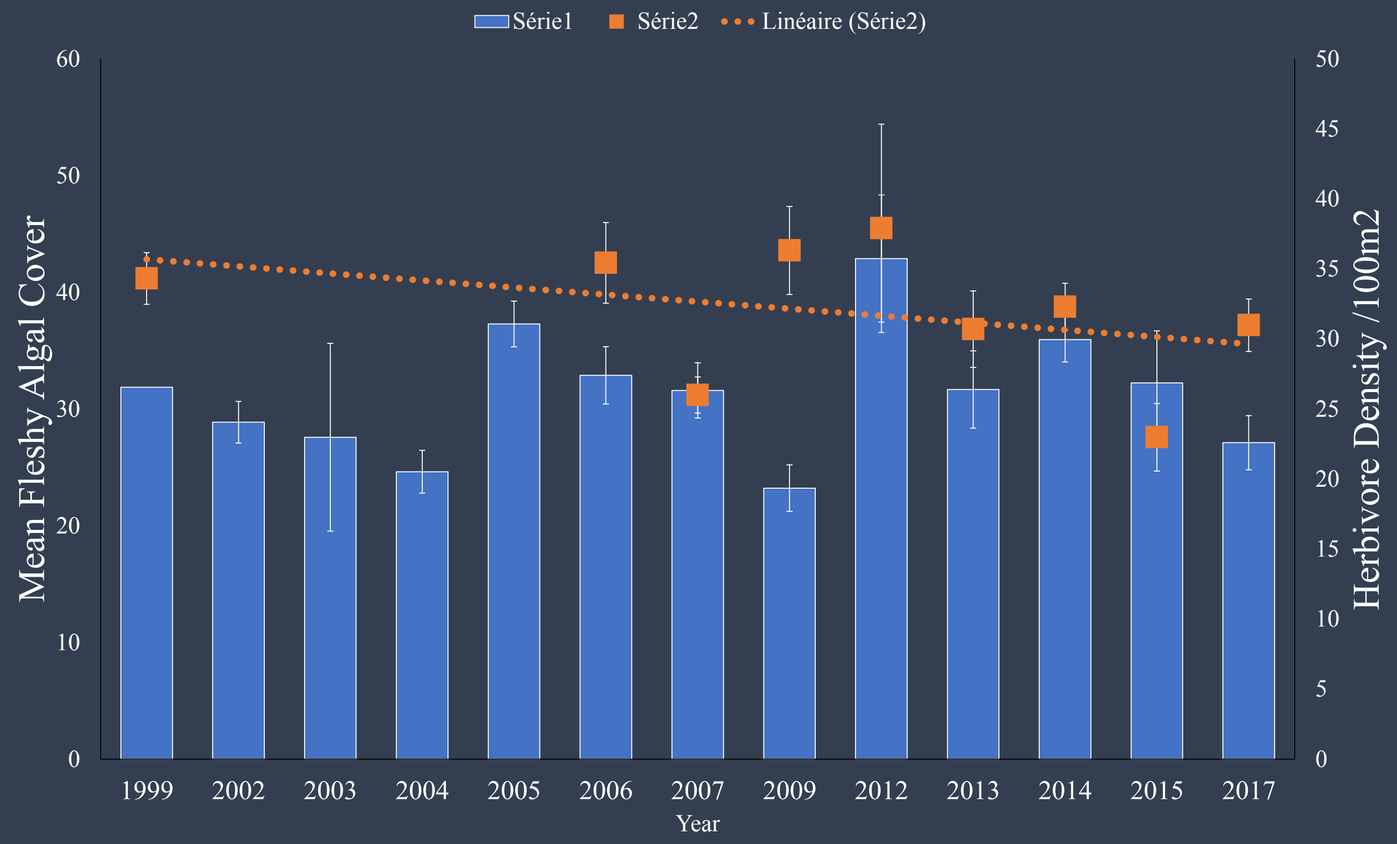
Little Cayman Research Centre – 20 YEAR TREND







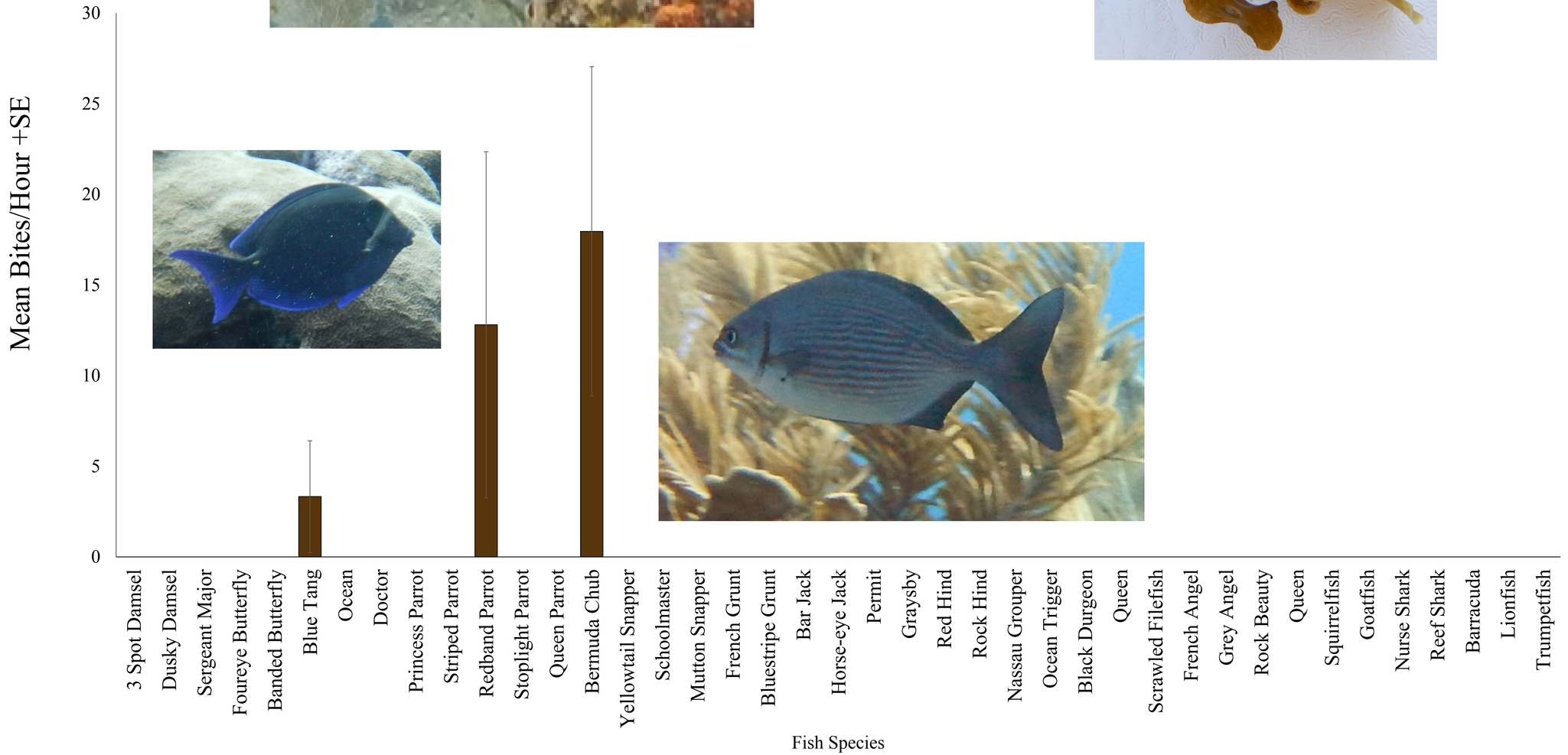
HERBIVORES


Série1
Série2
Linéaire (Série2)
Mean Fleshy Algal Cover
Herbivore Density /100m2
60
50
40
30
20
10
0
50
45
40
35
30
25
20
15
10
5
0
1999
2002
2003
2004
2005
2006
2007
2009
2012
2013
2014
2015
2017
Year

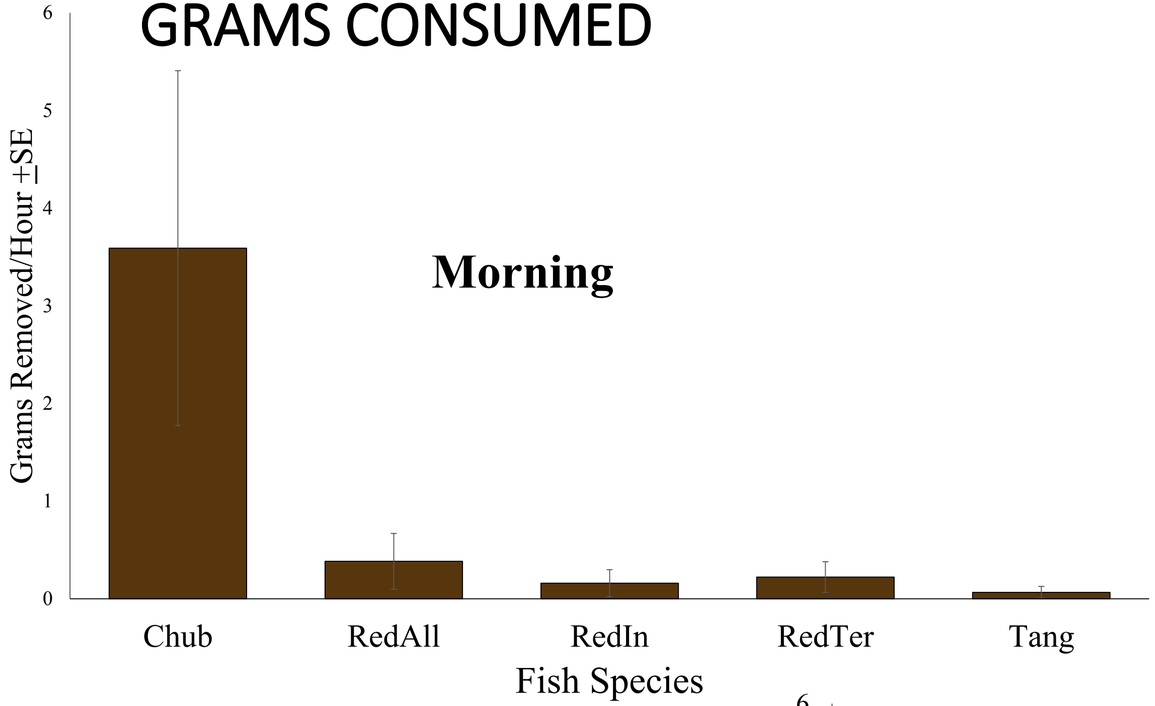
DARWIN INITIATIVE

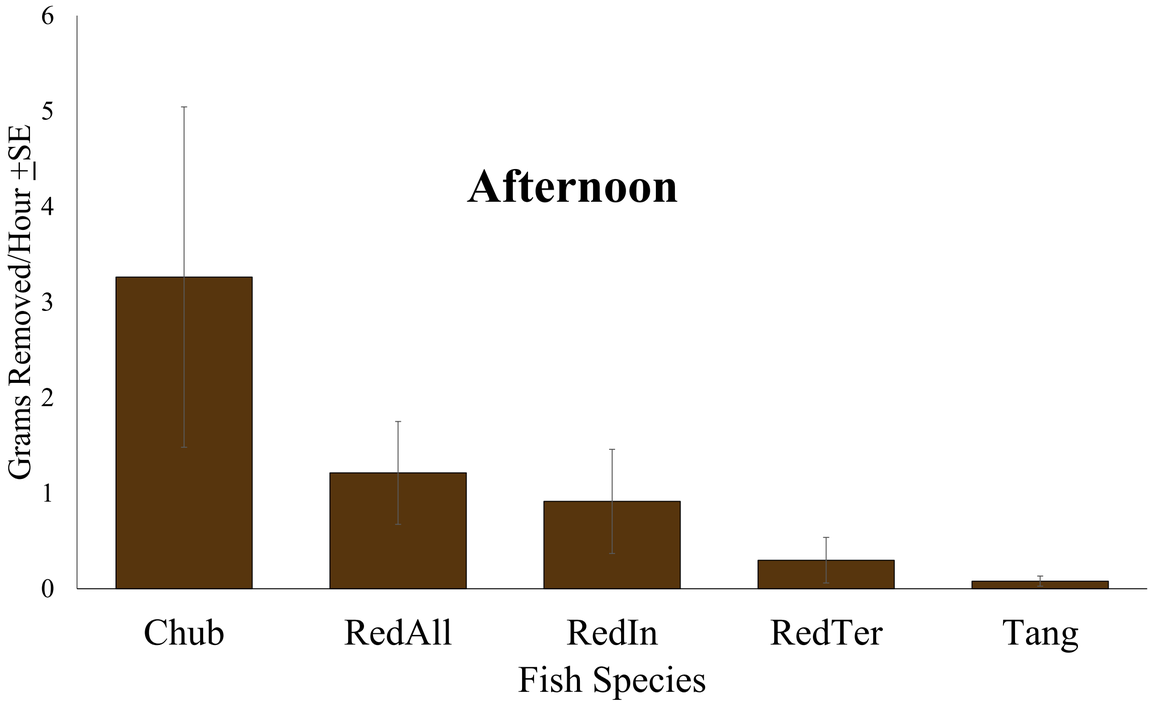
Which fish do we protect?

BITES

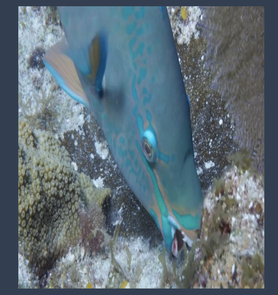

Mean Bites/Hour +SE
30
25
20
15
10
5
0
3 Spot Damsel
Dusky Damsel
Sergeant Major
Foureye Butterfly
Banded Butterfly
Blue Tang
Ocean
Doctor
Princess Parrot
Striped Parrot
Redband Parrot
Stoplight Parrot
Queen Parrot
Bermuda Chub
Yellowtail Snapper
Schoolmaster
Mutton Snapper
French Grunt
Bluestripe Grunt
Bar Jack
Horse-eye Jack
Permit
Graysby
Red Hind
Rock Hind
Nassau Grouper
Ocean Trigger
Black Durgeon
Queen
Scrawled Filefish
French Angel
Grey Angel
Rock Beauty
Queen
Squirrelfish
Goatfish
Nurse Shark
Reef Shark
Barracuda
Lionfish
Trumpetfish
Fish Species

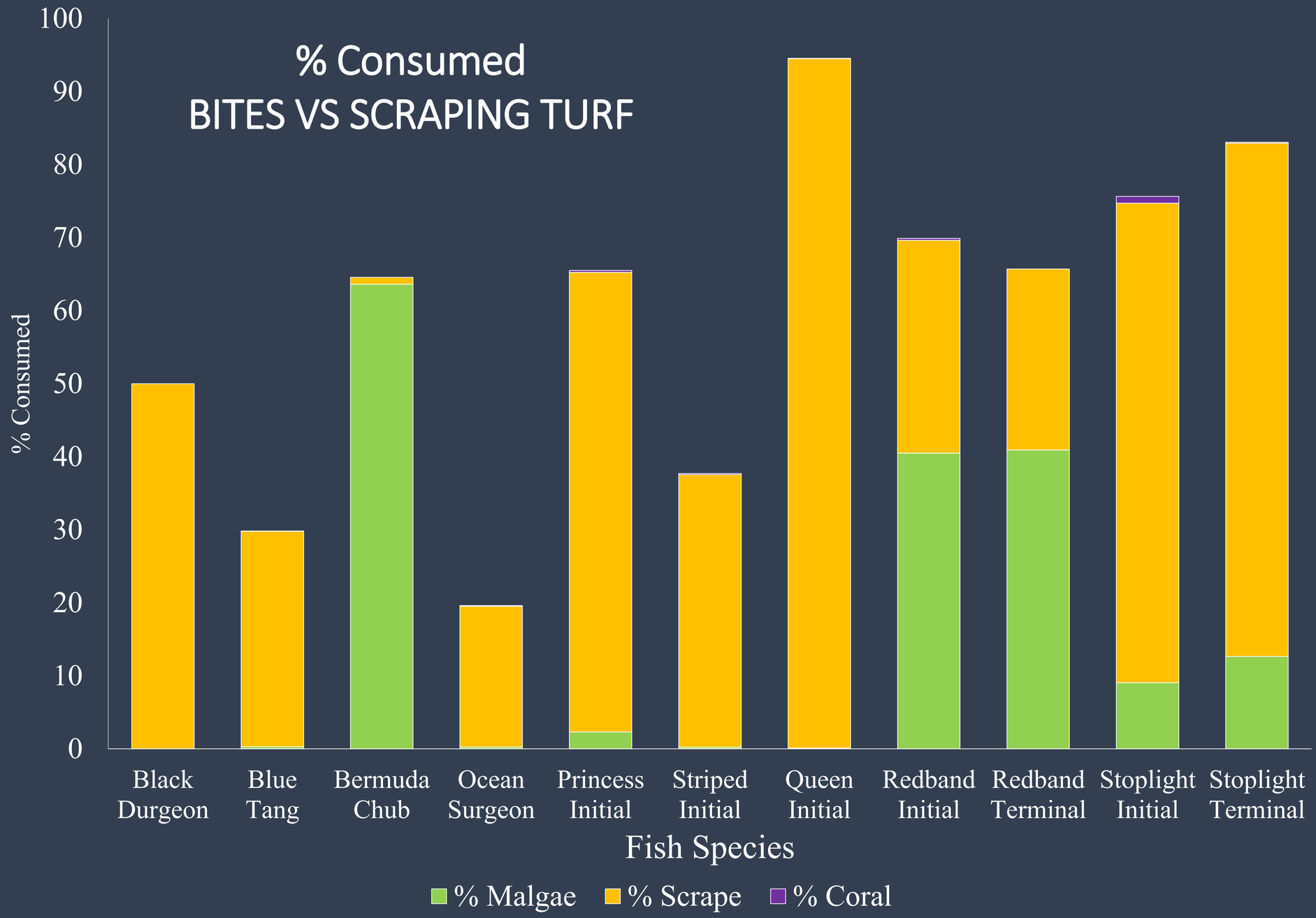
GRAMS CONSUMED





% Consumed
BITES VS SCRAPING TURF





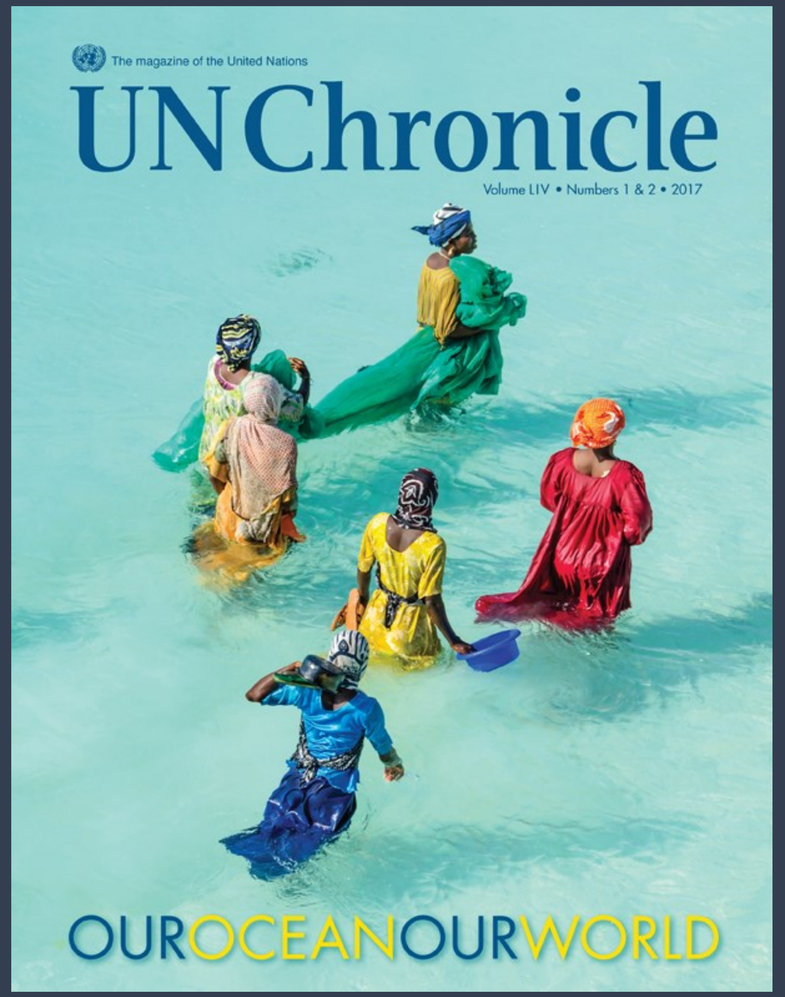
Can We Save Coral Reefs ?

With new conditions in the ocean

1) Fish - the roles of fish have shifted in importance. New work is needed that will lead to regional biodiversity action plans (partnership)

2) Corals – We need to understand which species will survive.
How should that influence our management approach? (Do we focus on species that are on the brink of extinction or on increasing those that are surviving? Or targeted approach, those producing larvae, etc.
Is our priority just creating habitat?

3) Algae – which species need to be attended to ? Which herbivores are responsible for reducing them.



IN SUMMARY.
Assisting the Natural Processes

- **Identify species critical to reef health:**

Reef building species

Algal controlling species

Bioeroding and scraping species

Assisting Natural Processes

Strategic Reef Restoration

1) Spatial Planning to reestablish key ecological processes (promoting habitat and larval connectivity, reinforcing structural complexity to enhance fish communities)

2) Can we reestablish structural complexity?

Other Solutions?

1) Assisted Adaptation/Selective restoration
2) In-vitro Fertilization
3) Management of invasive species

Consider Reefs of the Future

What do we do with the ‘new normal”?

1. Protect the fish that are doing the work. Which species are important?
2. Identify species that will be survivors (in the new conditions)
3. Assist coral regeneration using new strategies and winning species
4. Reduce our ecological footprint

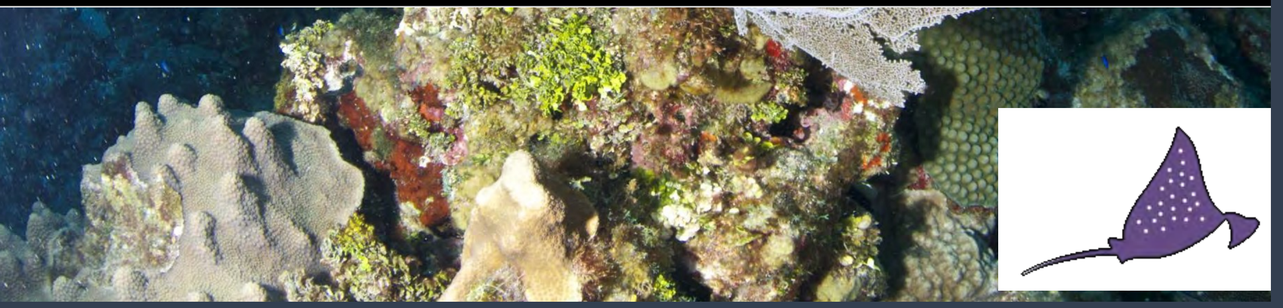
CCMI
CENTRAL CARIBBEAN MARINE INSTITUTE

Coral reefs are natural wonders of the world's oceans.

Their productivity and biological diversity are higher than just about any other ecosystem on earth. Scientists estimate more than one million species of plants and animals live on coral reefs. Communities rely on reefs for food and protection from major storms. Businesses and entire nations gain economic benefits that are clear in places like Little Cayman. Overall, the value of coral reefs is incalculable.

Currently, however, over 75% of coral reefs around the world are on the brink of collapse. Today, the Central Caribbean Marine Institute continues as the region's leading facility where science and society merge. The greatest challenge today is to find solutions to the decline of coral reefs.

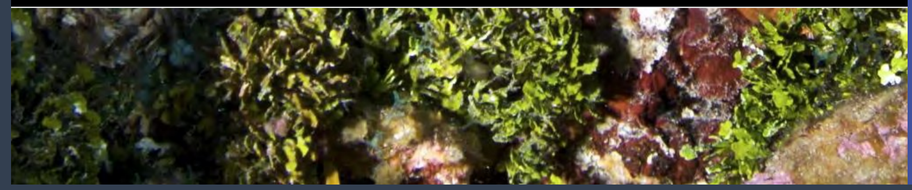
Our recent discoveries and immediate goals for the research programs offer a unique opportunity to demonstrate the significance of local actions to global issues.



Coral reefs all over the world are in danger.

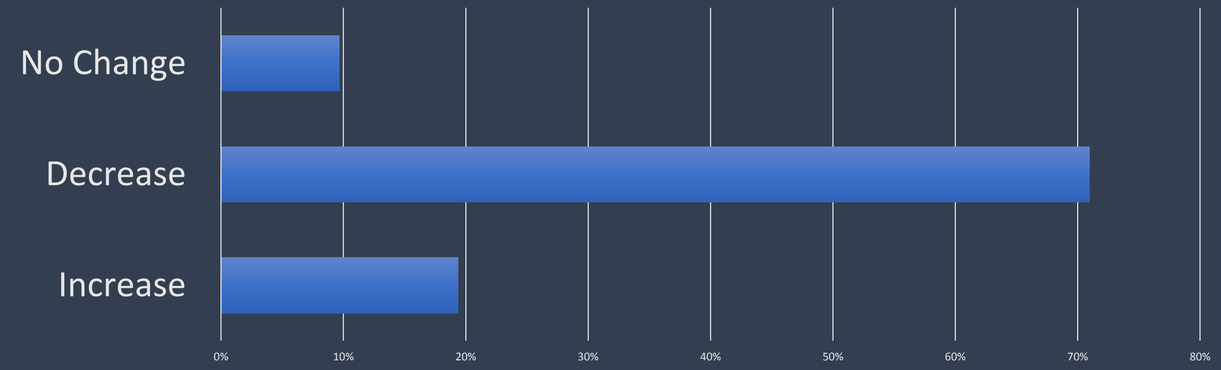
It doesn't have to be this way.

At CCMI, we are using our resources to improve the future for coral reefs by uncovering the secrets of resilience, regeneration, and biodiversity.



BEST
VOLUNTARY SCHEME FOR BIODIVERSITY AND ECOSYSTEM SERVICES IN TERRITORIES OF EUROPEAN OVERSEAS

Have you observed a change in the overall abundance of lionfish in your area over the last three years?



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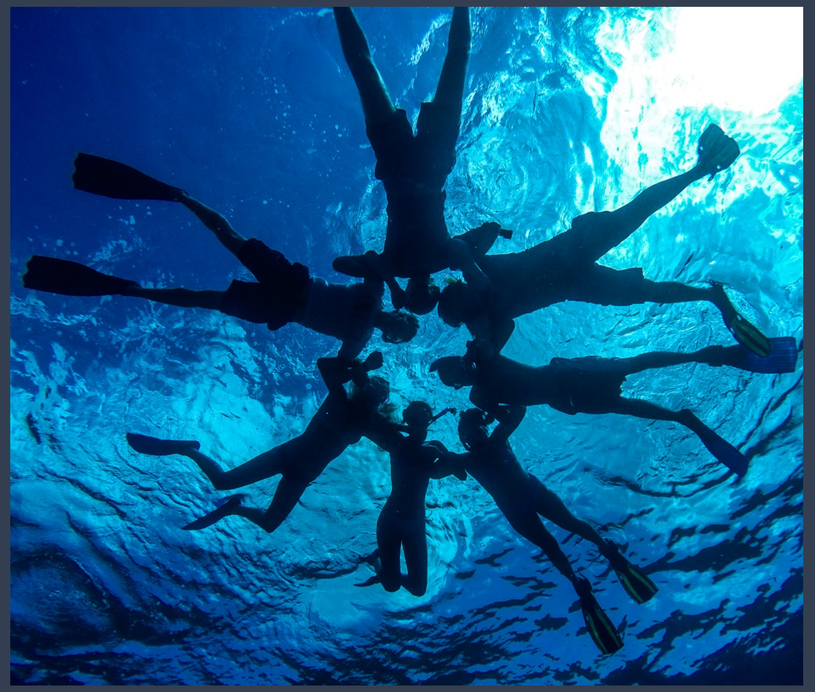
CARIBAEA INITIATIVE

"A world with vibrant oceans and healthy coral reefs"

DARWIN INITIATIVE

BEST
VOLUNTARY SCHEME FOR BIODIVERSITY AND ECOSYSTEM SERVICES IN TERRITORIES OF EUROPEAN OVERSEAS

European Commission

Partnerships and Collaborations