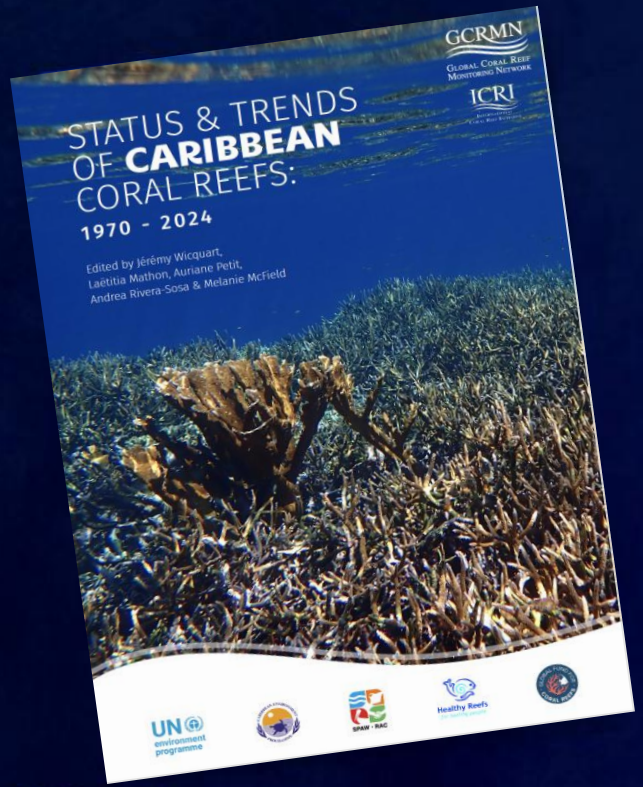

GCRMN

WEBINAR

Status and Trends of Caribbean Coral Reefs: 1970–2024

GCRMN-Caribbean Report Launch

Tuesday **December 9** | 10AM (UTC-4)

Housekeeping

Language

Presentations will be delivered in **English only**

Translation

Spanish translation available

Recording & Resources

The webinar will be recorded and shared on ICRI's YouTube Channel, the webinar's respective webpage, and the report's page on the GCRMN

Question & Answer

Please submit questions using the Q&A feature (bottom of your Zoom window) throughout the duration of the webinar

We may not have chance to cover all the questions, but we will compile the questions and aim to provide responses in the summary of the webinar

Please note, **questions posted in the chat may not be seen or answered**

Chat

The chat is open for general communication and technical help

Feel free to use it to connect with hosts or other participants

The speakers

Christopher Corbin
UNEP-CEP

Lucie Labbouz
SPAW-RAC

Laëtitia Mathon
Consultant

Jérémy Wicquart
Marepolis

Andrea Rivera-Sosa
Coral Reef Alliance

Aldo Croquer
The Nature Conservancy

Melanie McField
Healthy Reefs for Healthy People

Yabanex Batista
Global Fund for Coral Reefs

Tom Dallison
ICRI / GCRMN

Agenda of the webinar

	Part	Speaker(s)	Duration
1	Opening remarks	Christopher Corbin	5’
2	Overview of the report	Lucie Labbouz	5’
3	Main results	Laëtitia Mathon, Jérémy Wicquart	15’
4	Case studies	Andrea Rivera-Sosa, Aldo Croquer	10’
5	Recommendations	Melanie McField	5’
6	Insights from GFCR	Yabanex Batista	5’
7	Next steps	Tom Dallison	5’
8	Access to the report	Lucie Labbouz	5’

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1

OPENING REMARKS

Christopher Corbin
UNEP-CEP

UN environment programme

CARIBBEAN ENVIRONMENT PROGRAMME

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2

OVERVIEW OF THE REPORT

Lucie Labbouz
SPAW-RAC

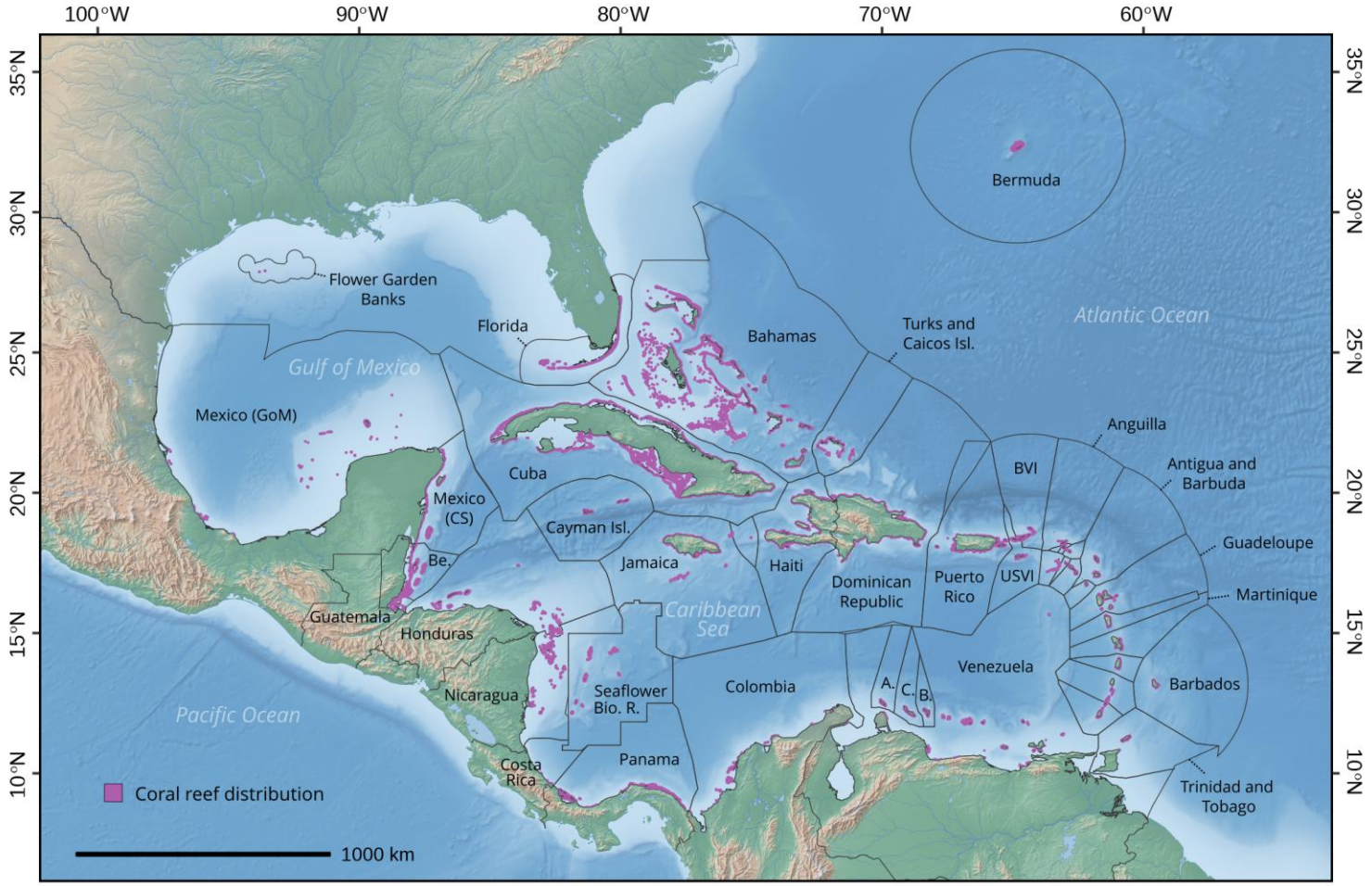
UN environment programme

CARIBBEAN ENVIRONMENT PROGRAMME

SPAW · RAC

The Caribbean region

- **24,230 km^2** of coral reefs
- **10%** of the world's coral reefs
- The **4th largest** GCRMN region
- Vital **ecosystem services**: biodiversity support, coastal protection, nutrient cycling, fisheries, livelihoods and cultural values



The report timeline

	2024						2025												2026		
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
Data collation	•	•	•	•	•	•	•	•	•	•	•										
Data analysis					•	•	•	•	•	•	•	•	•	•	•						
Writing and review							•	•	•	•	•	•	•	•	•	•	•				
Layout															•	•	•	•			
Dissemination												•						•	•	•	•
Data task force				•		•				•					•						

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UNITED NATIONS OCEAN CONFERENCE NICE, FRANCE 2025

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Structure of the report

Acknowledgments

Foreword

Executive Summary

Introduction

Synthesis for the Caribbean

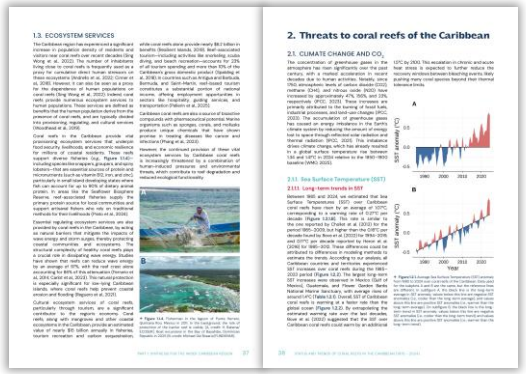
Syntheses for countries and territories

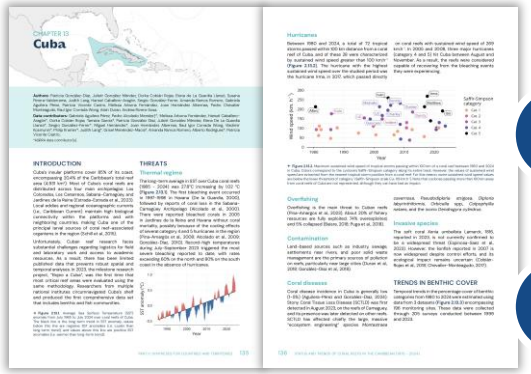
Materials and Methods

Authors' contributions

Bibliography

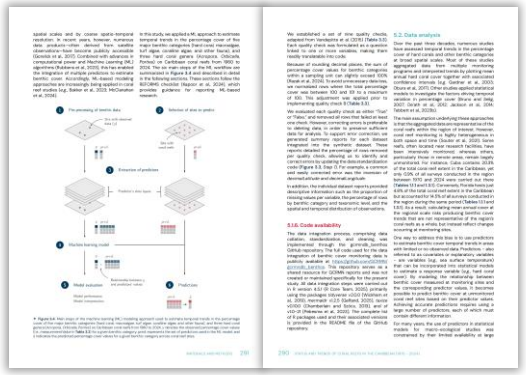
Supplementary Materials



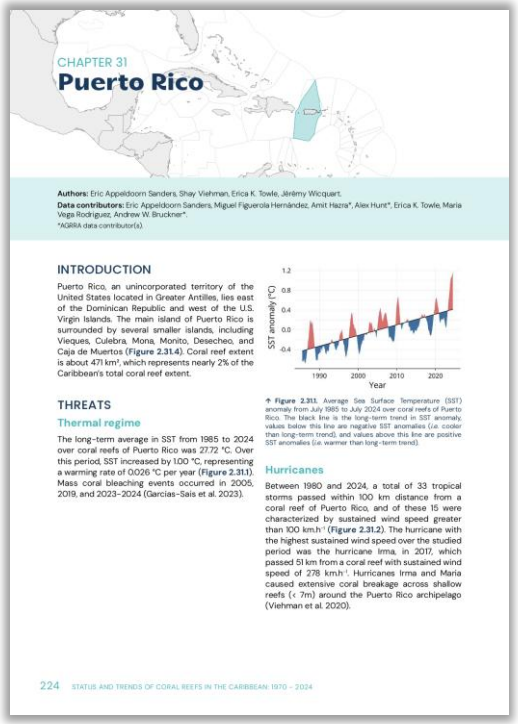


44 Chapters

9 Case studies



Countries and territories chapters


CHAPTER 31
Puerto Rico

Authors: Eric Appeldoorn Sanders, Shay Viehman, Erica K. Towle, Jérémy Wicquart.
Data contributors: Eric Appeldoorn Sanders, Miguel Figuerola Hernández, Amit Hazra*, Alex Hunt*, Erica K. Towle, Maria Vega Rodriguez, Andrew W. Bruckner*.
*AGRRA data contributor(s).

INTRODUCTION

Puerto Rico, an unincorporated territory of the United States located in Greater Antilles, lies east of the Dominican Republic and west of the U.S. Virgin Islands. The main island of Puerto Rico is surrounded by several smaller islands, including Vieques, Culebra, Mona, Monito, Desecheo, and Caja de Muertos (Figure 2.31.4). Coral reef extent is about 471 km², which represents nearly 2% of the Caribbean's total coral reef extent.

THREATS

Thermal regime

The long-term average in SST from 1985 to 2024 over coral reefs of Puerto Rico was 27.72 °C. Over this period, SST increased by 1.00 °C, representing a warming rate of 0.026 °C per year (Figure 2.31.1). Mass coral bleaching events occurred in 2005, 2019, and 2023–2024 (Garcías-Sais et al. 2023).

Figure 2.31.1. Average Sea Surface Temperature (SST) anomaly from July 1985 to July 2024 over coral reefs of Puerto Rico. The black line is the long-term trend in SST anomaly; values below this line are negative SST anomalies (i.e. cooler than long-term trend), and values above this line are positive SST anomalies (i.e. warmer than long-term trend).

Hurricanes

Between 1980 and 2024, a total of 33 tropical storms passed within 100 km distance from a coral reef of Puerto Rico, and of these 15 were characterized by sustained wind speed greater than 100 km·h⁻¹ (Figure 2.31.2). The hurricane with the highest sustained wind speed over the studied period was the hurricane Irma, in 2017, which passed 51 km from a coral reef with sustained wind speed of 278 km·h⁻¹. Hurricanes Irma and Maria caused extensive coral breakage across shallow reefs (< 7m) around the Puerto Rico archipelago (Viehman et al. 2020).

224 STATUS AND TRENDS OF CORAL REEFS IN THE CARIBBEAN: 1970 – 2024

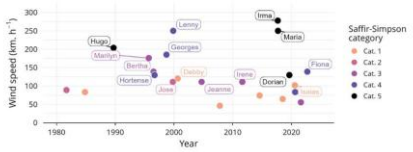


Figure 2.31.2. Maximum sustained wind speed of tropical storms passing within 100 km of a coral reef between 1980 and 2024 in Puerto Rico. Colors correspond to the cyclone's Saffir-Simpson category along its entire track. However, the values of sustained wind speed are extracted from the nearest tropical storm position from a coral reef. For this reason, some sustained wind speed values are below the lower threshold of category 1 Saffir-Simpson scale (i.e. 119 km·h⁻¹). Note that cyclones passing more than 100 km away from coral reefs of Puerto Rico are not represented, although they can have had an impact.

Coral diseases

Stony coral tissue loss disease (SCTLD) is the latest epizootic in a series that started with mass mortality of *Diadema antillarum* (1983–1984), white band disease affecting Acroporid corals (Gladfelter 1982) and other white diseases that affected massive species. SCTLD impacted many coral species, greatly reducing colony density, cover, and shifting population distributions of highly susceptible species to smaller sizes (Garcías-Sais et al. 2023, Viehman et al. 2025).

TRENDS IN BENTHIC COVER

Temporal trends in the percentage cover of benthic categories from 1980 to 2024 were estimated using data from 7 datasets (Figure 2.31.3) encompassing 2,825 monitoring sites. These data were collected through 3,130 surveys conducted between 1982 and 2024, with a considerable increase in survey effort and spatial distribution after 2014.

The temporal patterns of benthic cover of hard corals in Puerto Rico reflect a trajectory consistent with the well-documented decline of Caribbean coral reefs. Hard coral cover showed a sharp collapse during the 1980s, a period marked by the mass mortality of the herbivorous urchin Diadema antillarum (Lessios, 1988) and compounded by successive disturbances including hurricanes, disease outbreaks, and bleaching events (Gardner et al., 2003; Weil et al., 2009). Localized studies have documented similar declines linked to anthropogenic stressors such as sedimentation, pollution, and coastal development (Rogers, 1990; Hernández-Delgado, 2000; Ballantine et al., 2008). By the mid-1990s, coral cover had fallen below 15% and has remained low since, underscoring the poor recovery ability of Puerto Rican reefs and mirroring broader Caribbean trends where cumulative pressures and recurrent impacts have hindered coral resurgence (Hernández-Delgado et al., 2014). The sharp decline observed after 2005 is likely attributable to the region-wide mass bleaching event that year, which caused unprecedented coral mortality in Puerto Rico and across the Caribbean (Eakin et al., 2010; Hernández-Delgado et al., 2014). In contrast, macroalgae cover exhibited an inverse trajectory, steadily increasing over the same period and exceeding 20% over since 2015. The high percentage cover of macroalgae emerged through weakened grazing pressure and reduced competition from corals, reflecting a classic phase shift commonly reported in Caribbean reefs (Hughes, 1994; Mumby et al., 2007). Studies have indicated that algal expansion has been reinforced by low Diadema recovery and continued fishing pressure on herbivorous fishes, further limiting coral resilience (Ballantine et al., 2008; Hernández-Delgado et al., 2014).

PART II: SYNTHESES FOR COUNTRIES AND TERRITORIES 225

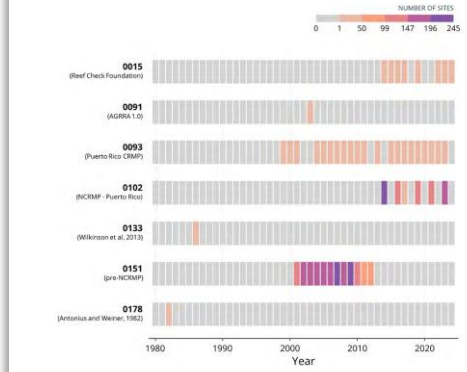


Figure 2.31.3. Temporal distribution of surveys from datasets included in the analyses to model temporal trends of the three benthic categories. The y-axis numbers denote individual dataset identifiers, and the text below, shown in parentheses, specifies the corresponding dataset names as defined in gcrmndb_benthos (see Materials and Methods).

226 STATUS AND TRENDS OF CORAL REEFS IN THE CARIBBEAN: 1970 – 2024

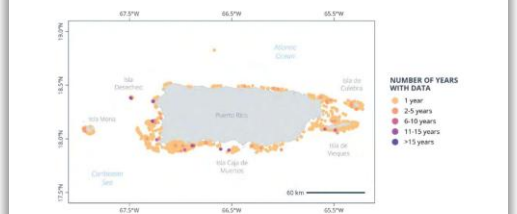


Figure 2.31.4. Spatio-temporal distribution of benthic cover monitoring sites across Puerto Rico. Sites monitored for the greatest number of years are displayed above those monitored for fewer years. For the purposes of this report, a site is defined as a unique set of GPS coordinates. Consequently, small year-to-year variations in these coordinates may have resulted in lower "number of years with data" in this figure compared to those reported in other publications based on the same dataset.

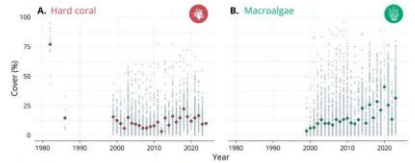


Figure 2.31.5. Modeled temporal trends of benthic percentage cover for hard coral (A), and macroalgae (B) in Puerto Rico from 1980 to 2024. The bold lines indicate the modeled mean cover, while the shaded ribbon represents the 95% confidence intervals. Grey points denote the annual means of observed data (i.e. monitoring data).

PART II: SYNTHESES FOR COUNTRIES AND TERRITORIES 227

Overview

Threats

Temporal trends in hard coral and macroalgae cover

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3

MAIN RESULTS OF THE REPORT

Laëtitia Mathon
Consultant

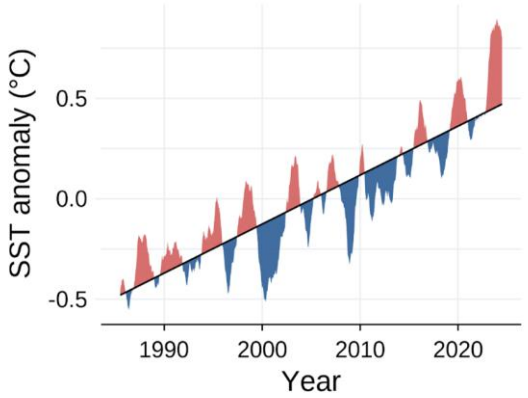
Jérémy Wicquart
Marepolis

Marepolis
Conseil en politiques de la mer

Threats to coral reefs of the Caribbean

Climate change

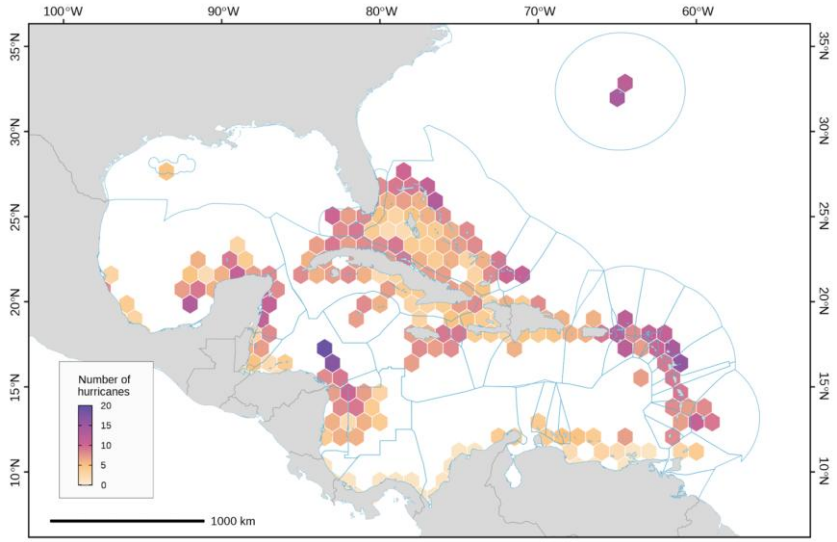
SST and Marine Heatwaves



+1.07°C SST between 1985 and 2024

Major heatwaves and **bleaching events** in 1998, 2005, and 2023-24

Hurricanes



171 hurricanes between 1980-2024

Allen in Mexico 1980, Irma in Lesser Antilles in 2017

Ocean acidification and deoxygenation

Unmitigated CO_2 emissions by 2100 → pH decline of 0.4 and decrease in calcification rates by 50%

Oxygen concentration could decrease by 1-7% by 2100

Threats to coral reefs of the Caribbean

Coastal developments

Nutrients and sediments

Runoff from **wastewater** and **coastal development**

Increase disease and oxidative stress

Promote **macroalgae growth**

Maritime traffic

Shipping for **international trade** and **cruise industry**

Damage coral through **anchoring**, **dredging**

Pollution through **oil spill** and **mass tourism**

Other pollution

Chemicals from agriculture and hydrocarbons

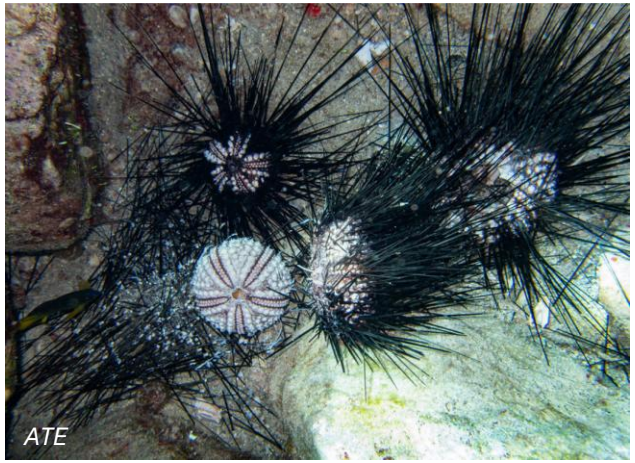
Plastic pollution

Disrupt reproduction and resilience

Threats to coral reefs of the Caribbean

Disease outbreaks

Urchin die-off



Long-spined sea urchin (*Diadema antillarum*) once the most abundant **herbivore**

Two extreme **mortality events** in 1983-1984 and 2022

Population collapse

Coral diseases

In the 1990s

- Yellow-Band disease → *Orbicella* mortality
- White-Band disease → *Acropora* mortality
- White plague → Multi-species mortality

Since 2014

- **SCTLD** → widespread massive mortality

Threats to coral reefs of the Caribbean

Unsustainable fishing

Carnivores

Groupers, **snappers**, and **sharks** targeted

Predator biomass declined by **80-95%**

Disrupt food webs

Protection measures in Belize and USVI show **population recovery**

Herbivores

Parrotfish and **surgeonfish** essential for algae control

Increasingly targeted by **fisheries**

Widespread increase in **macroalgae cover**

Invertebrates

Caribbean **Spiny Lobster** and **Queen Conch** are the most valuable fisheries

Sharp population **declines**

Disrupt food webs

Decrease reef resilience

Threats to coral reefs of the Caribbean

Invasive species

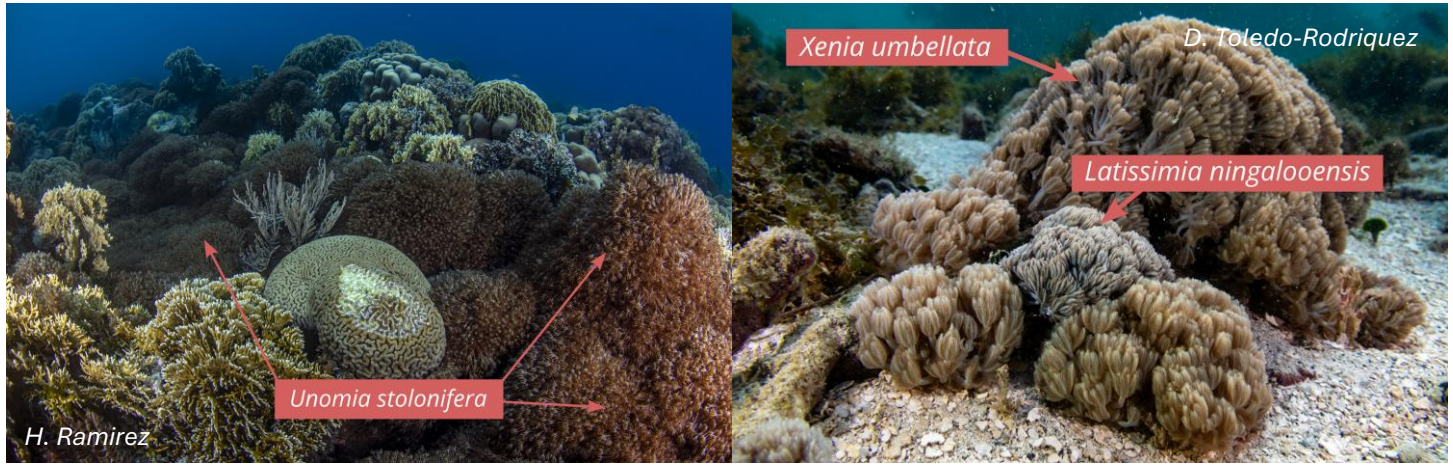
Lionfish

First detected in Florida in **1985**

Spread quickly across the Caribbean, to Central America and Colombia in 2009

Varying effects, disrupt local food webs

Soft corals



Unomia stolonifera detected in Venezuela in 2000

- Spread rapidly, cover 30-80% of reefs locally
- Overgrow native hard corals

Xenia umbellata first detected in Cuba in 2022

- Highly resistant to stress and competitive over native reef species

Latissimia ningalooensis detected in Puerto Rico in 2024

Temporal trends in benthic cover

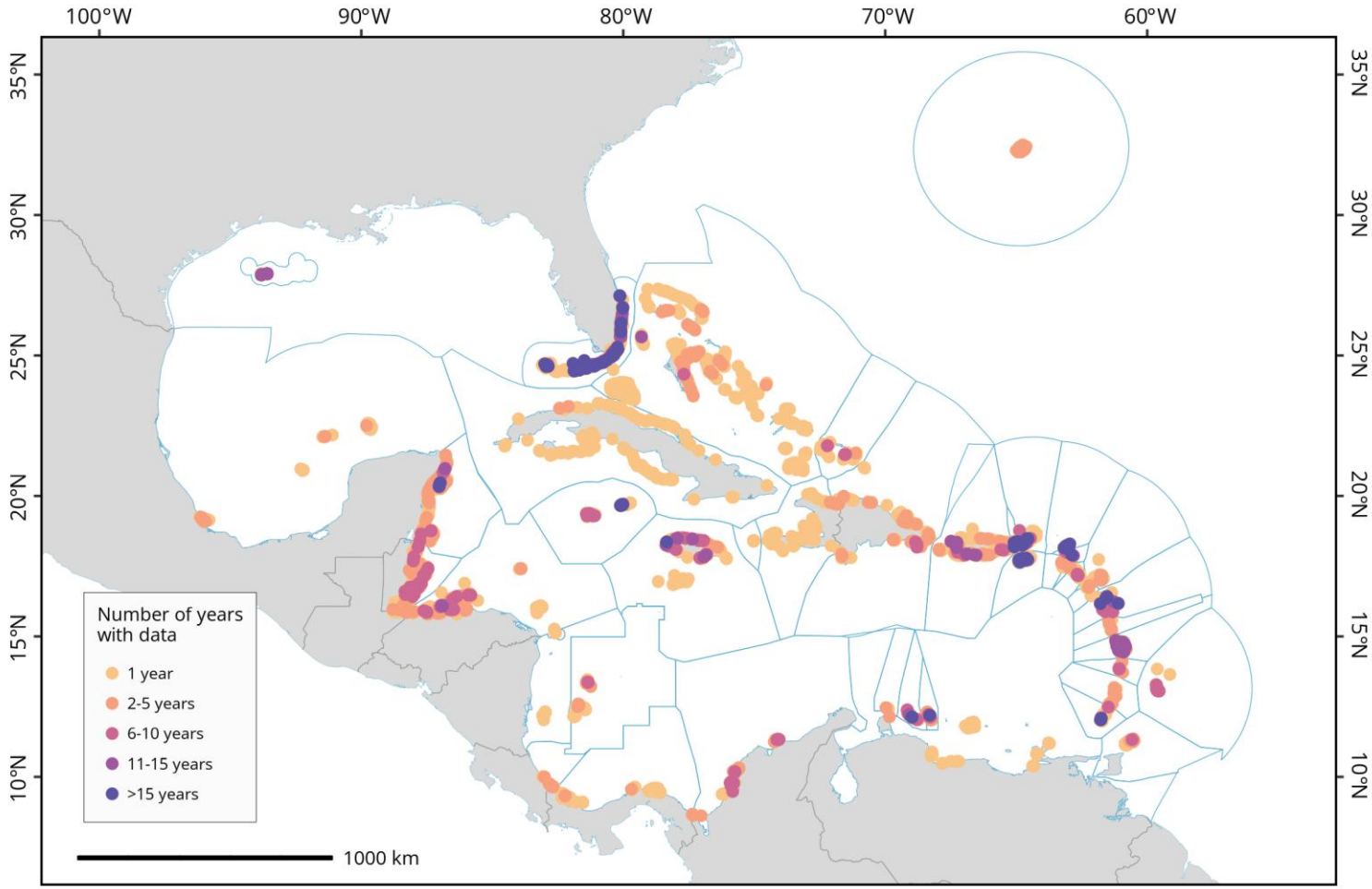
Monitoring data

72 datasets

13,864 sites

23,742 surveys

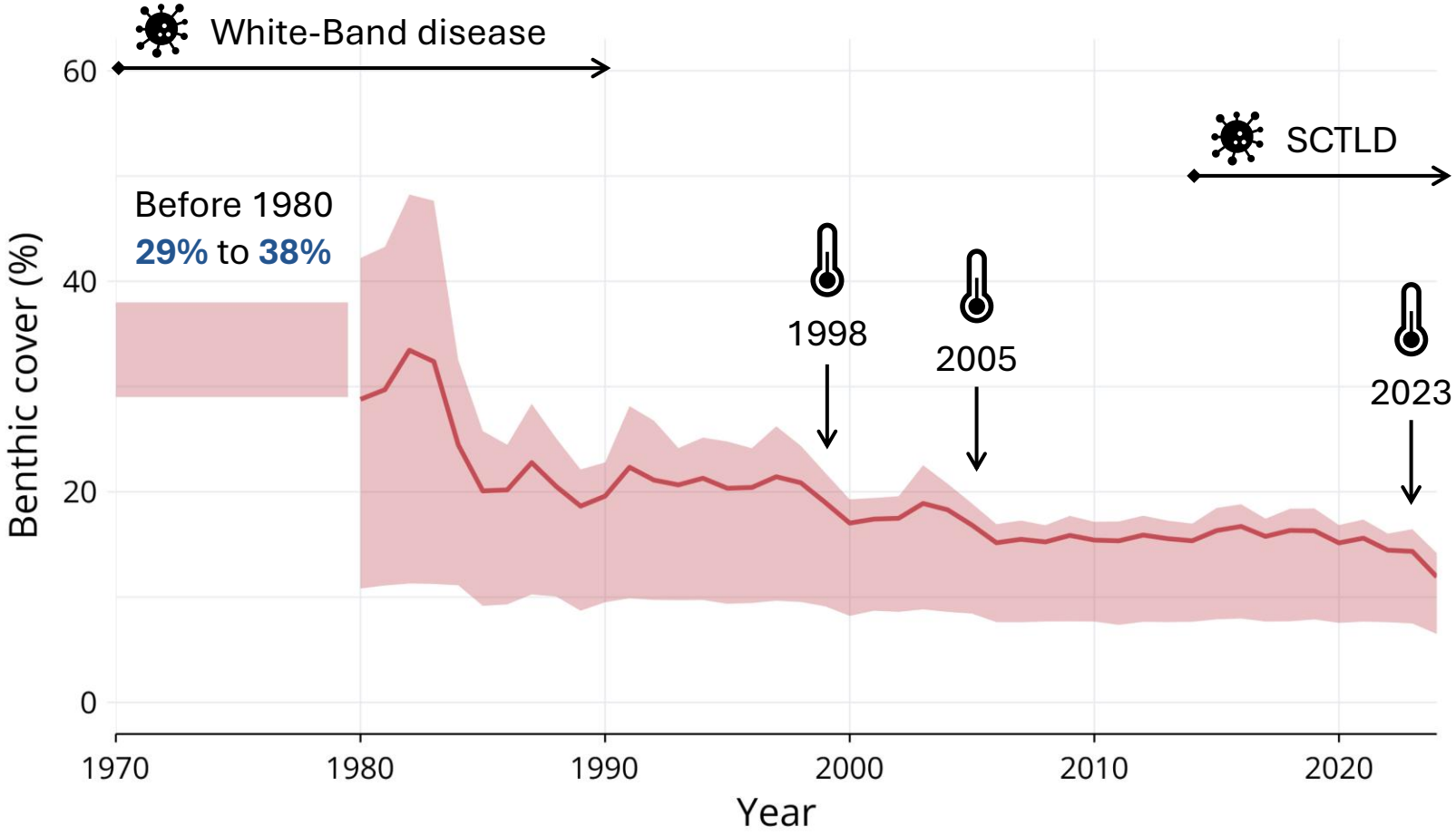
1973 – 2024



Temporal trends in benthic cover

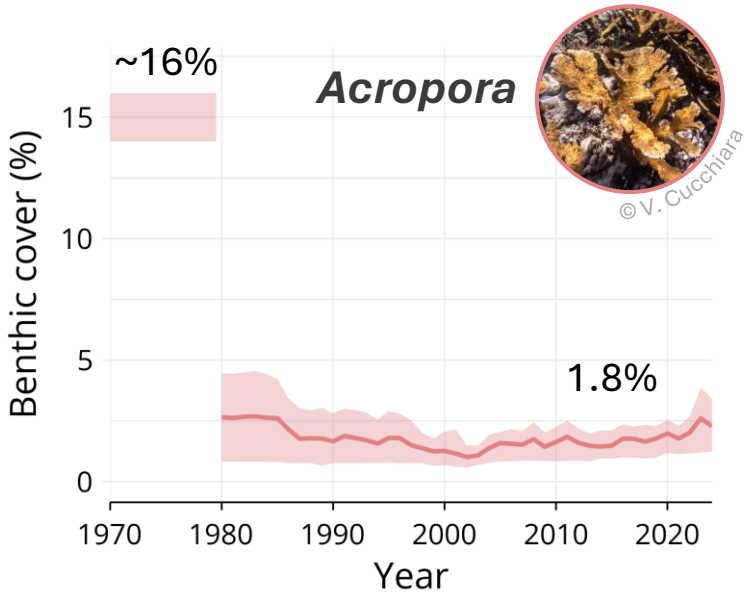
Hard coral cover

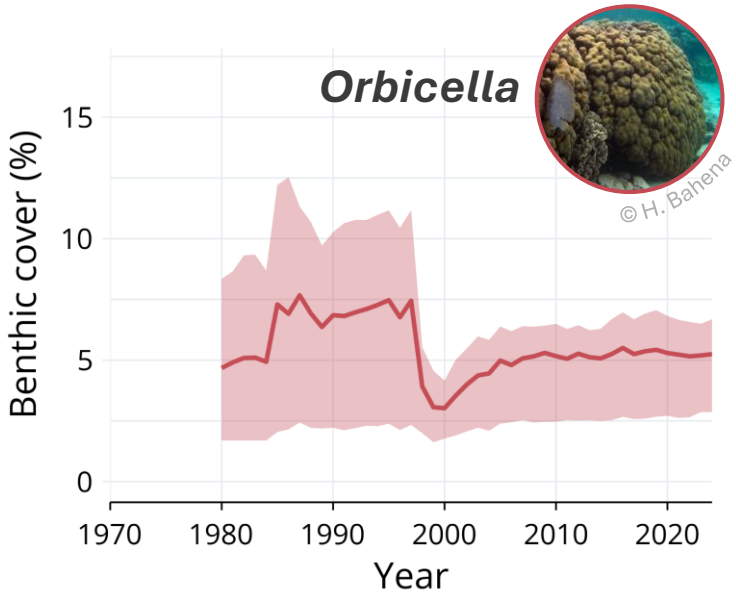
- Hard coral cover **declined** by **48%** between 1980 and 2024
- This decline was mainly driven by **coral diseases** and **bleaching events** (coupled with chronic stressors)

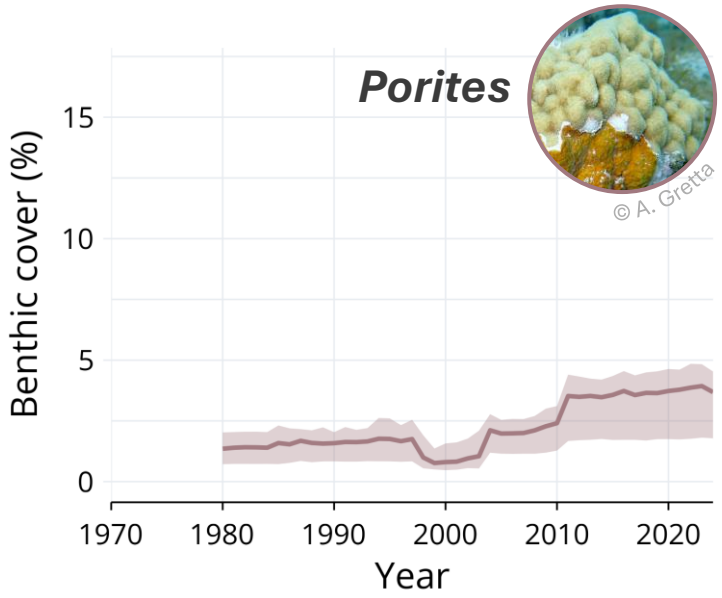


Temporal trends in benthic cover

Major hard coral genera



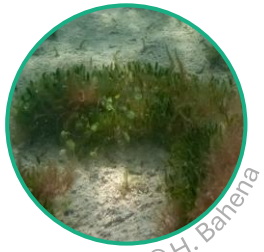




- ***Acropora*** cover declined dramatically in the 1970s and remained low since then
- ***Orbicella*** cover declined in 1998 and remained stable at ~5%
- ***Porites*** cover increased from 1980 to 2024

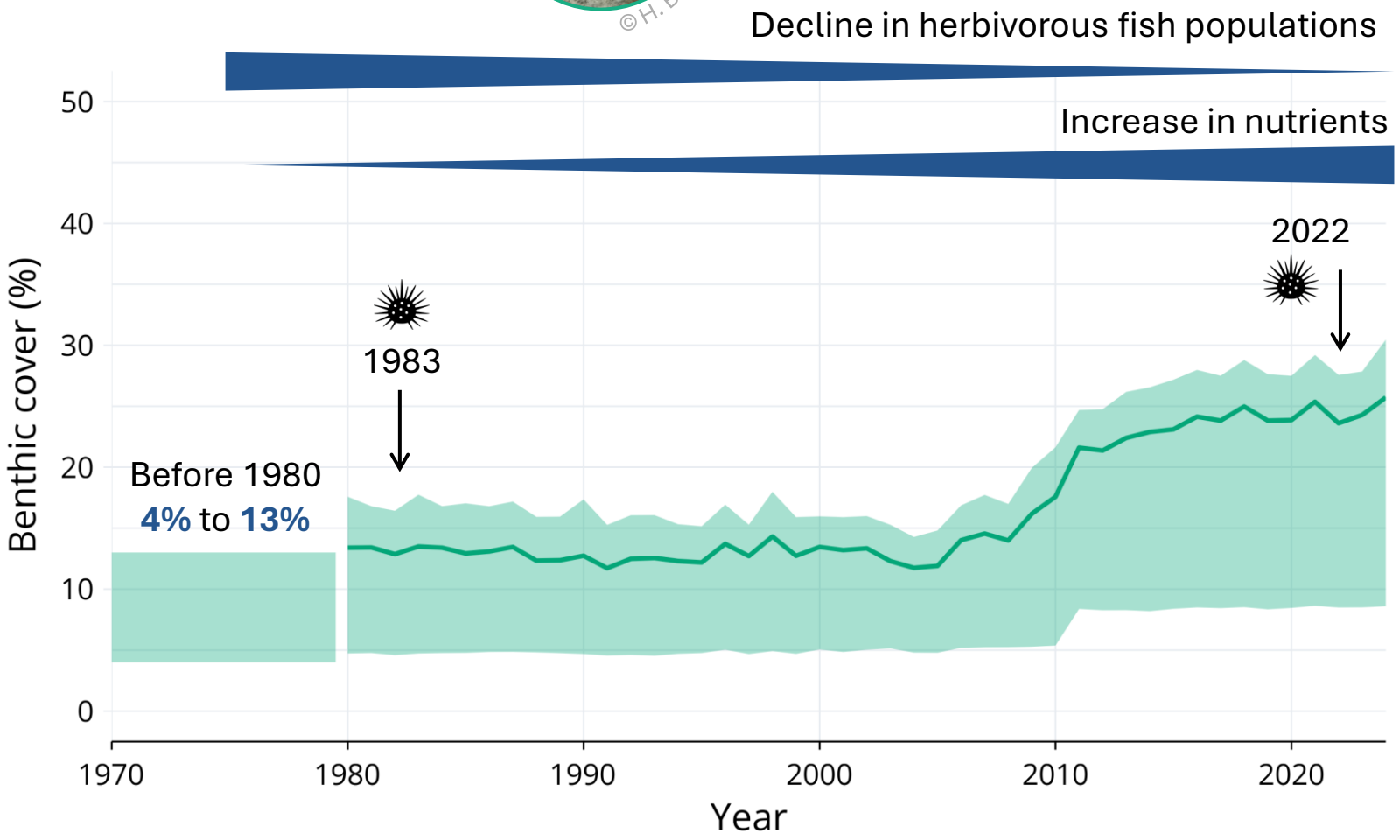
Temporal trends in benthic cover

Macroalgae



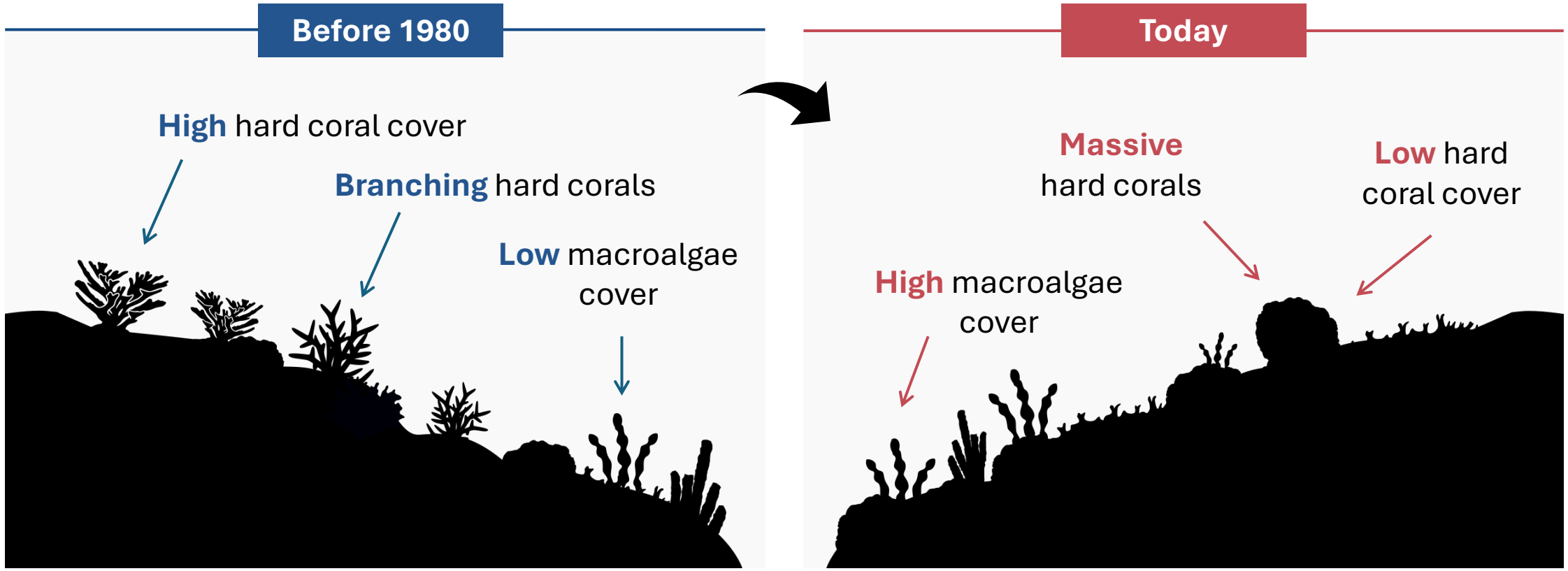
- Macroalgae cover **increased** by **85%** between 1980 and 2024

- This increase was likely driven by the decline in **herbivorous fish**, sea **urchins**, and increase in **nutrients**



Temporal trends in benthic cover

In summary



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QUESTIONS
ANSWERS

Melanie McField
HRHP

Healthy Reefs
for healthy people

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4

CASE STUDIES

Andrea Rivera-Sosa
Coral Reef Alliance

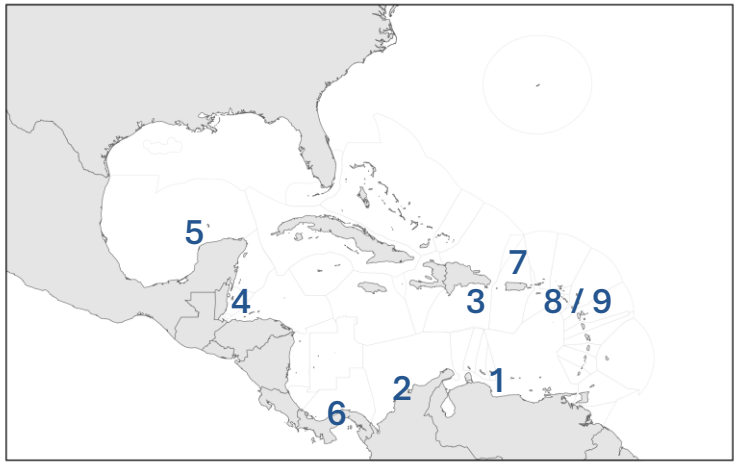
CORAL REEF ALLIANCE

Aldo Croquer
The Nature Conservancy

The Nature Conservancy

List of case studies

#	Country	Title
1	Bonaire	A tale of two islands: lessons from monitoring at fixed sites with the same researchers
2	Colombia	Colombia's paradoxical Varadero reef
3	Dominican Republic	The value of a joint coral-monitoring program to improve the outcome of coral restoration programs
4	Belize	Protecting the Mesoamerican Reef through blended finance
5	Mexico	Safeguarding unique coral reef ecosystems in the Gulf of Mexico
6	Panama	Coral reef fish abundance and reef rugosity in Bocas del Toro
7	Puerto Rico	Socioeconomic trends in the U.S. Caribbean
8	U.S. Virgin Islands	Forty years of research and monitoring documents the success of a large MPA in rebuilding a red hind spawning aggregation
9	U.S. Virgin Islands	Road to recovery for the endangered Nassau grouper

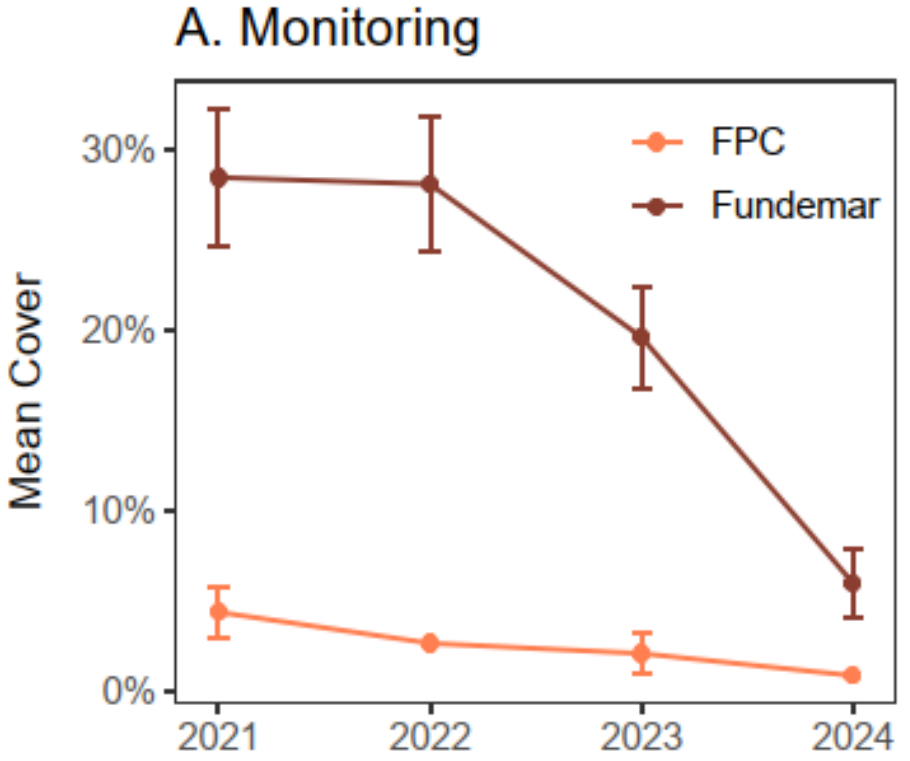


Case study #3

The value of a joint coral-monitoring program to improve the outcome of coral restoration programs

From 2022-2025 Dramatic changes

- 60-95% live coral cover loss in 3 years
- Dramatic mortality of reef-building coral populations that we used in our restoration efforts
- Three drivers: SCTLD, *Diadema* die-off, and bleaching
- Our nurseries have been severely affected
- We loss substantial amount of asexual outplants
- Sexual propagules are doing better



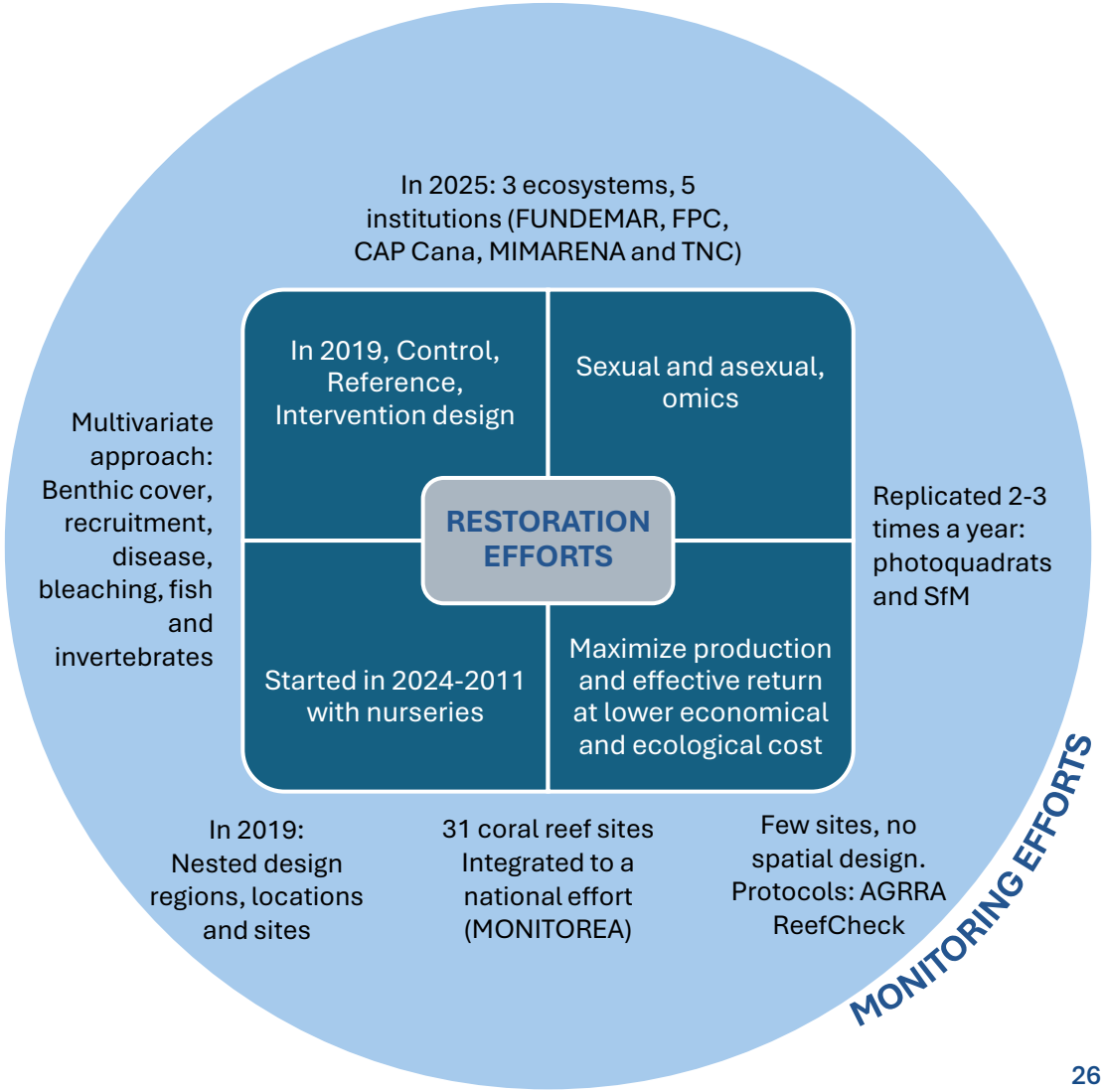
Lefcheck *et al.* in prep.

Case study #3

Benefits for SAMAR Restoration program

- **Setting objectives, goals and restoration models:** Maximum production and effective return, minimum cost and extraction of remnant coral populations
- **Site selection:** control, intervention and reference. Robust experimental design properly replicated in plots and followed before and after interventions.
- **Design of assertive interventions:** sexual and asexual propagation of resistant colonies
- **Reshape and adapt restoration plans**: optimization of efforts, logistics and investments to meet expected restoration outputs
- **Monitor restoration success:** multivariate approach to compare improved ecosystem structure and function between control, intervention and reference treatments.

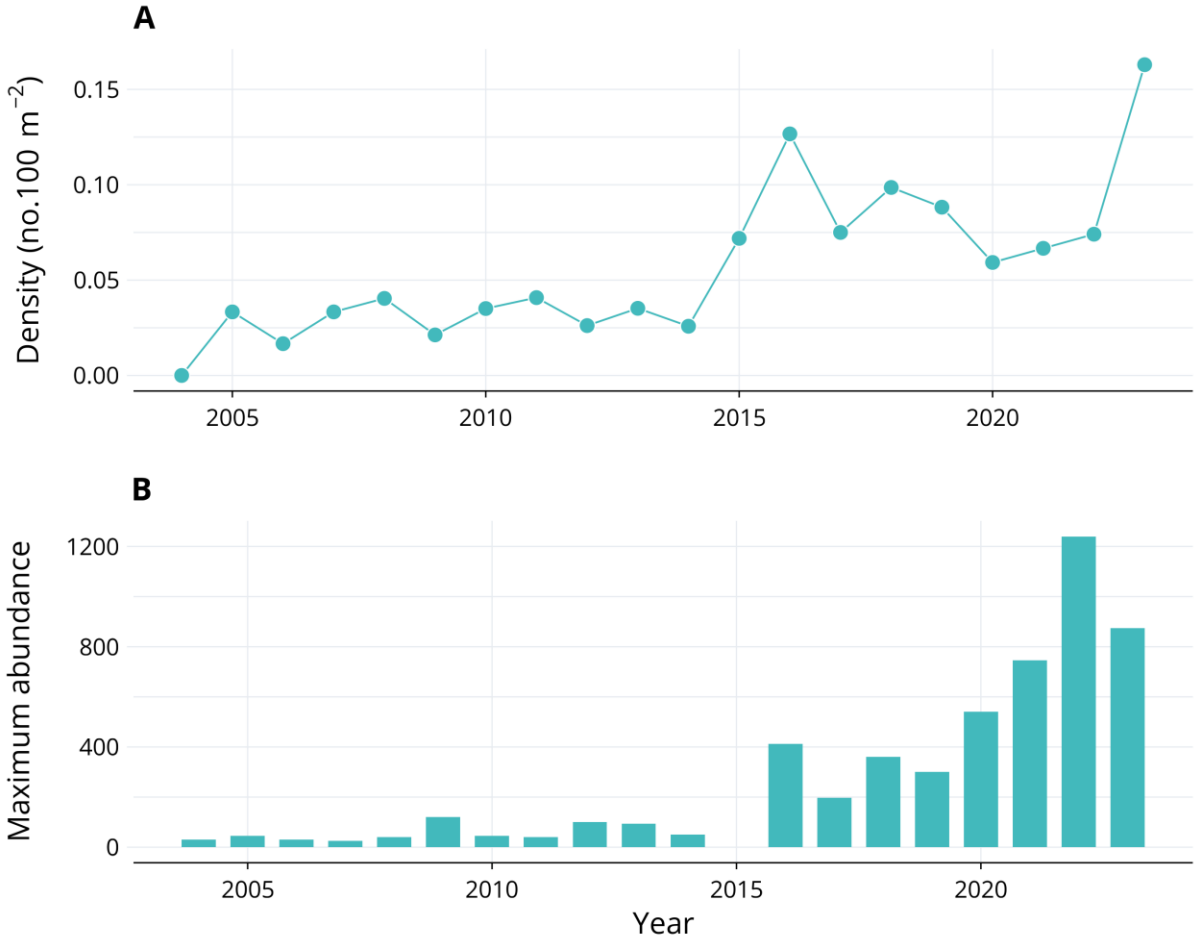
The value of a joint coral-monitoring program to improve the outcome of coral restoration programs



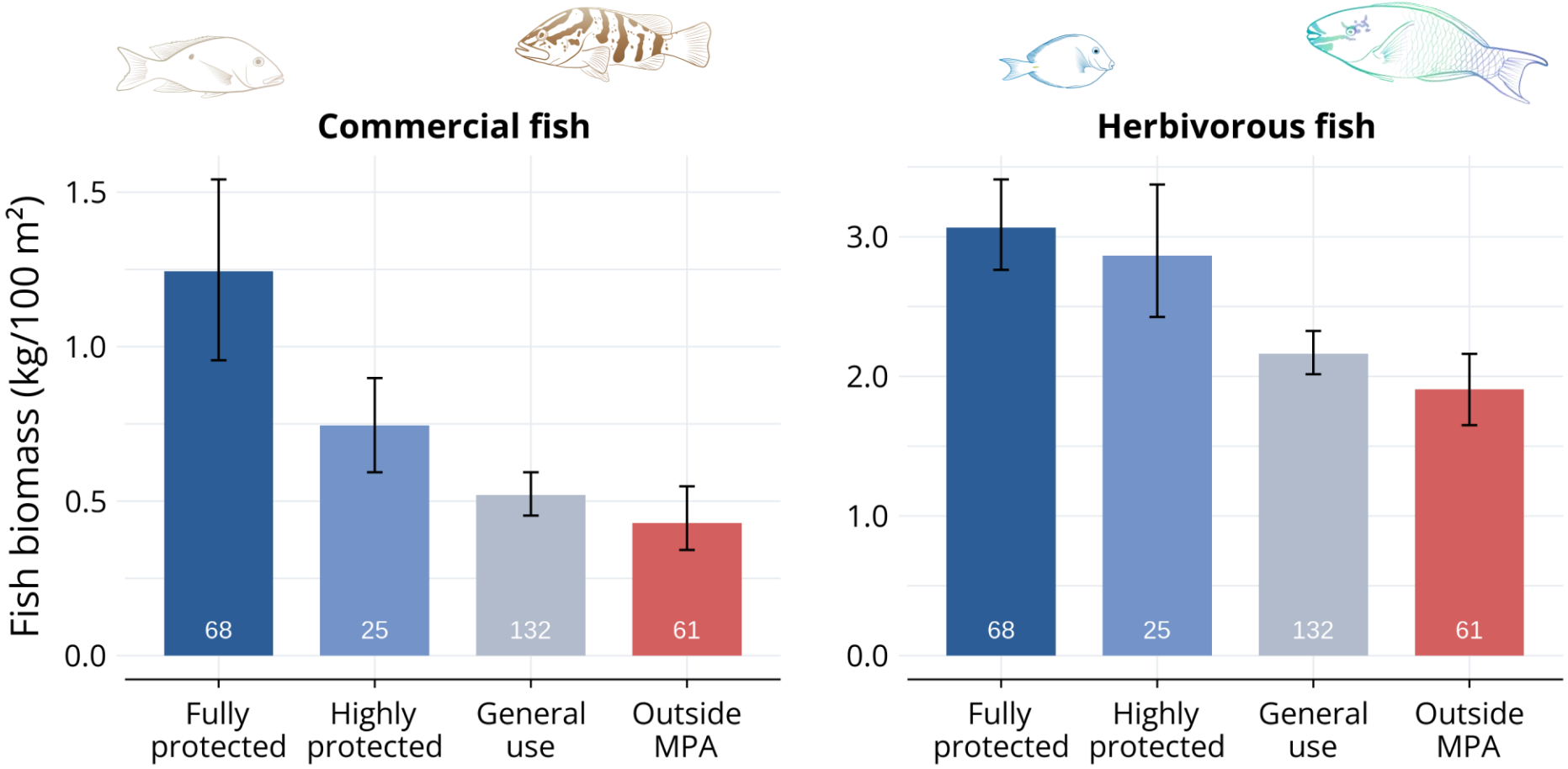
Case study #9

Road to recovery for the endangered Nassau grouper

- **Nassau grouper** (*Epinephelus striatus*) were once the largest grouper in the Caribbean
- Population **collapses** in the 1970's due to intensive fishing on fish spawning aggregation sites
- A 3-month **seasonal closure** area was implemented in Grammanik Bank (USVI) in 2005
- Since then, **density and maximum abundance** of Nassau groupers have increased



Mesoamerican reefs Marine Protected Areas



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5

RECOMMENDATIONS

Melanie McField
HRHP

Healthy Reefs
for healthy people

Recommendations

Urgently reduce greenhouse gas concentrations

Reduce local threats

Implement and enforce Marine Protected Areas (MPA)

Maintain and develop monitoring programs

Restore coral reefs

Policy brief

Short **summary** of report (4-5 pages)

Focusing on **recommendations**

Available in **English**, **Spanish** & **French**

Audience: **Decision makers**

Policy brief has more specific recommendations

- Strengthen and **invest in protection** through effective area-based management tools (including MPAs)
- Expand **ecologically connected area-based management** (MPAs, OECMs, LMMAs) including fully protected (no fishing) zones, to support Target 3 of the Kunming-Montreal GBF
- Strengthen engagement of interested parties, and **invest in monitoring, control, and surveillance** (MCS) to manage resources and ensure ecological and socio-economic benefits
- Build equitable and **collaborative governance**, and training for **MPA managers** through cooperation networks, such as the SPAW Protected area manager network, MPA Connect, or RedGolfo
- Identify areas of potential **climate resilient coral reefs** in the Caribbean region, and invest in protection of these hope spots as well as a diverse network to **promote adaptation**
- Catalyze **blended-finance initiatives** that leverage public and private funds to support coral reef resilience and create employment opportunities (e.g., the Global Fund for Coral Reefs-funded MAR+Invest)

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INSIGHTS AND PERSPECTIVE FROM GFCR

Yabanex Batista
GFCR

GLOBAL FUND FOR CORAL REEFS

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NEXT STEPS

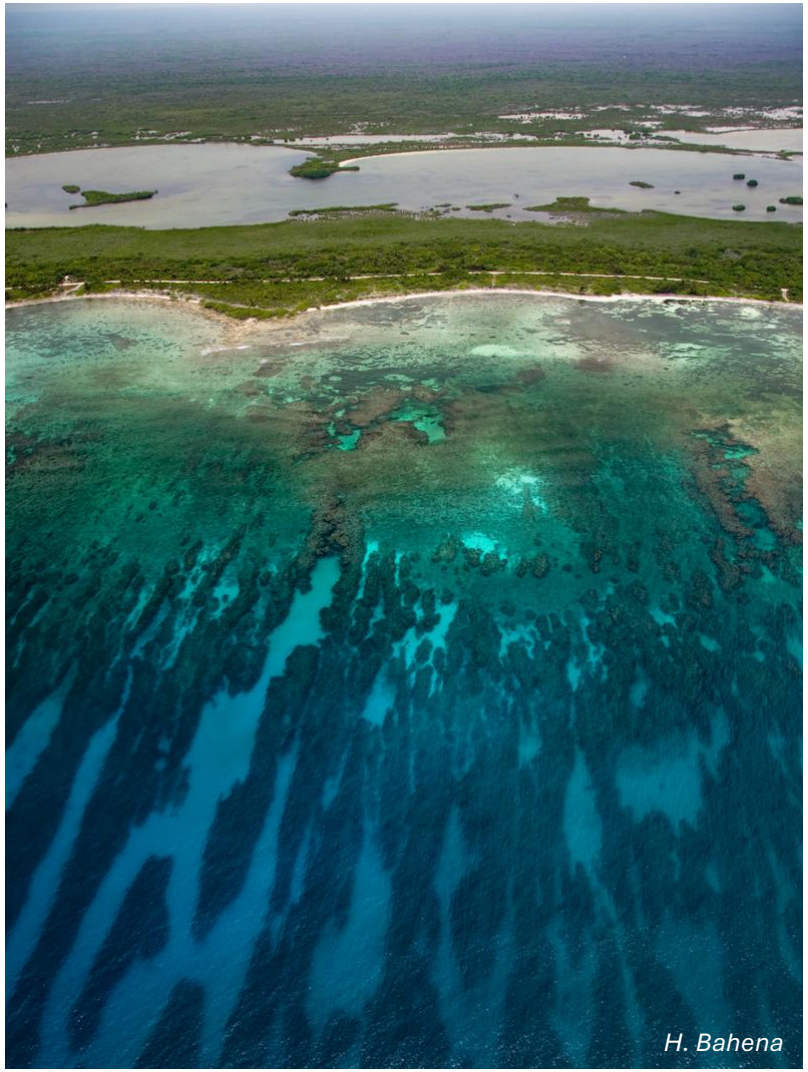
Tom Dallison
ICRI / GCRMN

ICRI
International Coral Reef Initiative

GCRMN
Global Coral Reef Monitoring Network

Status of coral reefs of the world: 2025

> *The Caribbean's coral reefs face significant loss and accelerating pressure, but their future is still something we can shape.*



Status of coral reefs of the world: 2025

Largest dataset ever assembled by the GCRMN:

- 21 million observations
- 90,000 surveys
- 39,000 sites
- 600+ experts
- 100+ countries

www.gcrmn.net/2025-report

Publication expected **Mid-late 2026**

It will provide the clarity, credibility and scale of evidence needed to drive **decisive global action for coral reefs**, and for all those depend on them

Gouvernement Princier PRINCIPAUTÉ DE MONACO
Government Offices of Sweden
MSCFOUNDATION
UNCDF Impact Capital for Development
Global Fund for Coral Reefs
UN environment programme
shams General Organization for Conservation of Coral Reefs and Turtles in the Red Sea

Status of coral reefs of the world: 2025

> *The situation is serious, but the story is not one of resignation. Reefs still have the capacity to survive, adapt and support millions of people. Our task is to shift the trajectory.*

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CARIBBEAN

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ACCESS TO THE REPORT

Lucie Labbouz
SPAW-RAC

UN environment programme

CARIBBEAN ENVIRONMENT PROGRAMME

SPAW · RAC

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PROYECTO PAE GEM | GOLFO DE MÉXICO

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Gouvernement Princier
PRINCIPAUTÉ DE MONACO

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Coordination

SPAW · RAC

Healthy Reefs for healthy people

UNAM

Ciencia y Tecnología
Secretaría de Ciencia, Humanidades, Tecnología e Innovación

ECOSUR

CORAL REEF ALLIANCE

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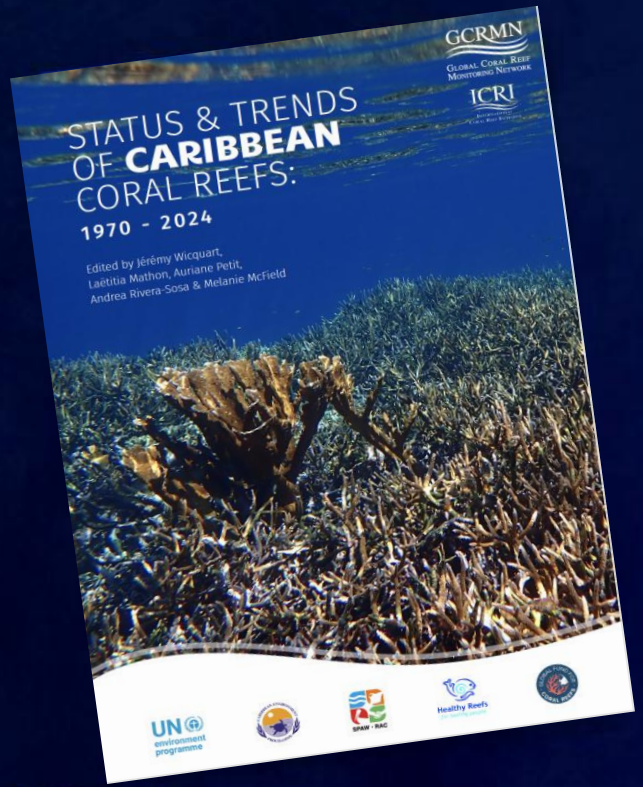
Full report

Executive Summary (EN, SP, FR)

Policy Brief (EN, SP, FR)



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WEBINAR

Status and Trends of Caribbean Coral Reefs: 1970–2024

GCRMN-Caribbean Report Launch

Tuesday **December 9** | 10AM (UTC-4)