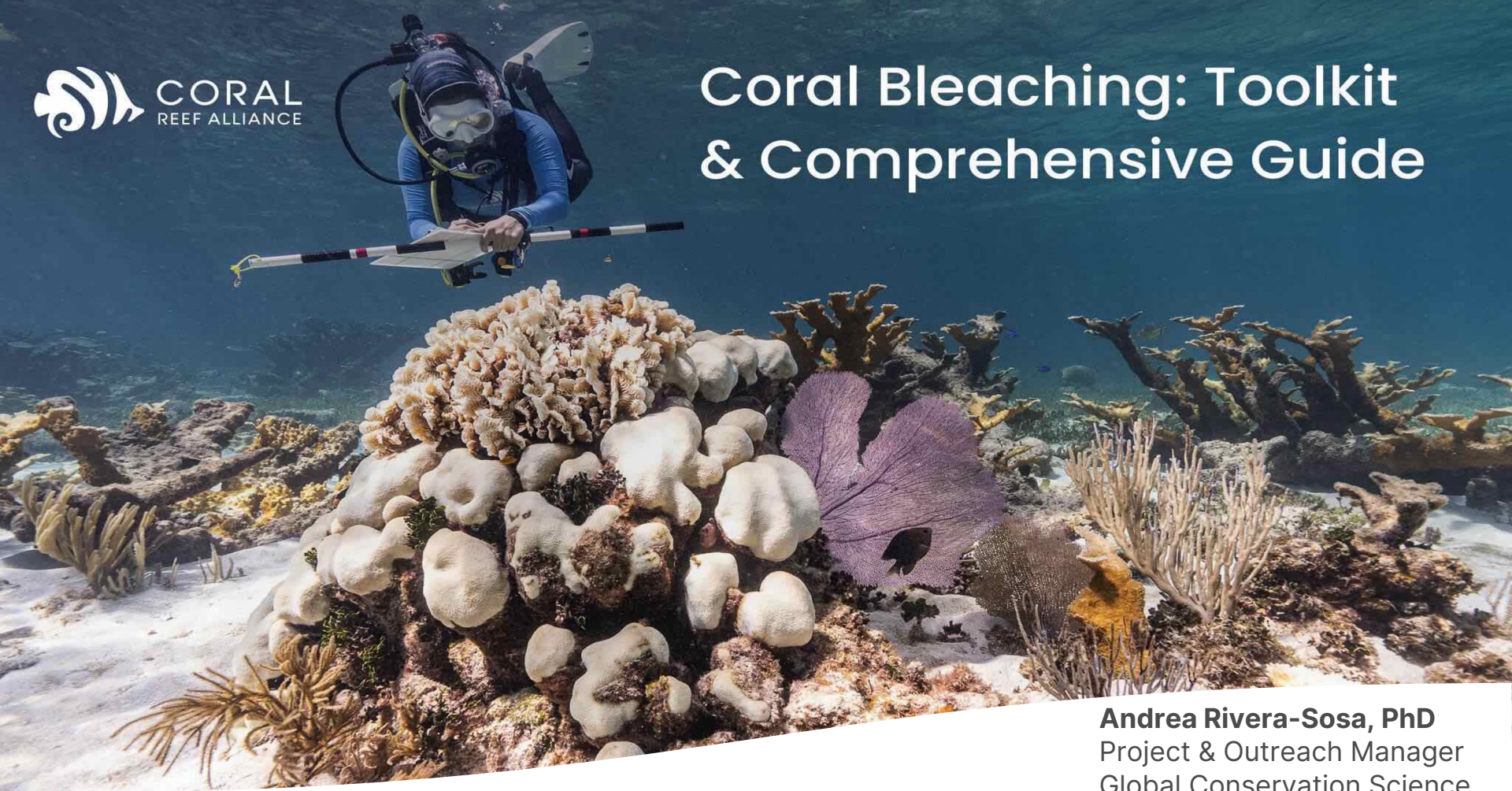




# Coral Bleaching: Toolkit & Comprehensive Guide



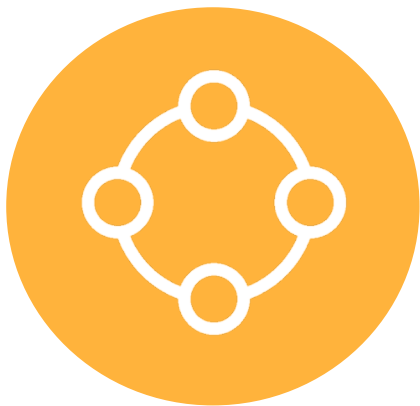
**Andrea Rivera-Sosa, PhD**  
Project & Outreach Manager  
Global Conservation Science  
[arivera-sosa@coral.org](mailto:arivera-sosa@coral.org)



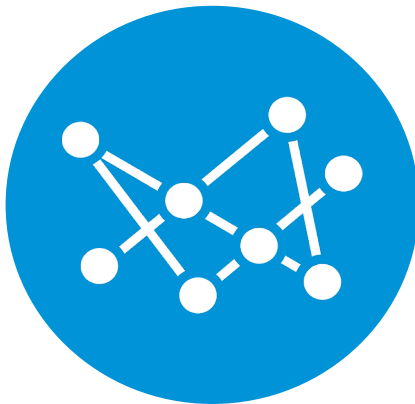
CORAL  
REEF ALLIANCE

*Our mission:*  
Save the  
world's  
coral reefs

# Our solution



Local



Regional



Global



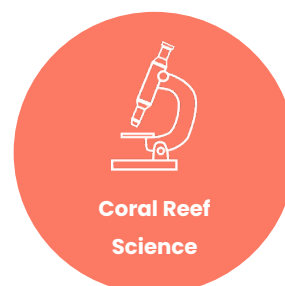
Resilient Coastal  
Communities



Sustainable  
Fisheries



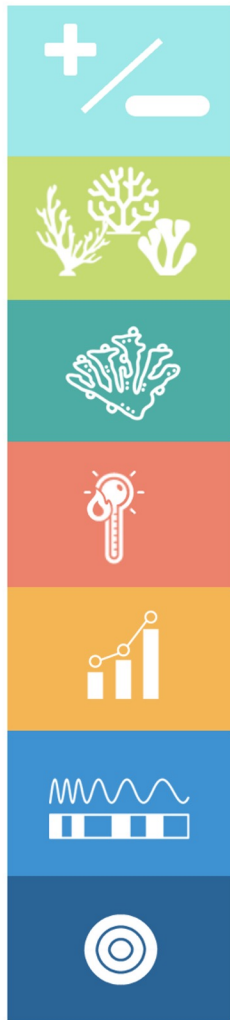
Clean Water for  
Reefs



Coral Reef  
Science

# ALLEN CORAL ATLAS





## **Presence or absence**

Qualitative (%)

## **Cover**

Hard coral cover bleached

## **Colony**

Percent bleached

## **Area at risk of bleaching**

## **Bleached area**

Quantitative (%)

## **Optical**

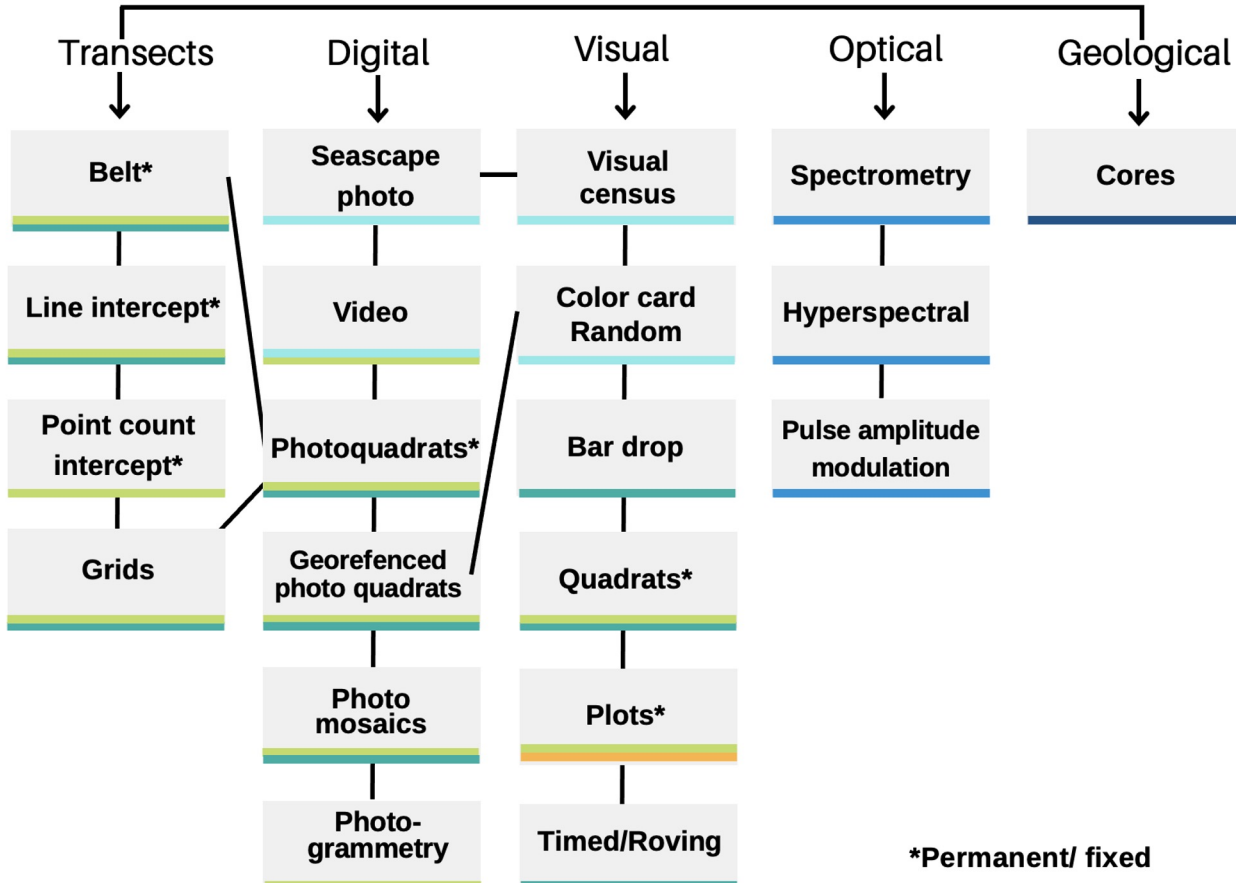
## **Growth rates**

Review of coral  
bleaching methods

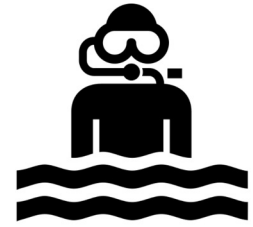
Disentangling the  
types of  
measurements across  
various scales

# Benthic surveys

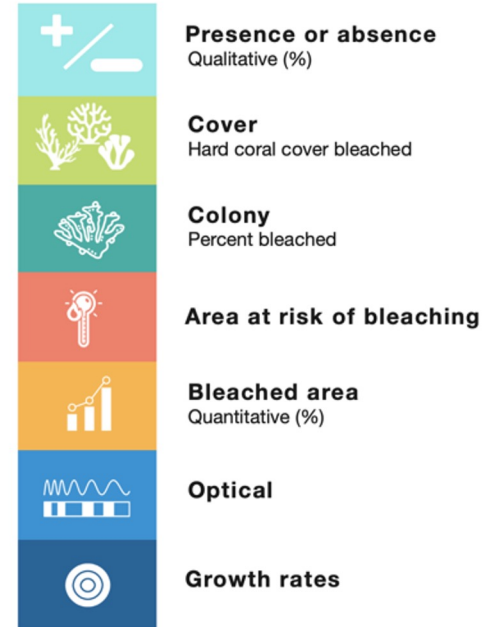
Scale (cm-km)



\*Permanent/ fixed



## Measurement



# Remote sensing

Scale (m-km)

Satellites



Aerial

Imagery

Planes,  
Helicopters etc.

Hyperspectral

Airborne  
imagery  
spectroscopy

Multi-spectral

SST heat  
stress indices

Small  
unmanned  
aerial  
systems/  
Drones

Bottom  
reflectance

# Boat-based

Scale (m-km)



Manta tow

Remotely  
operated  
Vehicles  
(ROVS)

## Measurement



**Presence or absence**  
Qualitative (%)



**Cover**  
Hard coral cover bleached



**Colony**  
Percent bleached



**Area at risk of bleaching**



**Bleached area**  
Quantitative (%)

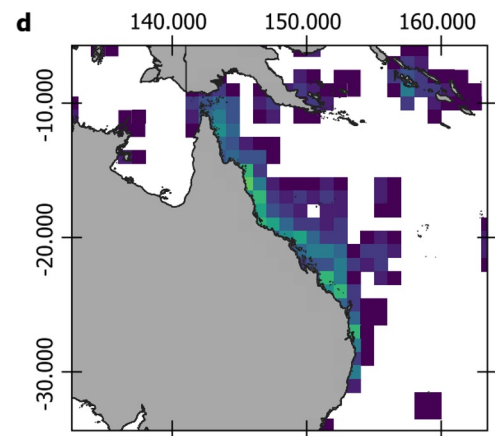
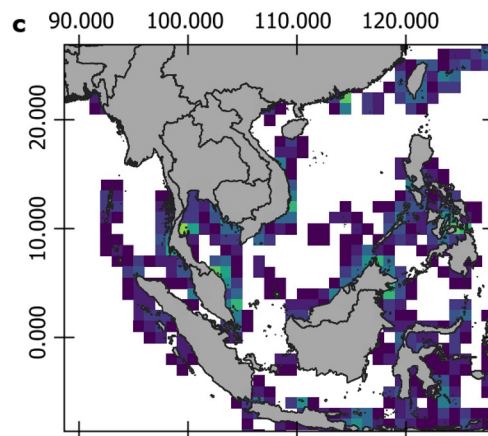
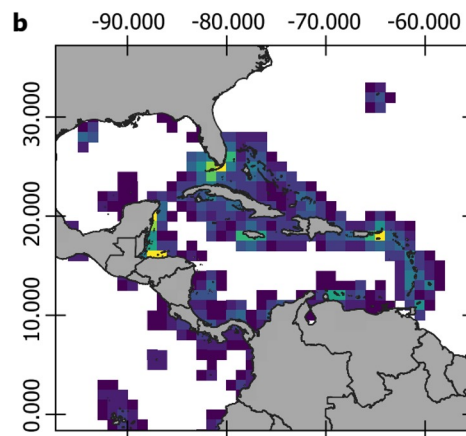
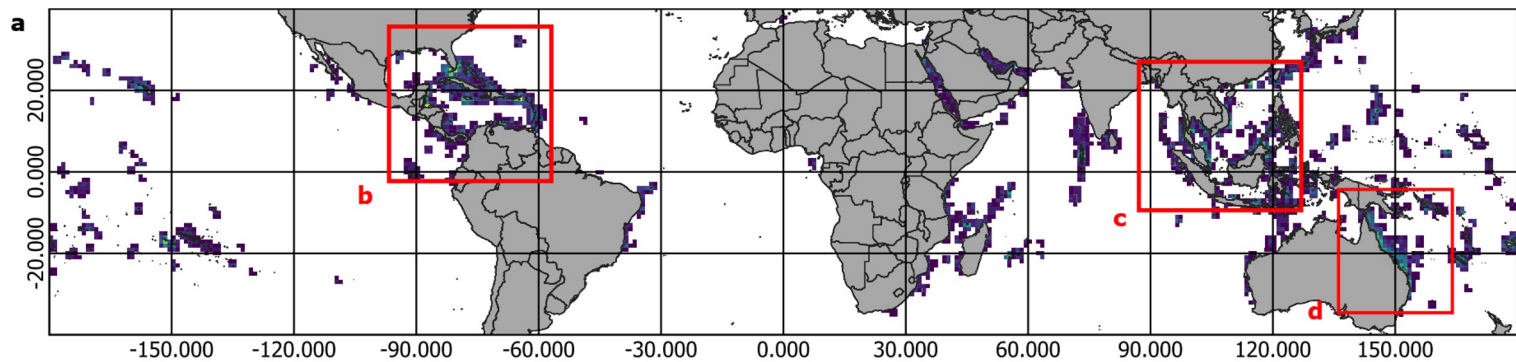


**Optical**



**Growth rates**

# Available data sets consolidated from 1970-2022 density map of coral bleaching observations

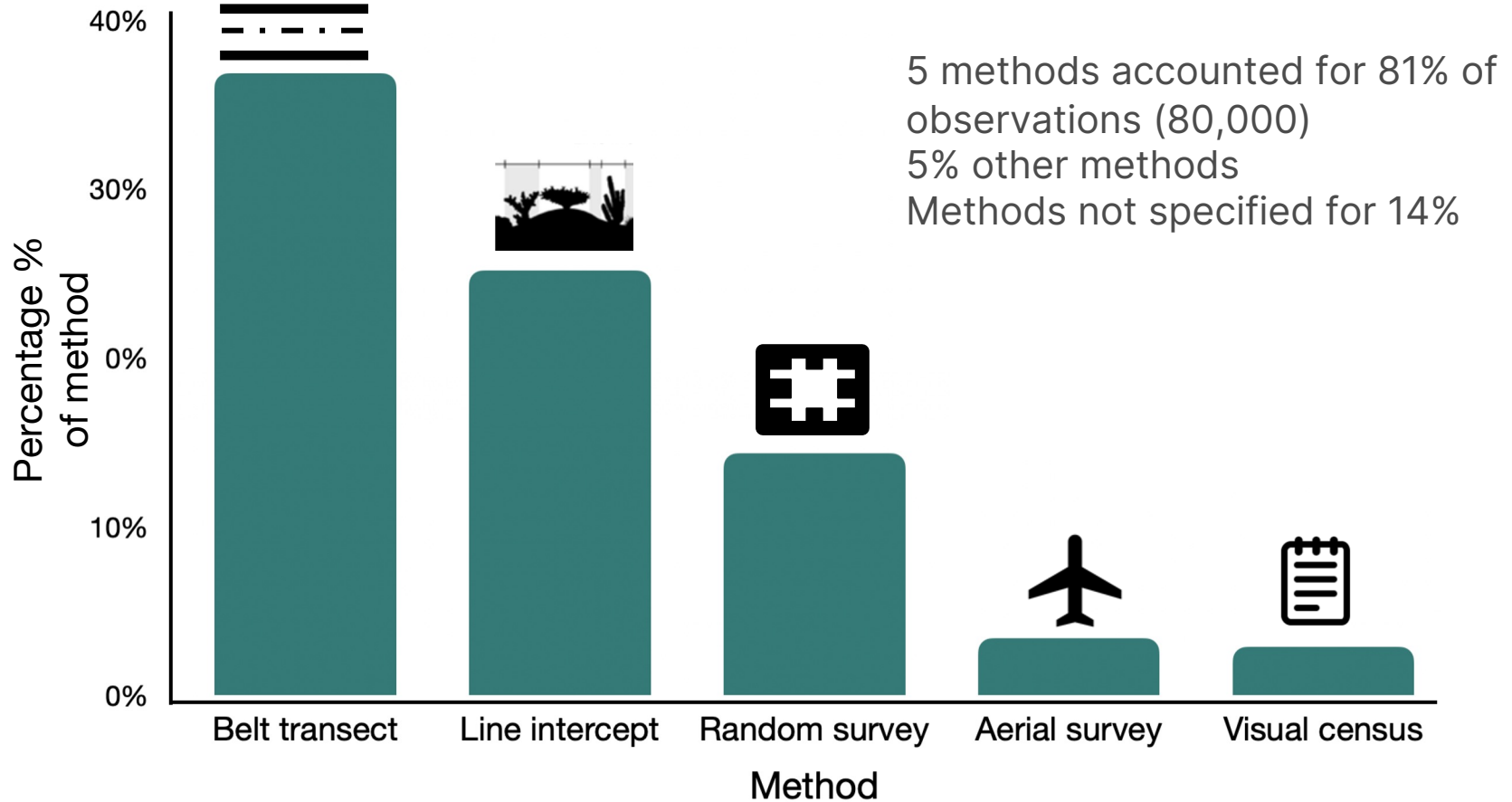


*In prep* (data from Donner et al, 2022, van Woesick et al 2022, Coral Watch, and others)





# Top 5 coral bleaching global field methods



# Coral bleaching Toolkit & Comprehensive Guide



Aims to pull together a wealth of information, **actionable guidelines**, resources for understanding and monitoring bleaching events at the **global** scale.

# Coral Bleaching: Toolkit & Comprehensive Guide

## Coral Bleaching Checklist: Managers and Dive Operators

Protecting sensitive corals before, during, and after bleaching events

### Before

Being prepared prior to a bleaching event helps tremendously in the long run. Avoid the scramble and take the following steps to get ahead.

- **Develop and/or review your bleaching (and other crises) response plans**
- Don't have one? Check the Reef Resilience Network guidance to develop a [Bleaching Response Plan](#)
- **Activate early warning systems** – Sign up for alerts, check bleaching for specific areas using
  - NOAA Coral Reef Watch – [coralreefwatch.noaa.gov](https://coralreefwatch.noaa.gov)
  - Allen Coral Atlas – [bleachingallenatlas.com](https://bleachingallenatlas.com)
  - IHO Coral Bleaching Monitoring Service
  - Caribbean SIMAS

- **Prepare to communicate with authorities, dive operators, and other key partners (CORAL, NOAA)**
- **Support monitoring plans for the region**
- **Plan with stakeholders how to reduce stressors on the reef**
- **Communicate to diving guests how they can support**
- **Join a citizen science monitoring network (examples below)**

- **Join a citizen science monitoring network (examples below)**
  - Global – [Coral Watch Reef Check](#)
  - Great Barrier Reef – [Eye on the Reef \(EOR\)](#)
  - Philippines Coral Bleaching Watch
  - Coral Bleaching Indonesia

### After

It's important to document lessons learned and to share it at the forefront of management decisions.

- **Observe and document long-term impacts**
  - Write down the species dying and surviving
  - Take photos of each

[coral.org/coral-bleaching](https://coral.org/coral-bleaching)

### During

#### □ Help reduce stressors on the reef

- Set up moorings, prevent anchoring
- Give busy dive and snorkel sites a rest
- Don't touch corals, keep hands and fins away from corals
- Reduce flapping pressure (protect & break)
- If you separate, take a break
- Use reef-safe sunscreen
- Ensure you have proper waste disposal
- Ensure you have proper waste disposal from sewage since bleacher corals are more susceptible

#### □ Document the bleaching event

- Observe carefully which corals are bleaching and note the location, depth, and species (and socioeconomic impacts) – this helps with adaptation, resilience and restoration planning
- Take before and after photos if possible
- Add an explanation of what's happening

#### □ Communicate bleaching events

- Ask them what they're going to do to support, if it's needed
- If authorities need support, let them know
- Connect with local monitoring networks
- Communicate about climate change and how to address it

#### □ Communicate observations to local monitoring networks

- Debrief about the coral bleaching event and coordinated management with all partners
- Continue planning on how to address climate change

#### □ Communicate observations to local monitoring networks

- Debrief about the coral bleaching event and coordinated management with all partners
- Continue planning on how to address climate change

if your ongoing restoration project

## ► INTRODUCTION

### Overview of Coral Bleaching

### Remote Sensing Tools

### On-Site Monitoring Tools

### CHECKLIST: How to Mobilize and Protect

### Coral's Future

### Other Ways You Can Help

## An Intro from CORAL's Conservation Science Director

Hello!

You may have noticed what a hot summer it has been and seen the news that this is a record-breaking hot year around the world.

**Indeed we are approaching a global marine heatwave (source),** and it's expected to get worse by the end of this calendar year.

Marine heatwaves can cause mass coral bleaching, a stress response in which corals expel the colorful algae living in their tissue, revealing the white calcium carbonate skeleton underneath, hence the term "bleaching". **This can lead to wide-spread coral death.**



In an effort to consolidate the information and resources on coral bleaching and what dive operators, managers, and stakeholders can do before, during, and after a bleaching event, we at CORAL have created this **Coral Bleaching Toolkit & Comprehensive Guide**.

We're also **supporting and mobilizing our partners to respond and coordinate with each other**, including fundraising for emergency funds to evaluate and respond to this predicted mass bleaching event this summer and fall. It's important to monitor this critical event as it unfolds, so we encourage you to learn more and find ways you can help.

Although the news is grim, we're staying strong to give corals the best chance possible to adapt to this warming world. We need to reduce emissions, change to renewable energy, and protect our coral reefs by reducing contamination from sewage and solid waste. We need to lessen our fishing pressure and help marine protected areas.

**We can do a lot, but we need to work together.**

Thank you for your support,

Helen Fox, PhD  
Conservation Science Director  
Coral Reef Alliance



# Summary of Tool Kit

- Remote Sensing Tools
- On-Site Monitoring Tools
- **CHECKLIST:**
  - How to Mobilize and Protect
- Next Steps!



# Remote Sensing Tools



Brianna Bambic

# Remote Sensing Tools

## Global

- NOAA Coral Reef Watch
- Allen Coral Atlas
- Aqualink

## Regional

- Coastal Marine Information and Analysis System (SIMAR)
- Western Indian Ocean Coral Bleaching Monitoring Service
- Hawaii and US Pacific Islands Region Climate Impacts and Outlook

# Allen Coral Atlas

Find Location

Mapped/Monitored Areas

My Areas

Mini Map

Legend

High Contrast Mode

Info/Help

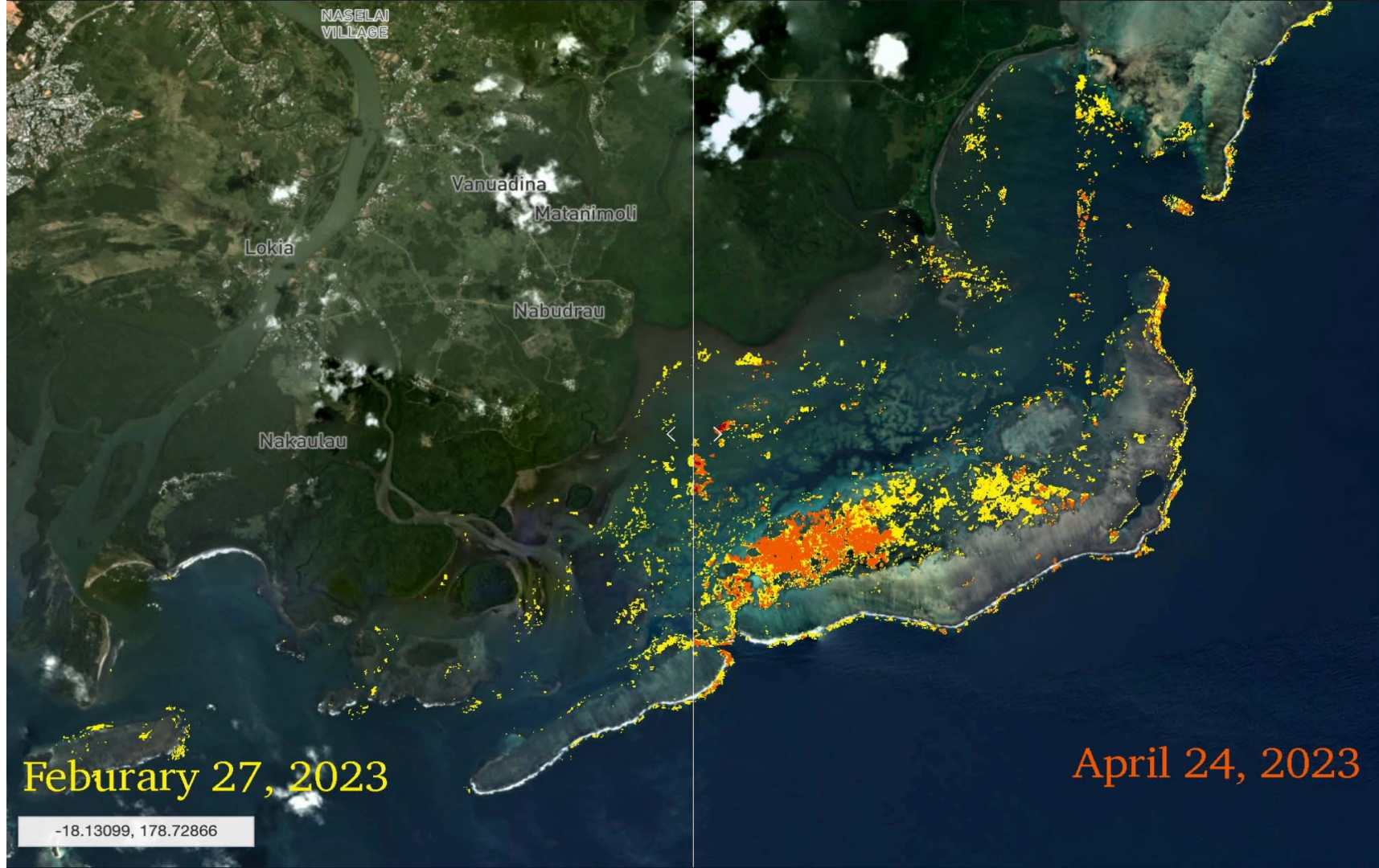
## February 18, 2019



2000 km

63.07937, -1.44200





-18.13099, 178.72866

🔍 Fiji

Mapped/Monitored Areas

◀ Shark Reef Fiji 📍 📄 🗑️ ▶

🗺️ Mini Map | ☰ Legend | 🔍 High Contrast Mode | ⓘ Info/Help



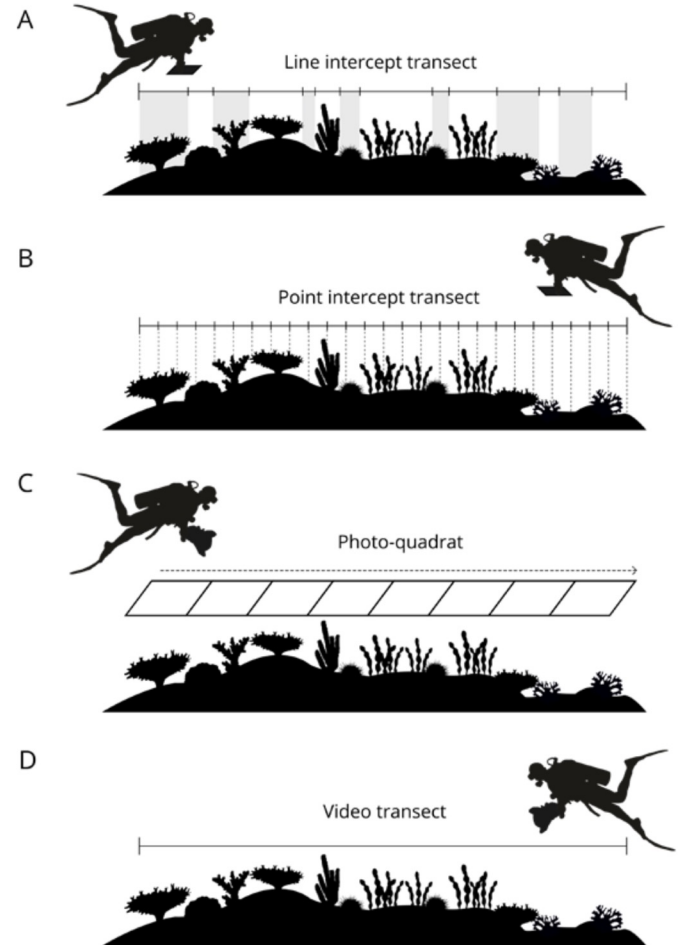
50 km | -20.98302, -178.23745

# On-Site Monitoring Tools & Platforms



# On-Site Monitoring Tools

- Global
- Atlantic
- Pacific
- East Asia
- Indian Ocean
- *Red Sea, Persian Gulf, Brazil coming soon!*



# Global

- NOAA Coral Reef Watch (CRW)
- Global Coral Reef Monitoring Network (GCRMN) is a global operational network of the International Coral Reef Initiative (ICRI)
- Coral Watch
- National Coral Reef Monitoring Program (NCRMP) US Territories

*Trainings! (virtual, in water, hybrid)*

- Reef Check
- Wildlife Conservation Society and MERMAID
- University of Queensland-Photo transects & ReefCloud, AIMS

# Atlantic

- **Atlantic Gulf and Rapid Reef Assessment (AGRRA)**

## Florida

- Florida Keys Mote Marine Laboratory BleachWatch,
- Florida Reef Resilience Program, Disturbance Response Monitoring (DRM)
- Florida Dept. Environmental Protection CRCP BleachWatch, Southeast Florida Action Network (SEAFAN) BleachWatch.

## Mesoamerican Region

- **Healthy Reefs Initiative and 70+ partner surveyors use the ECOMAR Belize Coral Watch Program (*Bardrop*) and input results into AGRRA.**



# Pacific

## Hawaiian Islands

- [Koa A Corps](#)
- [Eyes on the Reef](#)
- *new!* [Hawaiian Koʻa Coral Health Card](#)

## South Pacific

- [Site d'Observation-SO CORAIL](#) (National Observation Service), [Center for Insular Research and Environmental Observatory](#) (CRIOBE)

## New Caledonia

- [Pala Dalik](#), Citizen Science (presence/absence) and transects conducted by [Réseau d'Observation des Récifs Coralliens](#)/ Participatory Coral Reef Monitoring Network.



# Pacific cont.

## Australia–Great Barrier Reef

- [Australian Institute of Marine Science](#), AIMS monitors the Great Barrier Reef through two major programs – the [Long-Term Monitoring Program](#) (Great Barrier Reef Marine Monitoring Program for inshore coral reefs (MMP)).
- [Great Barrier Reef Marine Park Authority \(GBRMPA\)](#), Eye on the Reef, Citizen Science.





# East Asia

## Philippines

- [Philippines Coral Bleaching Watch](#), Citizen Science, an early warning system for coral bleaching (presence/absence), Crown-of-Thorns Sea Stars (COTS) outbreaks in the Philippines.

## Indonesia

- [Coral Bleaching Network in Indonesia](#) (Network of organizations and citizen scientists are trained to track reef health and bleaching using *belt transects*).

## Malaysia

- [Reef Check Malaysia](#) (Network of organizations and citizen scientists are trained to track reef health and bleaching using *belt transects*).

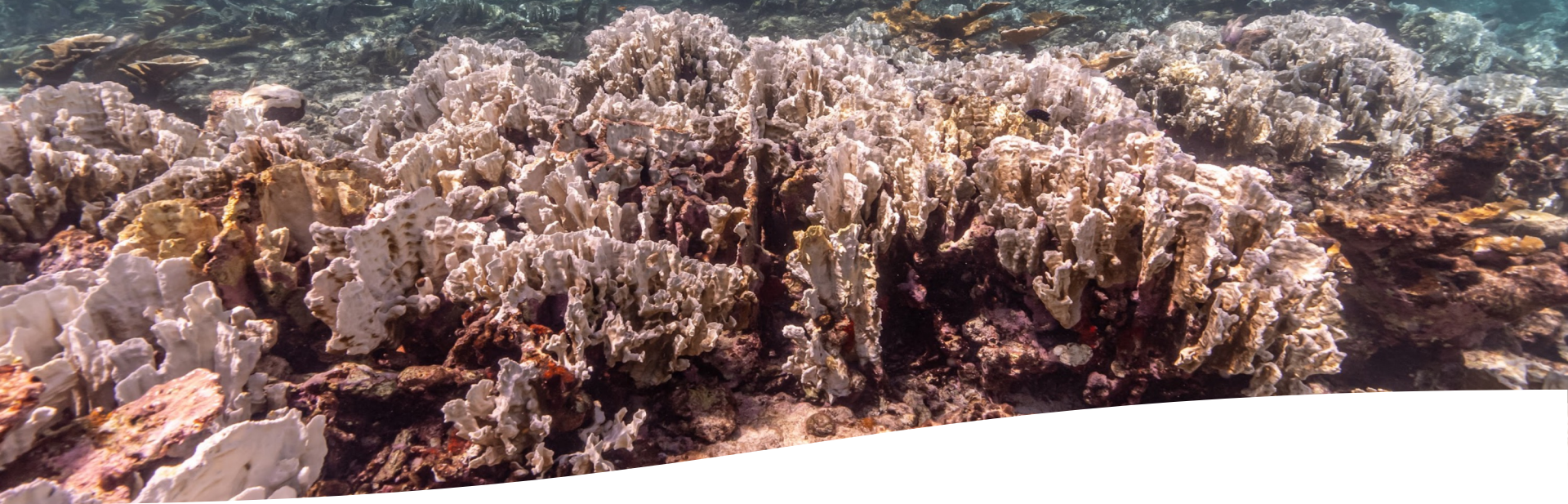


# Indian Ocean

- [CORDIO East Africa](#) leads the [Indian Ocean Coral Bleaching Network](#)
  
- [Maldives Marine Research Institute](#), Ministry of Fisheries and Agriculture, leads [the Coral Database](#), which includes monitoring via photo quadrats (random or, transects) and [reporting](#) of coral health and bleaching severity in the Maldives.



# CHECKLIST: How to Mobilize and Protect



# Coral Bleaching Checklist For Managers and Dive Operators

To access the digital  
version of this checklist,  
aim your phone camera  
at this QR code



## Before

Being prepared prior to a bleaching event helps tremendously. Avoid the scramble and take the following steps to get ahead.

### Develop and/or review your bleaching response plans

- Don't have one? Check the Reef Resilience Network guidance to develop a [Bleaching Response Plan](#)

### Sign up for bleaching alerts for specific areas using:

- [NOAA Coral Reef Watch](#) (global)
- [Allen Coral Atlas](#) (global)
- [Western Indian Ocean Coral Bleaching Monitoring Service](#)
- [SIMAR](#) (Caribbean)

### Get contact information for authorities, dive operators, managers and other key partners ([coralreefwatch@noaa.gov](mailto:coralreefwatch@noaa.gov), [beaching@allencoralatlas.org](mailto:beaching@allencoralatlas.org), and other local NGOs)

### Connect with local monitoring groups and support monitoring plans for the region

### Join a citizen science monitoring network (examples below)

- Global – [Coral Watch](#), [Reef Check](#)
- Great Barrier Reef – [Eye on the Reef \(GBRMPA\)](#)
- [Philippines Coral Bleaching Watch](#)
- [Coral Bleaching Indonesia](#)

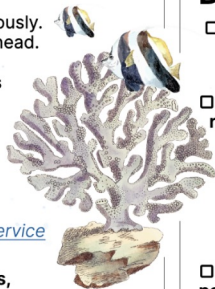
### Observe and document changes on the reef

- Take plenty of photos of corals and their environment

### Work with stakeholders to reduce other stressors on the reef

- Set up mooring to prevent anchoring (if you must anchor, do so in sand patches)
- Reduce fishing pressure and protect key herbivore species, like parrotfish
- Don't touch corals, and keep hands and feet off the reef (stand in the sand)
- Use reef-safe sunscreen
- Ensure you have proper wastewater treatment to reduce contaminants from sewage since bleached corals are more susceptible to diseases

### Communicate to diving guests how they can support



## During

### Help reduce stressors on the reef

- Give busy dive and snorkel sites a rest, especially if corals are fluorescing
- Take a break from fishing, including spearfishing

### Connecting with local monitoring groups and NGOs to document and report the bleaching event

- Observe carefully which corals survive and which ones die (ecological and socioeconomic impacts) – this is really important for understanding adaptation, resilience and restoration efforts
- Take photos in the same landscapes as your “before” sites
- Send the information to [coralreefwatch@noaa.gov](mailto:coralreefwatch@noaa.gov) and/or [bleaching@allencoralatlas.com](mailto:bleaching@allencoralatlas.com)

### Communicate about bleaching events as climate impacts, and advocate for policies that address climate change to the media and government authorities

- Ask them what they'll do to take action - see ideas on this checklist

### Add an explanation of what's happening to the reef in your dive brief



## After

It's important to document lessons learned and ensure data informs management decisions.

### Observe and document long-term impacts

- Write down and take photos of the species dying and surviving
- Communicate observations to authorities and NGOs

### Debrief about the coral bleaching impacts and responses in a coordinated manner with all stakeholders

### Continue working to reduce stressors on the reef

### Communicate about climate impacts, and advocate for policies that address climate change

If your ongoing restoration project is facing coral bleaching, check the [Coral Restoration Consortium Guidelines](#), for information on what you can do now to minimize damage, as well as how to identify resilient corals for future restoration efforts.



NOAA  
CORAL REEF  
CONSERVATION PROGRAM

# NOAA CoRis

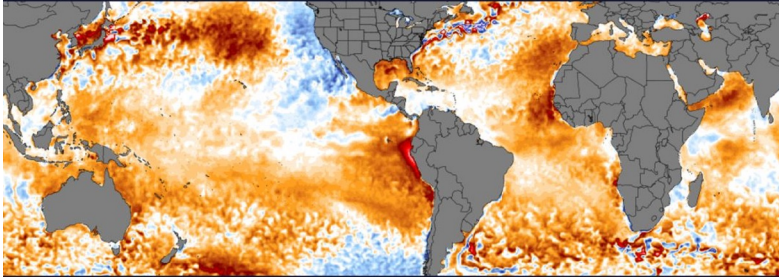


Coral  
Restoration  
Consortium

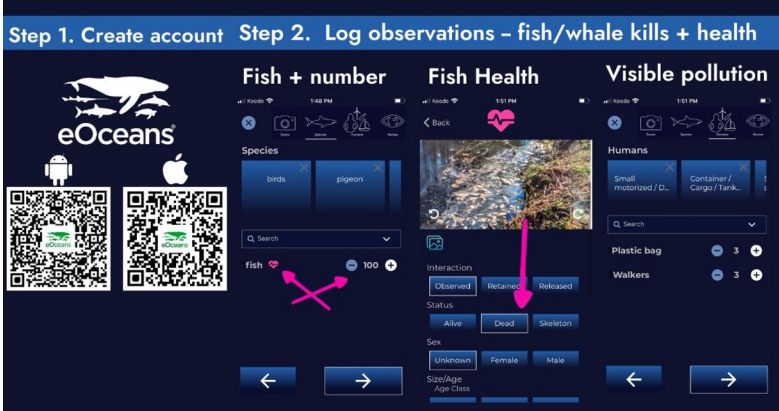
**Next Steps!**

# Include review of bleaching Apps!

Marine Heatwaves IMPACTS around the world?



Step 1. Create account Step 2. Log observations - fish/whale kills + health



**eOceans**

**Fish + number**

Species: birds, pigeon

fish 100

**Fish Health**

Interaction: Observed, Retained, Released

Status: Alive, Dead, Skeleton

Sex: Unknown, Female, Male

Size/Age: Age Class

**Visible pollution**

Humans: Small motorized / D..., Container / Cargo / Tank...


Plastic bag: 3

Walkers: 3




ADVENTURE SCIENTISTS

EXPLORE. COLLECT. PROTECT.



CITIZENS OF THE GREAT BARRIER REEF

THE GREAT REEF CENSUS



1/3 About the highlighted coral

2/3 What type of coral dominates this image?

3/3 What level of coral cover do you see?

# Outreach to Dive operators!



ADVENTURE SCIENTISTS  
EXPLORE. COLLECT. PROTECT.

DEMA, The Diving Equipment &  
Marketing Association



In partnership with



# White-Out Campaign

Raise awareness of coral bleaching and bring to light actions we can take

Idea-White out logos to be a shadow of themselves

We've applied for November to be Coral Bleaching Awareness month





# Support

- Review, synthesis, typology can aid current efforts led by GCRMN et al., ICRI to apply the Darwin Core Standard
- Coordination comparability of methods & databases
- **Trained** citizen science methods play a key role in monitoring



Thank you!



CORAL  
REEF ALLIANCE

**Andrea Rivera-Sosa, PhD**  
Project & Outreach Manager  
Global Conservation Science  
[arivera-sosa@coral.org](mailto:arivera-sosa@coral.org)



**CORAL**  
REEF ALLIANCE



Photo by Sharon Wolff

## Become a Reef-Safe Traveler

Your guide to enjoying an ocean-friendly vacation

## Contents

Letter from the Executive Director	3
Traveling During COVID-19	4
Choosing a Hotel	5
During Your Stay	6
Shopping and Dining	7
Exploring	8
Diving and Snorkeling	9
Sunscreen	10
Everyday Actions	11



# Allen Coral Atlas bleaching ground truthing

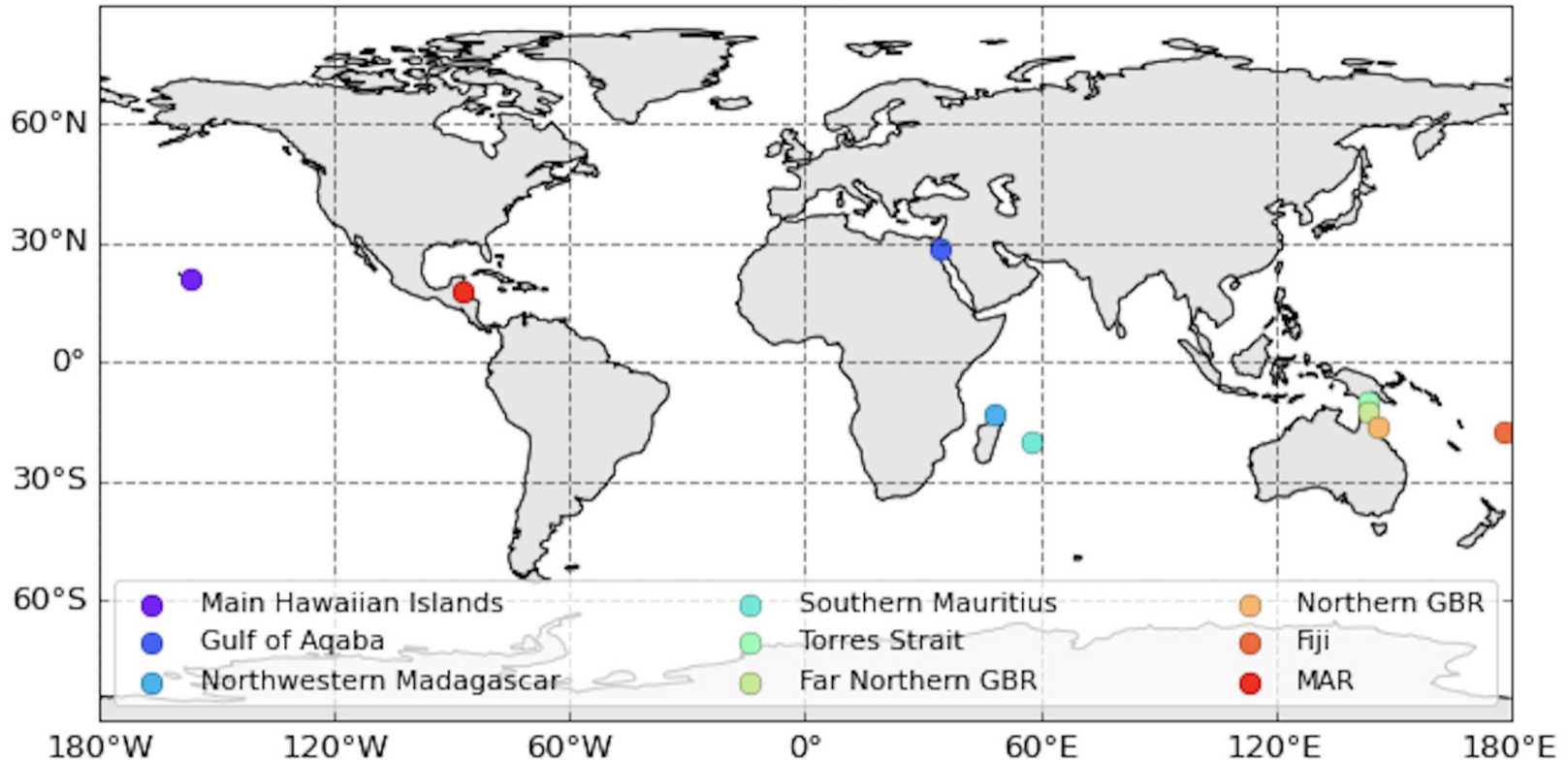




Photo By: Antonio Buzalelo

# Protocol Handbook For Monitoring Marine Water Quality in the Mesoamerican Reef System



Bay Islands Conservation Association, Coastal Zone Management  
Authority and Institute, Healthy Reefs Initiative and The Coral Reef Alliance

## Contents.

- 6 Introduction
- 8 Objectives
- 10 Parameters Descriptions
- 12 Sampling Design
- 14 Field Safety
- 14 Site Characterization
- 14 Quality Assurance and Quality Control (Qa/Qc)
- 16 Labelling Samples
- 17 Water Sampling
- 18 Pathogen Collection Protocol
- 19 Biophysical Parameters Collection Protocol
- 20 YSI ProDSS Calibration
- 21 Nutrient Collection Protocol
- 21 Ammonia ( $\text{NH}_3$ )
- 24 Nitrite ( $\text{NO}_2$ )
- 25 Nitrate ( $\text{NO}_3$ )
- 27 Total Phosphorus (P)
- 30 Isotope Collection Protocol
- 31 Recording Information and Database Format
- 32 Bibliography
- 33 Annexes