3.4.2019

Ocean heat waves are killing underwater life, threatening biodiversity

A new study published in *Nature Climate Change* found that the occurrences of marine heat waves have substantially grown in the past three decades, and it's becoming clearer how deadly warmer temperatures are for biodiversity.

She adds that climate-conscious fishery management and **monitoring ocean warming in real time are tools that can help** minimize impacts from warming events in the meantime.

https://www.nationalgeographic.com/environment/2019/03/ocean-heat-waves-threaten-sea-life-biodiversity/

https://www.nature.com/articles/s41558-019-0412-1

WE’RE MISSING OUR CHANCE

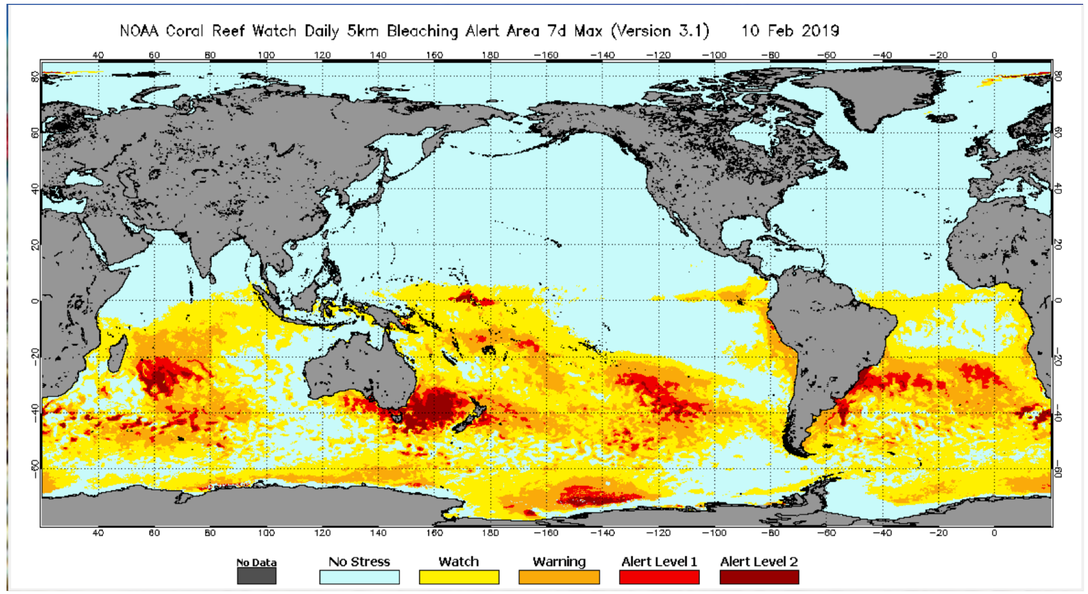
PROBLEM 1: EXTREME TEMPS KILL CORALS

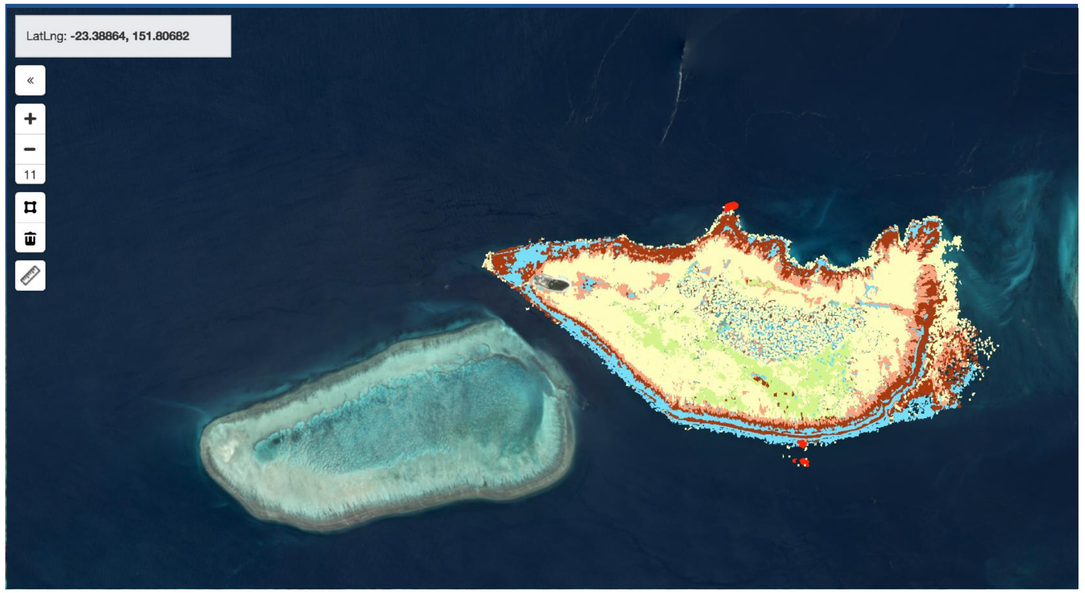
Ocean temperatures are increasing and as a result coral bleaching is becoming more prevalent. Scientists forecast that if we do nothing most of the coral reefs on the planet will disappear by 2030.

PROBLEM 2: WE DON’T HAVE THE DATA

We don’t have the necessary data to respond. We’re missing critical baseline data on reef temperatures and status. Without it, any mitigation or transplantation plan is useless.

OVERVIEW OF CURRENT TOOLS





NOAA CORAL REEF WATCH

BENEFITS

- Near-real time
- Global coverage

LIMITATIONS

- Surface temps only

ALLEN CORAL ATLAS

BENEFITS

- Near-real time
- Global coverage
- Benthic Maps

LIMITATIONS

- Surface temps only

OVERVIEW OF CURRENT TOOLS

LOW-COST TEMPERATURE LOGGERS

BENEFITS

- Inexpensive
- Wide depth coverage available

LIMITATIONS

- Must deploy and retrieve in-situ
- Limited battery life
- Mid-range accuracy and sensitivity

HIGH-END TEMPERATURE LOGGERS

BENEFITS

- High accuracy
- Wide depth coverage available

LIMITATIONS

- Must deploy and retrieve in-situ
- Limited battery life
- Expensive

OVERVIEW OF CURRENT PROCESS

THE CURRENT PROCESS FOR INSTALLING TEMPERATURE SENSORS IS AS FOLLOWS:

1. Put data logger in a waterproof housing and create a custom anchor
2. Scuba dive down to the reef and drill the anchor into a nearby rock
3. Take a video of the surrounding reef to capture the current state of the coral
4. Mark the gps coordinates of the sensor location on the surface
5. Several months later, try and find the sensor based on surface gps location, dive down and retrieve the data logger, connect the data logger to a computer and then analyze the csv file

REAL-TIME IN SITU SENSORS ARE NEEDED

SATELLITES ARE LIMITED (JUST SURFACE TEMP).
TEMP LOGGERS ARE LIMITED (DIFFICULT AND NOT REAL-TIME).

"As co-Chief scientist of the Phoenix Islands Protected Area, which is the largest and deepest UNESCO World Heritage Site and one of the most remote marine protected areas on our planet, it is a huge challenge to accurately gauge real-time thermal stress. In this far-flung locale, even the local government sits over 1000 miles away from the largest island. While satellite-derived monitoring products coupled with field-deployed-and-retrieved sensors are helpful, a real-time, in situ sensor would be invaluable to science and decision-making. From where I sit, I have to travel over 6000 miles to deploy a logger, and 6000 miles to retrieve a logger, before I actually know what temperatures the reef experienced. We need a better mousetrap”

RANDI ROTJAN, PHD - BOSTON UNIVERSITY

Leading researcher in coral physiology and organismal biology with tropical and temperate species, and on behavioral ecology of tropical marine invertebrates, including corals and crustaceans.

REEFS ARE COMPLEX. SOLUTIONS ARE COMPLEX. MONITORING SHOULD BE SIMPLE.

OUR PLAN: DEPLOY REAL-TIME TEMPERATURE SENSORS WORLDWIDE AND DEVELOP A WEBSITE FOR DATA ANALYSIS AND COLLABORATION

HOW WILL IT WORK?

DEPLOY SENSORS

- Install sensors into diverse marine ecosystems worldwide
- Activate a global community of citizen scientists working in coordination with scientists

MONITOR

- Connect the people and sensors through a website
- Analyze temperature data, post and review imagery, collaborate with scientists

RESPOND

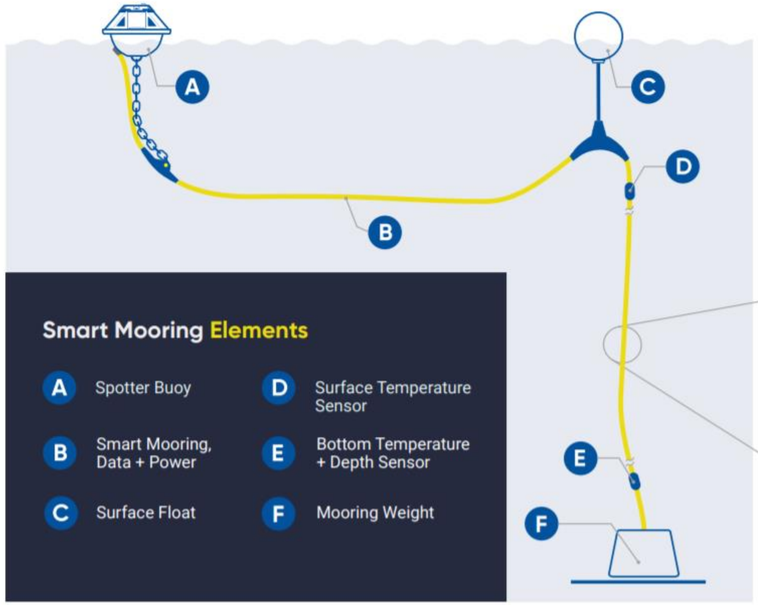
- Early detection of threatening temperatures triggers conservation activities
- Experts work remotely with citizen scientists to activate response plans

EASY TO DEPLOY REAL TIME MONITORING

Spotter + Smart Mooring

A mooring that can do more.

The Sofar Smart Mooring integrates data and power directly into the mooring system, allowing you to collect data throughout the water column (and bottom) with a single, fully-integrated system. Data is collected by sensors integrated in the Smart Mooring system and the surface Spotter provides real-time communication to your Dashboard and API.



Smart Mooring Elements

- A Spotter Buoy
- B Smart Mooring, Data + Power
- C Surface Float
- D Surface Temperature Sensor
- E Bottom Temperature + Depth Sensor
- F Mooring Weight

High Fidelity Temperature Profiling

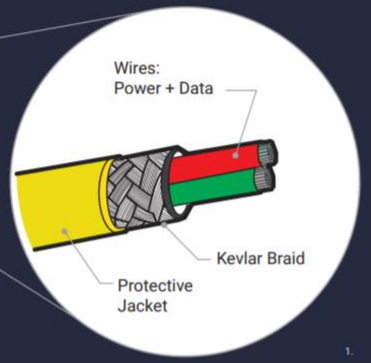
Monitor temperature variability and stratification across the water column in real-time.

Easy-to-Deploy

The smart mooring and profiler are lightweight, designed to be shipped anywhere in the world, and can be easily deployed by a single person from a small vessel.

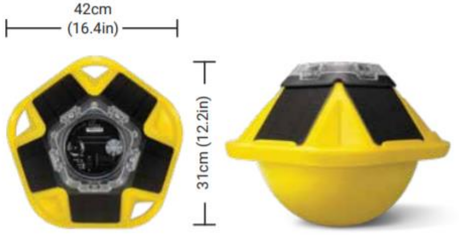
Durable and Tough

The polyurethane cable with Kevlar braid is designed to withstand the harshest marine environments.



1.

DATA OUTPUTS: * Can derive from SD card data.	standard mode	spectrum mode	on device
SIGNIFICANT WAVE HEIGHT	X	X	X *
PEAK PERIOD	X	X	X *
MEAN PERIOD	X	X	X *
PEAK DIRECTION	X	X	X *
MEAN DIRECTION	X	X	X *
PEAK DIRECTIONAL SPREAD	X	X	X *
MEAN DIRECTIONAL SPREAD	X	X	X *
VARIANCE DENSITY SPECTRUM		X	X
DIRECTIONAL MOMENTS (a1, b1, a2, b2)		X	X
3D DISPLACEMENT TIME SERIES @ 2.5 Hz (x,y,z)			X
WIND SPEED	X	X	
WIND DIRECTION	X	X	
DRIFT SPEED			X *
DRIFT DIRECTION			X *
GEOGRAPHICAL COORDINATES (lat, lon)	X	X	X *



2.

OPERATIONAL DEPTH RANGE	5m to 40m
OPERATIONAL TEMPERATURE RANGE	-5°C To 50°C
SENSORS INCLUDED	Customizable; Configuration shown is with surface and bottom temperature (w/ depth on bottom)
MOORING ATTACHMENT POINT	3/8" shackle and chain (included)
CABLE	
LENGTH	Polyurethane, high visibility yellow, UV stabilized, cut and abrasion resistant.
OUTER JACKET	3000N kevlar reinforced
MAXIMUM TENSILE LOAD	Customizable; configured for 2 (surface and bottom)
DIAMETER	7mm
FIELD CONDITIONS	-55°C to 125°C, wet/dry/frozen
TEMPERATURE SENSOR	
TEMPERATURE ACCURACY	+/- 0.1°C
TEMPERATURE RESOLUTION	0.02°C
TEMPERATURE RESOLUTION	-5°C To 50°C
DEPTH SENSOR	
DEPTH ACCURACY	+/- 75mbar (0.75m)
DEPTH RESOLUTION	0.2cm
DEPTH RANGE	0m to 100m

A GLOBAL MONITORING SYSTEM AVAILABLE ONLINE

CORAL CASTLE

KANTON ISLAND, KIRIBATI

CURRENT TEMP
27.6° C

PAST YEAR MAX
28° C

PAST 7 DAY MAX
28° C

PAST 7 DAY MIN
22° C

AVERAGE
27° C

DEGREE HEATING WEEKS
2° C WEEKS

START DATE 08/01/18

END DATE 12/31/18

ALERTS

MAX TEMP GREATER THAN 27.7° C

DEGREE HEATING WEEKS 2 DHW

9:27

10:20

VIDEOS

DEC 2, 2018
4 VIDEOS

JUN 6, 2018
6 VIDEOS

JAN 1, 2018
3 VIDEOS

RESPOND: CORAL REEF EMERGENCY RESPONSE PLAN.

OCEAN ECOSYSTEMS ARE COMPLEX. CORAL REEFS ARE AMONG THE MOST COMPLEX.

WHY WOULD A RESPONSE PLAN BE ONE-SIZE-FITS-ALL? RESPONSE PLAN NEEDS TO REFLECT THE COMPLEXITY OF THE NATURAL WORLD.

- If 10% of a reef bleaches, would you take the same action as when 100% of a reef bleaches?
- Why would you wait for a reef to bleach to devise a plan?
- Plans can be devised in advance, as can the resources needed to mobilize those plans.
- Plans can be tailored to site, and to level of threat / catastrophe

BUT HOW WILL YOU ASSESS THREAT LEVEL? AND HOW WILL YOU KNOW WHEN ITS TIME TO ACT? SENSORS.

MANAGED BY THE SAME TEAM THAT CREATED THE NATIONAL GEOGRAPHIC OPEN EXPLORER PROGRAM

Ordinary people who have a deep concern for their local marine environment will be given the tools and access to experts to help conserve their reefs

First fifty locations will be selected by July 31st, apply at oceansystems.org starting on May 1st

Ocean systems will provide a free spotter and the Citizen scientist will be expected to do the following:

- Pay for shipping and any applicable duties ($300 estimate)
- Provide mooring weight
- Deploy spotter with mooring weight (can be done from a canoe)
- Maintain spotter (inspect and clean every 6 months)
- Conduct periodic photographic surveys of monitored area and upload imagery to website
- Help to save the reef with support from Scientists