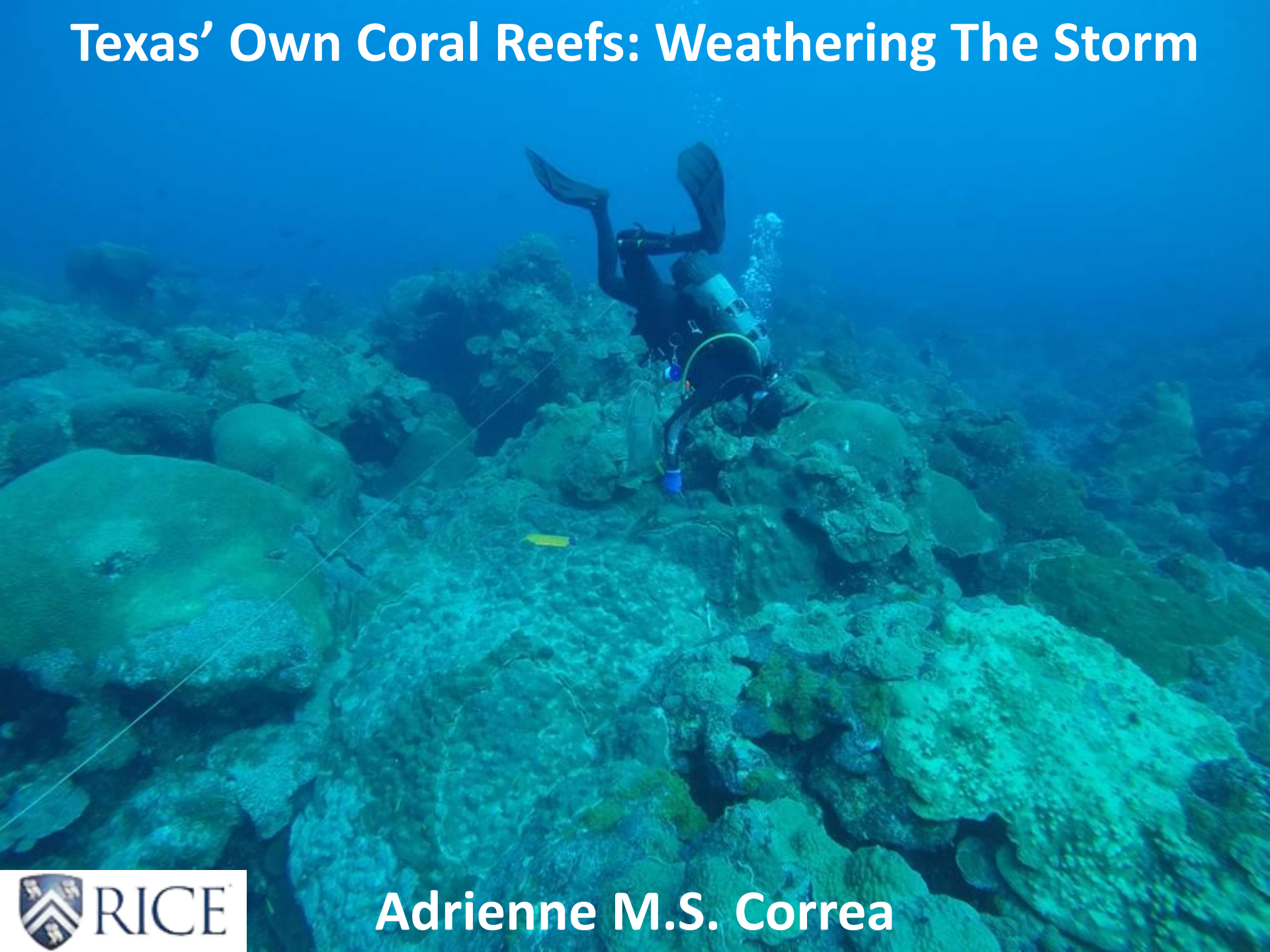
The University of Texas at Austin
Environmental Science Institute

Hot Science - Cool Talk # 111

Texas' Own Coral Reefs: Weathering the Storm

Dr. Adrienne Correa
February 16, 2018

Texas' Own Coral Reefs: Weathering The Storm



RICE

Adrienne M.S. Correa

Three Main Ideas

Coral reefs are diverse and valuable ecosystems, and are in decline.

Extreme storms: local stressors that can harm reefs in various ways.

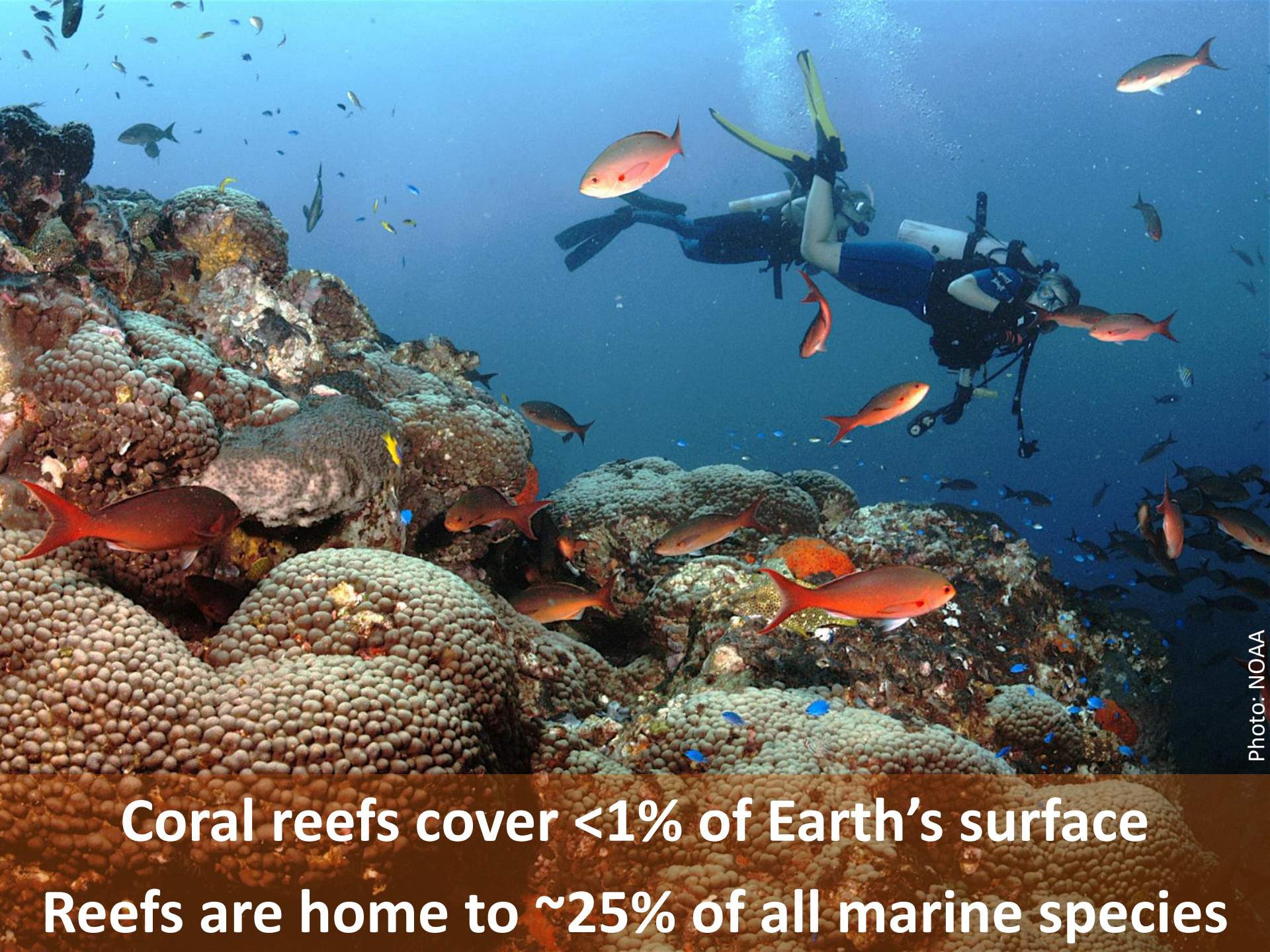
Interdisciplinary teamwork is needed to limit reef decline.

Coral reefs are living habitats

NASA/Goddard Space Flight Center Scientific Visualization Studio


Photo: University of Guam

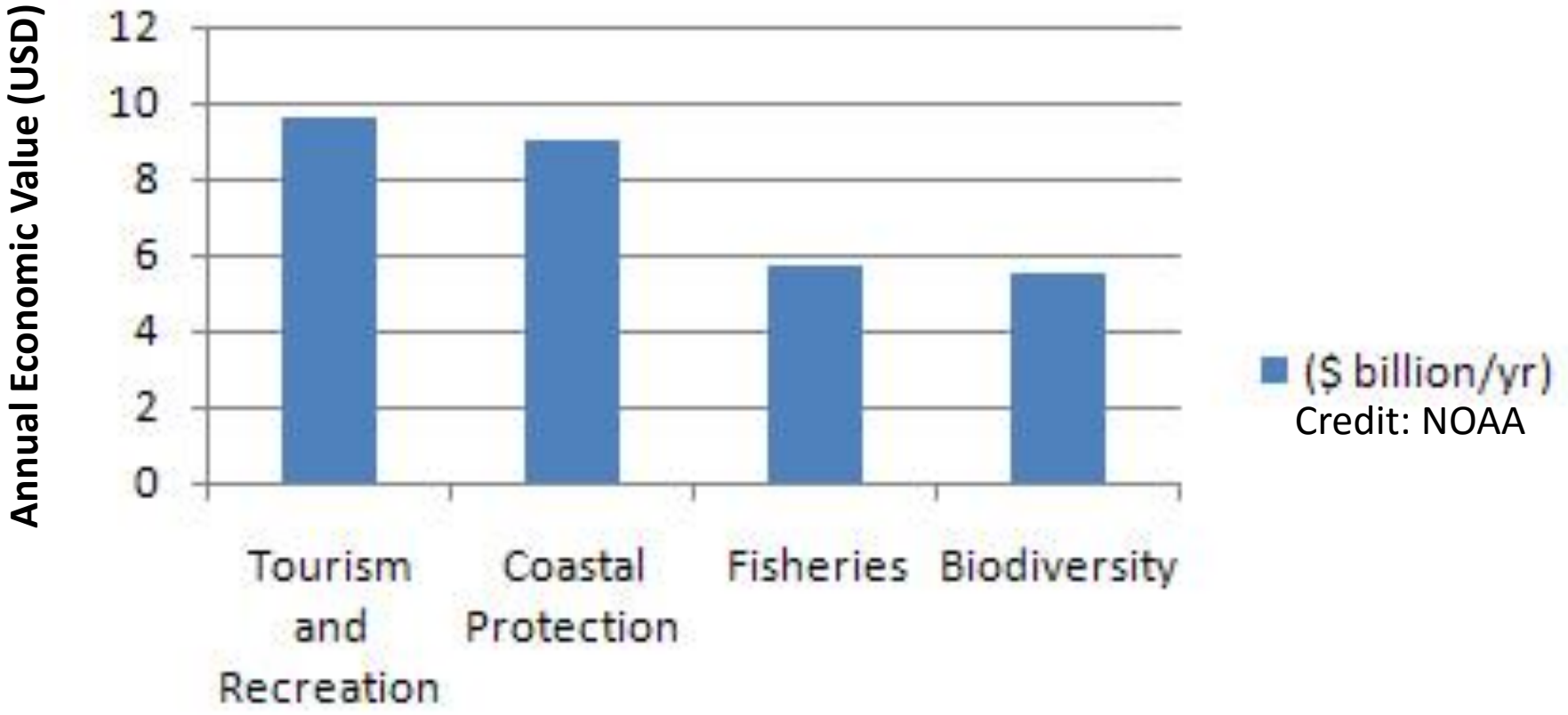
Photo: Andy Lewis



Coral reefs cover <1% of Earth's surface

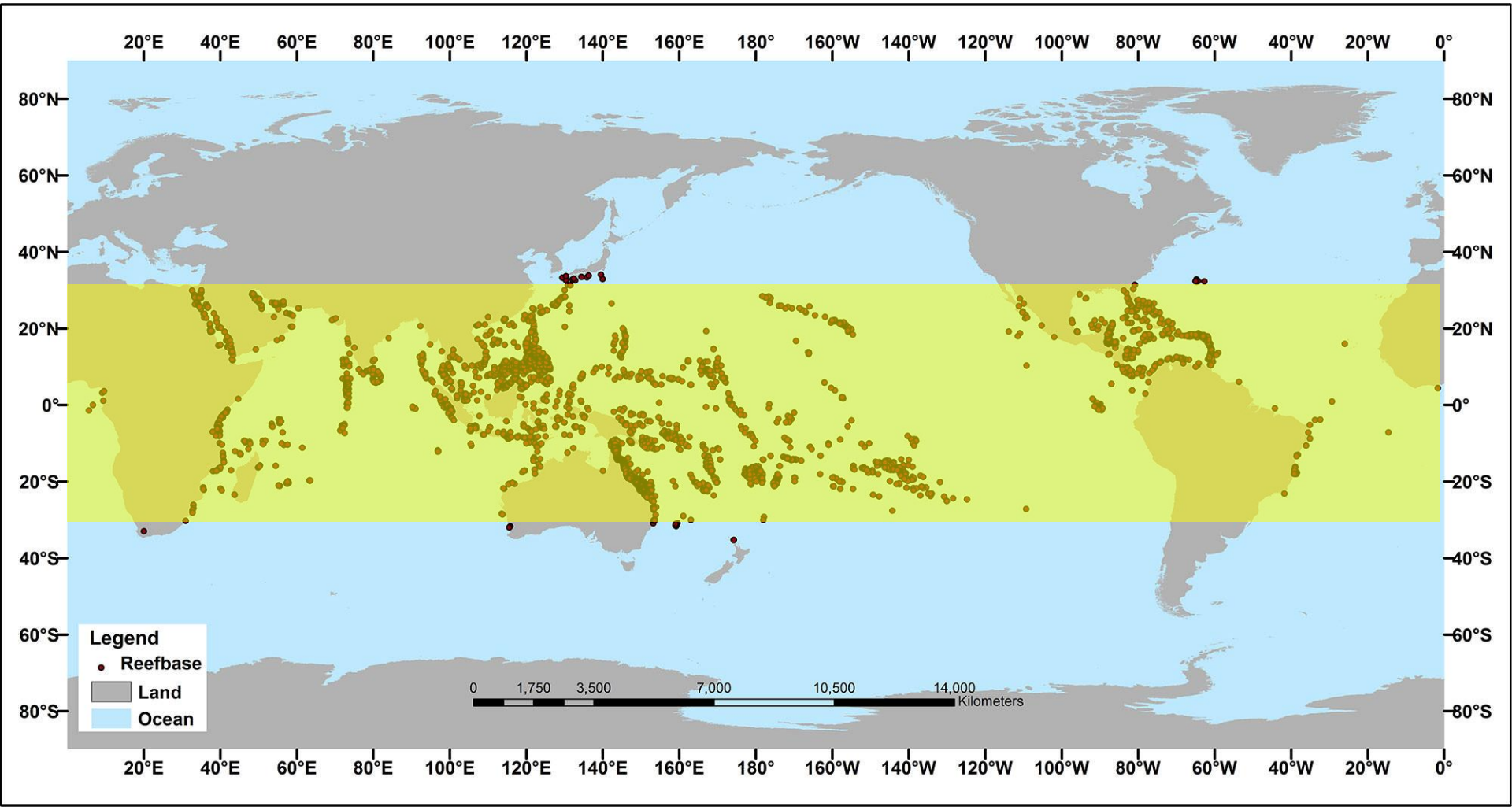
Reefs are home to ~25% of all marine species

Reefs contribute >$30 billion annually to our world economy!



Credit: NOAA

Shallow water coral reefs…



…are mainly in the tropics between 30°N and 30°S

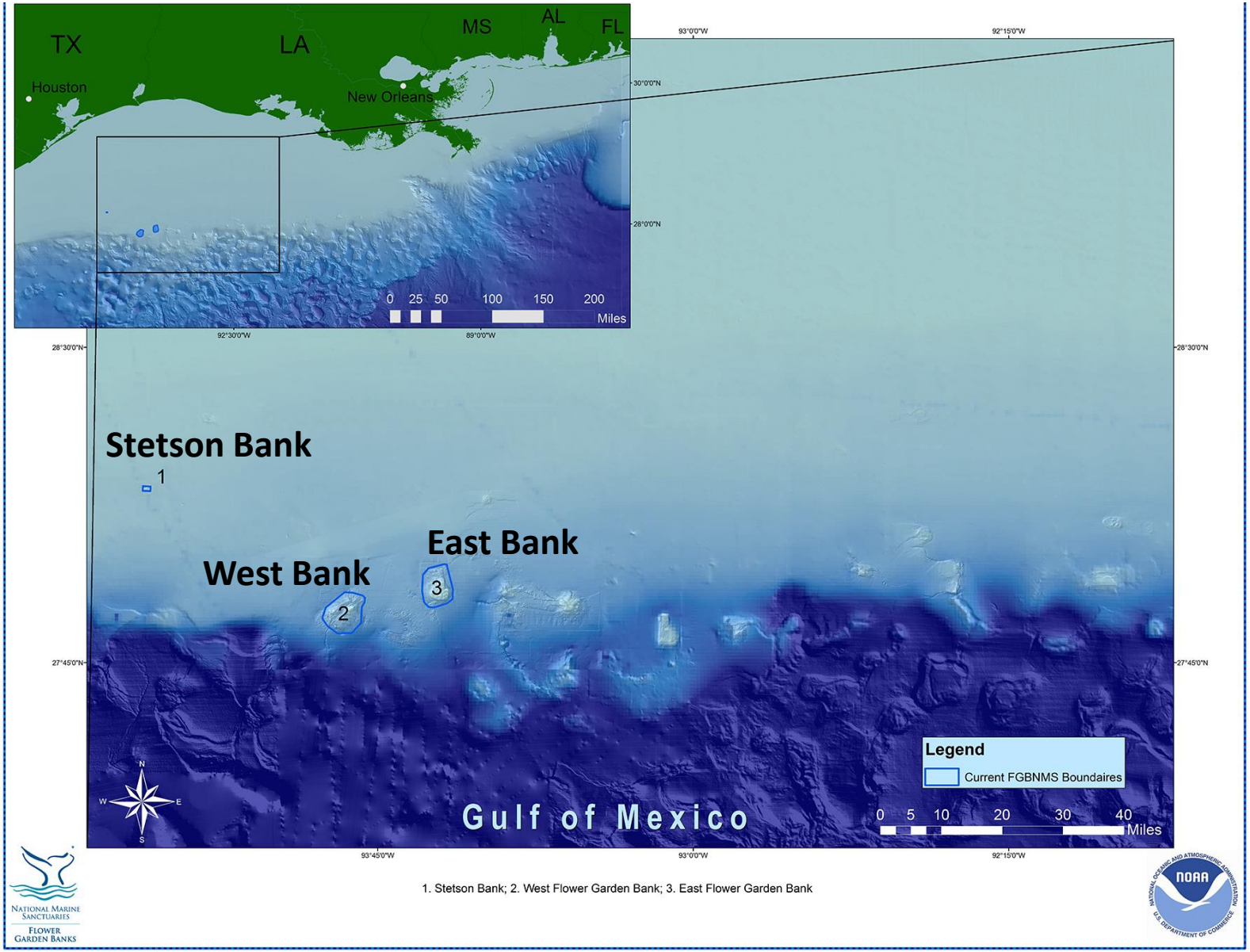
https://oceanservice.noaa.gov/education/kits/corals/media/supp_coral05a.html

Out of 11 U.S. National Marine Sanctuaries:

Scale varies in this perspective. Adapted from National Geographic Maps.
www.flowergarden.noaa.gov

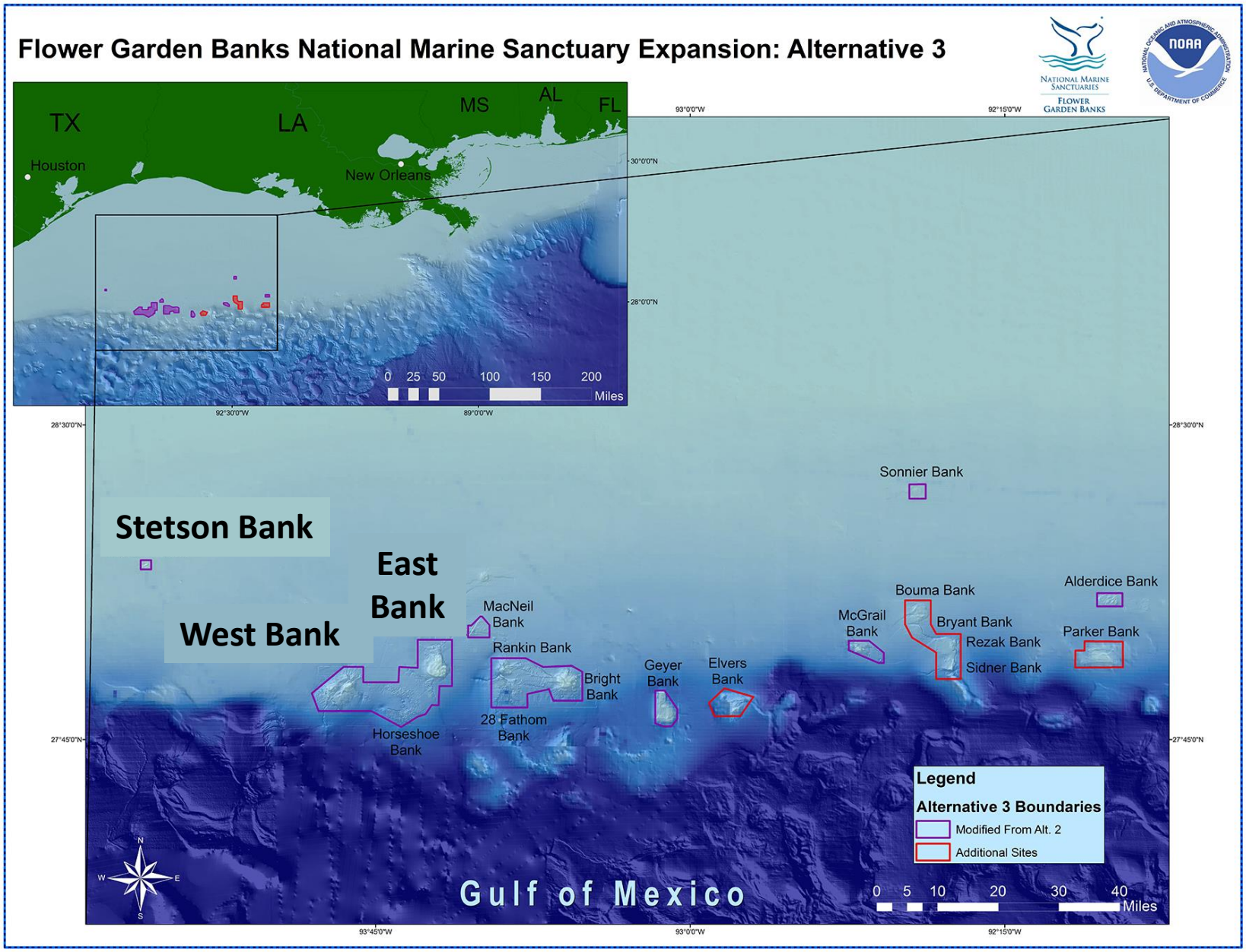
Five contain coral reefs!

FLOWER GARDEN BANKS NATIONAL MARINE SANCTUARY: EXISTING BOUNDARIES

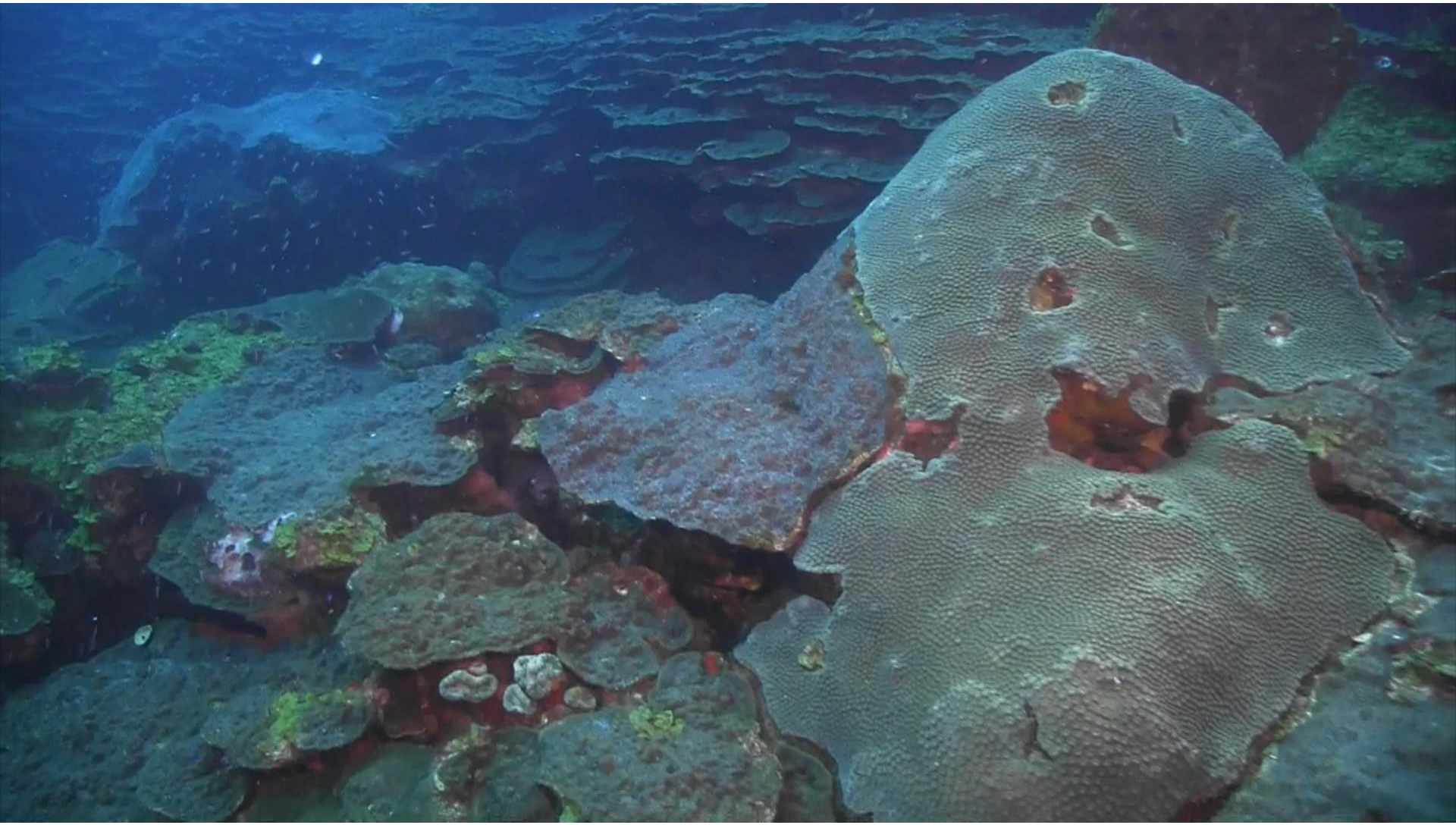


1. Stetson Bank; 2. West Flower Garden Bank; 3. East Flower Garden Bank

PROPOSED BOUNDARY EXPANSION WOULD PROTECT ADDITIONAL VALUABLE CORAL FEATURES

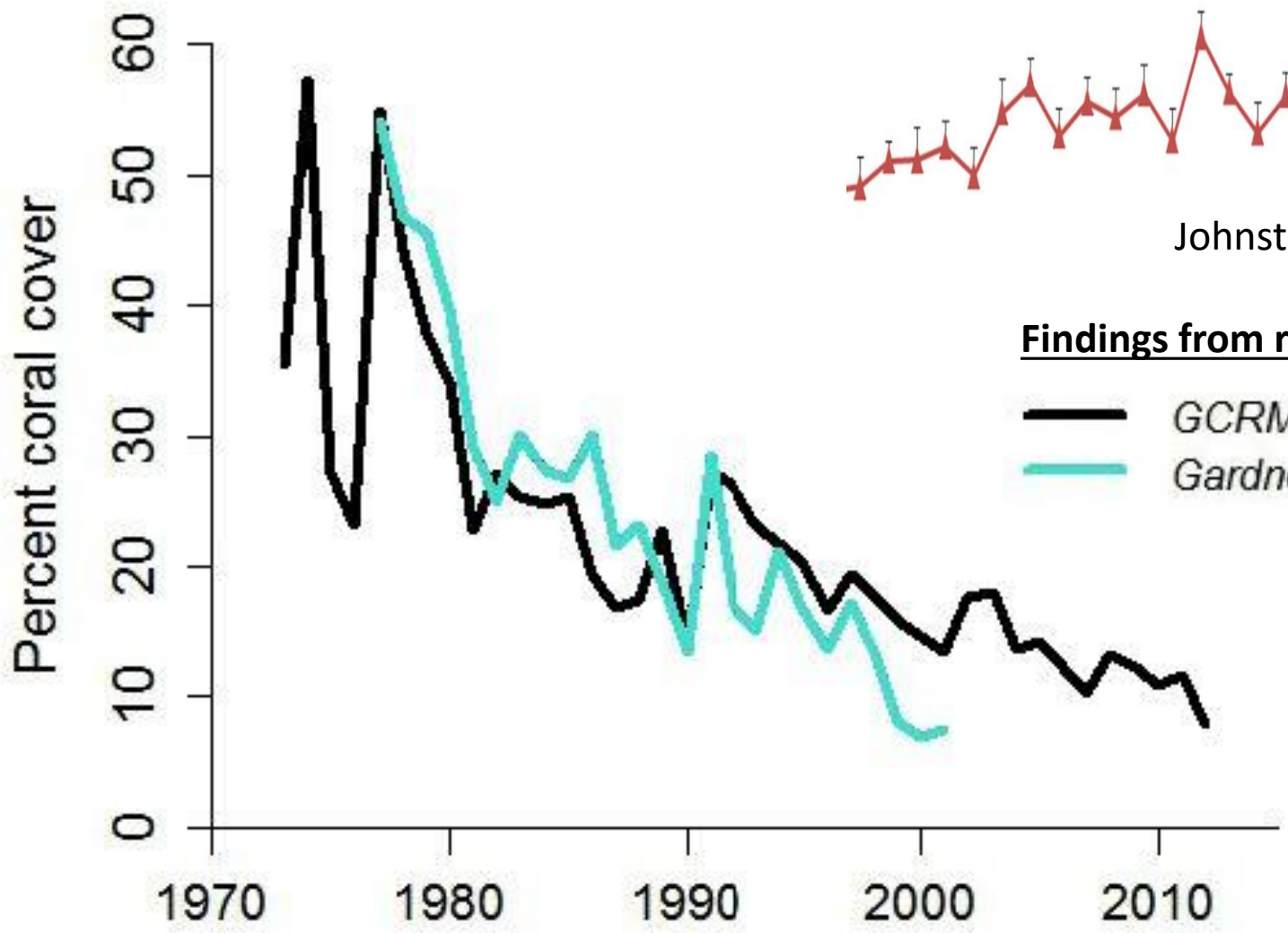


Most (> 50%) of FGBNMS seafloor is covered by corals!



Video credit: Michelle Johnston, NOAA

Caribbean coral reefs have declined by ~84% since the 1970's.
Average 50% live coral cover → 8%.



West Bank FGBNMS 1998-2014

Johnston et al. 2016

Findings from review studies:

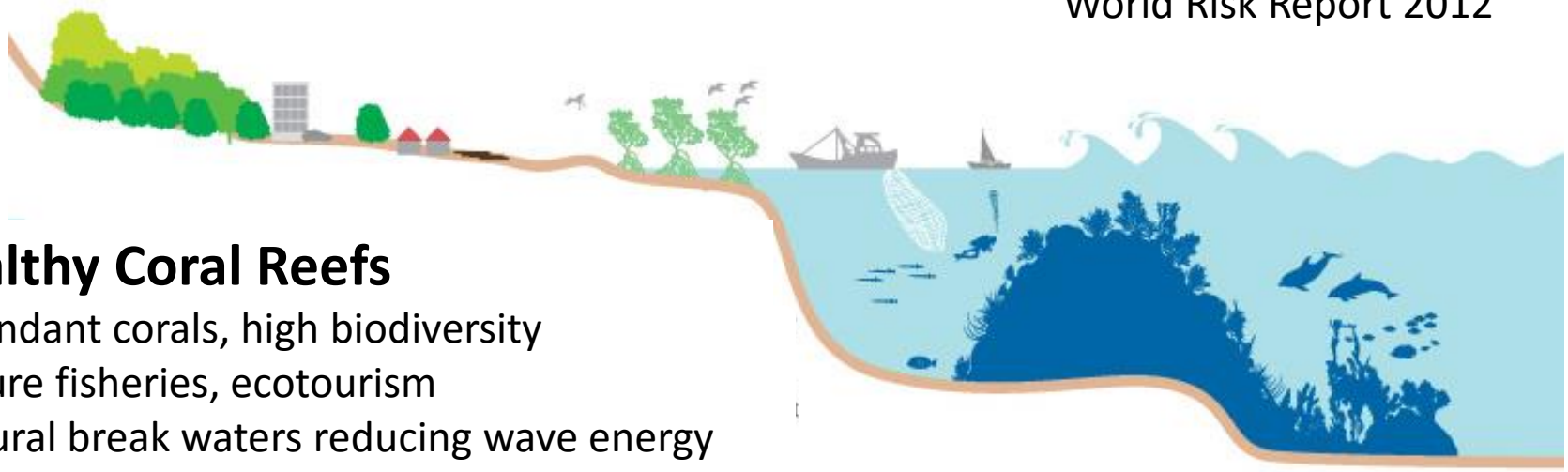
GCRMN

Gardner et al. 2003

Graph Credit: IUCN

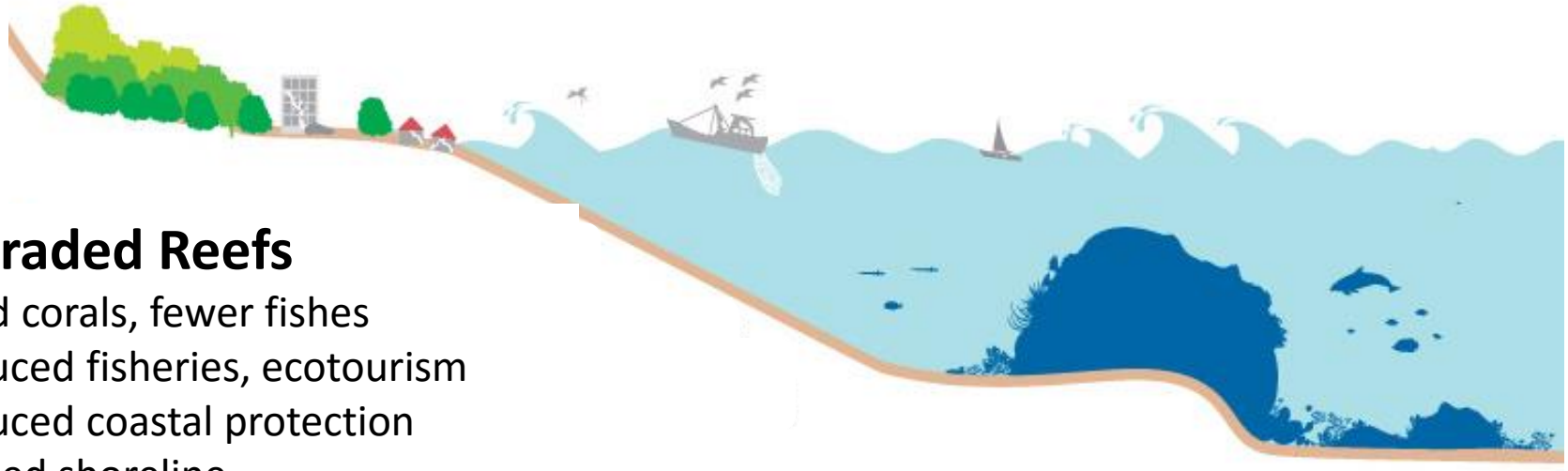
Degraded Reefs Change the Ecosystem

World Risk Report 2012



Healthy Coral Reefs

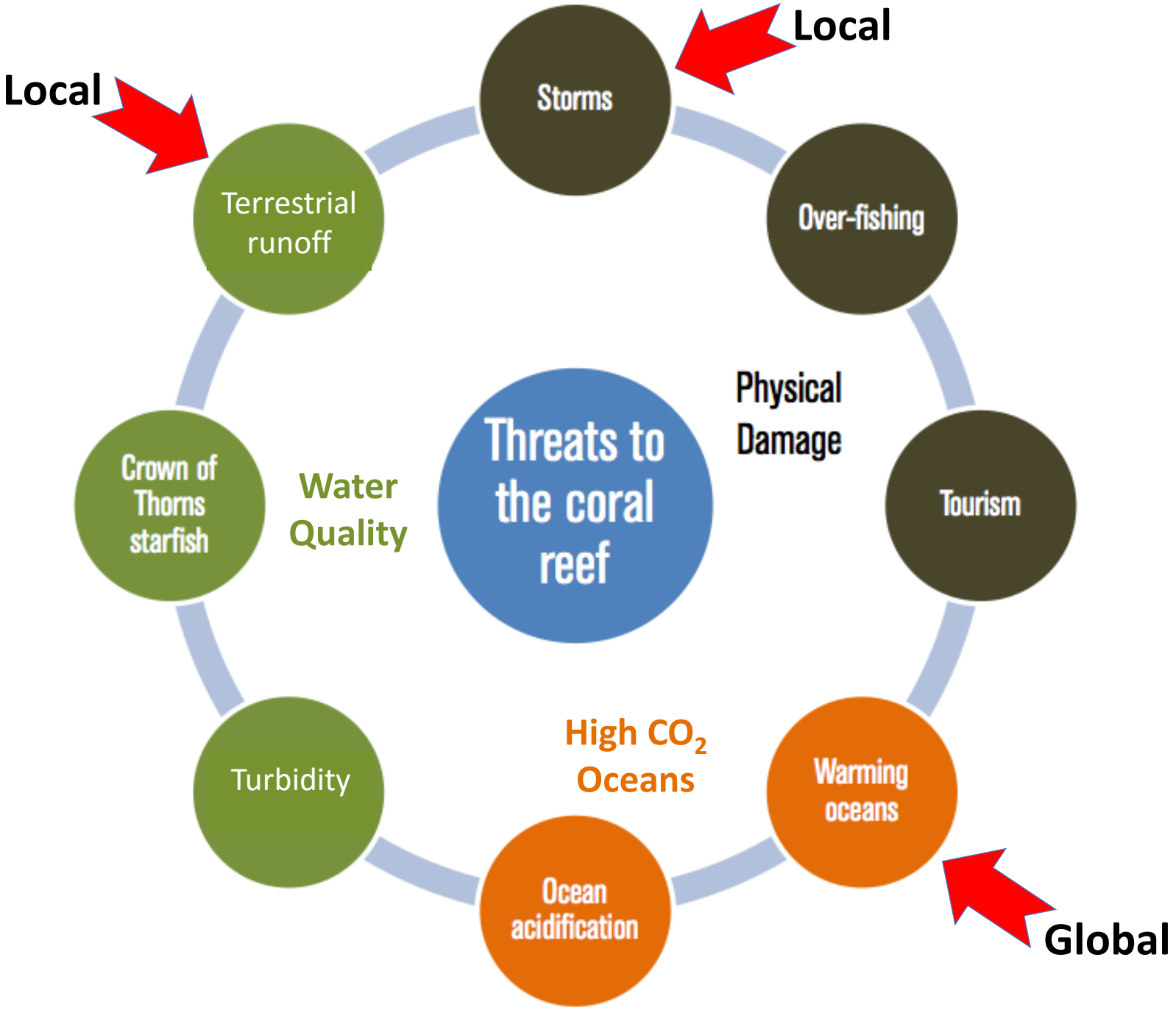
-Abundant corals, high biodiversity
-Secure fisheries, ecotourism
-Natural break waters reducing wave energy



Degraded Reefs

-Dead corals, fewer fishes
-Reduced fisheries, ecotourism
-Reduced coastal protection
-Eroded shoreline

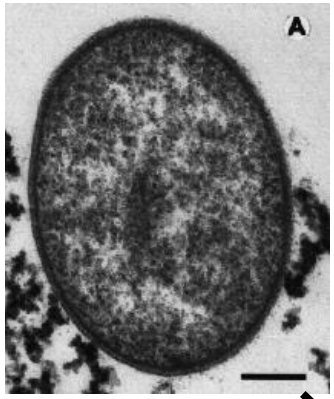
Threats to Reefs



http://cloudlovinggeographer.weebly.com/coral-reef-threats-decision-making.html

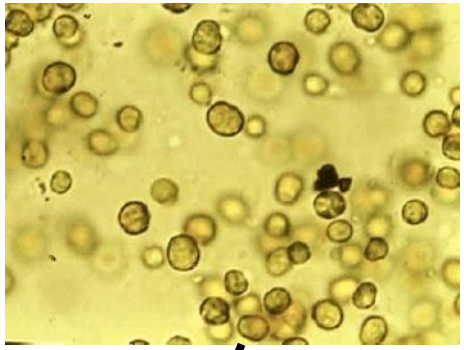
Coral polyp {

Archaea

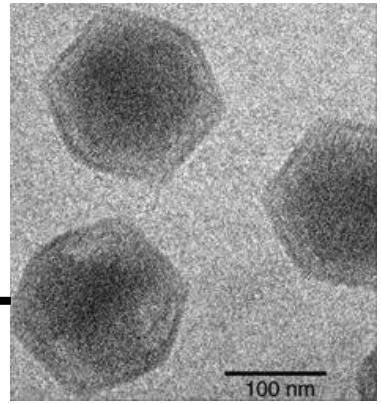


Bacteria

Symbiodinium



Fungi



Viruses

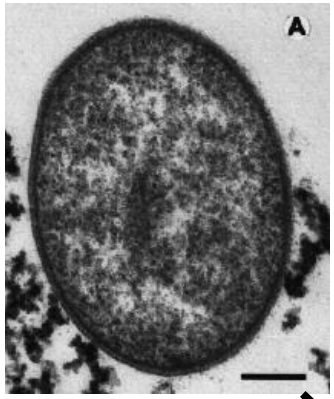
(Blackall et al. 2015 *Mol Ecol*)

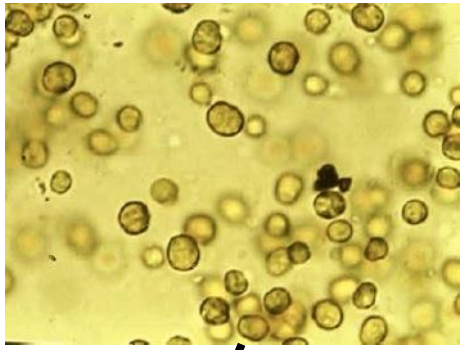
Microbes that live in corals are <u>symbionts</u>

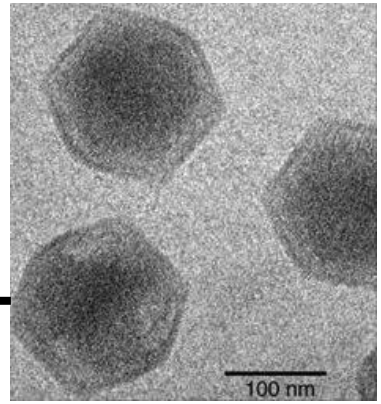
Microbial symbionts play critical roles in the human digestive system

https://virginiaburges.files.wordpress.com/2017/01/microbiome_sm.jpg

Archaea **Bacteria** ***Symbiodinium*** **Fungi**





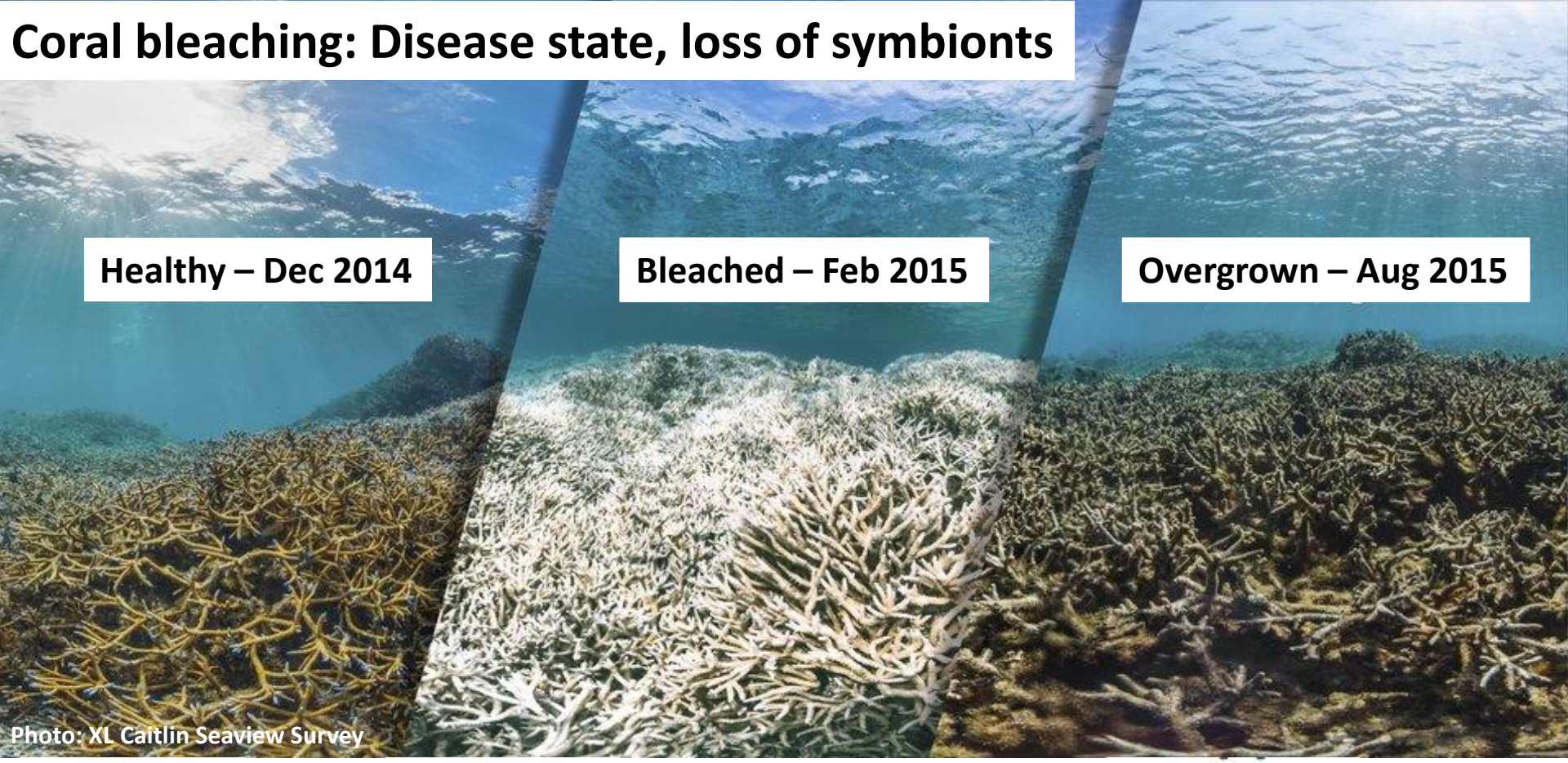


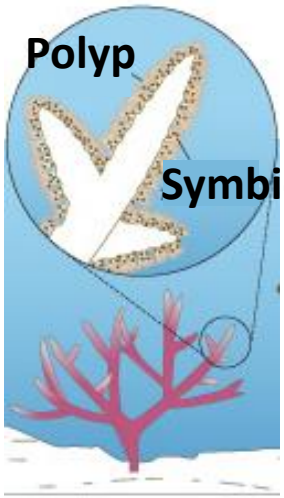
Viruses

(Blackall et al. 2015 *Mol Ecol*)

Corals: the world's most diverse symbiotic ecosystem

Coral bleaching: Disease state, loss of symbionts





Loss of symbionts

Symbiont community must be recovered in 4-6 weeks

Shift from coral to algae dominance

Photo: XL Caitlin Seaview Survey

Photo: XL Caitlin Seaview Survey

Photo: XL Caitlin Seaview Survey

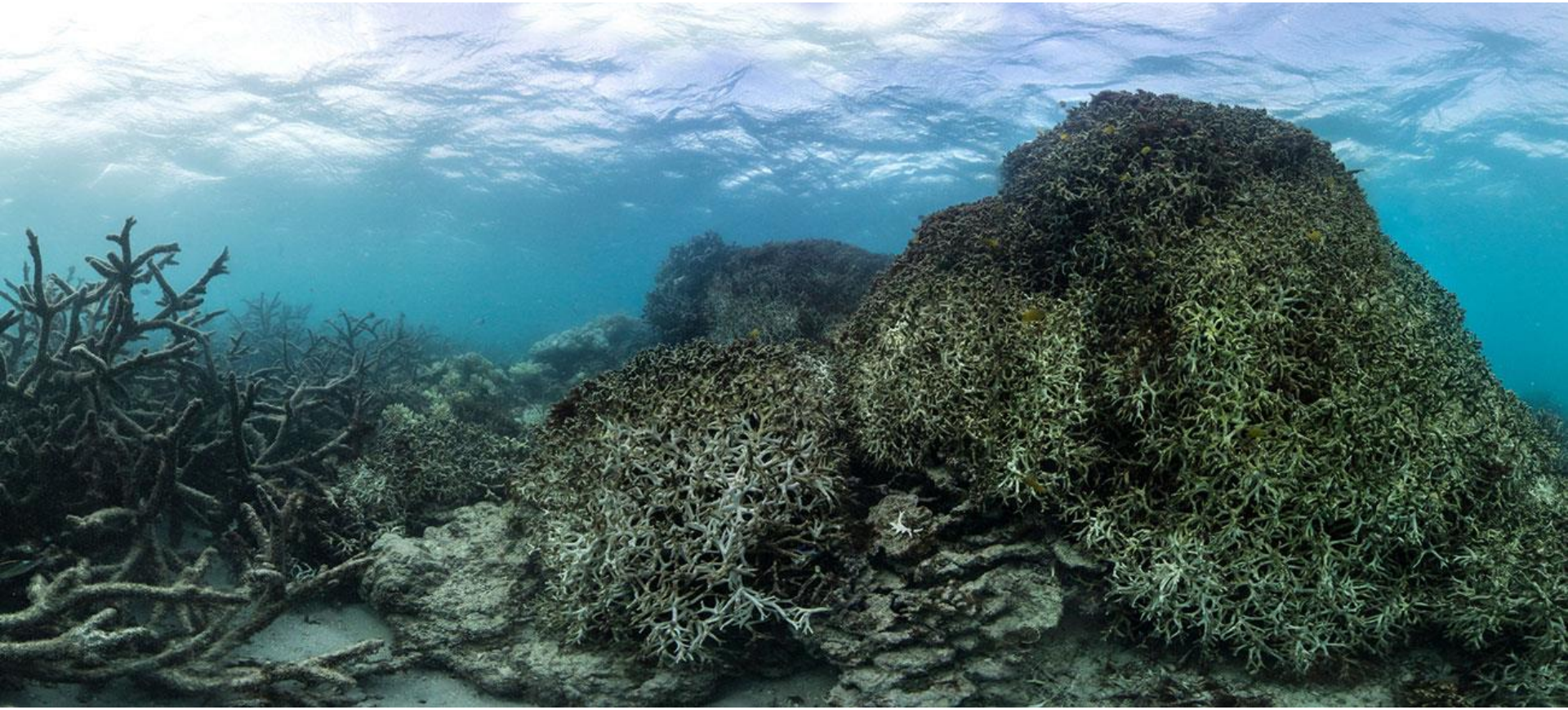
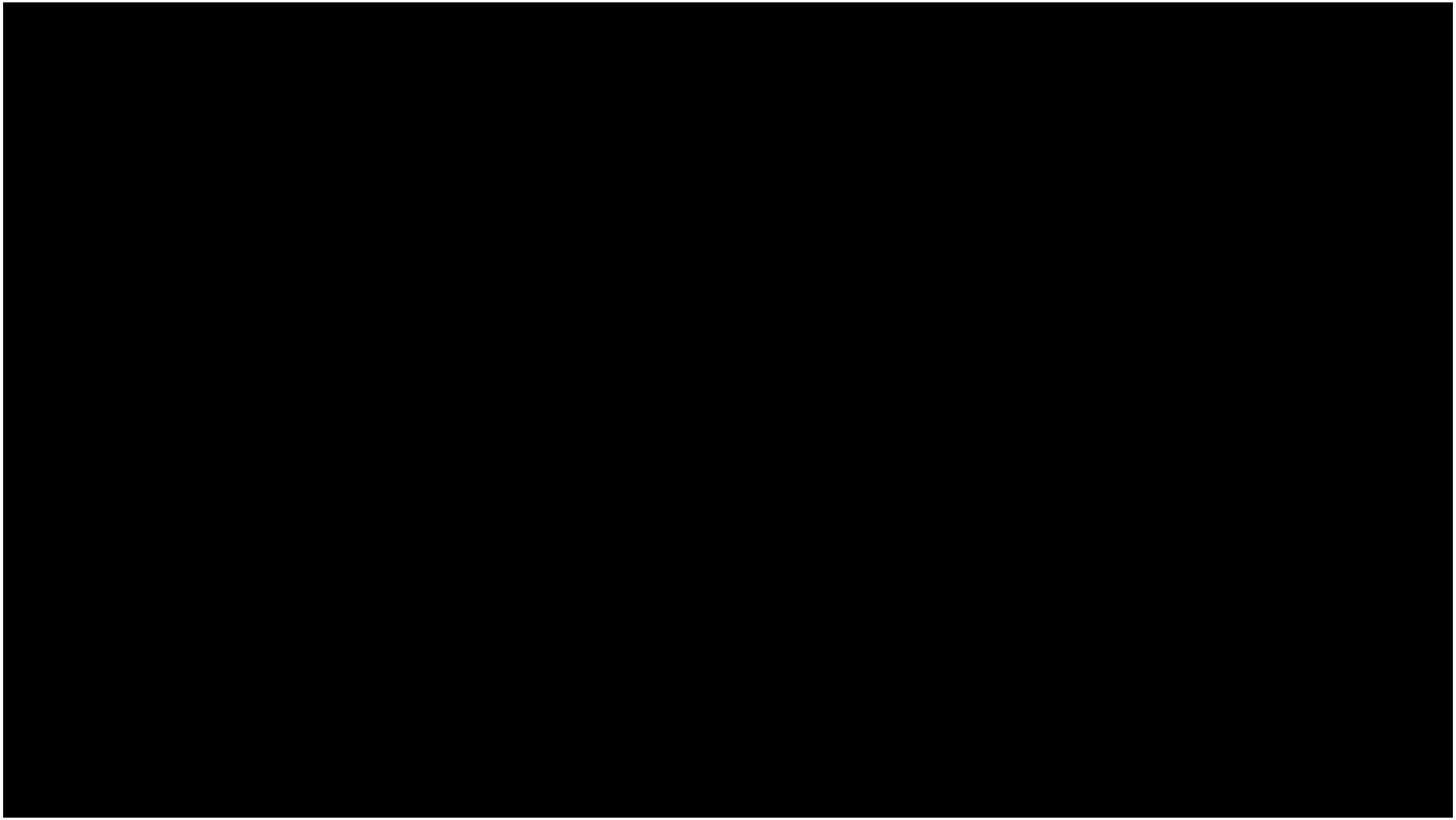


Photo: XL Caitlin Seaview Survey

2014-2016 Largest Loss of Corals in Recorded History



Three Main Ideas

Coral reefs are diverse and valuable ecosystems, and are in decline.

Extreme storms: local stressors that can harm reefs in various ways.

Recent Extreme Storms in SE Texas:

Memorial Day Flood, late May 2015

Tax Day Flood, mid-April 2016

Hurricane Harvey, late August 2017

Did these storms affect the Flower Garden Banks? If so, how?

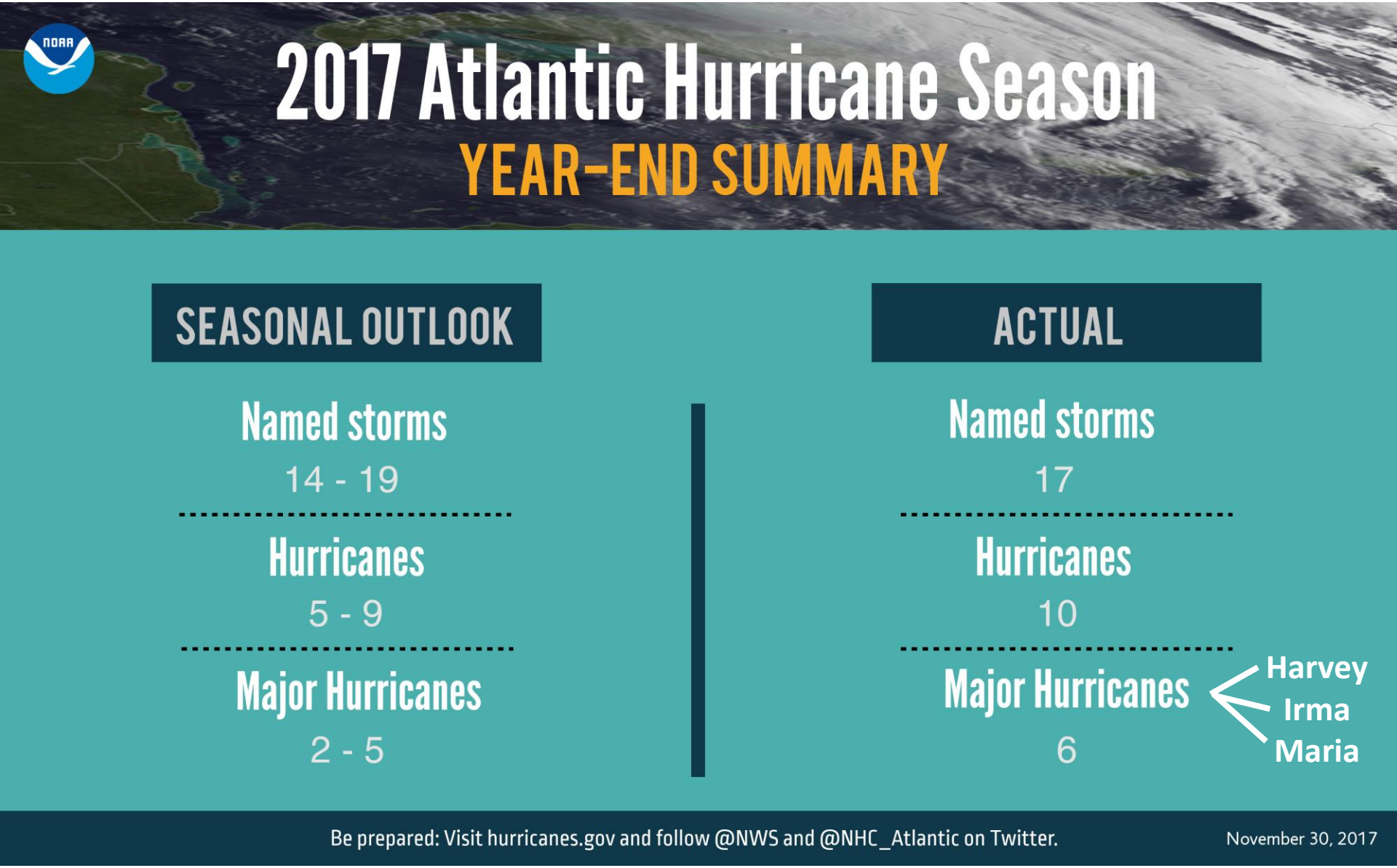
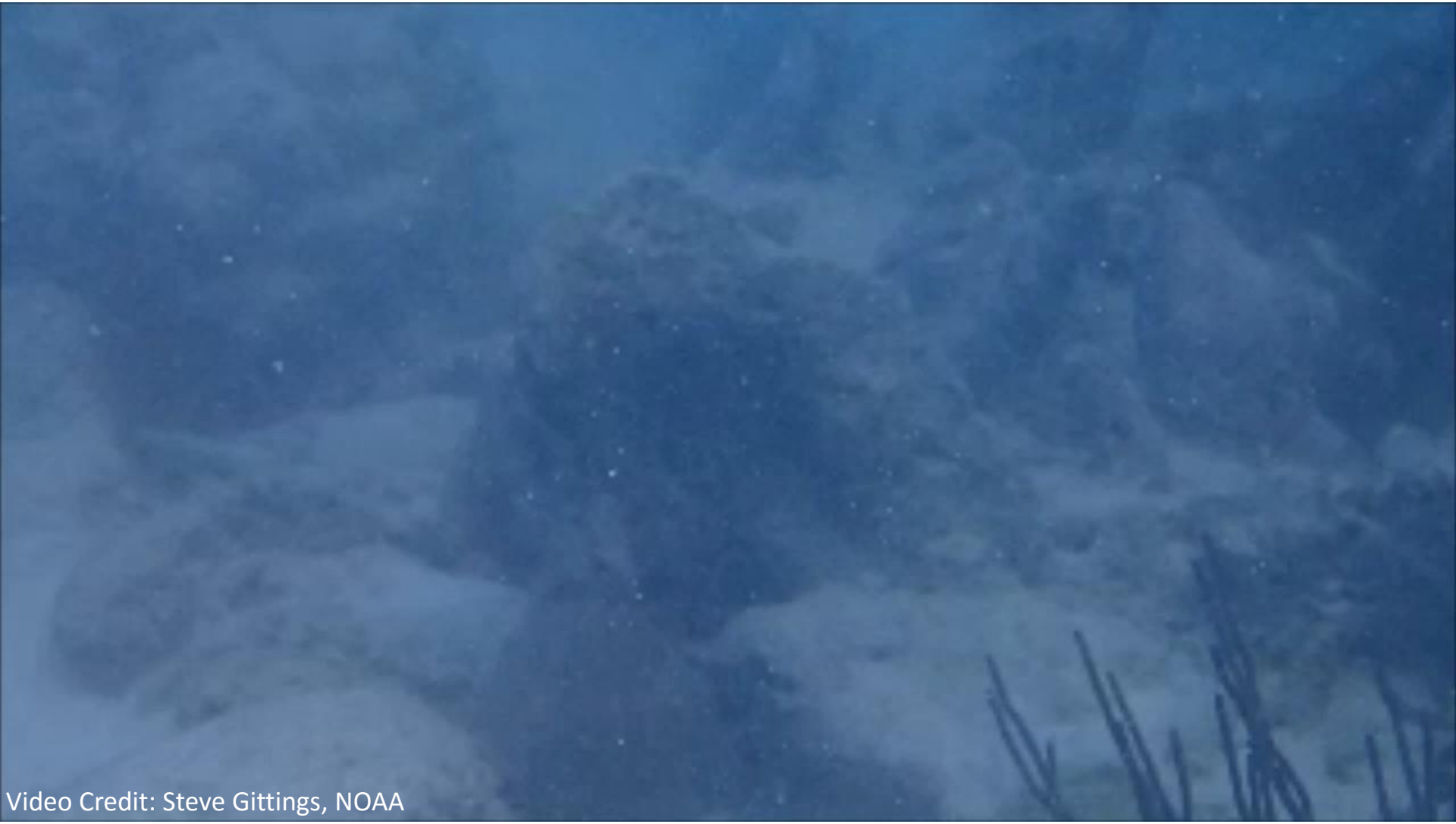


Photo credit: NOAA

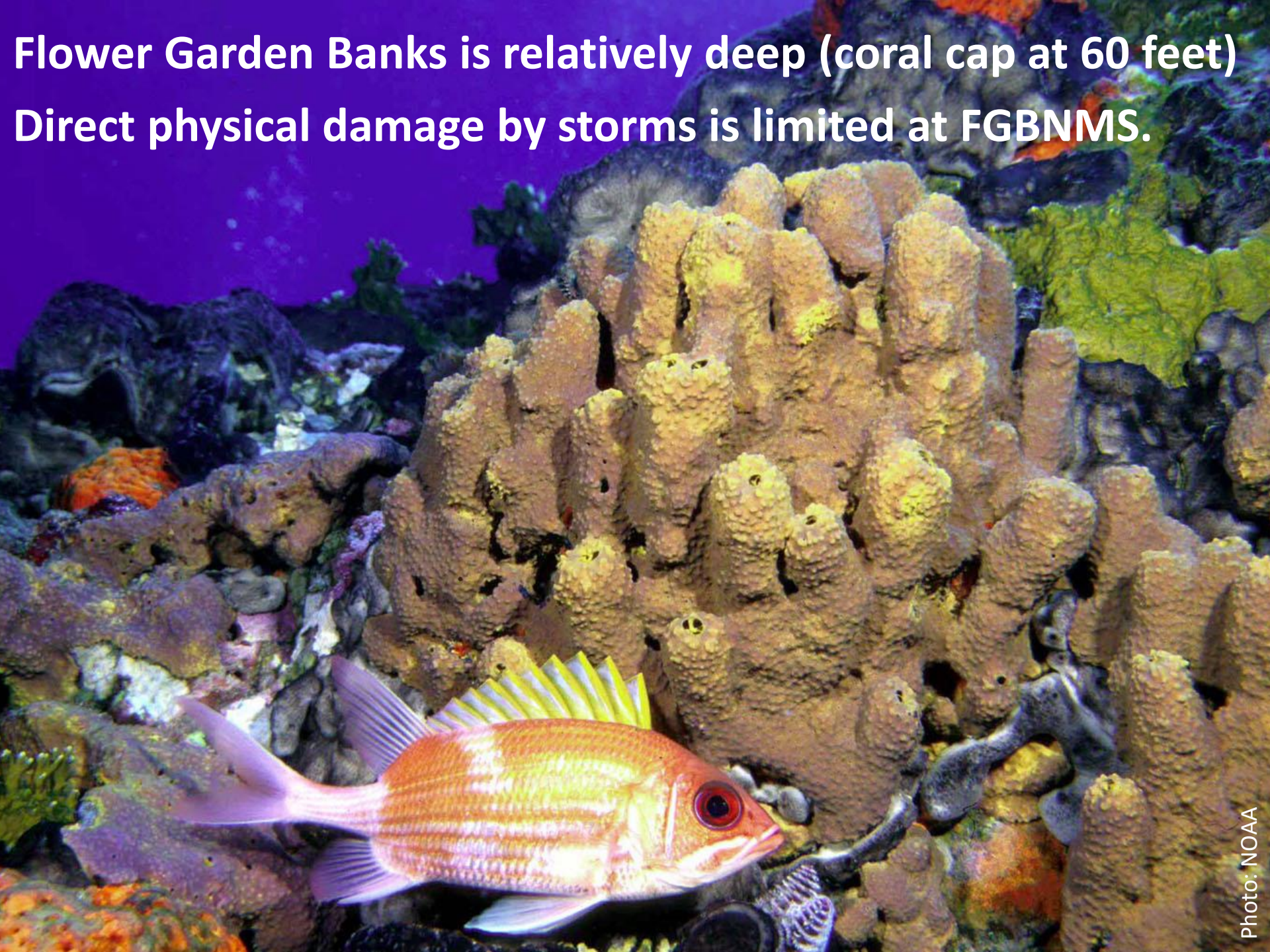
Direct physical storm damage to reefs



Hurricane Irma impacts on Florida Keys reefs, 2017

Physical damage: Sediments smother organisms

Hurricane Irma impacts on Florida Keys reefs, 2017


Flower Garden Banks is relatively deep (coral cap at 60 feet)
Direct physical damage by storms is limited at FGBNMS.
Photo: NOAA

Can poor water quality damage reefs following extreme storms?

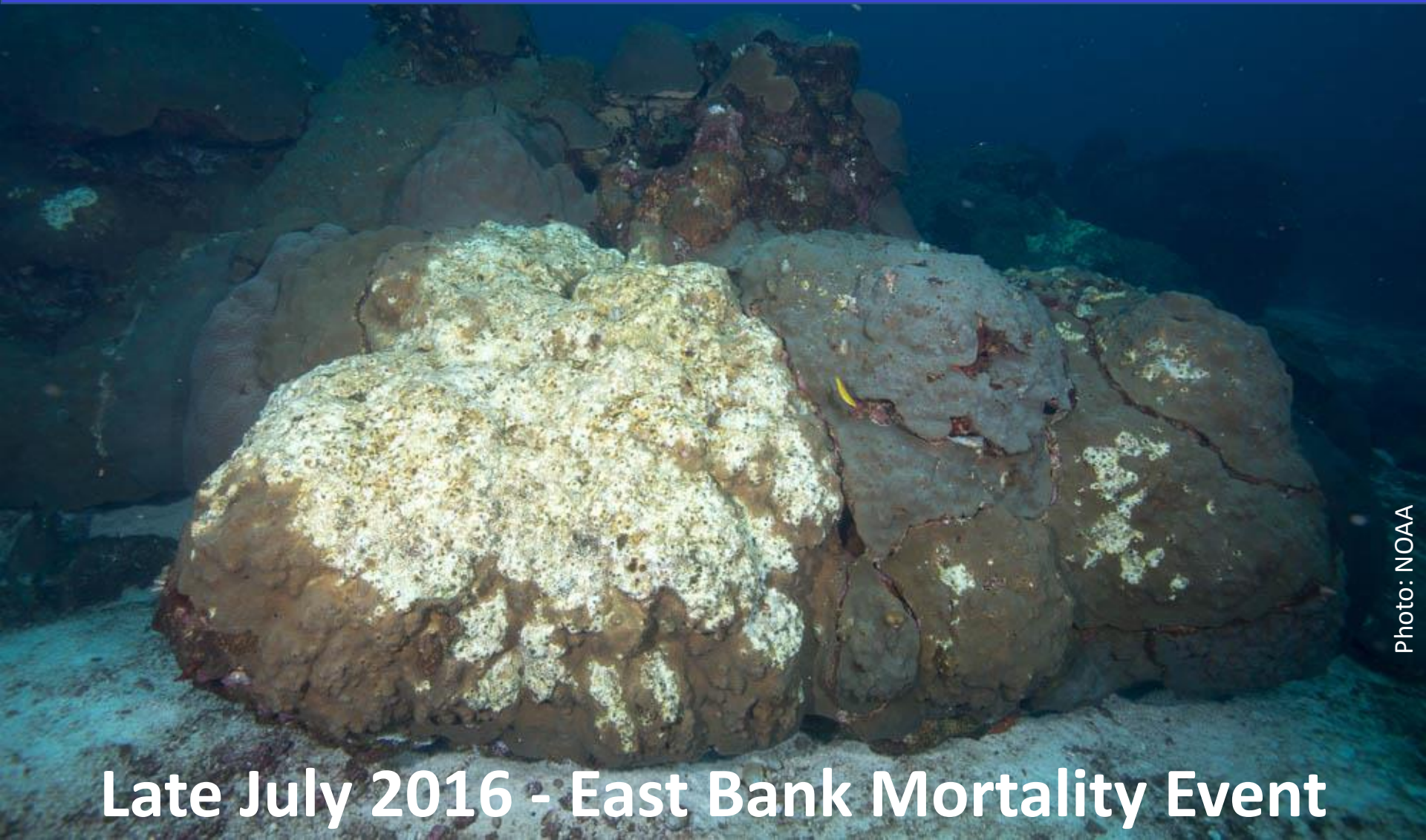


Photo: NOAA

Late July 2016 - East Bank Mortality Event

Photo: Houston Chronicle

Nearshore salinity after Tax Day Flood Jul 08, 2016 00Z [91.2H]

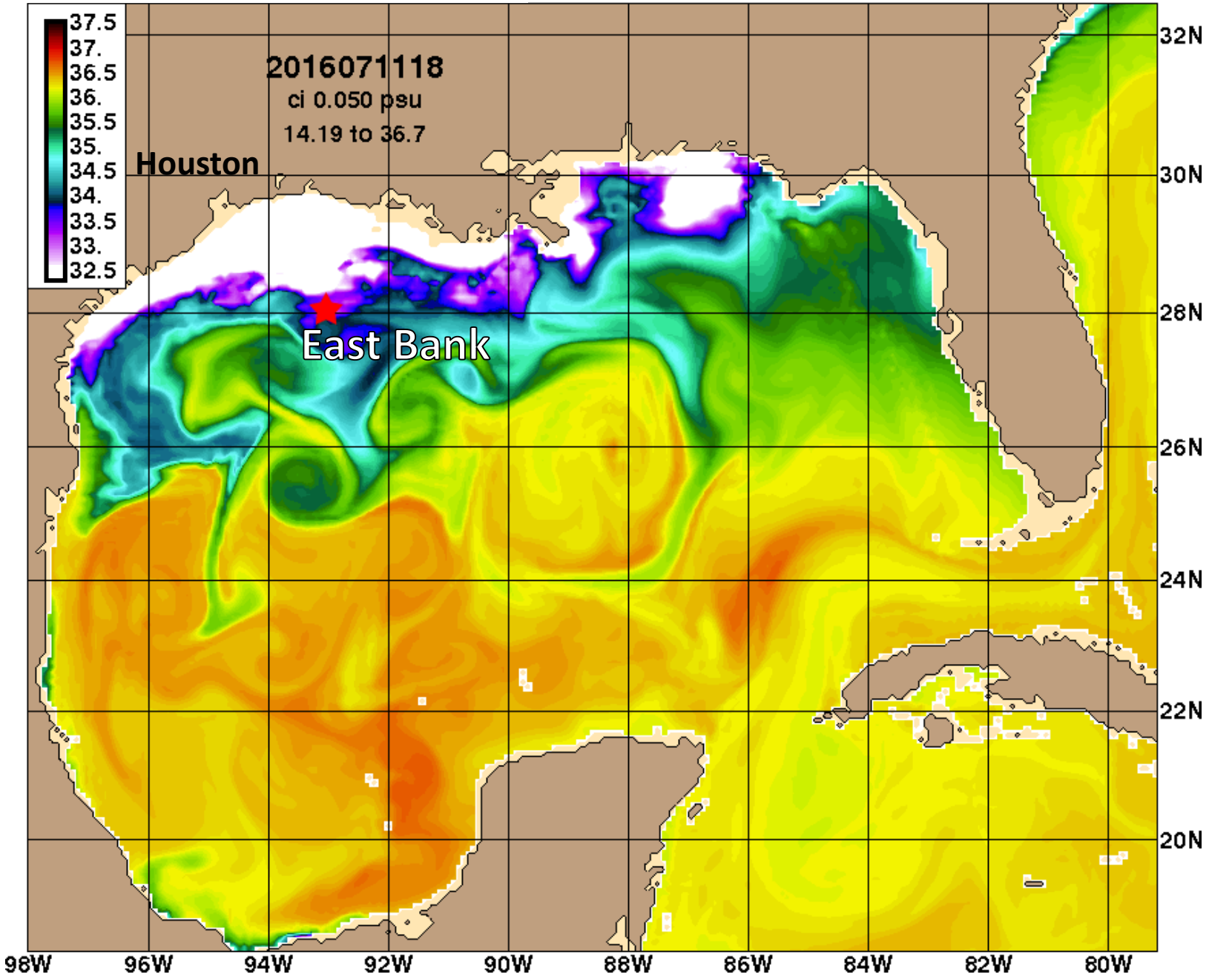


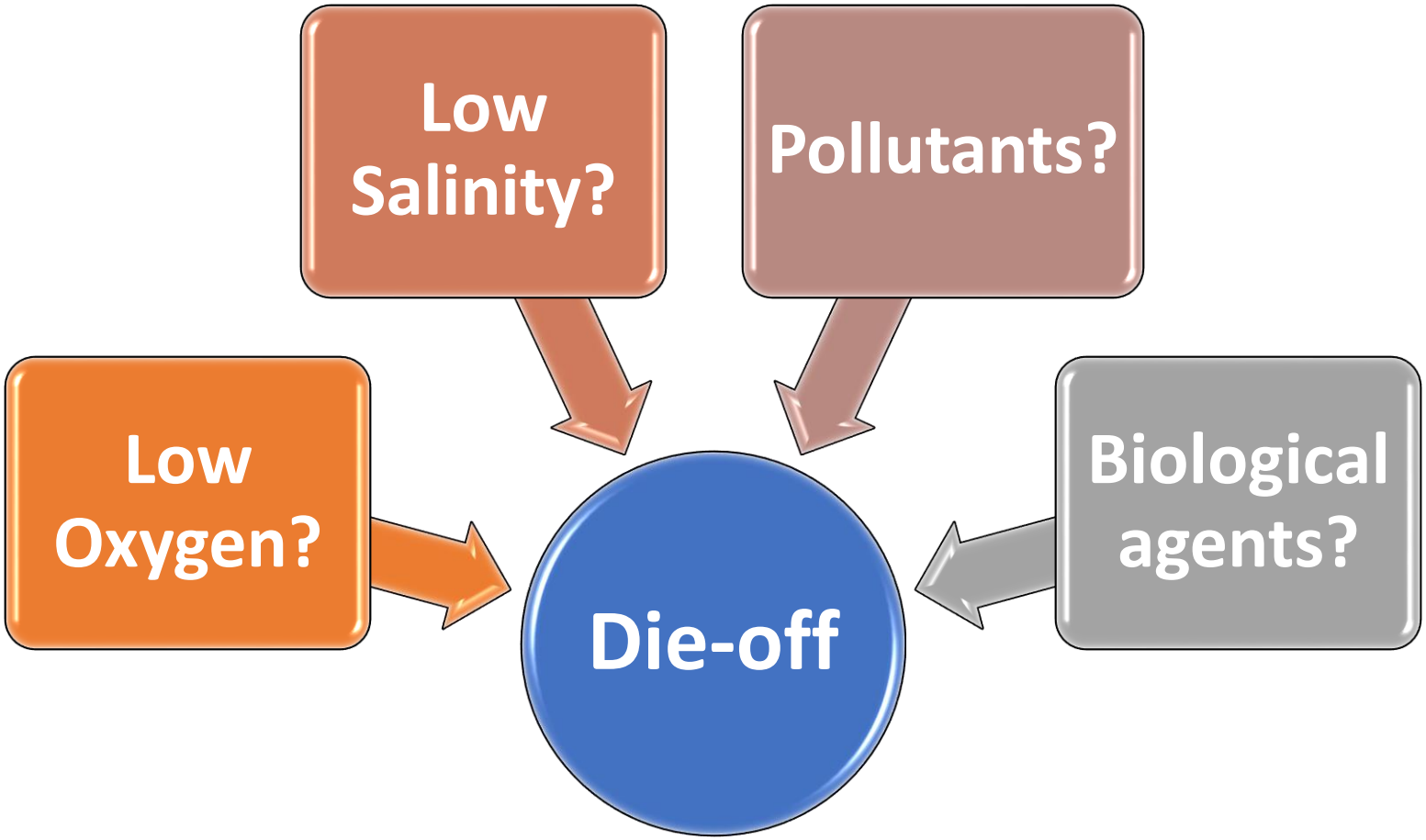
Image Credit: United States Naval Research Laboratory – Stennis Space Center

Late July 2016 - East Bank Mortality Event

White bacterial mat growing on corals and sponges

Photos: NOAA

What caused the 2016 Mortality Event?



Combination of stressors

Some hypotheses:

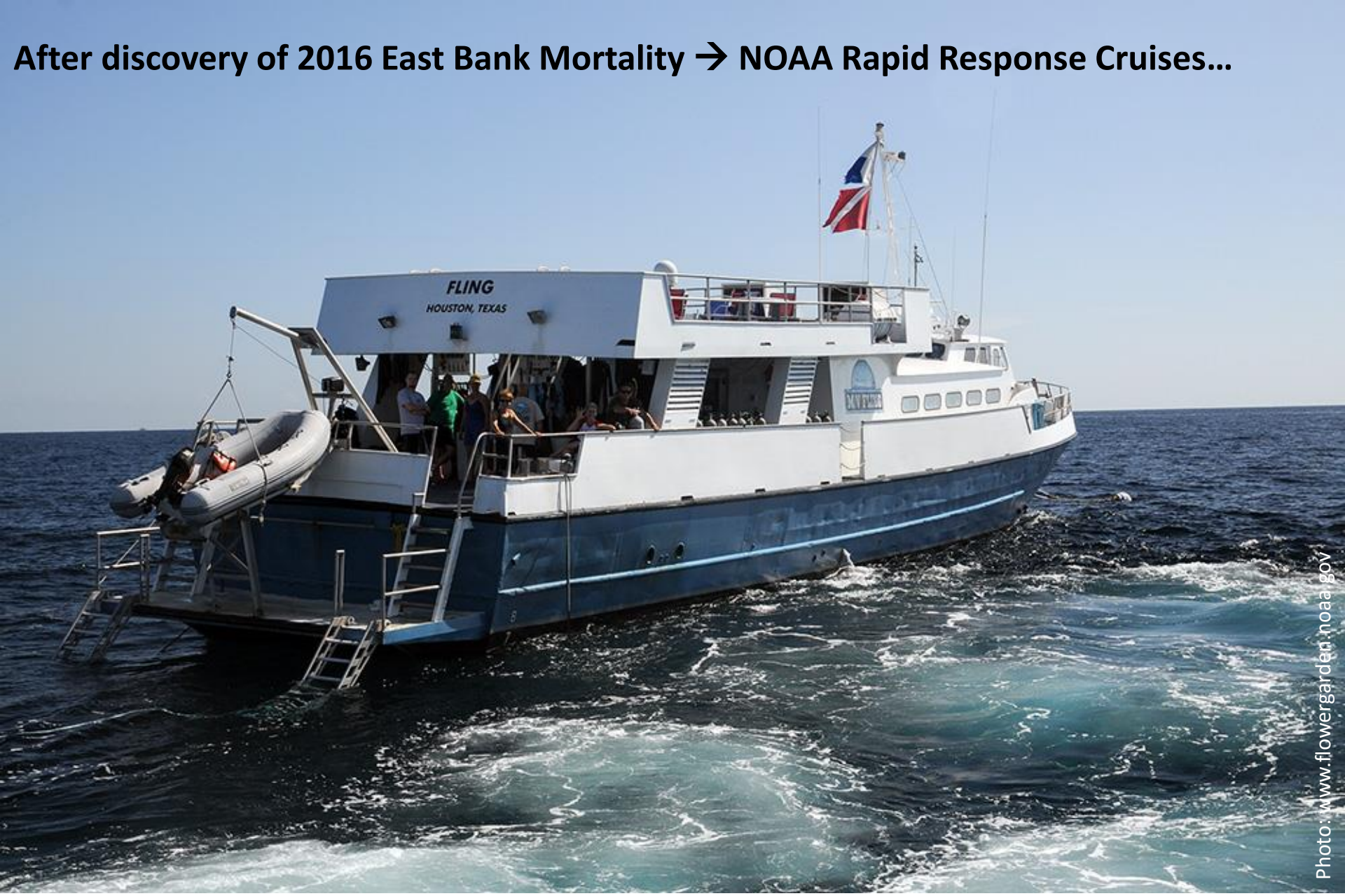
(1) Floodwater runoff lowers ocean salinity → directly kills reef organisms

(2) Low salinity stress kills some organisms → bacterial bloom (decomposers) reduces oxygen levels in water → additional reef organisms suffocate

(3) Low salinity floodwater runoff floats on top of ocean water → prevents ocean mixing → low oxygen levels → reef organisms suffocate

(4) Nutrients/chemicals in floodwater runoff trigger shifts towards disease-causing bacteria → kill reef organisms

After discovery of 2016 East Bank Mortality → NOAA Rapid Response Cruises…



… but start date unknown and no 'before' samples from affected East Bank area

2016 East Bank Mortality Event

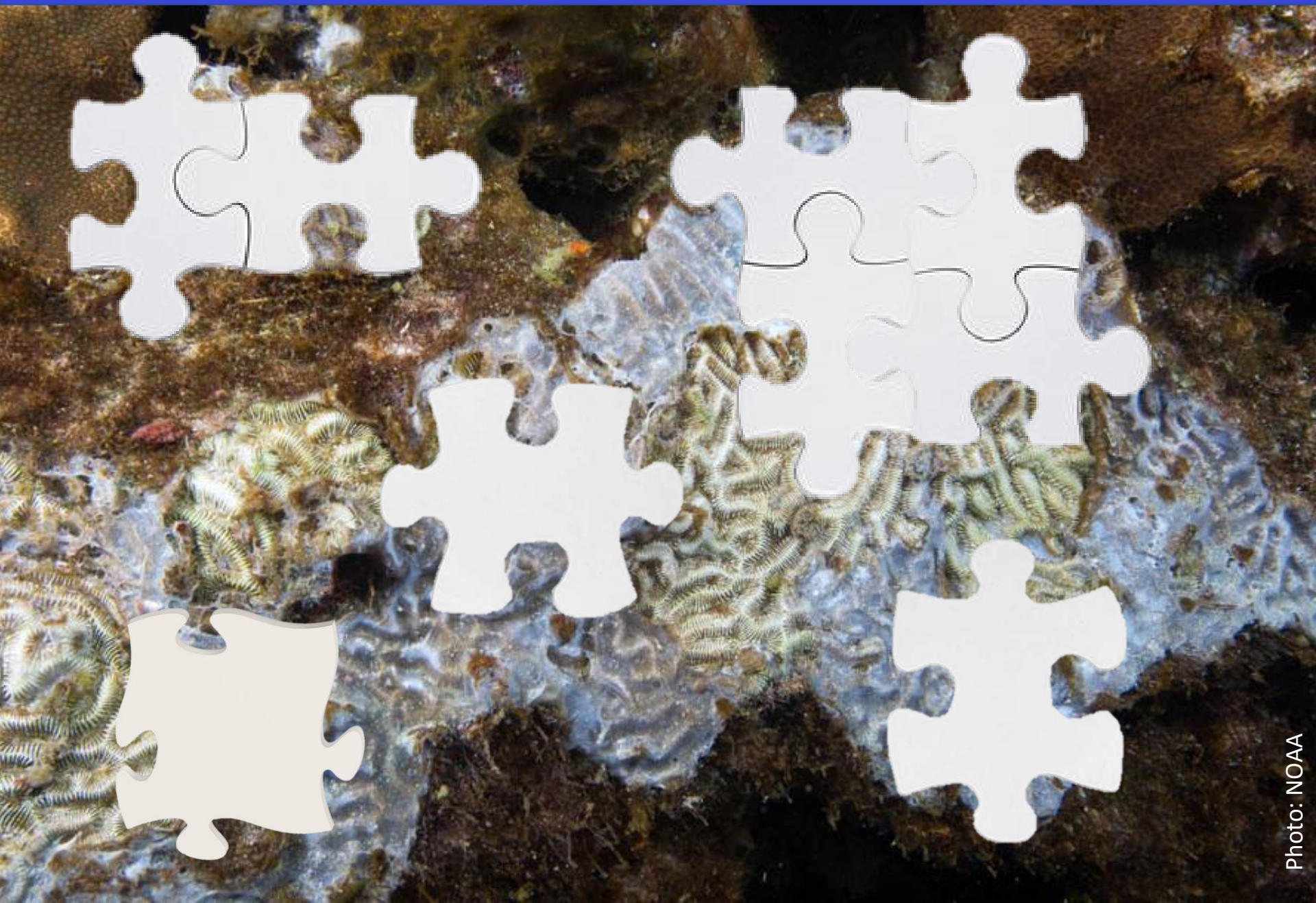


Photo: NOAA

Photo: Houston Chronicle

Flood Response: The Importance of Community

Flood Response:
The Importance of Scientific Community

Sarah Davies
Boston U.

Lory Santiago-Vazquez
UH Clear Lake

Kathryn Shamberger
Texas A&M

Jason Sylvan
Texas A&M

Shawn Doyle
Texas A&M

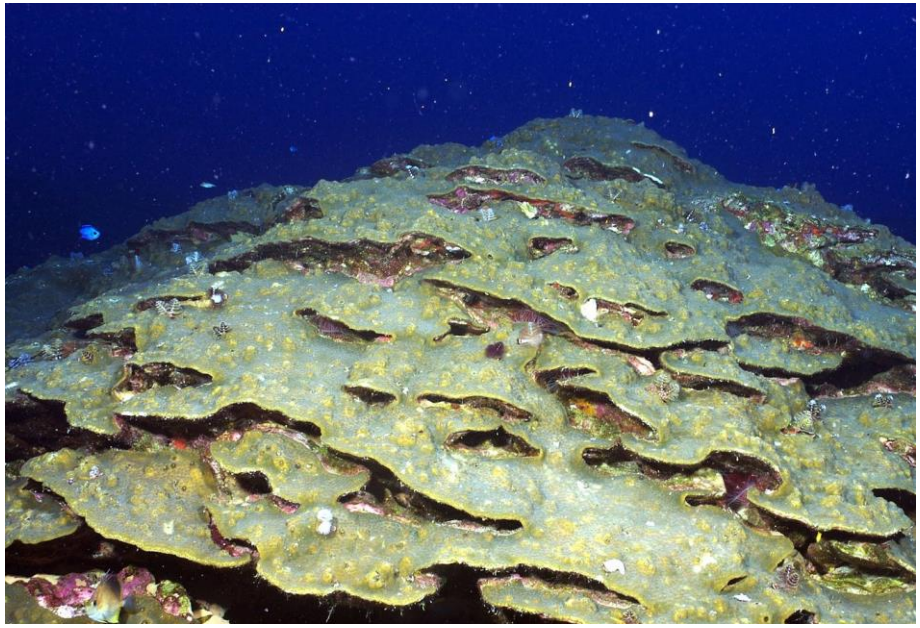
Rachel Wright
Boston U.

The Correa Lab
R/V Point Sur

GIANT BARREL SPONGE – *Xestospongia muta*

Mountainous star coral – *Orbicella faveolata*

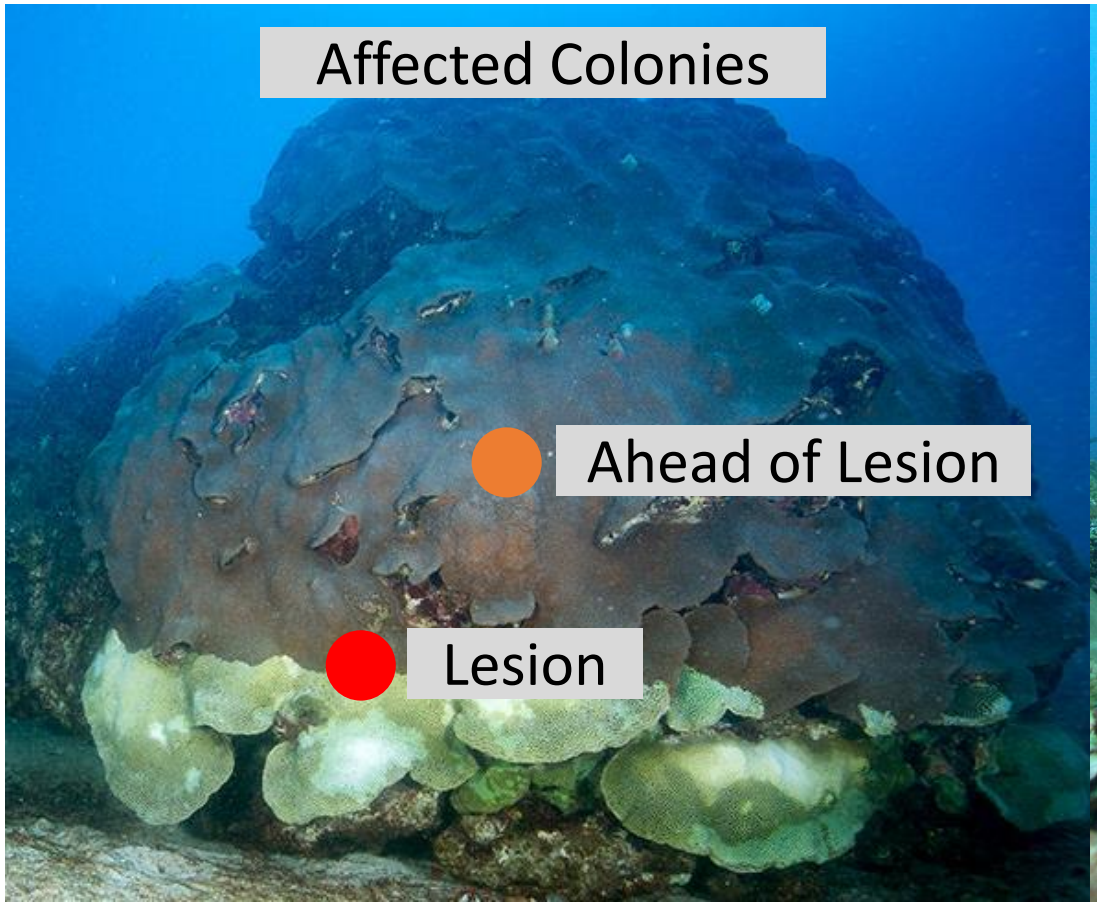
ELEPHANT EAR SPONGE – *Agelas clathrodes*

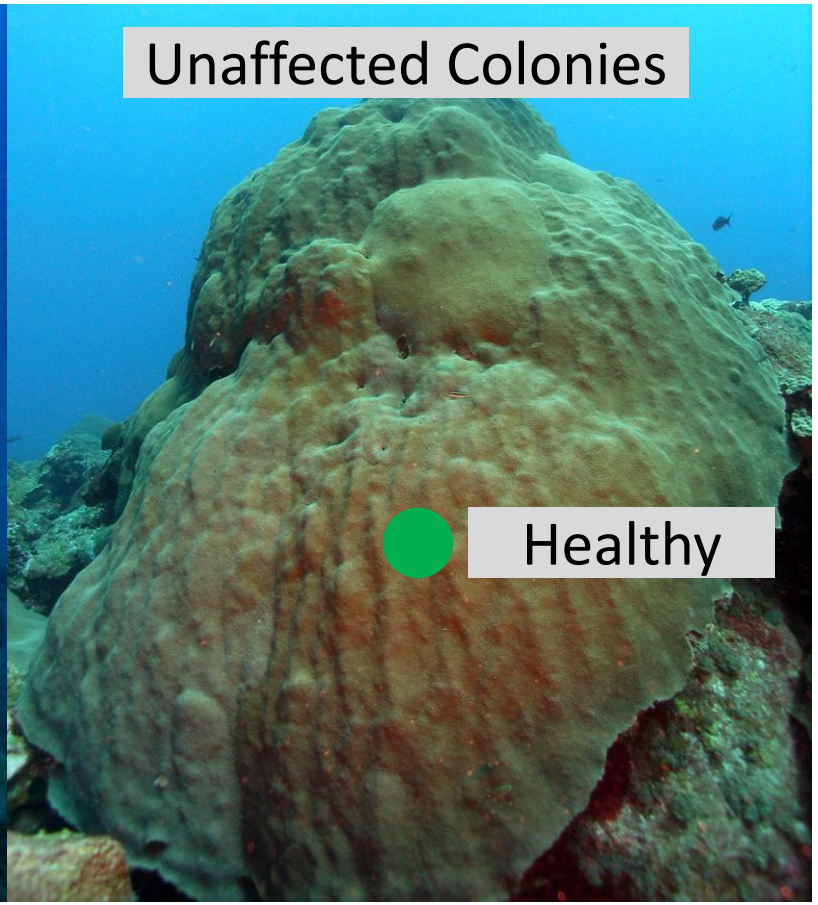


Boulder star coral – *Orbicella franksi*

Photos: NOAA

SAMPLING REEF ORGANISMS & THEIR MICROBES:



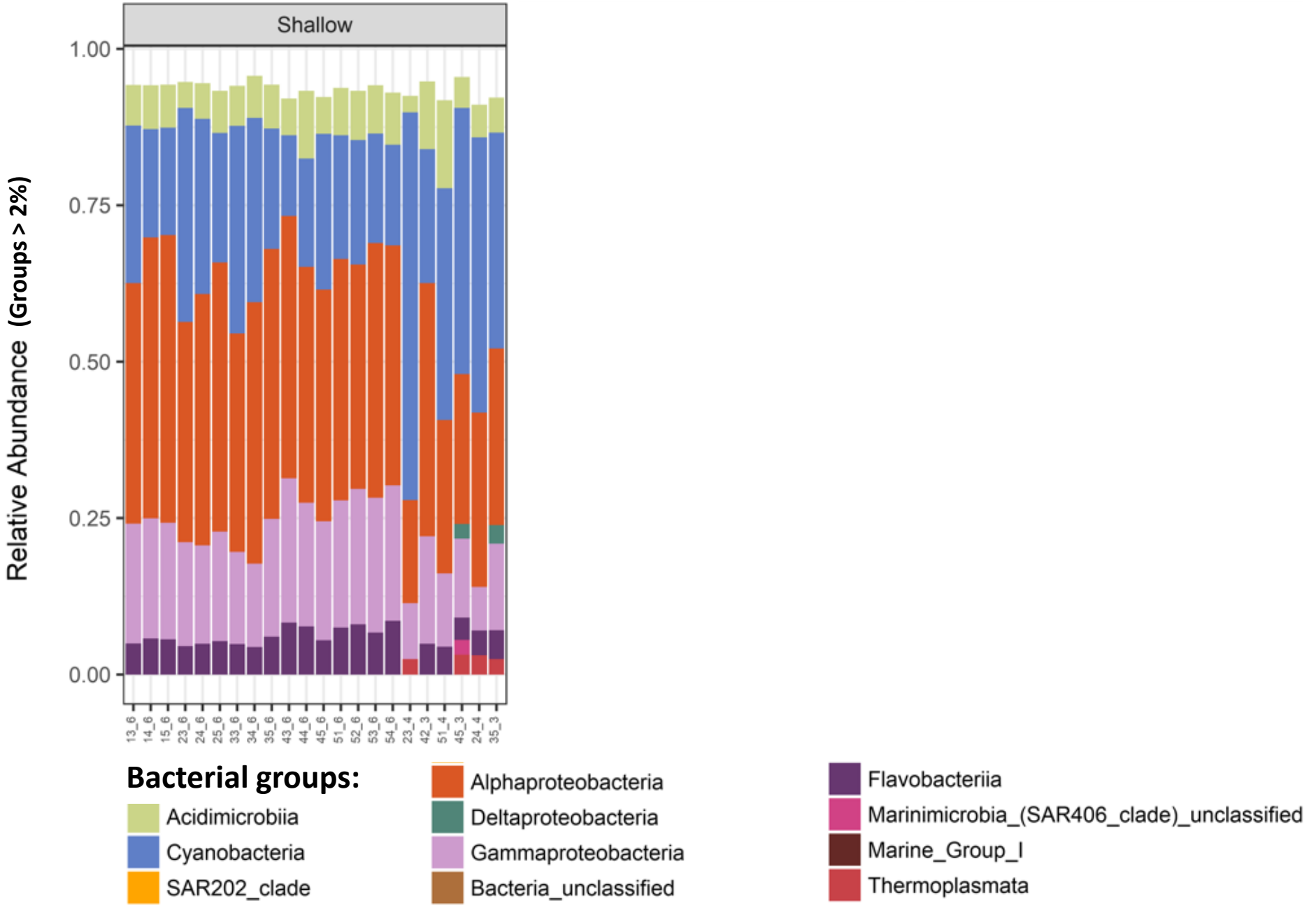


EAST BANK ONLY

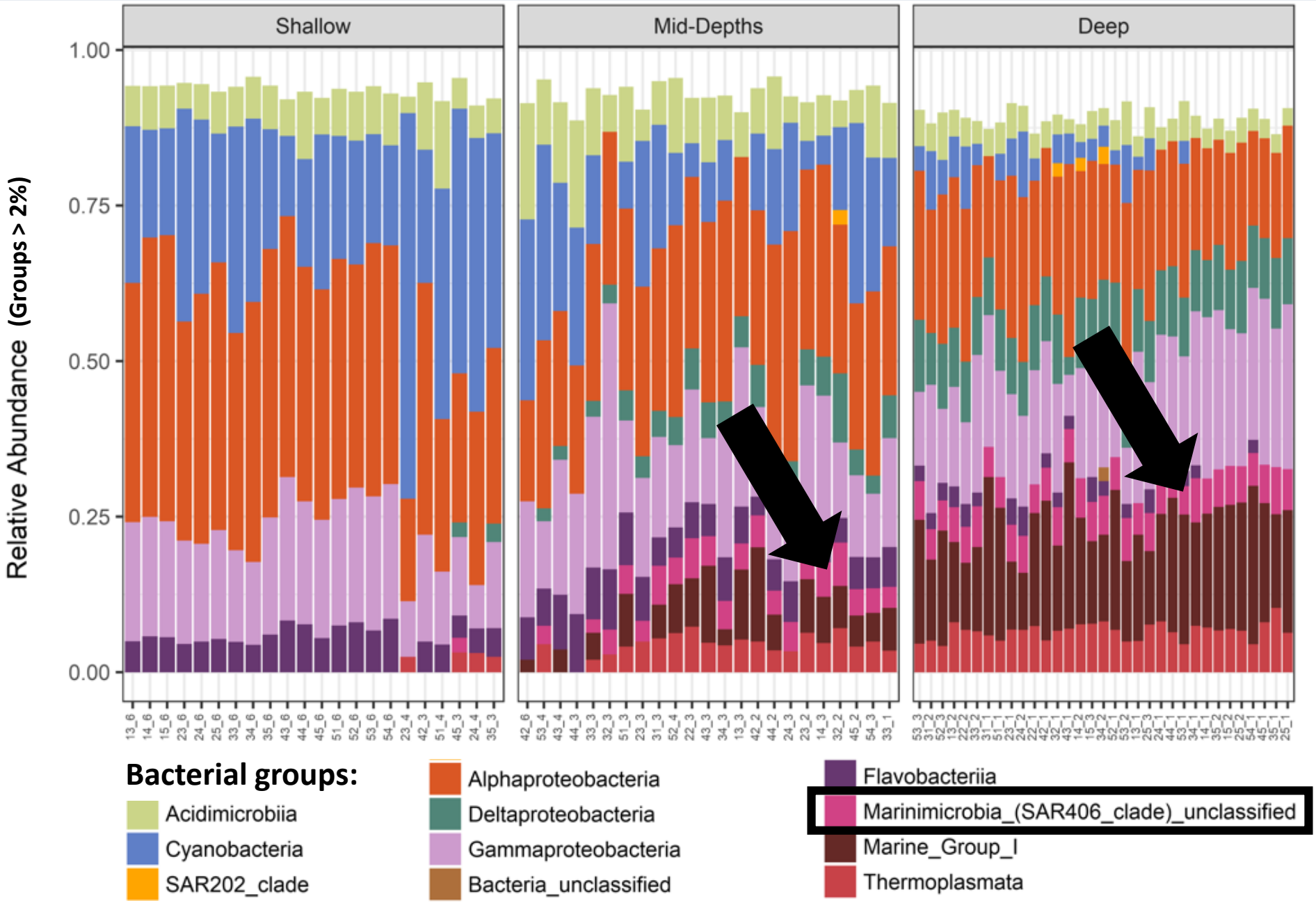
EAST AND WEST BANKS

<u>Additional sampling:</u> seawater chemistry, water column microbes

Aug. 2016 Water Column Bacterial Communities



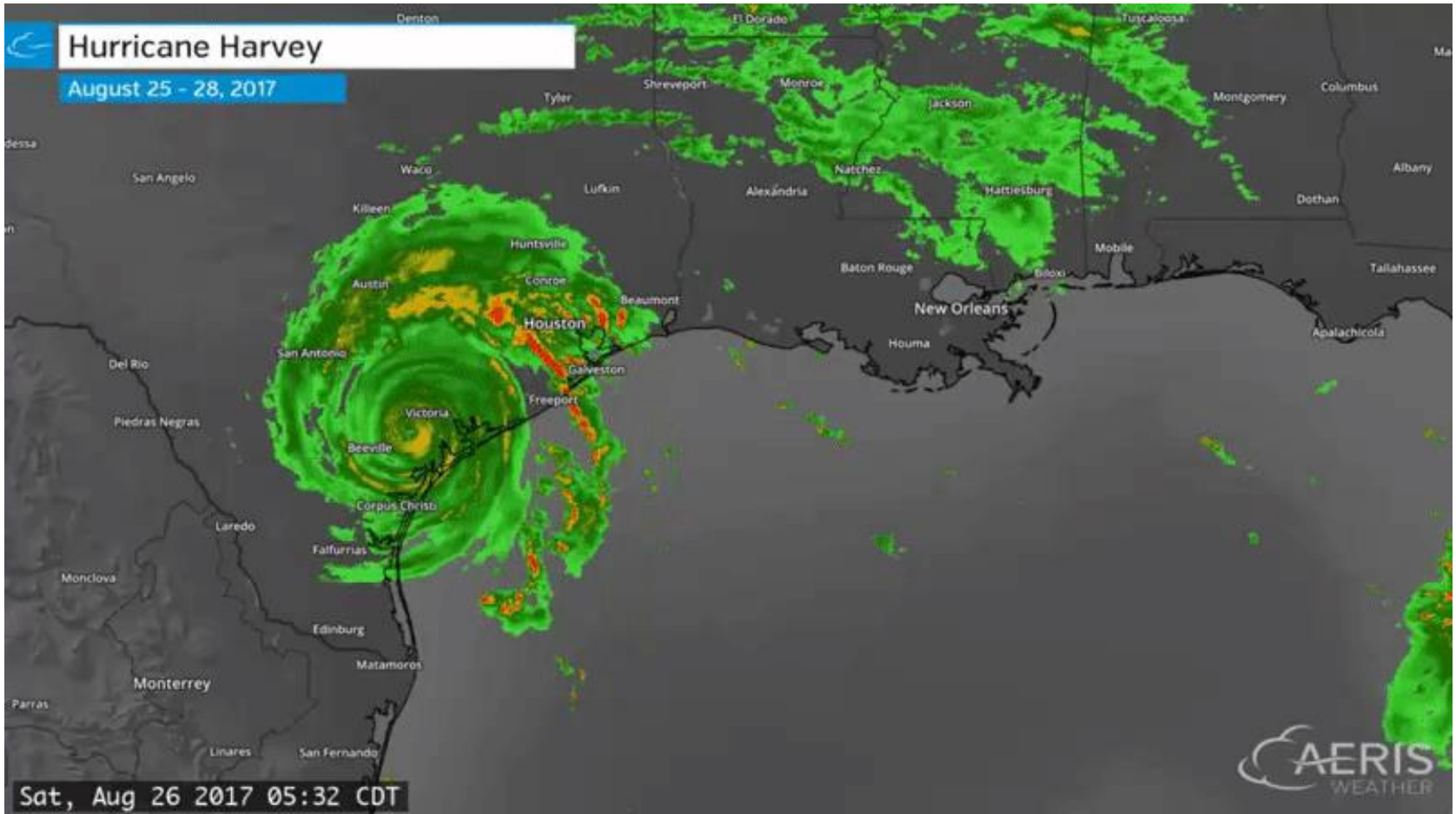
Marinimicrobia: Low Oxygen Zone?



Preliminary analyses of 2016 event suggest:

--Decreased salinity alone was not enough to cause 2016 East Bank Mortality

--Low oxygen conditions likely contributed to mortality



GIF credit: Star Tribune

Hurricane Harvey, Aug. 2017

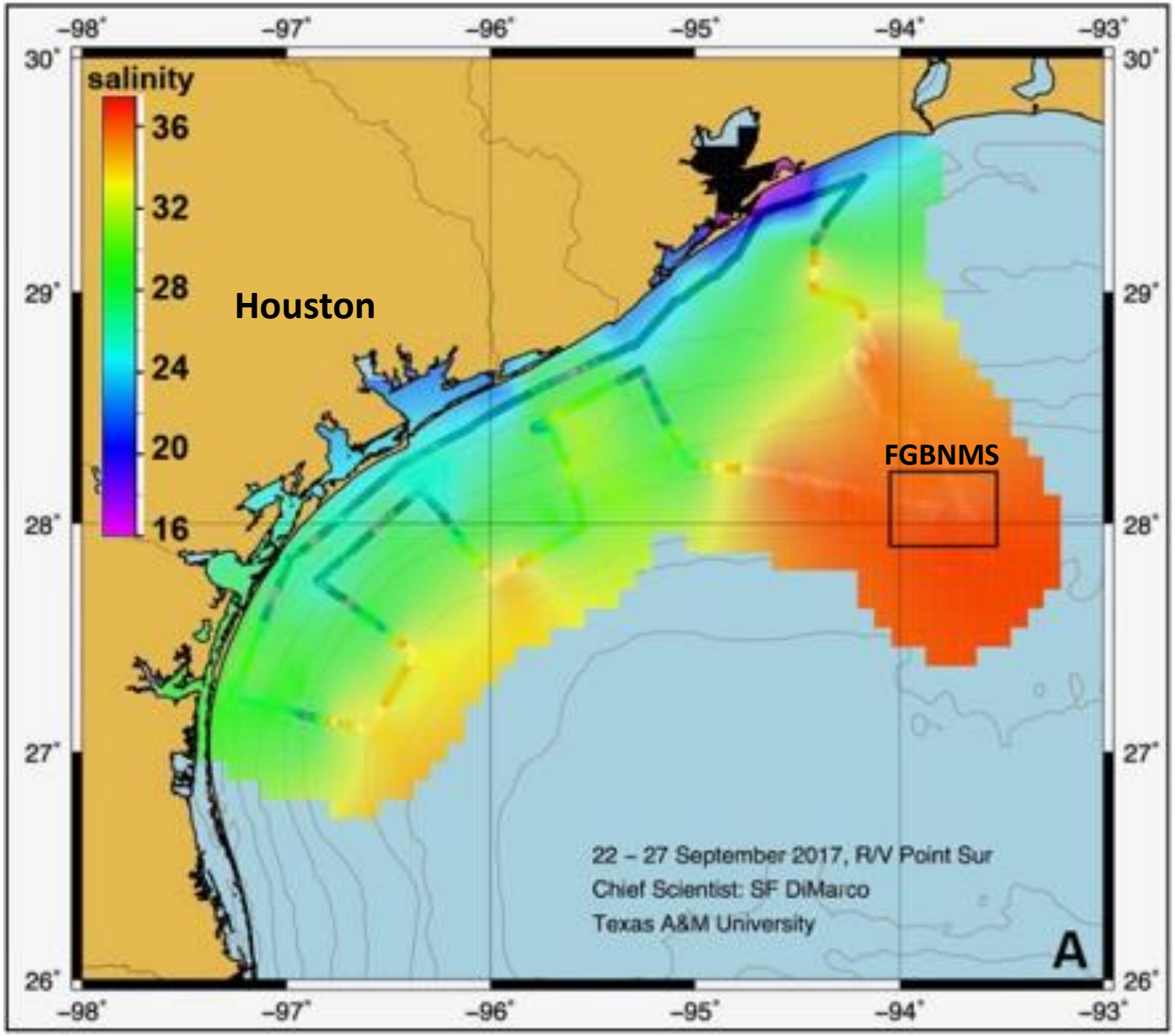
●●○○○ AT&T Wi-Fi 9:12 PM 87%

Harvey: Recupe...

"Se estão fugindo de uma inundação, não fiquem no sótão como último recurso. Se os andares mais altos de seu prédio se tornarem perigosos... suba para o telhado e chame o 911 para obter ajuda", disseram no Twitter.

No estado do Texas, 250 estradas foram fechadas por causa das enchentes da tormenta Harvey - **David J. Phillip / AP**

Sept. 2017: One Month after Hurricane Harvey



= No Data

No mass death at 3 sites visited at East and West Bank (late Oct. 2017)

FGBNMS ~2 months after Hurricane Harvey

Was Harvey a once-in-a-million year hurricane?

Did we dodge a bullet?

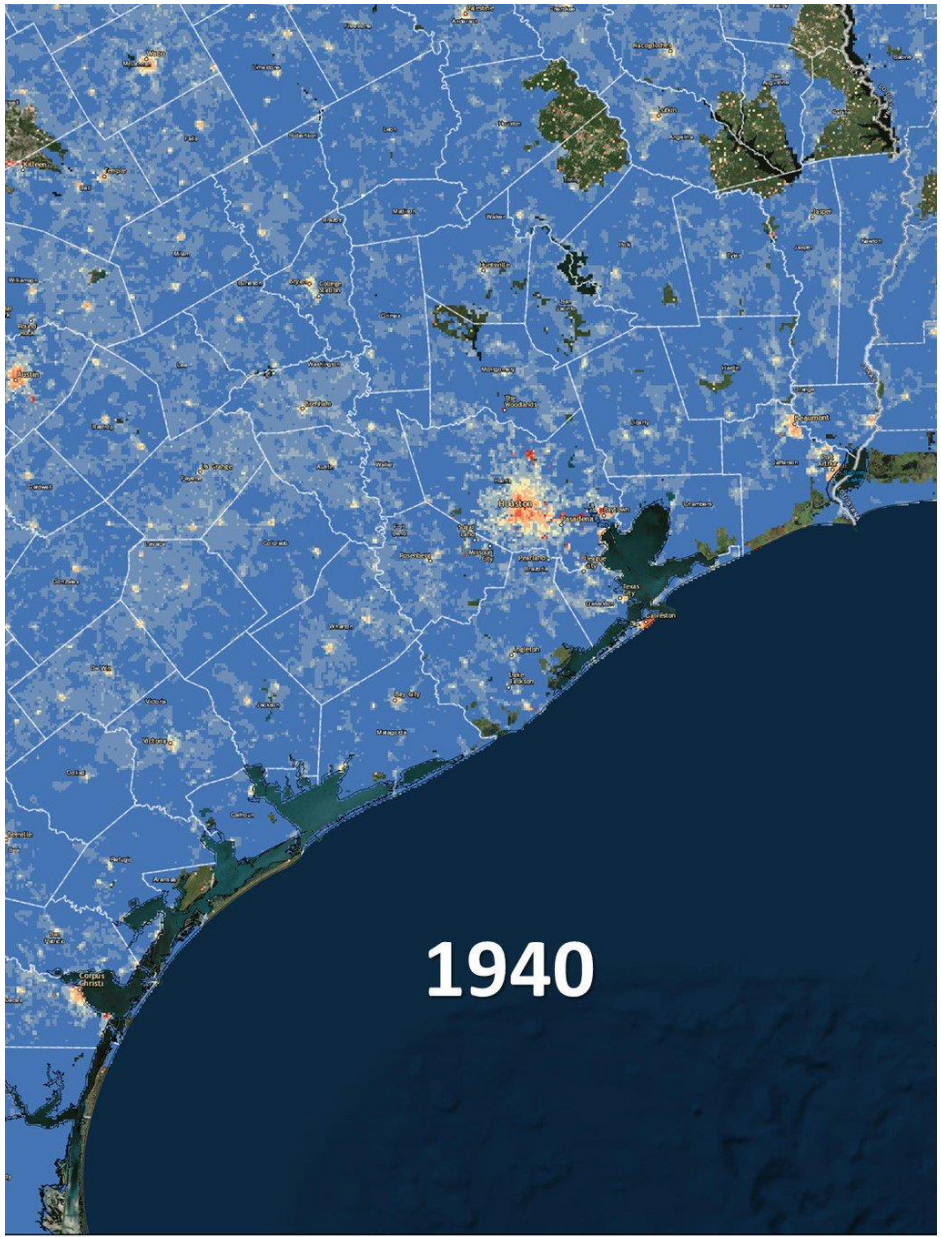
Flooding each of past 3 years in Houston:

Memorial Day Flood, late May 2015

Tax Day Flood, mid-April 2016

Hurricane Harvey, late August 2017

Percentage Impervious Surface (concrete, pavement, etc) Houston, TX Area



@stephenmstrader

% Impervious Surface

- 0.01 - 0.1
- 0.11 - 0.5
- 0.5 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 5
- 5.1 - 15
- 15.1 - 25
- 25.1 - 50
- 50.1 - 100

The Elements of a NEIGHBORHOOD GREENWAY

TRAFFIC CALMING DEVICES

Traffic calming devices, including speed bumps, bulb-outs, and traffic circles are provided to keep traffic at a safe speed along low-traffic residential streets. This helps to ensure that Neighborhood Greenways priorize bicyclists, pedestrians, and neighbohood residents while limiting high-speed cut-through traffic.

PEDESTRIAN IMPROVEMENTS

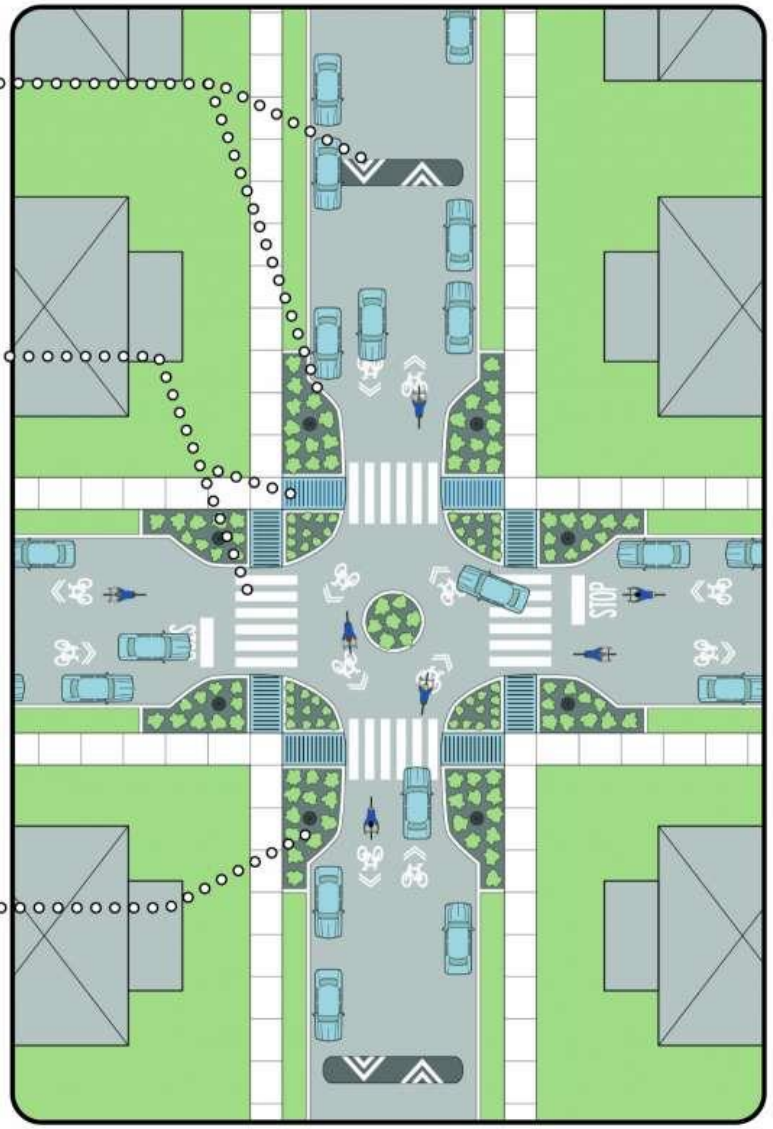
Improving the existing pedestrian infrastructure with new sidewalks, ADA ramps, high-visibility crosswalks, and shorter crossing distances helps to create a pedestrian environment that is safe for people of all ages and abilities.

SIGNED BIKE/PED. NETWORK

Clear signage is provided so that pedestrians and bicyclists are aware of the various neighborhood destinations within biking and walking distance. This wayfinding system helps to direct all users to the safest route for traveling between destinations.

STORMWATER MANAGEMENT

Stormwater-cleaning bioswales are installed within the traffic calming bulb-outs to naturally retain and treat stormwater runoff. This helps to reduce neighborhood flooding while also reducing the contanination of the natural waterways the existing stormwater system drains into.



Green Infrastructure:
Curbside gardens catch stormwater runoff

Photo: Department of Environmental Protection

Take to the Beach Ideas

There are relatively healthy, valuable coral reefs in your backyard: the Flower Garden Banks National Marine Sanctuary!

Extreme storms may harm coral reefs in complex ways – not just through physical damage.

Interdisciplinary teamwork will be needed to limit storm impacts on reefs → scientists, city planners, managers, policy makers, and you!

For students: If marine science is your passion… you can do it!

Thank you! Questions?

John Embesi
NOAA

Jake Emmert
Moody Gardens

Rapid Reefs 2017 Cruise Participants
The Crew of the UNOLS Point Sur
Ben Acker (Point Sur)
Laura Mydlarz (UTA)
Lauren Fuess (UTA)
Kaitlin Buhler (Moody Gardens)
Jimmy MacMillan (NOAA)
Emma Hickerson (NOAA)
Marissa Nuttall (NOAA)

OCE-1800914

Want to dive deeper?

https://flowergarden.noaa.gov/management/expansiondeis.html

https://flowergarden.noaa.gov/newsevents/massmortalityresponsearticle.html

https://www.chron.com/news/houston-texas/article/Low-salinity-poor-water-quality-from-Hurricane-12461793.php

http://www.owlnet.rice.edu/~ac53/