After the Disaster: Plans for Coral Propagation Activities to Support Restoration of Mesophotic and Deep Benthic Communities Impacted by Deepwater Horizon Oil Spill

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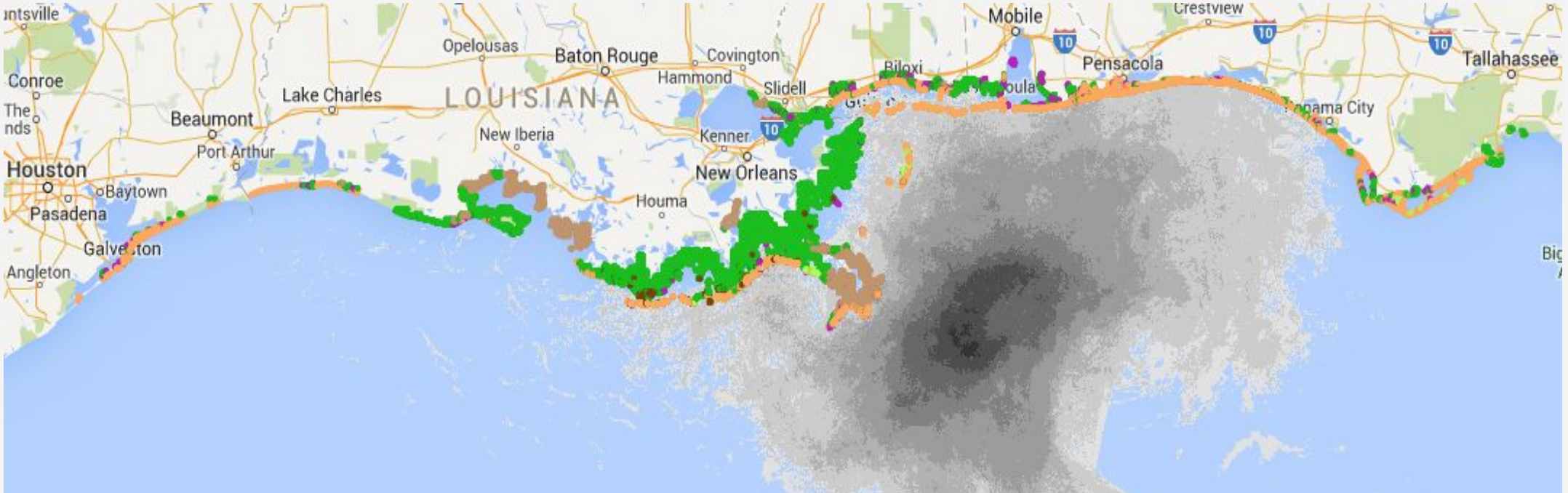
Deepwater Horizon Oil Spill

Image source: US Coast Guard

- Tragic incident resulting in deaths of 11 workers in April 2010.
- Largest ocean spill in U.S. history.
- 507 M liters of oil released (3.19 M barrels) into the ocean **over 87 days**
- 111,000 sq km: Cumulative extent of surface oil slick— larger than Portugal or Austria

A Massive Spill, a Massive Response



DWH Natural Resource Damage Assessment:

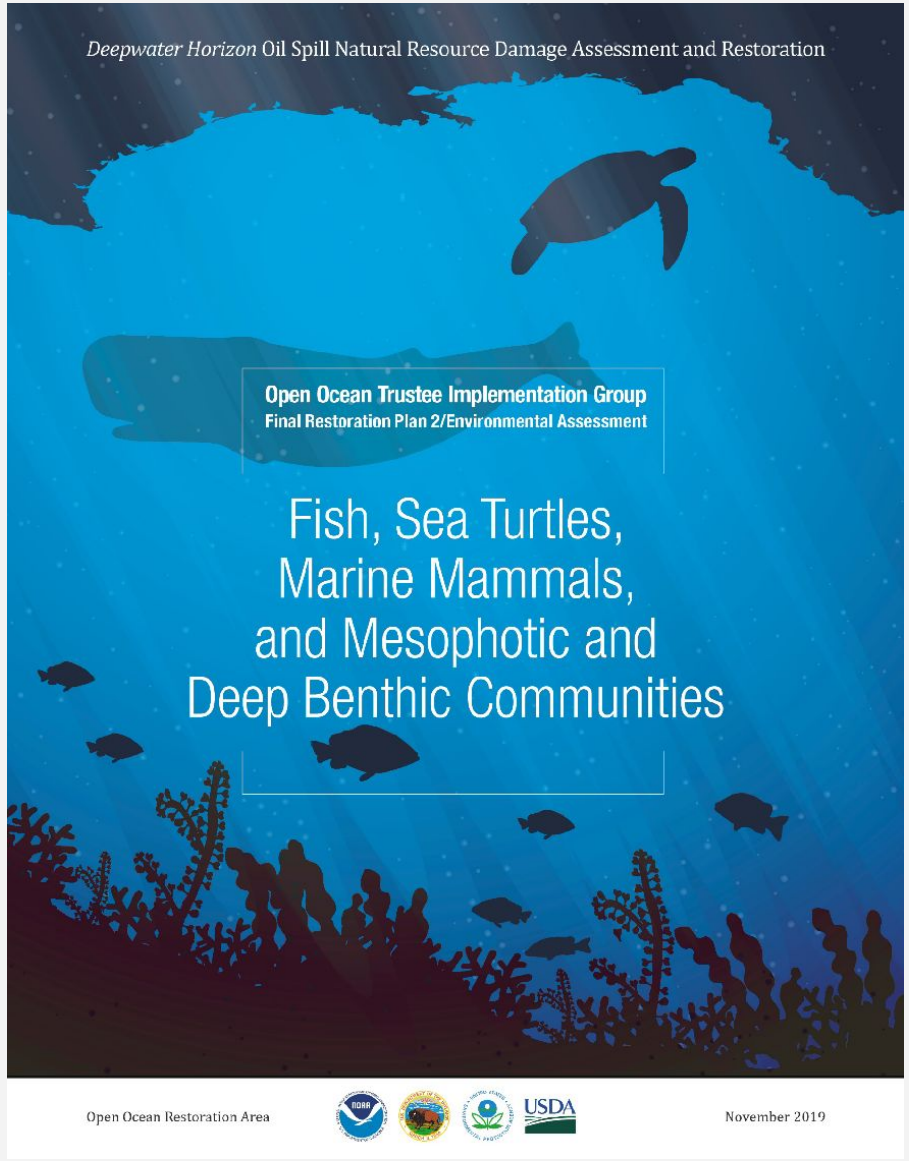
- Severe injury *offshore* to sea birds, mammals, fish, and sea fan corals
- Broad contamination of deep-sea sediments (Montagna et al 2013, Reuscher et al 2020)
- Tissue loss in deep-sea *Paramuricea* sea fans 1500 - 1800 m (White et al 2012, Fisher et al 2014)
- Significant declines in mesophotic sea fans 60 -80 m (Silva et al 2016; Etnoyer et al 2016)

Open Ocean Restoration Plan (OORP2)

The 'Open Ocean Trustee Implementation Group' finalized Restoration Plan in 2019

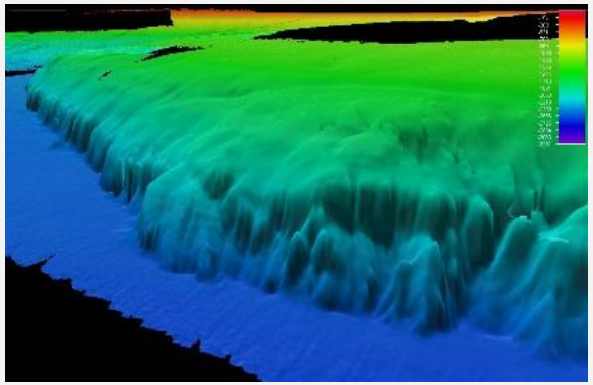
18 projects selected, totaling ~$226 M to help restore fish, sea turtles, marine mammals and deep-sea coral habitat

OORP2 intends to restore **benthic communities** on deep hard grounds & soft sediments injured by the oil spill*



gulfspillrestoration.noaa.gov/restoration-areas/open-ocean

MDBC Projects total $126M over 8 yrs



Mapping, Ground-Truthing, and Predictive Habitat Modeling

Est. Budget: $36M

Coral Propagation Technique Development*

Est. Budget: $17M

Habitat Assessment and Evaluation

Est. Budget: $53M

Active Management & Protection

Est. Budget: $21M

Coral Propagation Technique Development

A pilot project to *propagate corals* and *deploy artificial substrates*

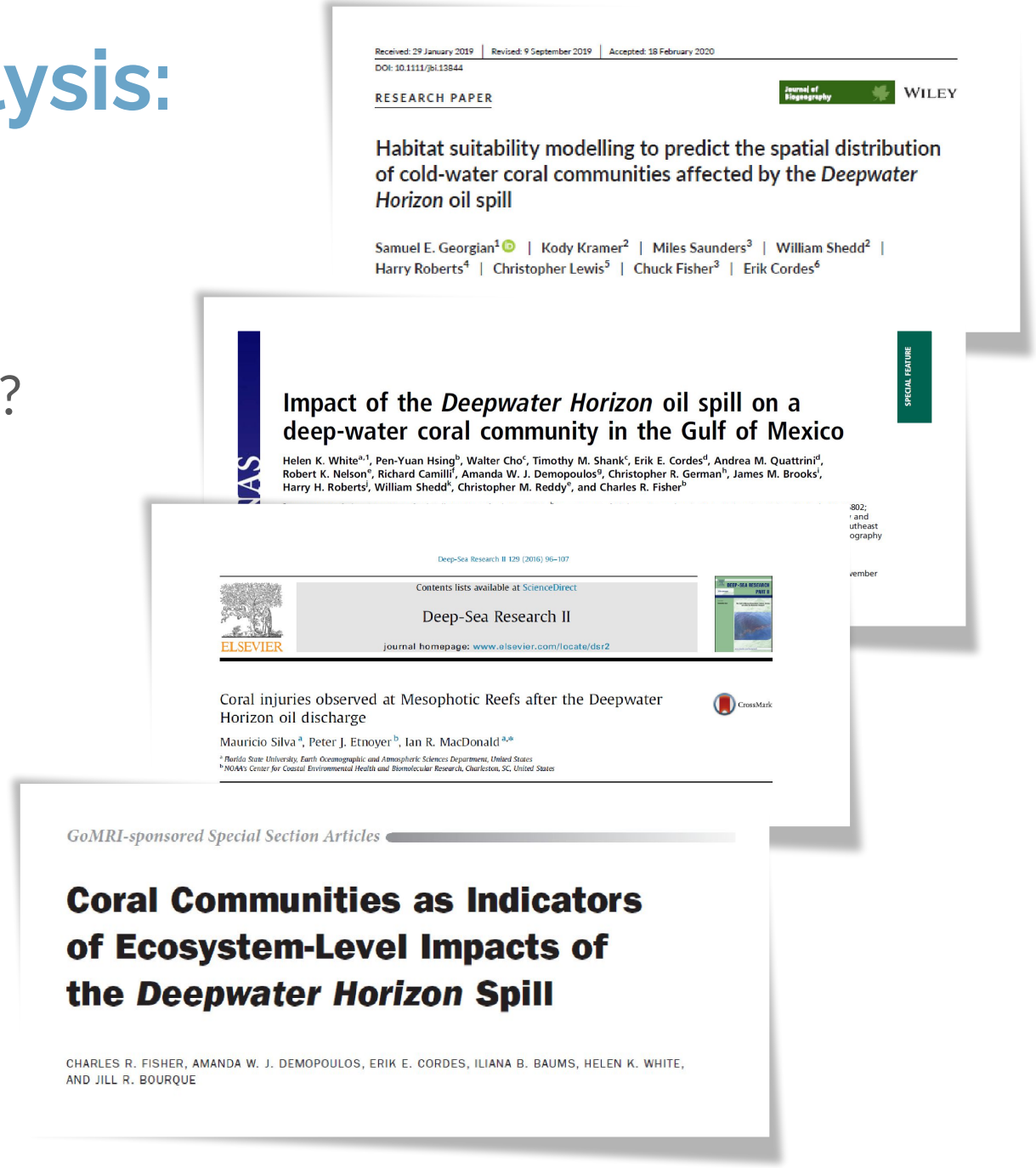
Year	1	2	3	4	5	6	7	8
FY	2021	2022	2023	2024	2025	2026	2027	2028
Prepare and plan								
Build out labs								
Conduct fieldwork								
Implement projects								
Report results								
Assess performance								

Data inventory and Analysis:
Species prioritization

Which species to propagate?

How many do we need to compensate?

- Review of DWH literature related to coral impacts, species distribution papers, policy documents
- Drew from **16 papers** to develop list of **42 deep coral taxa** 'present' in areas of injury
- Gathered information on their degree of injury for use in a ranking exercise



Data Inventory and Analysis: Species priority matrix

Which species to propagate?

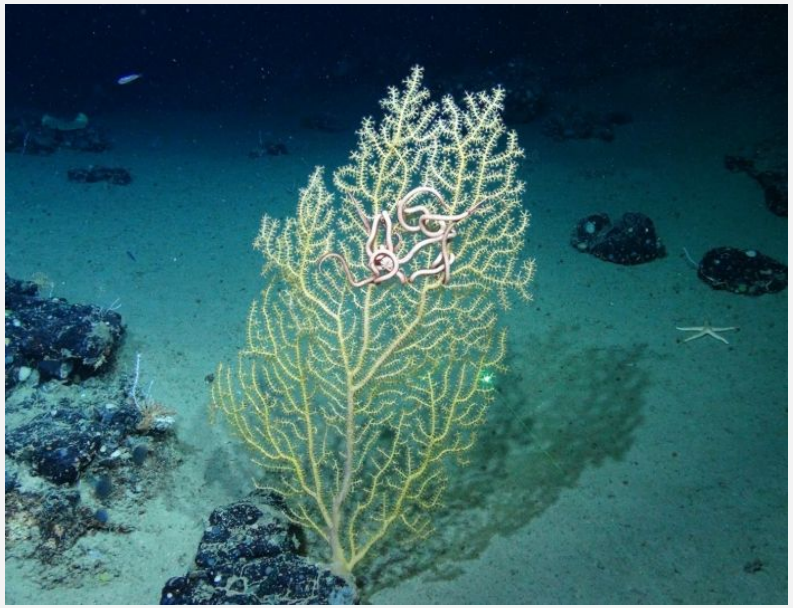
How **many** do we need to compensate?

- Ranked species according to these criteria
  - Frequency of injury
  - Frequency of occurrence*
  - Relevance to management
- Ran three trials, each w/ 5 respondents
- *Strong* consensus on the **Top 3**, and *good* consensus on Top 12
- ~ **619 corals** were *documented* as injured of which 70% are in three taxa
- Totals do not include injury that was not observed, nor injuries at control sites.

Species	Average Rank	Injury counts	Frequency of occurrence
Muricea pendula = H. pendula	1	182	1432
Swiftia exserta	1	82	1477
Paramuricea biscaya	1	166	819
Bebryce spp.	2	76	1402
Thesea nivea	3	64	509
Antipathes atlantica	4	24	1150
Paramuricea sp. B3	4	3	819
Placogorgia sp.	4	5	771
Bathypathes cf patula	4	2	135
Leiopathes glaberrima	4	0	2288
Callogorgia delta	4	0	908
Lophelia pertusa	4	0	8564

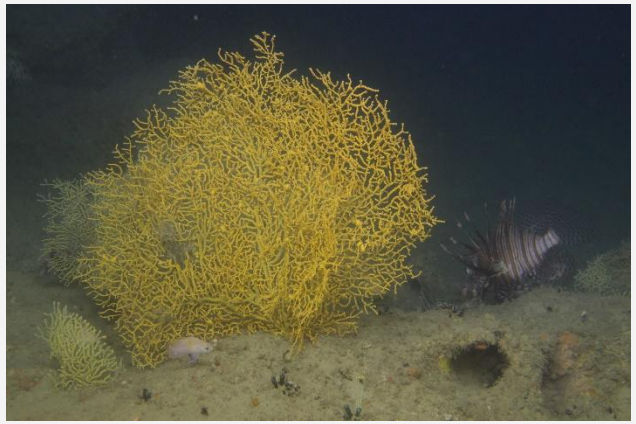
* # of observations in GoMx since 2010, from https://deepseacoraldata.noaa.gov

Deep water gorgonians in the Gulf of Mexico

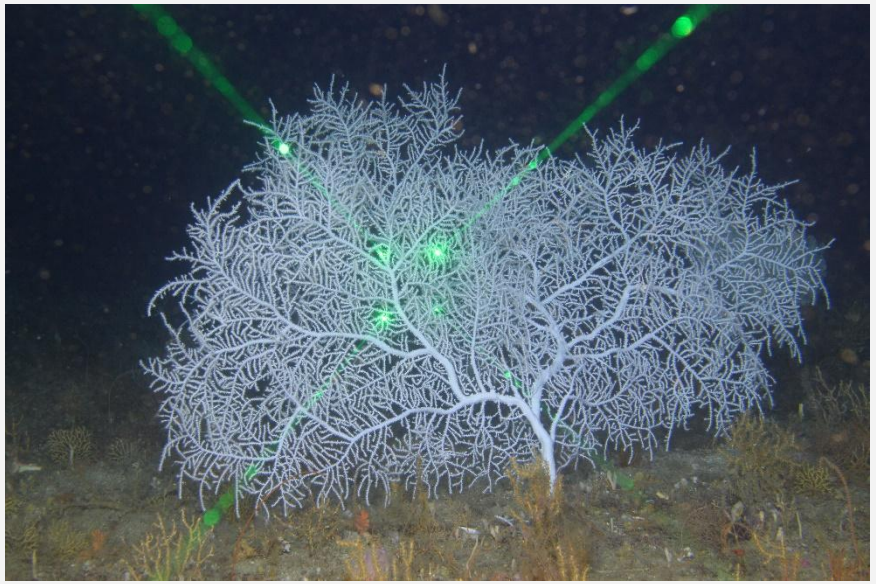


Paramuricea spp., temp ~ 4C

Placogorgia, temp ~20 C



Muricea (= Hypnogorgia) pendula



Thesea nivea

Swiftia exserta, temp 18-22 C

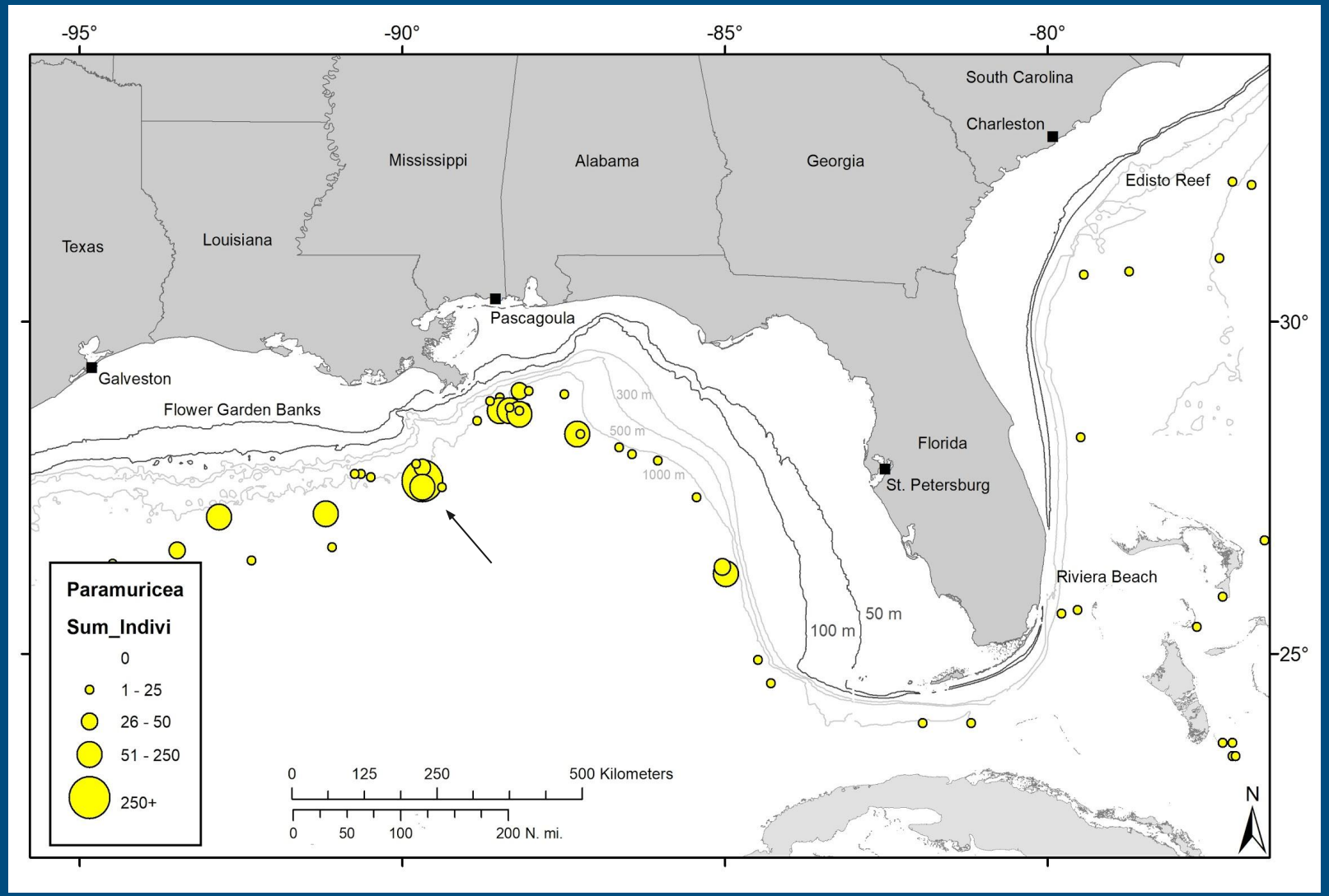
Where to access corals for propagation activity?

The known *Paramuricea*

- Using abundance data to identify large aggregations
- Using size class data for demographics
- Using temperature data to inform the laboratory designs

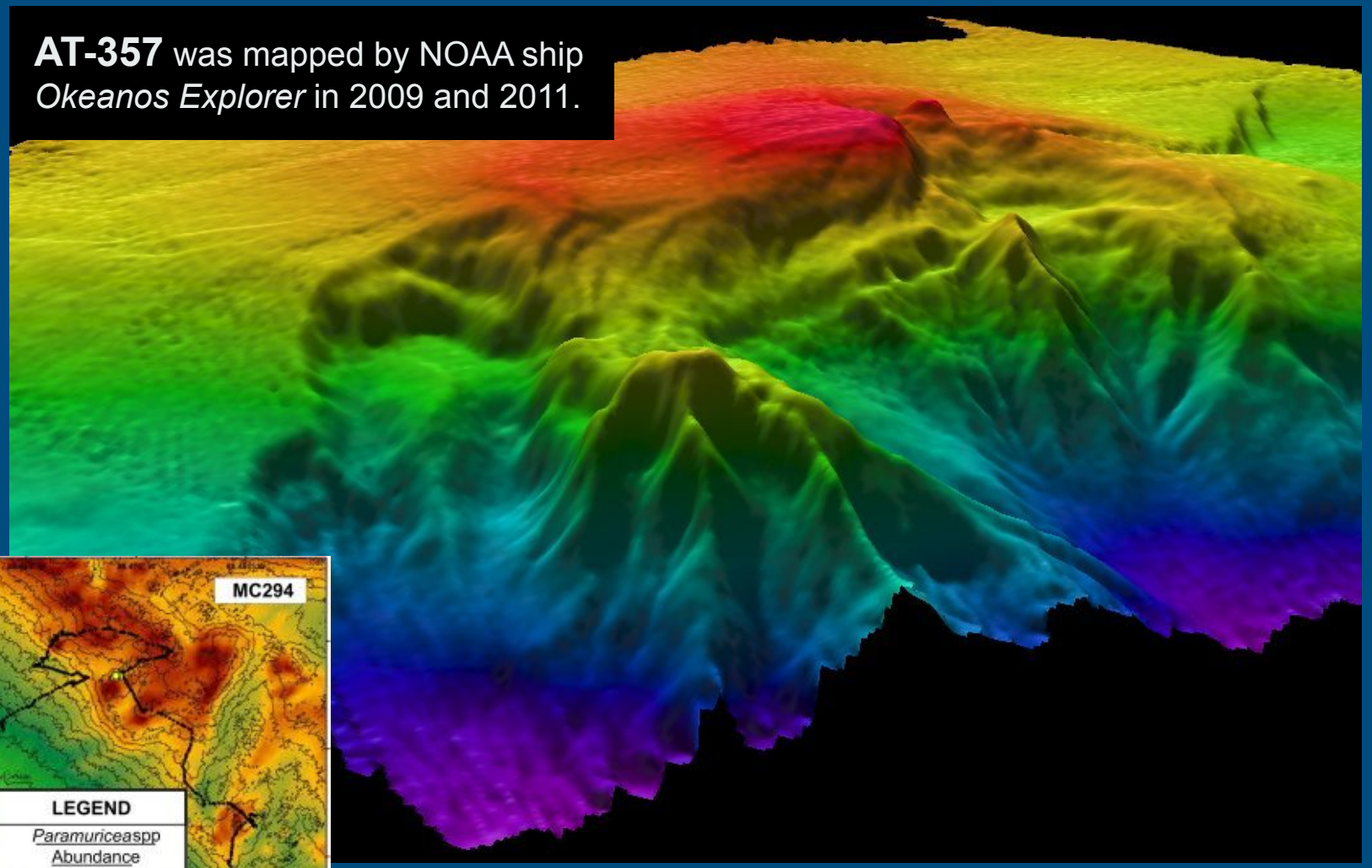
The unknown *Paramuricea*

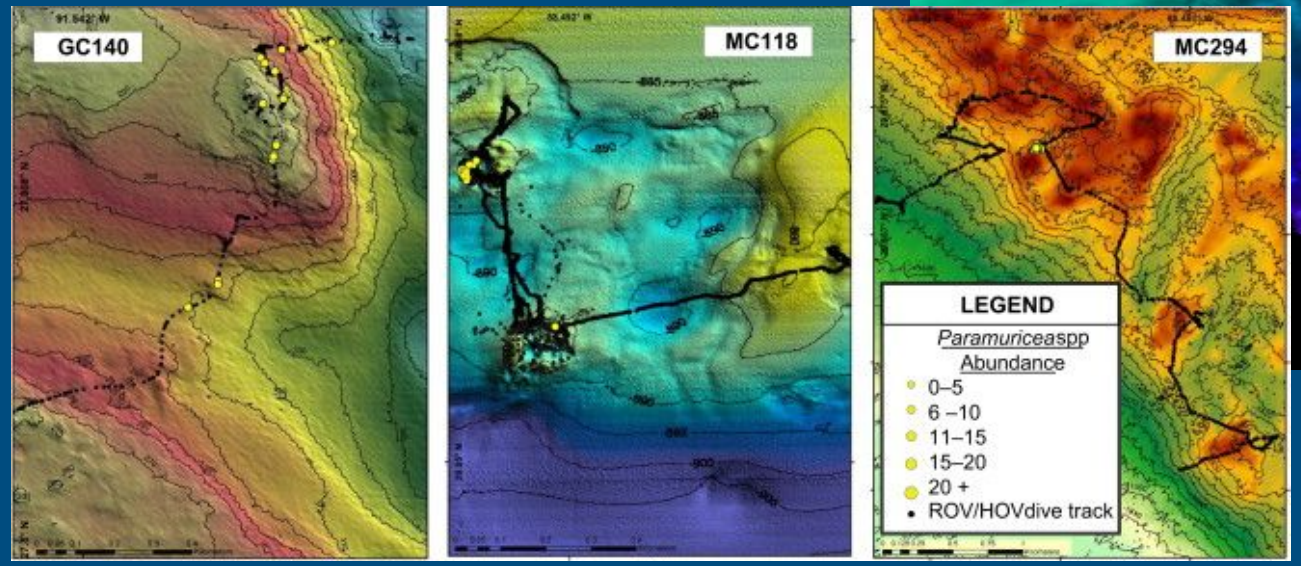
- Known areas are large and not well explored
- Habitat suitability models are available, will need validation (e.g. Georgian et al, 2021)
- Genetic connectivity studies in progress (e.g., Herrera et al 2019)



Where to access corals for propagation?

High abundance at AT 357 Cordes, E. 2013. Live from a research cruise on RV Nautilus. Blog from Rutledge Marine Lab



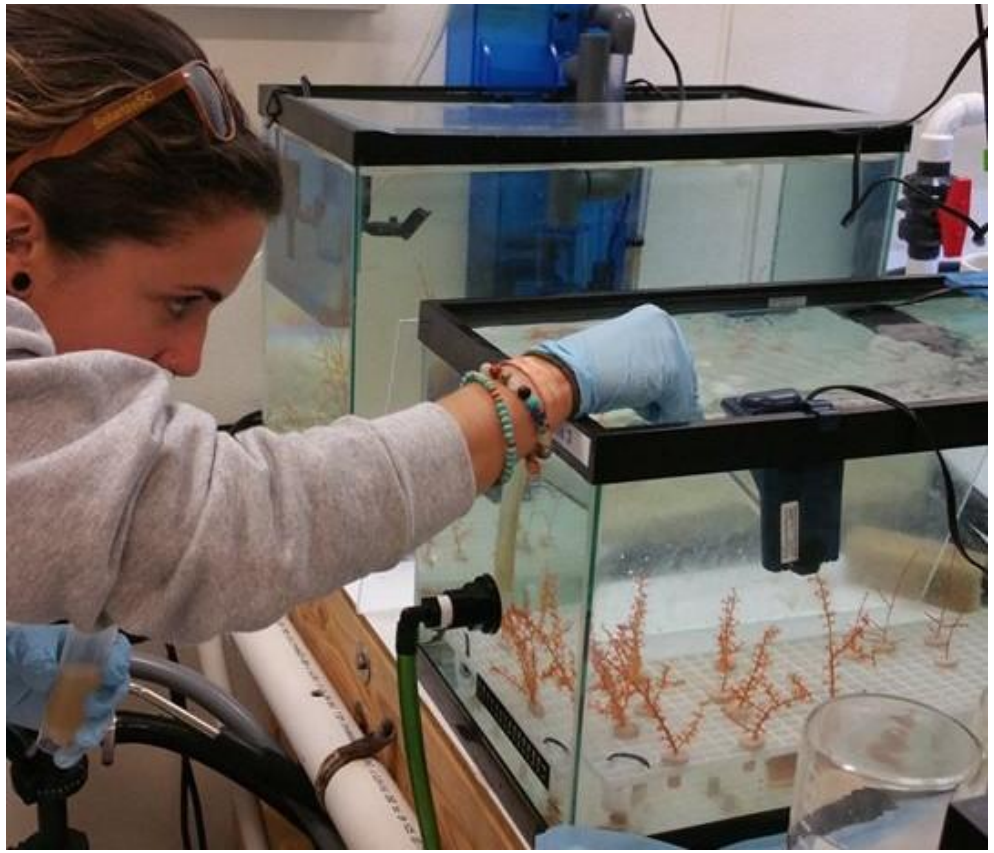


Other known sites from Doughty, Quattrini, Cordes. 2014 DSR II

Building a Network of Laboratories

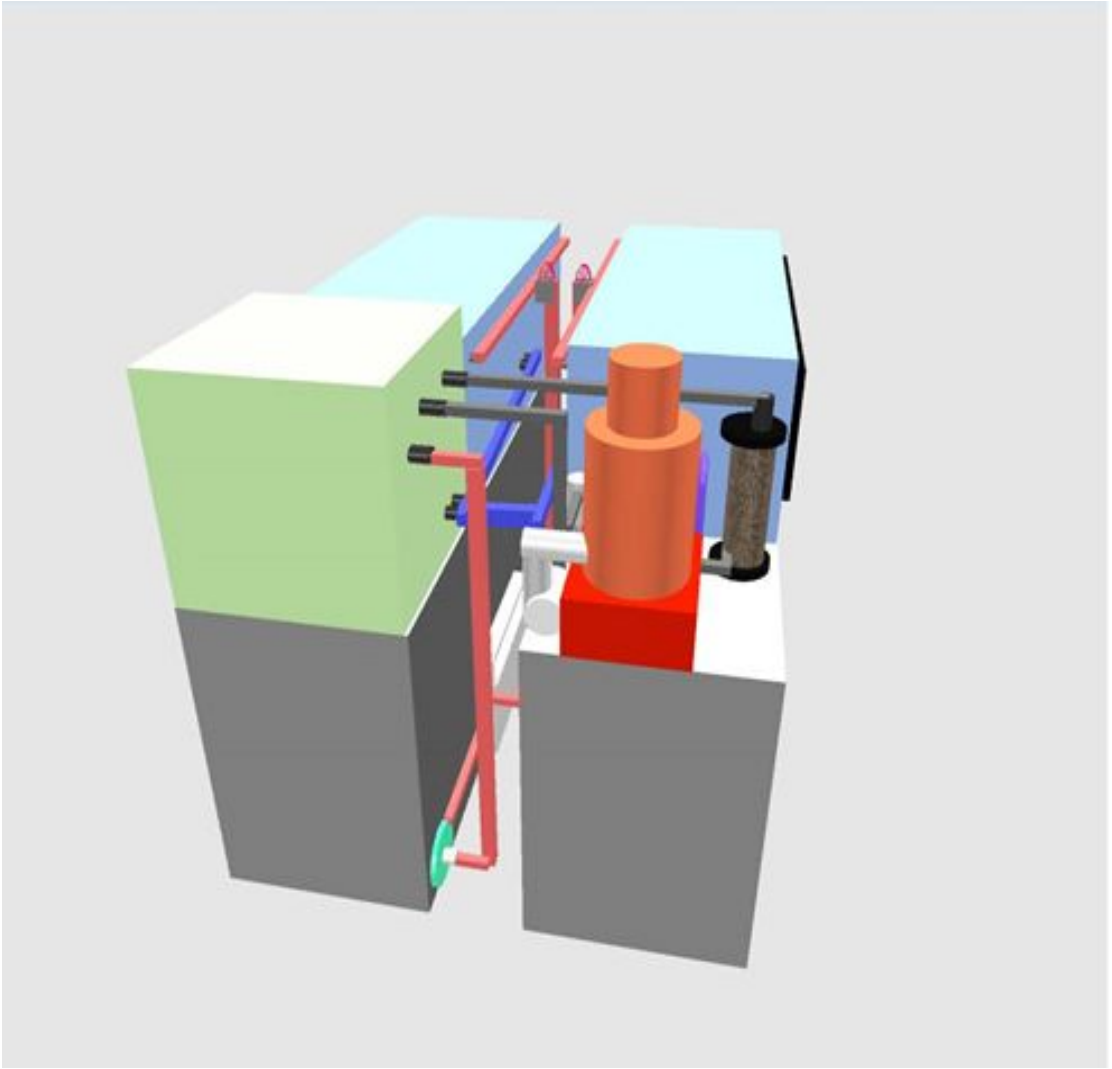
Upgrading infrastructure and increasing human capacity to meet these goals :

- Develop methods & techniques for effective enhancement of coral growth and recruitment
- Produce healthy, growing fragments through asexual propagation, and sexual reproduction
- Standardize methods for husbandry across facilities, to share among the planned network and build capacity among partner institutions



Modular Scalable System

- Thermally insulated, 230 gal system
- Allows flexible plumbing configurations in **parallel** (shown), in **L**, **T**, or **linear** footprint
- Footprint is 5’ x 7’ for configuration shown
- Capacity for temperature range from **4 – 20 C**

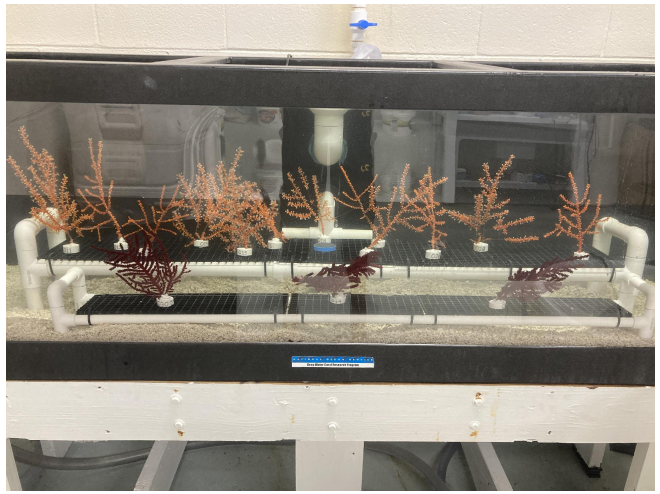


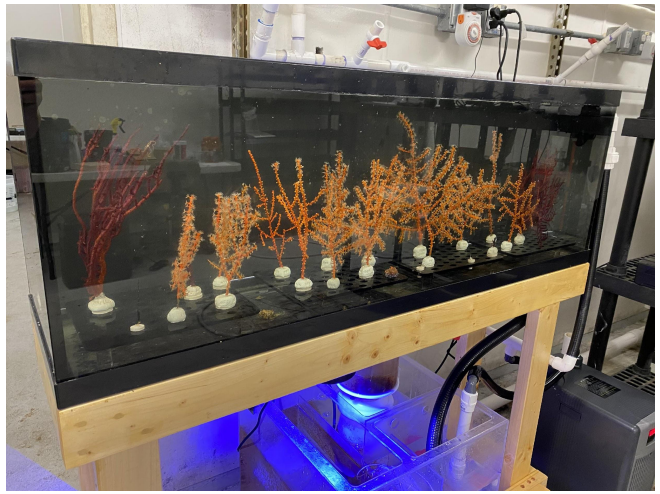
Specifications:
Volume: 220 (87+87+ 46) gallons
Footprint: 5’ x 7’
Culture area: 2,240 sq. inches
25-40 Mother colonies + 100’s of fragments
2 Chillers (main + back-up), fractionator, biological filtration, chemical filtration, algae reactor, current simulator, Neptune Apex water monitoring, automatic water exchange, alarms

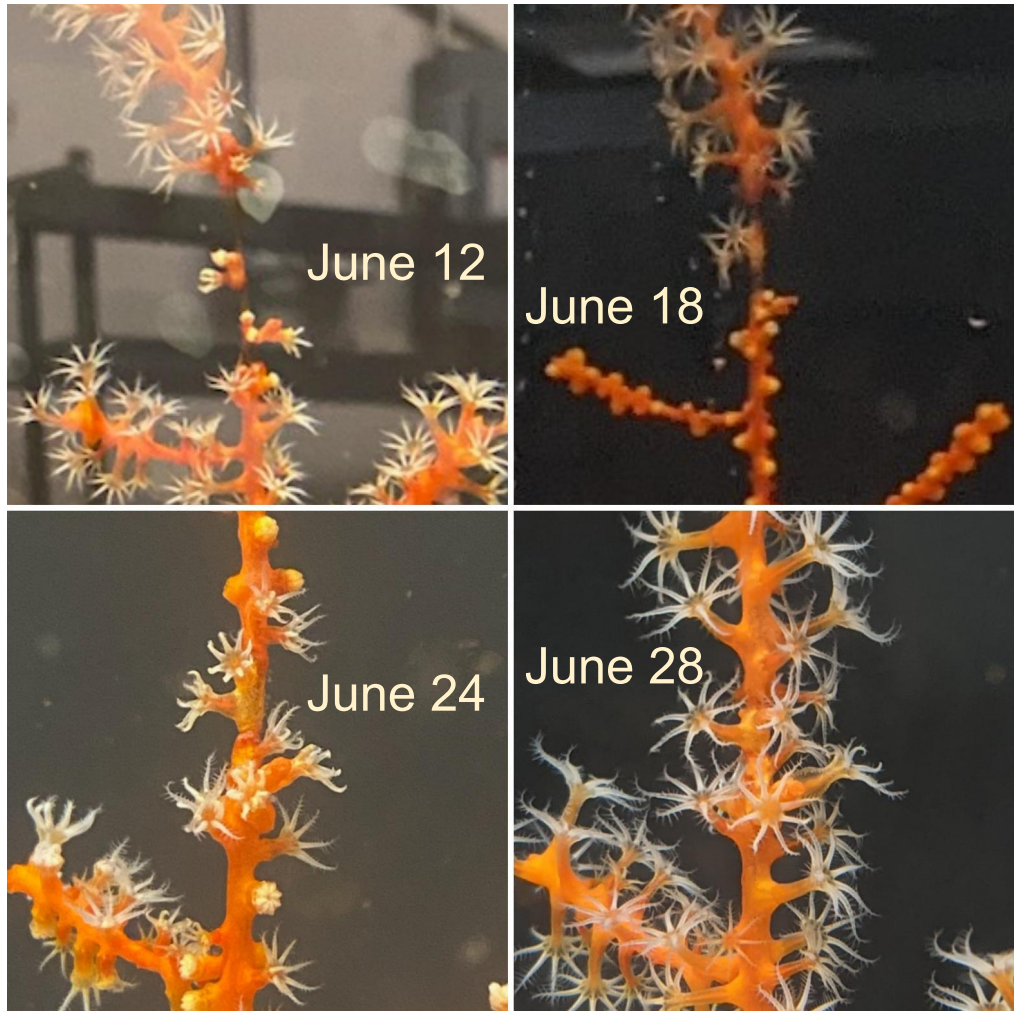
Live Corals in Laboratory Aquaria

Mesophotic corals arrived June 2021 from Atlantic on PC-21-02
(PIs Stacey Harter & Andy David)

- USGS Wetlands Aquatic Resources Center in Gainesville, FL
  - 15 live Swiftia sp., inc 2 Swiftia frags
  - 3 live Muricea sp., inc 3 Muricea frags
- NOAA Hollings Marine Lab in Charleston, SC
  - 12 live Swiftia sp.
  - 3 live Muricea sp.







Visible growth at both labs,
polyps open and feeding @ 20 C


Our stakeholder engagement strategy is to grow a network of labs, aquaria, study sites, & partners.
- GoMx mesophotic site
- GoMx deep sea site
- W. Atlantic sites
- Many partner opportunities
NOAA Charleston
USGS Gainesville
NOAA Galveston

Thank you!

Please contact our Project Managers for more information

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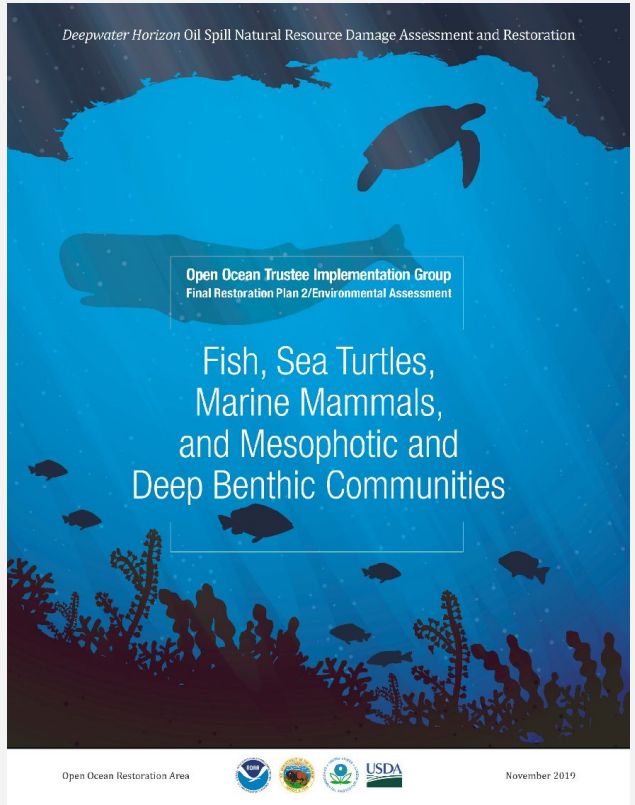

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