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

- 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.

Image source: US Coast Guard
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)
- Significant declines in mesophotic sea fans 60 - 80 m (Silva et al 2016; Etnoyer et al 2016)
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](gulfspillrestoration.noaa.gov/restoration-areas/open-ocean)
Mapping, Ground-Truthing, and Predictive Habitat Modeling
Est. Budget: $36M

Habitat Assessment and Evaluation
Est. Budget: $53M

Coral Propagation Technique Development*
Est. Budget: $17M

Active Management & Protection
Est. Budget: $21M

MDBC Projects total $126M over 8 yrs
## Coral Propagation Technique Development

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

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<tr>
<th>Year</th>
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<th>4</th>
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<tr>
<td>FY</td>
<td>2021</td>
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<td>2026</td>
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<td>Prepare and plan</td>
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<td>Build out labs</td>
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<td>Conduct fieldwork</td>
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<td>Implement projects</td>
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<td>Report results</td>
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<td>Assess performance</td>
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</table>
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.

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

* # of observations in GoMx since 2010, from https://deepseacoraldata.noaa.gov
Deep water gorgonians in the Gulf of Mexico

*Paramuricea* spp., temp ~ 4C

*Plagocorida*, 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?

AT-357 was mapped by NOAA ship *Okeanos Explorer* in 2009 and 2011.

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

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

Please contact our Project Managers for more information

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