# Overview of Charleston Harbor Post 45 Mitigation Reef Monitoring

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# Acknowledgments


- Funding: USACE Cooperative Agreement W912HP-17-2-0002
- USACE: B. Ward and E. Fritz
- Grants Management: E. Heyward, K. Joyner, S. Chapman
- Project Management/Reporting: M. Arendt
- Scientific Divers: M. Arendt, C. Evans, K. Kolmos, K. Spanik, M. Davin, W. Sinkus, E. Waldrop, J. Evans, L. Vinyard, S. Burns, M. Taliercio, B. Austin, G. Sorg, H. Hiers, C. Pickens, W. Gould, R. Gray, H. Hillman, P. Mikell
- Logistics/Vessels: B. Von Harten, R. Dunlap, P. Mikell, Inshore Fisheries (bait), B. Merritt
- Video Review and Support: C. Evans, C. McQuaid, W. Sinkus, H. Hiers., D. Glasgow, C. Hilton

# Post 45 Project Background

**Planning began in 2011 and was initiated to ensure safe navigation of the largest commercial vessels**

- **Target depth: 52 feet (formerly 45 feet)**

**Completed December 2022**

- **Charleston Harbor becomes deepest port on U.S. East Coast**

**Environmental Impact Assessment:**

- **Estimated 28.6 acres of hard bottom adversely impacted**

# Impact Site Baseline Data

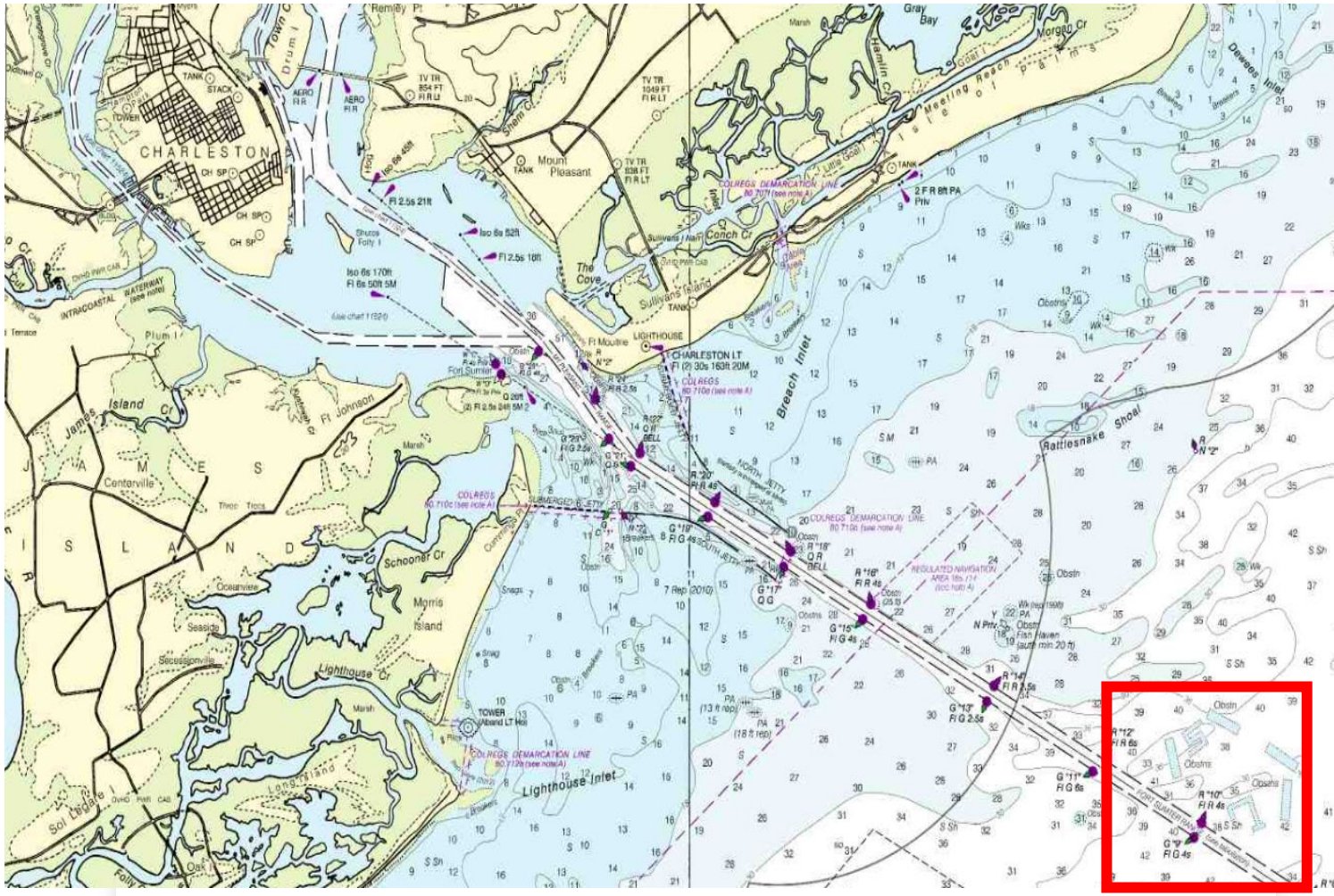
- Scientific divers documented fish and invertebrate taxa at impact site along 20 m transects in 2016 (Dial Cordy & Associates)

- Impact site characterized as relatively low species diversity
  - 13 finfish species
  - 8 sessile invertebrate species

# Mitigation Reef: Background

- Two “mitigation” and Four “beneficial use” reefs created on North side of shipping channel using materials dredged from shipping channel during Post 45

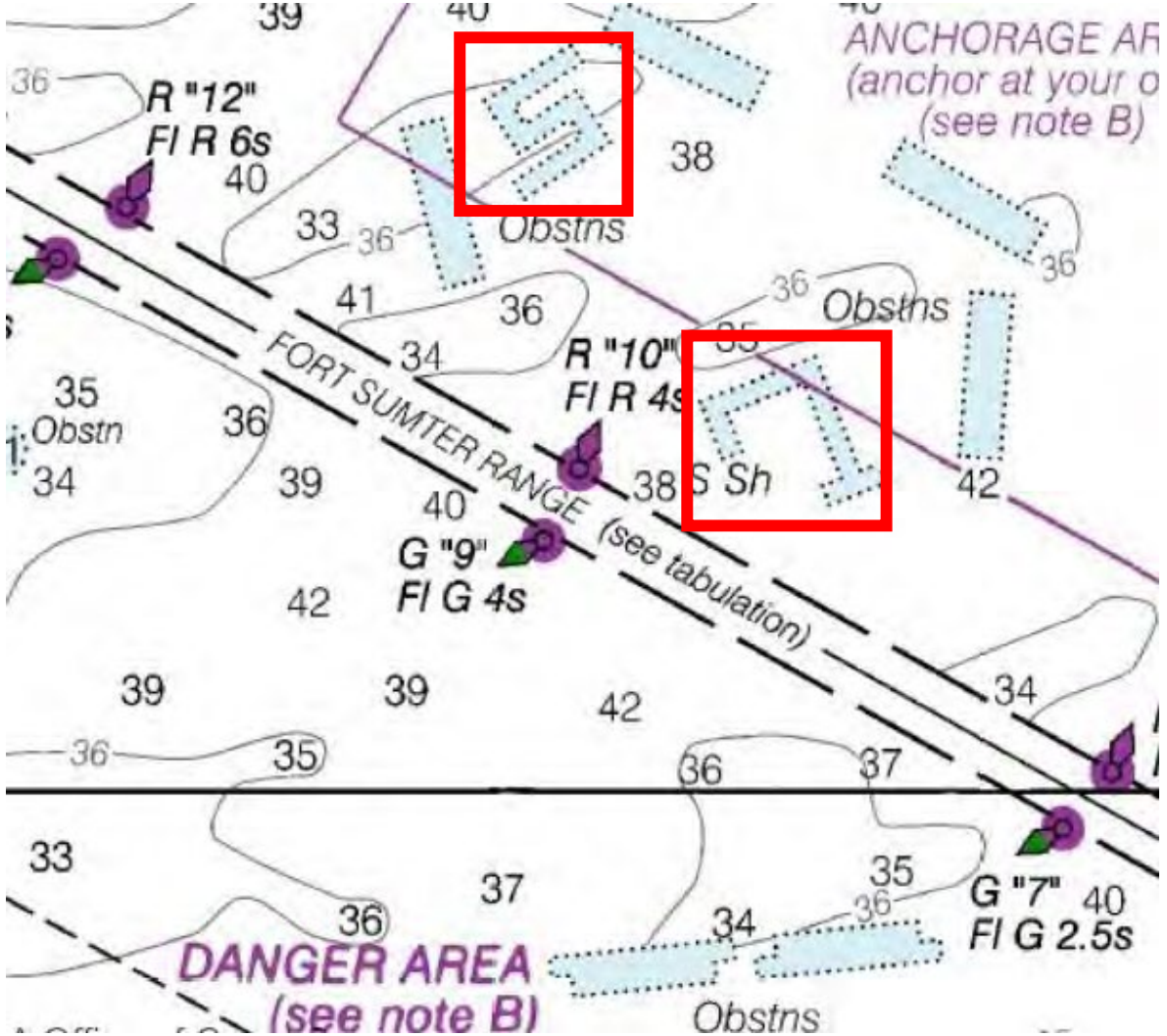
- Two additional “beneficial use” reefs created on south side



# Mitigation Reef: Background

Two “mitigation reefs” created on North side of shipping channel using materials dredged from shipping channel during Post 45

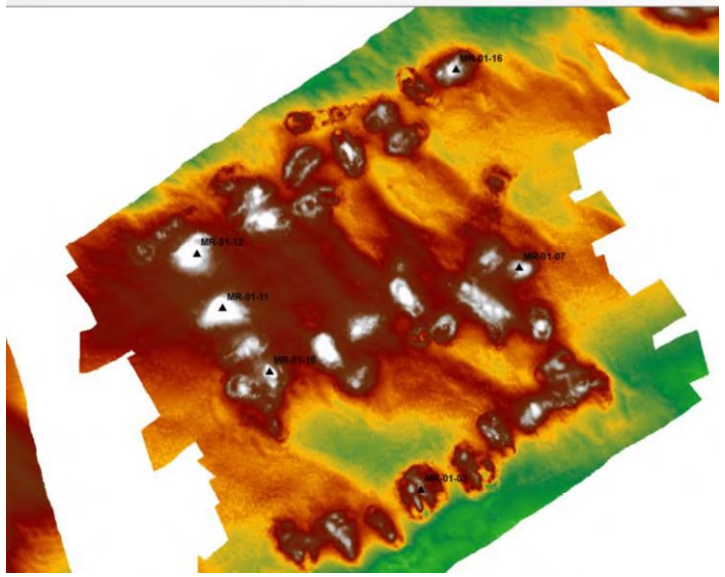
- 16 contiguous spatial cells per reef, each representing 90,000 $ft^2$ of seafloor
- MitReef construction completed in 2018, and a 5-year monitoring plan began in 2019

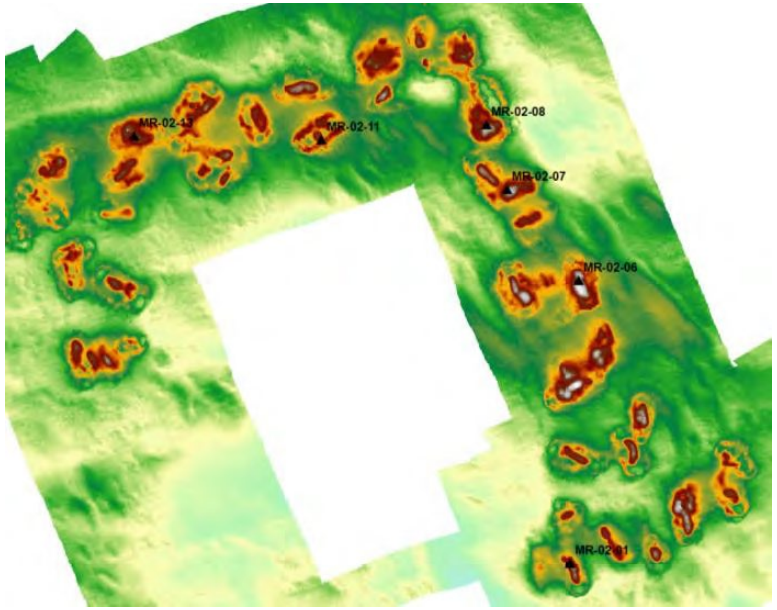


# Mitigation Reef: Survey Site Selection

**Bathymetry imagery revealed uneven distribution of rubble grids between reefs:**

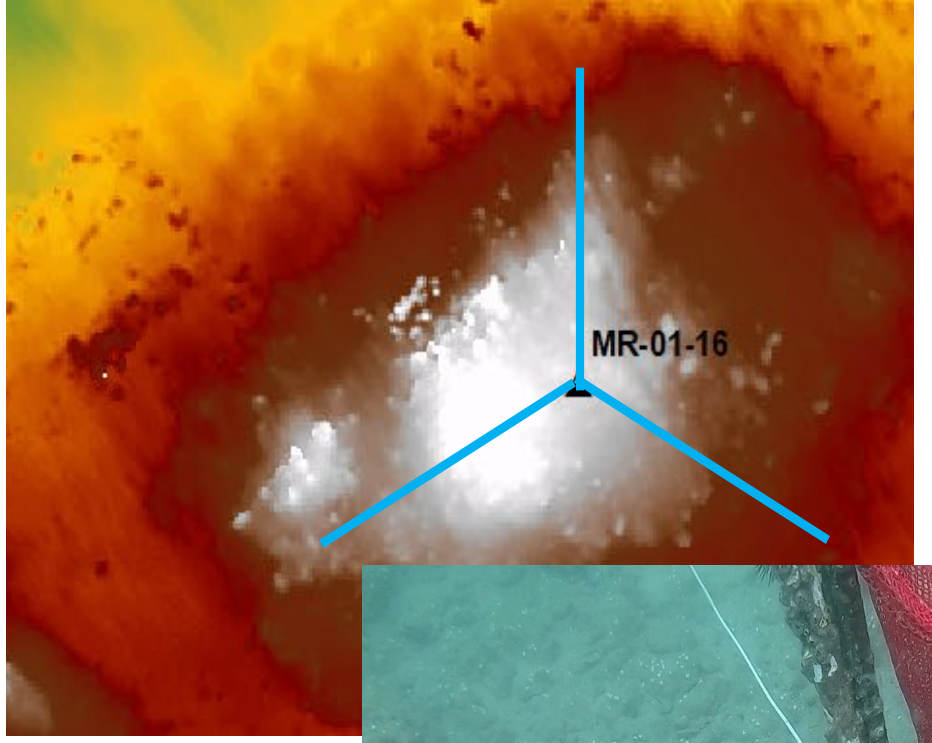
- **“S” reef: two high density (HD), five medium density (MD), and nine low density (LD) grids.**
- **“J” reef: five MD and 11 LD grids**
- **Both HD grids were selected for monitoring, with stratified (MD, LD) random selection of remaining grids for monitoring. 12 total survey sites**

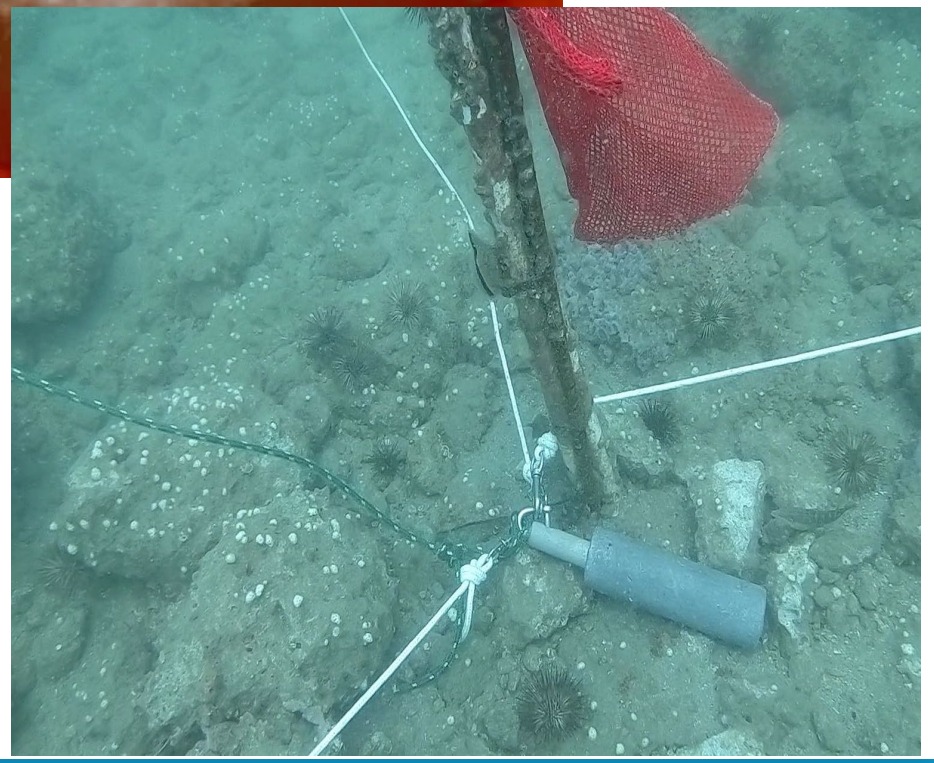


# Monitoring:
# **Diver Surveys**

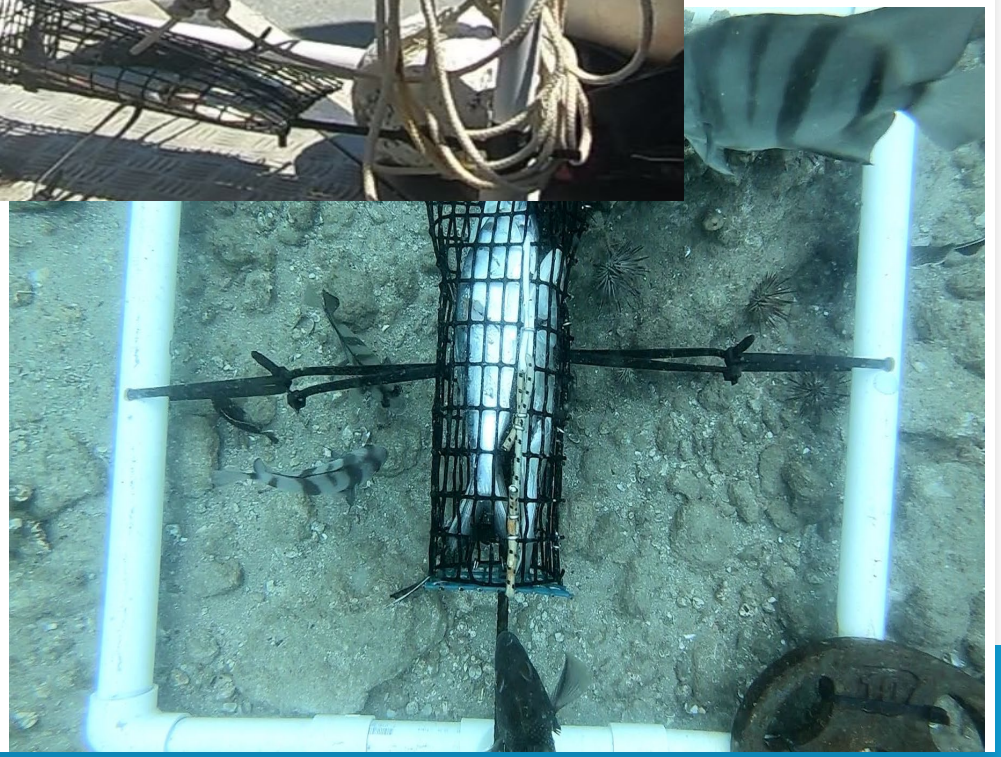
- **3x 20 m transects placed at 0°, 120°, 240° headings from center**
- **Diver recorded ID's and counts of priority fishes and counts/ sizes of priority invertebrates**
- **Diver video transects for later review**



# Monitoring:
# **Baited Camera Frames**

- **Devoid of diver presence and associated influence on species behavior**
- **1 hr deployment at center reference mark for each site**



# Monitoring:
# **Acoustic Telemetry**

- **Acoustic receivers installed (Innovasea) at 2 “S” reef Sites and 3 “J” reef sites, strategically arranged to provide full coverage**

- **Detection range ~ 250 m**


# Results:
# **Invertebrates**

- **Overall, greater invertebrate diversity at MitReef than impact site**

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| Status | Group | Code | ScientificName | Combined abundance 2019 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|
| Target | Hard coral | H039 | *Astrangia danae* | | 17707 | 22912 | 586 |
| Target | Hard coral | H305 | Scleractinia | | 21526 | 1 | 23 |
| Target | Soft coral | H002 | *Leptogorgia virgulata* | 146 | 552 | 33 | 113 |
| Target | Soft coral | H275 | *Leptogorgia hebes* | 1 | 20 | 193 | 12 |
| Target | Soft coral | H351 | *Titanideum* sp. | 1 | 310 | 687 | 175 |
| Target | Sponge | C324 | *Microciona prolifera* | 4 | 32 | | |
| Target | Sponge | C357 | *Cliona celata* | 50 | 117 | 208 | 135 |
| Target | Sponge | C374 | Porifera | 118 | 282 | 1 | |
| Target | Sponge | C375 | *Cliona* sp | | 329 | | |
| Target | Sponge | C400 | Poecilosclerida | | | 117 | 34 |
| Target | Sponge | C402 | Demospongea | | | 95 | 65 |
| Target | Sponge | C414 | *Haliclona sp.* | | 447 | 2900 | 279 |
| Target | Sponge | C428 | *Ircinia sp.* | | 2 | | |
| Non-target | Algae | Q004 | Algae | | 370 | | 1530 |
| Non-target | Algae | T265 | *Polysiphonia* sp. | | 144 | | |
| Non-target | Anemone | H288 | Actiniaria | | 2 | | |
| Non-target | Ark | X002 | Arcoida | 1 | | | |
| Non-target | Barnacle | E316 | Cirripedia | 60005 | 13188 | 5527 | 22 |
| Non-target | Bryozoan | M545 | *Schizoprella floridana* | 2 | 23 | | |
| Non-target | Crustacean | D112 | *Calappa flammea* | 1 | | | |
| Non-target | Crustacean | D195 | *Stenorhynchus seticorni* | | 1 | | |
| Non-target | Echinoderm | J001 | *Asterias forbesi* | | 2 | | |
| Non-target | Echinoderm | J072 | *Lyttechinus variegatus* | 1 | | | |
| Non-target | Echinoderm | J085 | *Arbacia punctulata* | 2003 | 3512 | 3826 | 375 |
| Non-target | Echinoderm | J090 | *Echinaster* sp. | 2 | 1 | 8 | 1 |
| Non-target | Hydroid | H300 | Hydroidolina | 192 | 197 | 549 | 66 |
| Non-target | Jellyfish | H246 | *Aurelia aurita* | | 1 | | |
| Non-target | Mollusc | N001 | Nudibranchia | | | 1 | |
| Non-target | Mollusc | N112 | *Pleuroploca gigantea* | 1 | | | |
| Non-target | Mollusc | N227 | *Crassostrea virginica* | | 14 | 444 | 70 |

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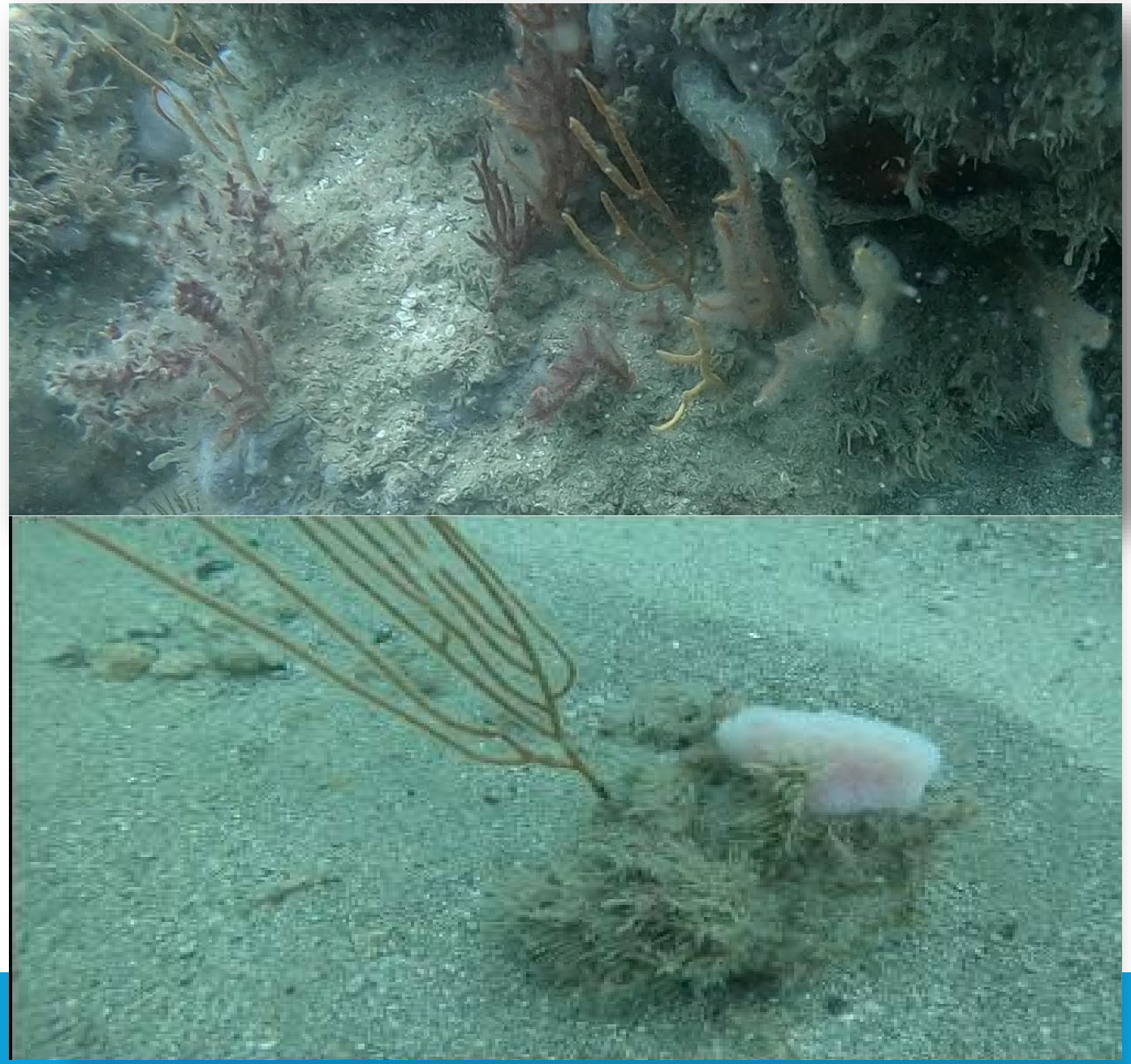
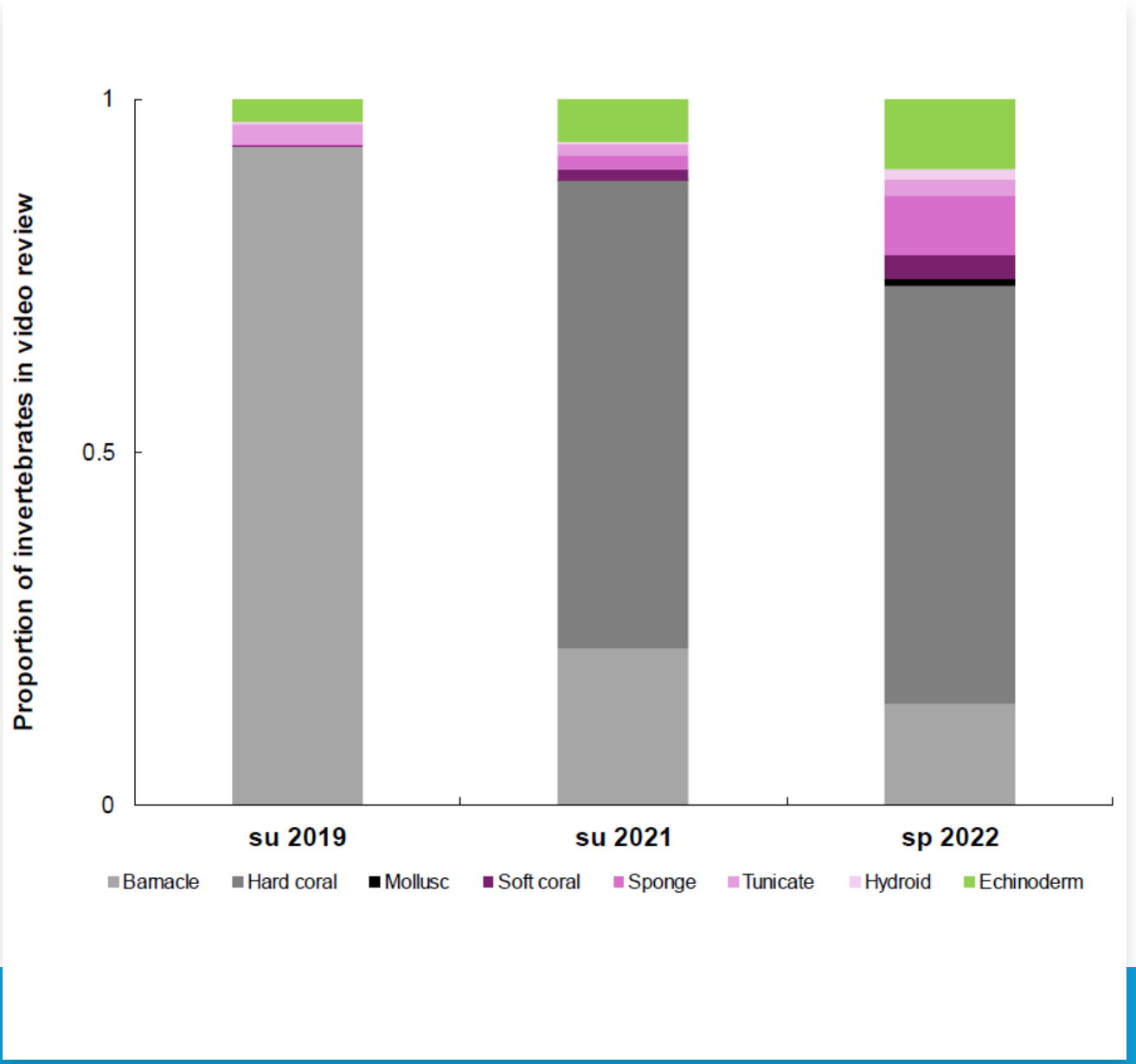
- Overall, greater invertebrate diversity at MitReef than impact site
- Greater Sponge and hard coral density than baseline site, but species composition differed
- **Lower soft coral recruitment: Significantly lower densities and smaller sized specimens of both *Titanideum* and *Leptogorgia* spp.**



# Results: **Invertebrates**

- **Temporal succession evident**
  - **Hard encrusting organisms > soft encrusting (sponges) and echinoderms> soft corals**



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**Mean count (per deployment replicate) of target finfish species by survey technique.**

| Species | Diver slate | Diver video | Baited frames |
|---|---|---|---|
| Batfish | 0 | 0 | 0 |
| Belted Sandfish | 7 | 3 | <1 |
| Black Sea Bass | 99 | 30 | 22 |
| Cubbyu | 1 | <1 | <1 |
| Gag grouper | <1 | <1 | <1 |
| Oyster Toadfish | <1 | <1 | <1 |
| Pinfish | 27 | <1 | 20 |
| Scad | 4 | 0 | 0 |
| Sheepshead | 26 | 1 | 4 |
| Slippery Dick | 8 | 3 | 1 |
| Southern Flounder | <1 | <1 | <1 |
| Southern Hake | <1 | 0 | <1 |
| Spottail Pinfish | 5 | <1 | 1 |

# Results: **Fish**

- 12 of 13 (92%) target finfish species seen by divers in the impact area in March 2016 were also seen at MitReef sites
- **Additional 9 elasmobranch and 66 finfish species (5x as many species) were observed at MitReef sites than at the impact area**

| | Baited frames | | | | Diver video | | | |
|---|---|---|---|---|---|---|---|---|
| | *2019 - 2022* | | *2023* | | *2019 - 2022* | | *2023* | |
| Common Name | Freq | Sum | BU | MR | Freq | Sum | BU | MR |
| White shark | 1 | 1 | | | 0 | 0 | | |
| Southern stingray | 2 | 2 | | | 0 | 0 | | |
| Roughtail stingray | 6 | 6 | | | 0 | 0 | | |
| Tiger shark | 1 | 1 | * | | 0 | 0 | | |
| Smooth butterfly ray | 1 | 1 | | | 0 | 0 | | |
| Bullnose ray | 5 | 5 | | | 0 | 0 | | |
| Atlantic guitarfish | 3 | 3 | | | 1 | 1 | | |
| Atlantic sharpnose shark | 12 | 13 | | | 0 | 0 | | |
| Hammerhead shark | 1 | 1 | | | 0 | 0 | | |
| Yellow Jack | 6 | 17 | | | 0 | 0 | | |
| Blue runner | 14 | 1259 | | | 3 | 11 | | |
| Bank Sea Bass | 0 | 0 | | | 1 | 1 | | |
| juvenile black sea bass | 12 | 25 | | | 2 | 9 | | |
| Atlantic spadefish | 29 | 163 | | | 5 | 28 | | |
| Reef butterflyfish | 0 | 0 | | | 0 | 0 | | |
| Striped burrfish | 5 | 6 | | | 2 | 2 | | |
| Atlantic bumper | 10 | 707 | | | 0 | 0 | | |
| UnID Herring | 4 | 320 | * | | 0 | 0 | | |
| Weakfish | 7 | 14 | | | 0 | 0 | | |
| Dwarf sand perch | 1 | 1 | | | 0 | 0 | | |
| Sand perch | 17 | 30 | | | 18 | 45 | | |

# Results: **Fish Acoustic Telemetry**

**22 species tagged by other research groups detected**

- **88 - 446 deployment days across 5 upload cycles**

| Species | N codes | N days | N detections | *Gross day/code* |
|---|---|---|---|---|
| Atlantic sharpnose shark | 1 | 1 | 4 | *1* |
| Atlantic sturgeon | 199 | 354 | 3,845 | *2* |
| Black sea bass | 32 | 5,111 | 593,602 | *160* |
| Blacknose shark | 2 | 4 | 94 | *2* |
| Blacktip shark | 12 | 15 | 71 | *1* |
| Bonnethead shark | 1 | 1 | 4 | *1* |
| Bull shark | 5 | 8 | 24 | *2* |
| Cobia | 19 | 29 | 528 | *2* |
| Cownose ray | 11 | 19 | 118 | *2* |
| Finetooth shark | 2 | 2 | 7 | *1* |
| Gag grouper | 1 | 153 | 18,083 | *153* |
| Leatherback sea turtle | 1 | 1 | 15 | *1* |
| Lemon shark | 2 | 4 | 92 | *2* |
| Little tunny | 1 | 1 | 31 | *1* |
| Manta ray | 1 | 1 | 3 | *1* |
| Red drum | 8 | 19 | 446 | *2* |
| Roughtail stingray | 1 | 1 | 11 | *1* |
| Sand tiger shark | 9 | 19 | 1,005 | *2* |
| Sandbar shark | 6 | 13 | 160 | *2* |
| Tarpon | 2 | 2 | 9 | *1* |
| Thresher shark | 2 | 5 | 96 | *3* |
| Tiger shark | 10 | 31 | 231 | *3* |
| White shark | 71 | 106 | 674 | *1* |

# Results: **Fish Acoustic Telemetry**

**Black Sea Bass Tagging Study**

- **34 telemetered fish 27.9 – 38.5 cm TL**
- **Fish detected between 1 and 567 days post-release (median 166 days)**
  - **Only 2 fish never detected**

# Takeaways

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  - **26 field days, additional monitoring modes, over 60 hours of underwater footage examined vs Dial and Cordy 2 field days (6 total transects), examined subset of footage**

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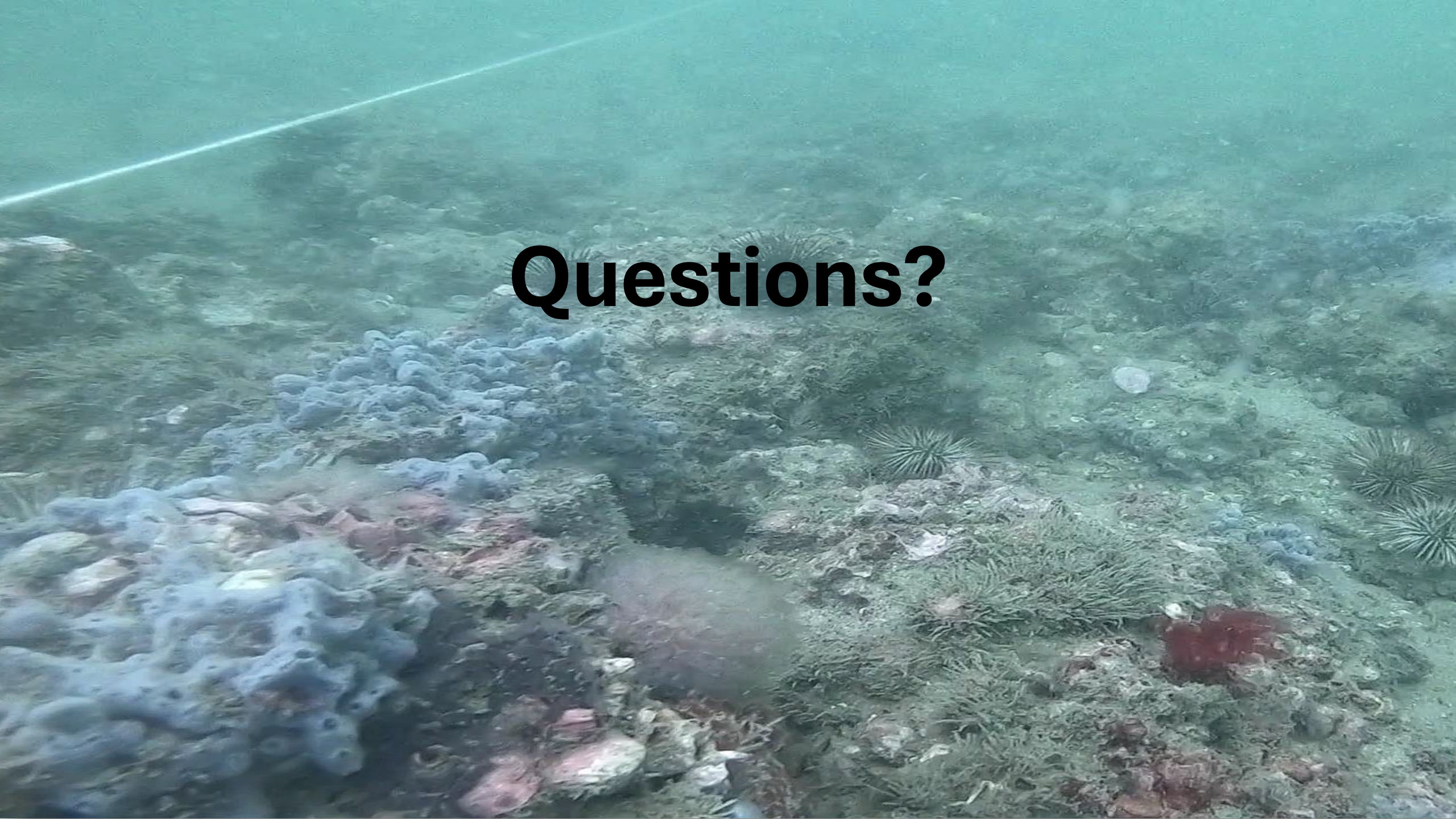
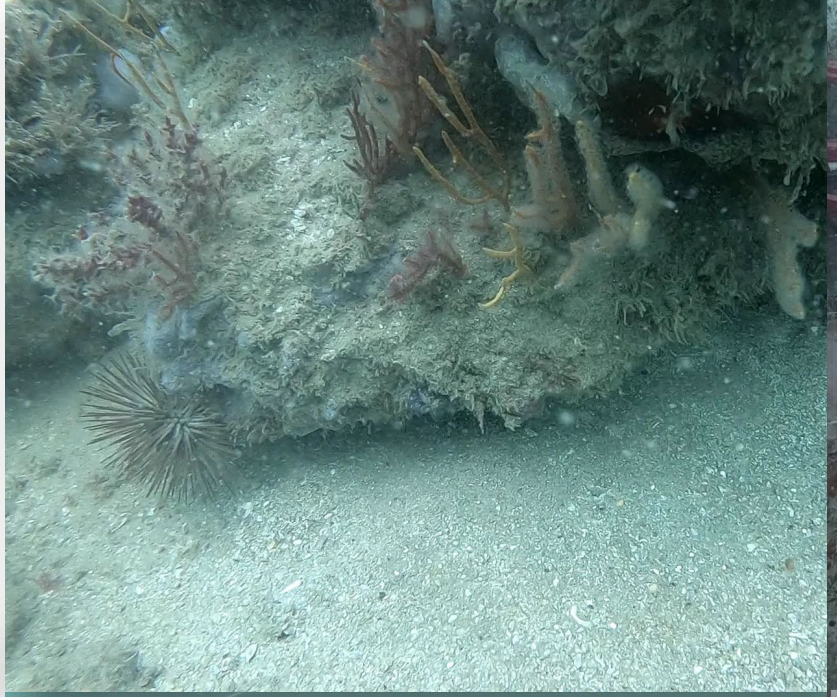
  - Visibility highly variable
  - **Video analysis methods differed**

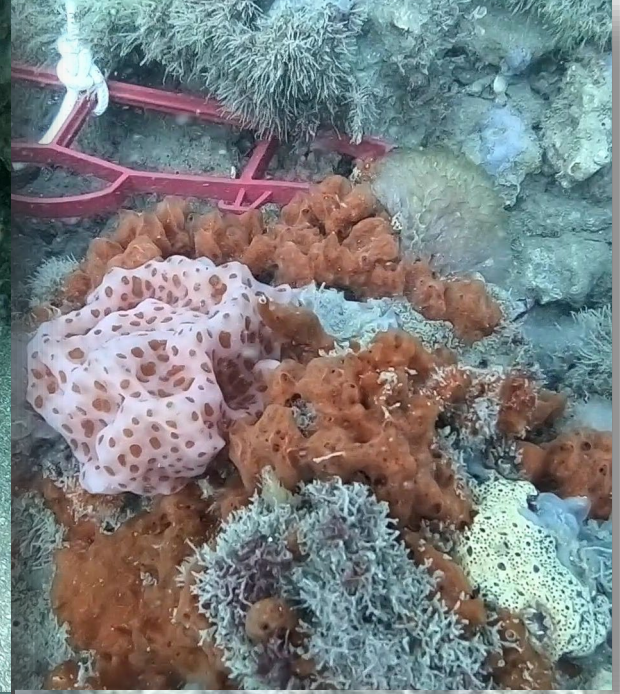

Questions?

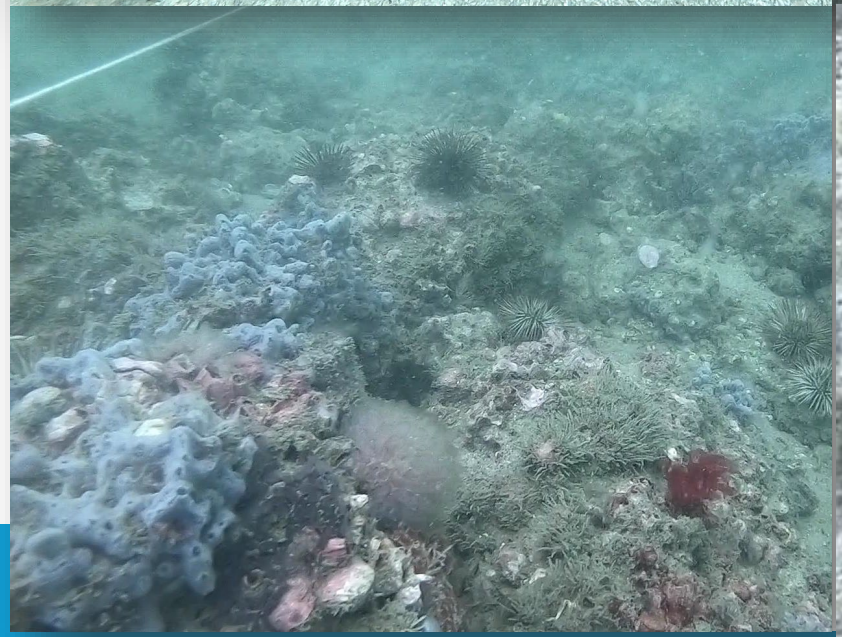
# Supplemental Slides

# Success Criteria: **Invertebrates**

- **No departure from octocorals comprising three-quarters of benthic invertebrates.**
- **No departure from an inverse correlation between octocoral and sponge abundance.**
- **No departure from *Titanidium* sp. being 2.9 times more abundant than *Leptogorgia* sp.**
- **No departure from *Titanidium:Leptogorgia* transect ratios spanning 0.6 (T2) to 40.3 (T5)**
- **No departure from a mean of 5.3 (±3.0 95% CI) octocoral colonies per square meter.**
- **No departure from sponges being the third most prevalent "functional group" and represented by the following genera: *Ircinia; Spirastrella; Chondrilla; Desmapsamma*.**
- **No departure from a mean of 1.7 (±2.0 95% CI) stony coral colonies per square meter**
- **No difference in size distributions for octocorals, sponges, and stony corals relative to baseline**







# Success Criteria: **Fish**

- **Minimum 10 of 13 (75%) baseline species**
- **Relative abundance for each species statistically similar to baseline**