Can Coral Reefs and Large-Scale Dredging Projects Coexist?

William F. Precht

DIAL CORDY AND ASSOCIATES INC
Environmental Consultants

Port expansion projects throughout the tropics and subtropics have created a conflict between ports, environmentalists, regulators, dredging contractors, and the public.

Miami's Choice: Bigger Ships or Coral Reefs?

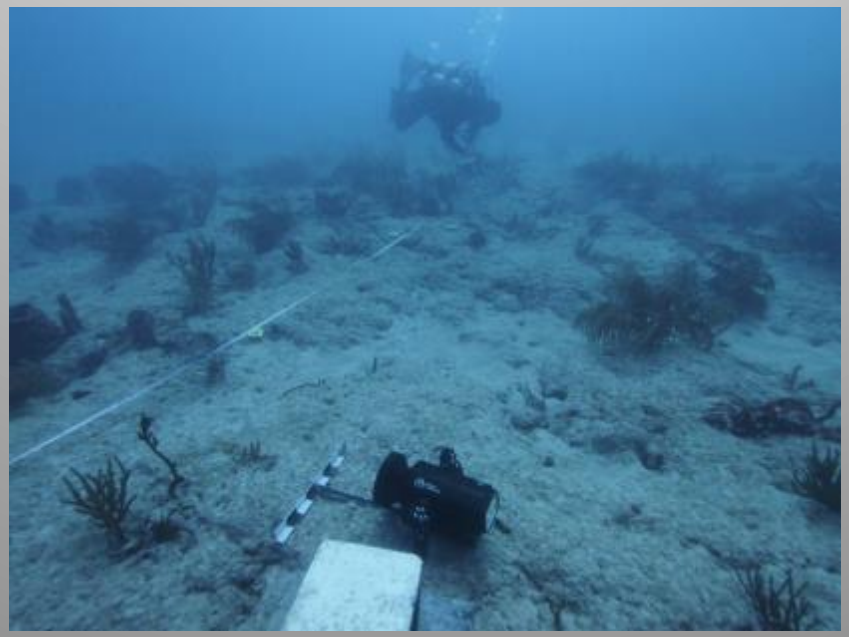
Dredging in Biscayne Bay inflicts heavy damage on North America's only coral reef tract.

By Scott Wyland
for National Geographic

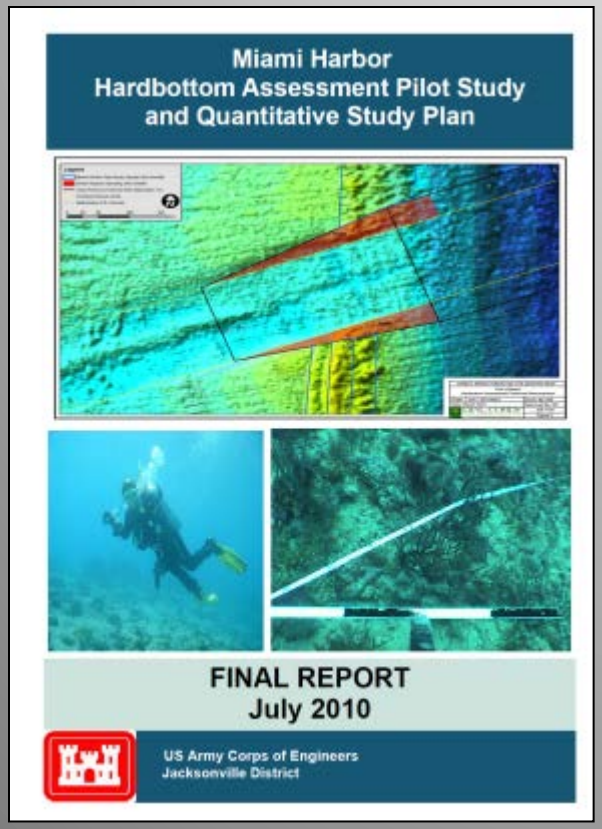
PUBLISHED FEBRUARY 26, 2015

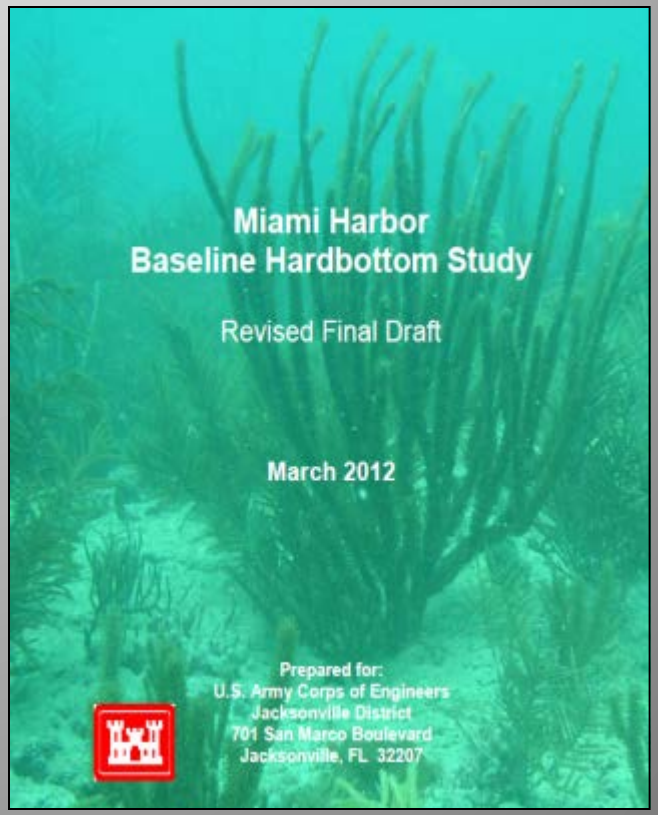
We have developed, based on projects in the US and Caribbean, a set of guidelines that if implemented with care and directed by sound science, will help to assure for an environmentally compliant project with minimal impacts to fragile coral resources.

The first and most important step in the process is the careful preparation and vetting of a feasibility study that includes a pre-project environmental assessment that allows for an accurate description and quantification of all anticipated impacts (both direct and indirect).

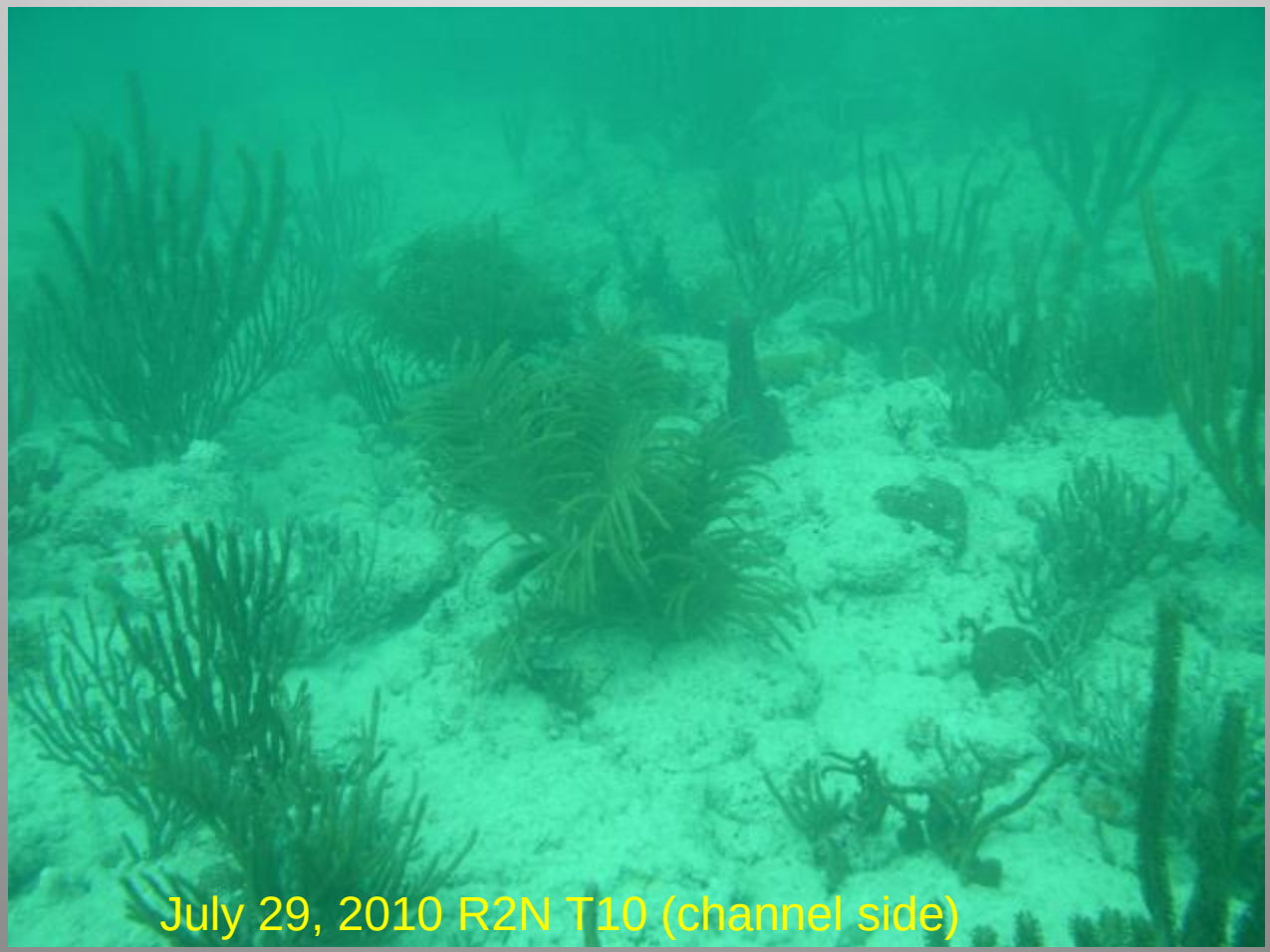


The EIA/EIS should detail all avoidance and minimization options (per NEPA) as well as outlining protective measures during construction to assure for environmental permit compliance.





Quantitative Baseline Studies Help to Define Pre-Project Conditions – Both Biotic and Abiotic.



This background should include detailed data on hydrodynamics, sedimentation, geotechnical investigations, water quality, and biology.

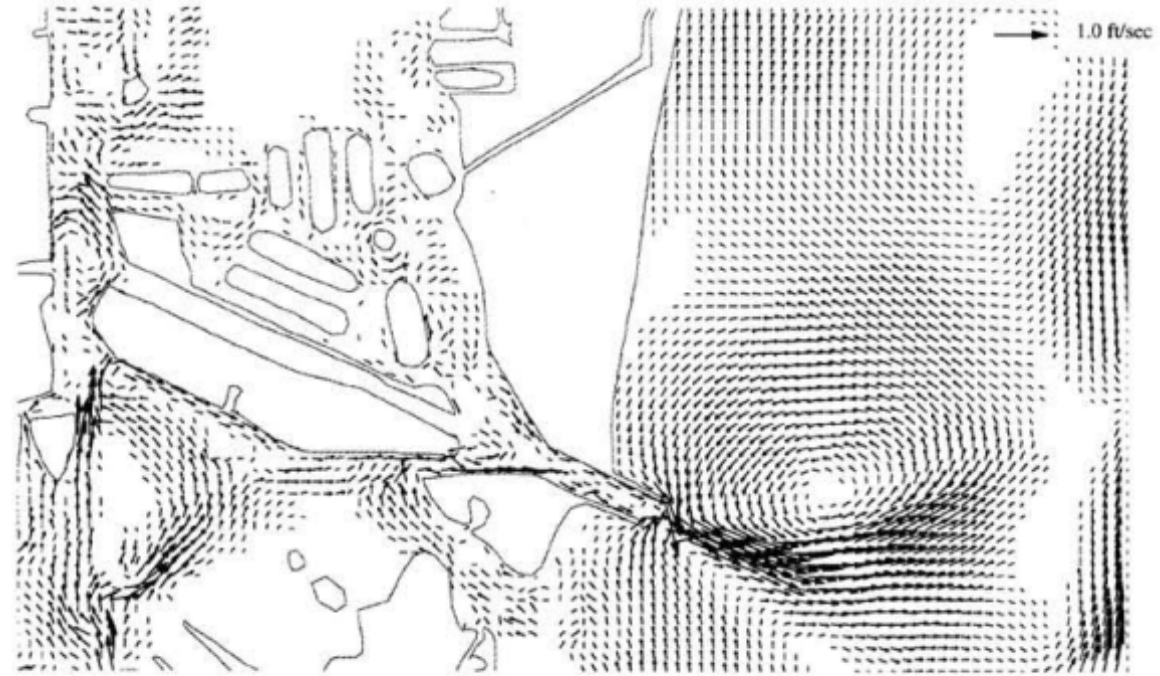


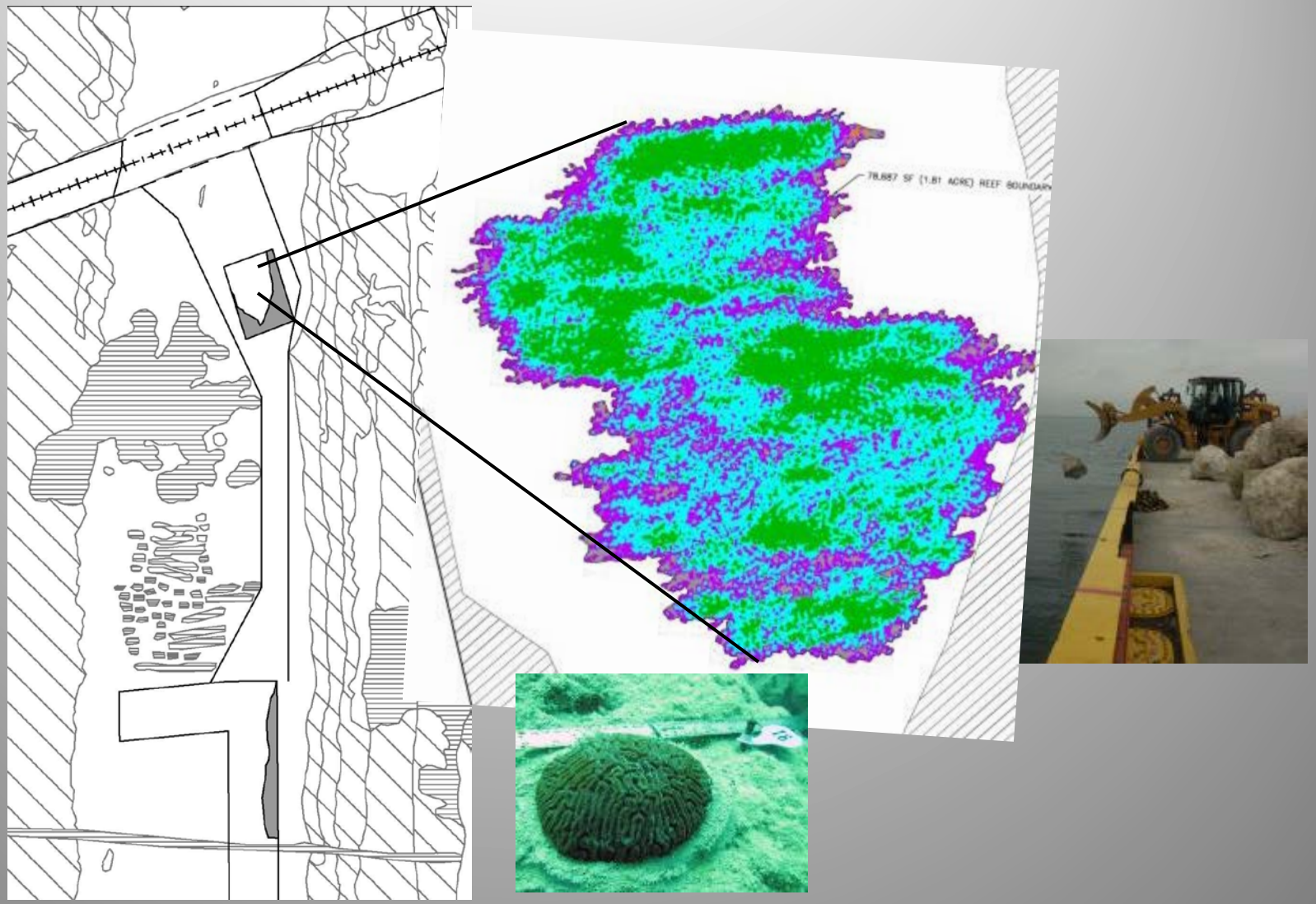
Figure 13: Residual Velocities, Existing Conditions, Average Flow Hydrograph

The more information the better!

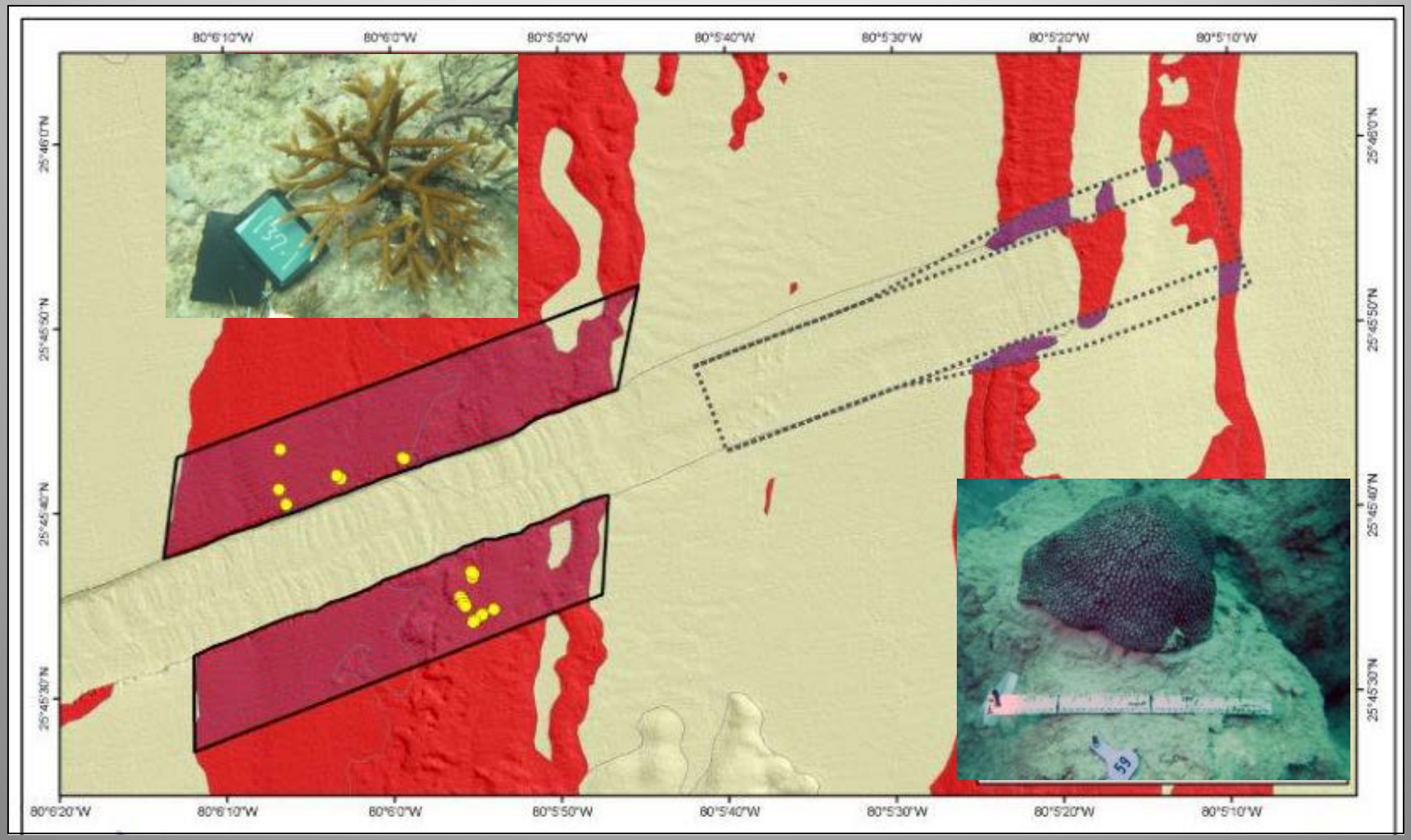
Unavoidable Impacts

To make the public whole for impacts to the environment, there is a need for active restoration of any injured resources and mitigation for those that are lost or displaced during construction. These projects should aspire to return the degraded environment to levels equivalent to their pre-project baseline condition.

Up-Front Artificial Reef Construction



Pre-Project Coral Relocation Activities



During construction, quantitative monitoring of key biotic and abiotic parameters need to be performed so that corrective adaptive management measures can be employed mid-stream if BMPs are failing to perform as designed. It is imperative that these monitoring programs carefully employ off-site controls for comparison (BACI).

Environmental Compliance Monitoring

Repeated Measures!
These efforts need to be both temporally and spatially expansive.

Environmental Monitoring

- Agency Reporting – weekly data collection, analysis, interpretation, and reporting for offshore and seagrass data.
- Data Management including raw data, spreadsheets, photos, video

Weekly Offshore Coral Stress and Sediment Stock Compliance Report 62
FDEP Permit #0260721-001-JB – Port of Miami Phase III Federal Channel Expansion Project
Week 62: 01/25/15-01/31/15 Dredge Activity

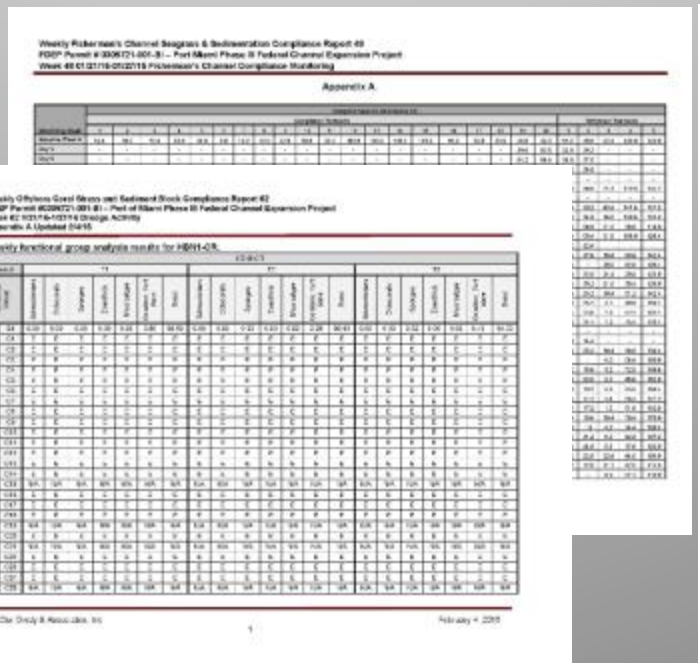
Background

The hopper dredge Terrapin Island began dredging on November 20, 2013 adjacent to hardbottom monitoring sites. The dredge Texas and the Spider barge began dropping rock and offloading dredged material to access for ODMDS and ITSMR disposal on December 17, 2013. Terrapin Island left the job site on December 27, 2013, but the Texas and Spider barge have since continued working offshore. The hopper dredge Liberty Island arrived at the Project site on May 14, 2014 and worked offshore until July 3, 2014. The hopper dredges Terrapin Island and Liberty Island are not expected to return to this Project at this time. Dredging operations in the channel flare (easternmost portion of Cut 1) commenced on August 9, 2014. On August 24, 2014, the Texas and Spider barge moved inshore for repairs. The Texas and Spider barge dredged in Cut 2 for seventeen days before returning to Cut 1 on September 12, 2014.

During Week 62 of compliance monitoring (January 31, 2015 to January 27, 2015), the dredge 85 operated offshore in Cut 1 (STA 37+83 to 67+81) and in Cut 2 (0+00 to 27+98). Active dredge activity only occurred offshore between 1/21/15 and 1/22/15 of Compliance Week 62. Biological monitoring was required for sites within 750 m of an active dredge and included all hardbottom, middle, and outer reef sites (Figure 1). Data collection was completed at HBR1, HBR2, HBR3, HBNC1, HBR1, HBR2, HBR3, and HBRC1 in Compliance Week 62. Due to the proximity of active dredge equipment and hazardous environmental conditions, data from HBR4 was not collected until 1/30/2015 (Compliance Week 63) but is included here for data analysis. Poor environmental conditions prevented data collection at the middle and outer reef sites in Compliance Week 62. Adverse environmental conditions (e.g., excessive wind speeds, wave heights, extreme currents, and/or low visibility) made conditions unsafe for offshore dive operations for portions of 47 days in Week 62. Safe diving conditions are described in EM-385 (EM-385 is the safety regulation document that guides all USACE scientific diving operations) as current <1 knot and visibility >3 feet additionally best professional judgement of wind, waves, and traffic conditions is used to determine whether or not scientific dive operations may be conducted safely.

During the baseline survey period (October 17 to November 18, 2013), a natural sand transport event was documented on the north side of the channel, close to the north jetty. A sand wave moved from north to south following the general movement of the regional longshore drift in the vicinity of HBR1. At HBR1 all marked corals documented in Weeks 1 and 2 were buried by Week 3 of baseline, as documented in photos and video collected at the site on November 1, 2013. Photos from HBR2 and HBR3 show turbid water and sedimentation during baseline surveys, although no corals were buried at these sites. It was apparent that natural sand transport influences the sediment dynamics of the nearshore hardbottom communities. In the interim, the last full monitoring of the site was conducted on 4 December 2013. After the burial event, HBR1 was visited periodically when the site was within the 750m compliance monitoring zone, and weather and sea conditions allowed, but it appeared to be buried from the surface during these periodic visits and therefore no monitoring was conducted. In Week 43 (September 2014) of compliance monitoring, scientific divers determined the site was no longer buried by sediment, so in situ, photo, and video data were collected and will continue to be collected unless the site is triggered by the 750m rule as long as the site does not undergo another burial event. HBR1 was again buried, as observed by scientific divers on December 12, 2014 and this was again documented on January 22, 2015. Two massive coral heads of HBR2 are also buried under coarse sand as of January 22, 2015.

Methods



Weekly Fisherman's Channel Seagrass & Sedimentation Compliance Report 49
FDEP Permit #0260721-001-JB – Port Miami Phase III Federal Channel Expansion Project
Week 49 01/27/15-01/27/15 Fisherman's Channel Compliance Monitoring

Appendix A

Weekly Offshore Coral Stress and Sediment Stock Compliance Report 62
FDEP Permit #0260721-001-JB – Port of Miami Phase III Federal Channel Expansion Project
Week 62: 1/21/15-1/27/15 Dredge Activity
Appendix A Updated 01/15

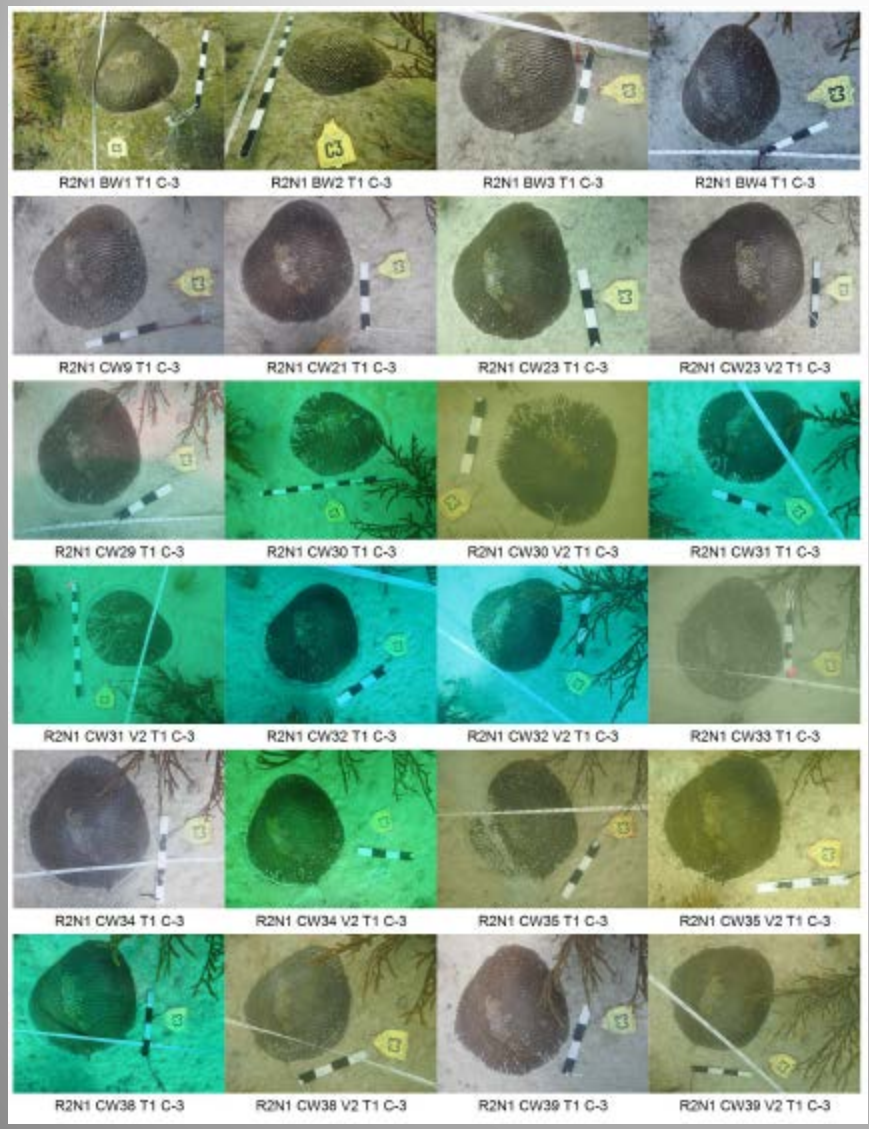
Weekly functional group analysis results for HBR1-CR.

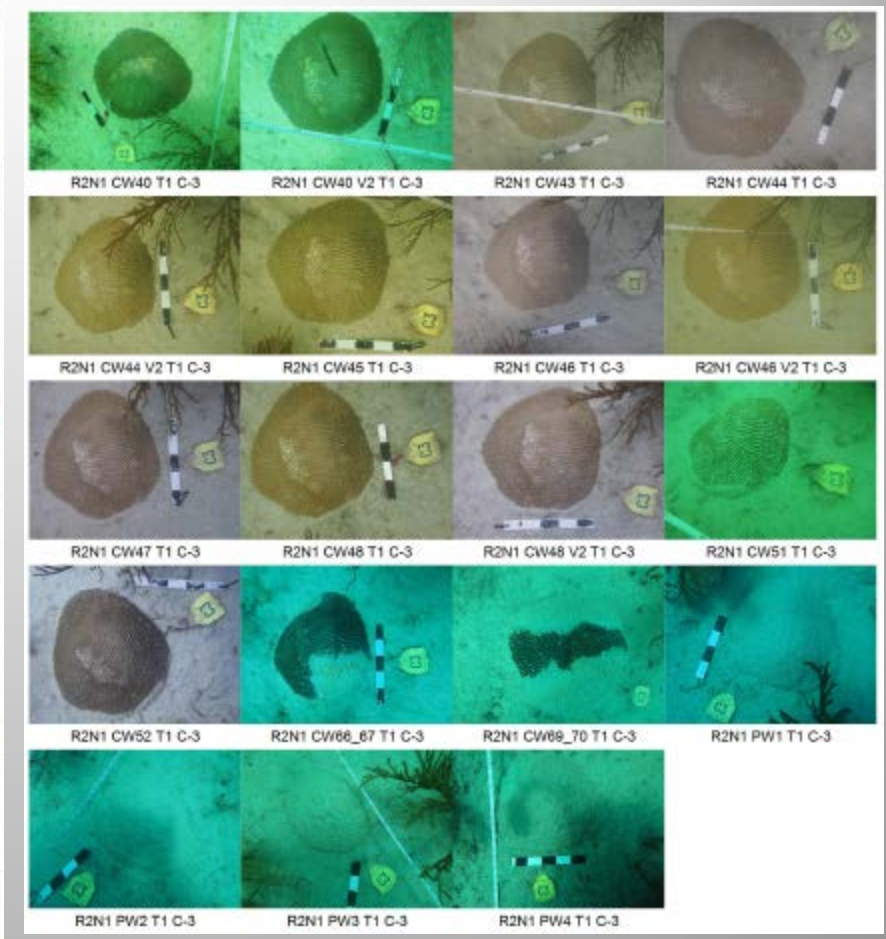
Port Miami Regulatory Agency Permit Directed Compliance Monitoring

- Over 9,600 scientific scuba dives were performed in less than two years

  (10,865 in total from 2013-2017))
- 26 sites with three 20 m transects per site were regularly monitored and video-graphed.
- Approximately 650 corals were tagged for long-term monitoring (controls and compliance)
- Each coral was evaluated in-situ for stress and photographed 40-45 times during the 80 week project

  (>25,000 individual observations)
- Each in-situ observation was paired with ~125,000 photos





Each coral has its own project history that can be tracked in time and space.

In the laboratory, in situ coral condition data were compared with corresponding still photographs for cross-verification and validation for the 643 tagged corals.

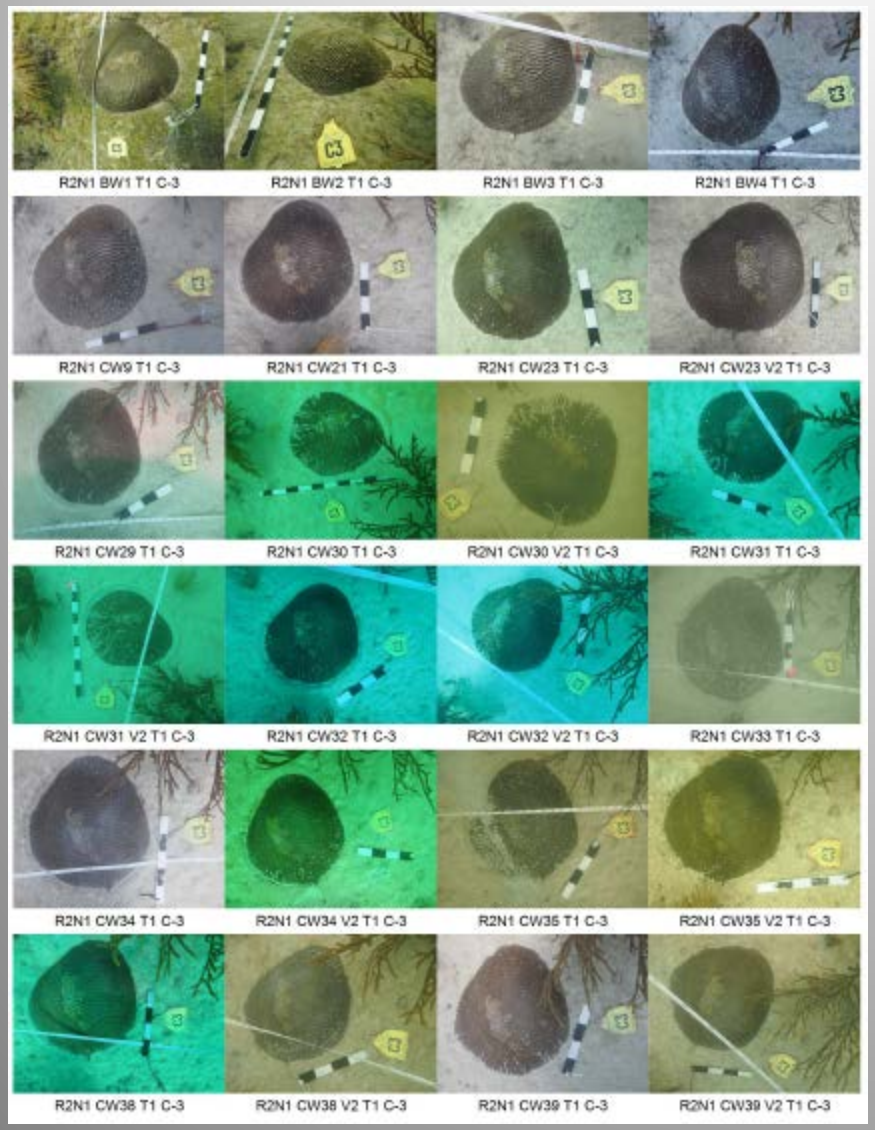
Combining these data with other collected abiotic metrics (sediment, SST, etc.) allowed us to differentiate between chronic and acute stressors, natural and anthropogenic.

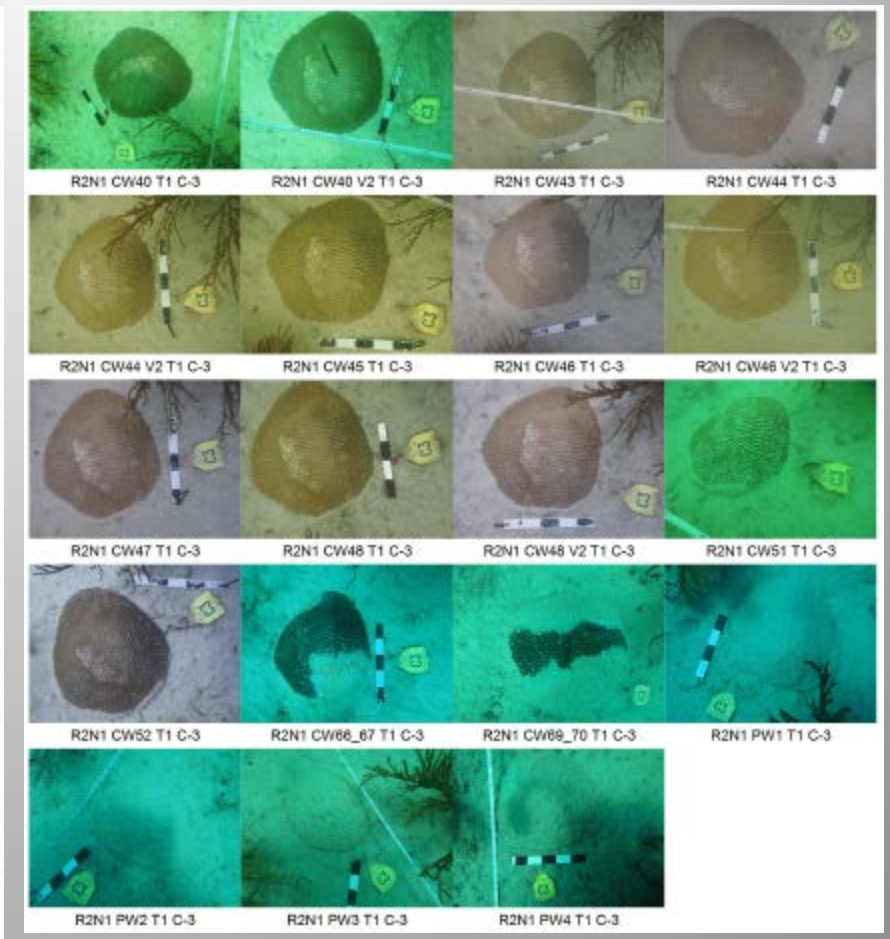
We were specifically able to calculate the prevalence of corals impacted by sedimentation, predation, competition, coral bleaching, and disease.

Most importantly, in cases where corals had died, we were able to discern the exact cause of mortality by carefully evaluating the sequence of events recorded (and photographed) prior to their death.

If you just saw this – how would you know when, how, and why this coral died?

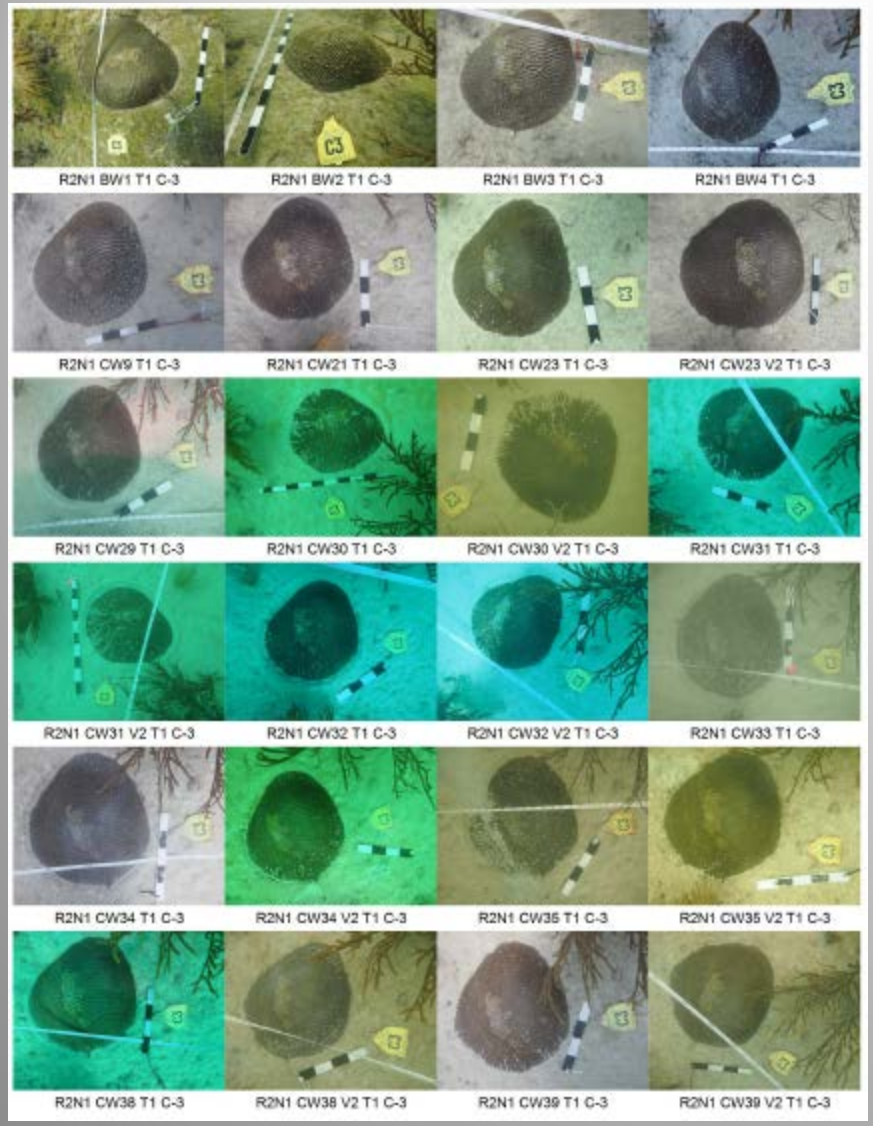
Unless you had this!

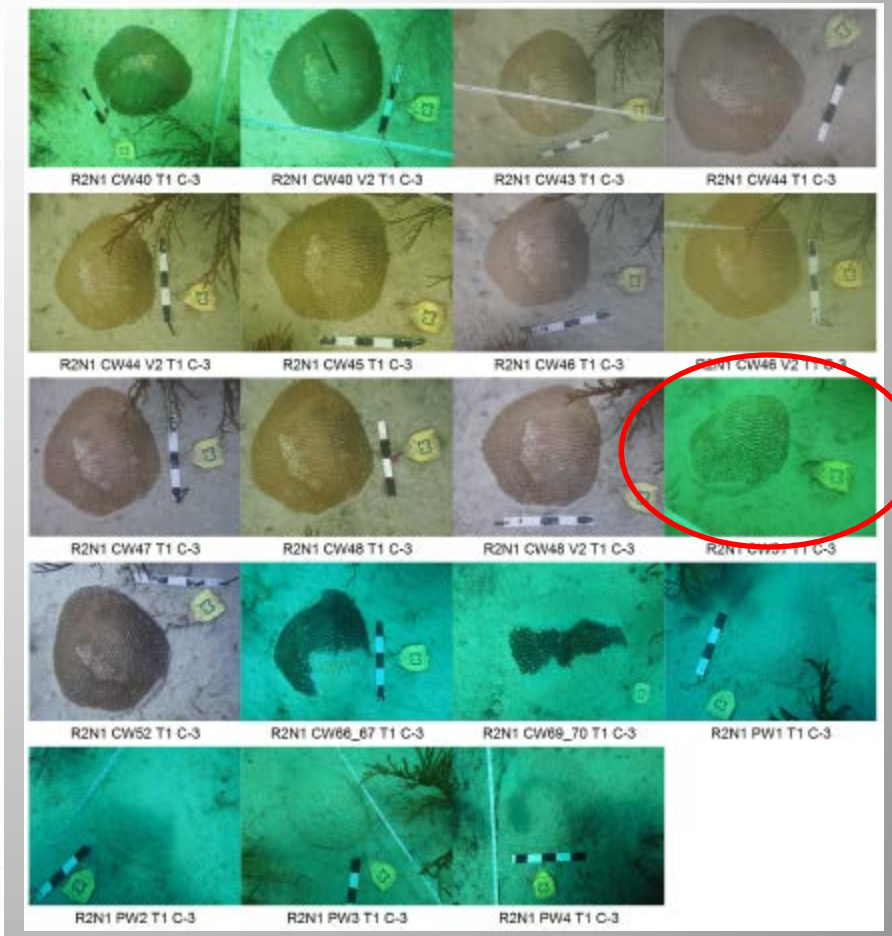




Tagged *Pseudodiploria strigosa* colony R2N1 T1 C3

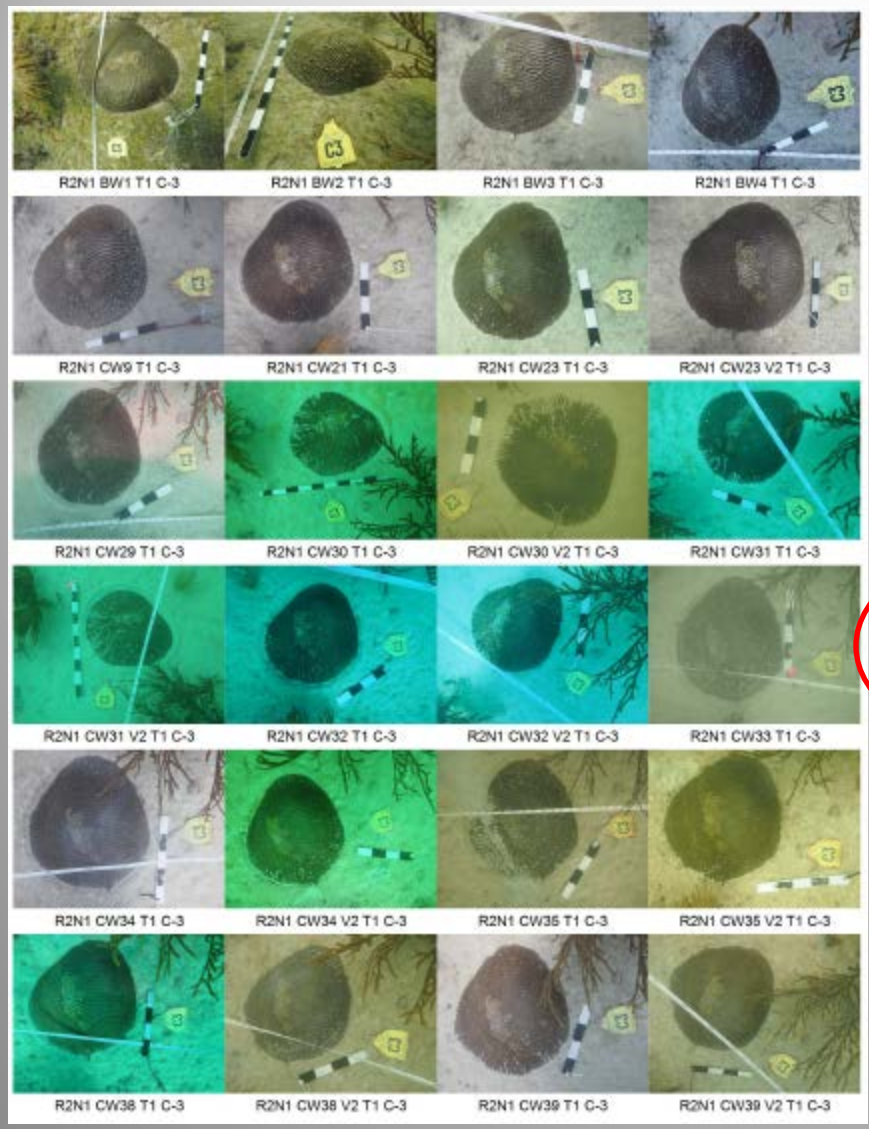
DCA Monitoring Photos – Port Miam

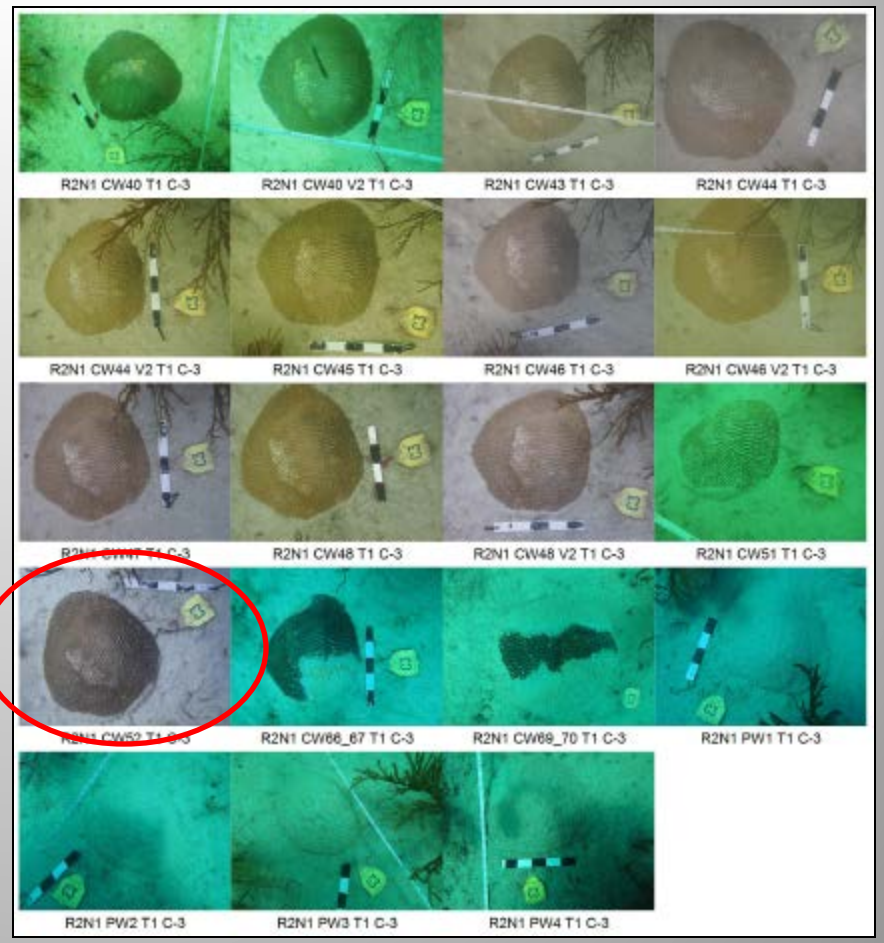




Paled/Bleached

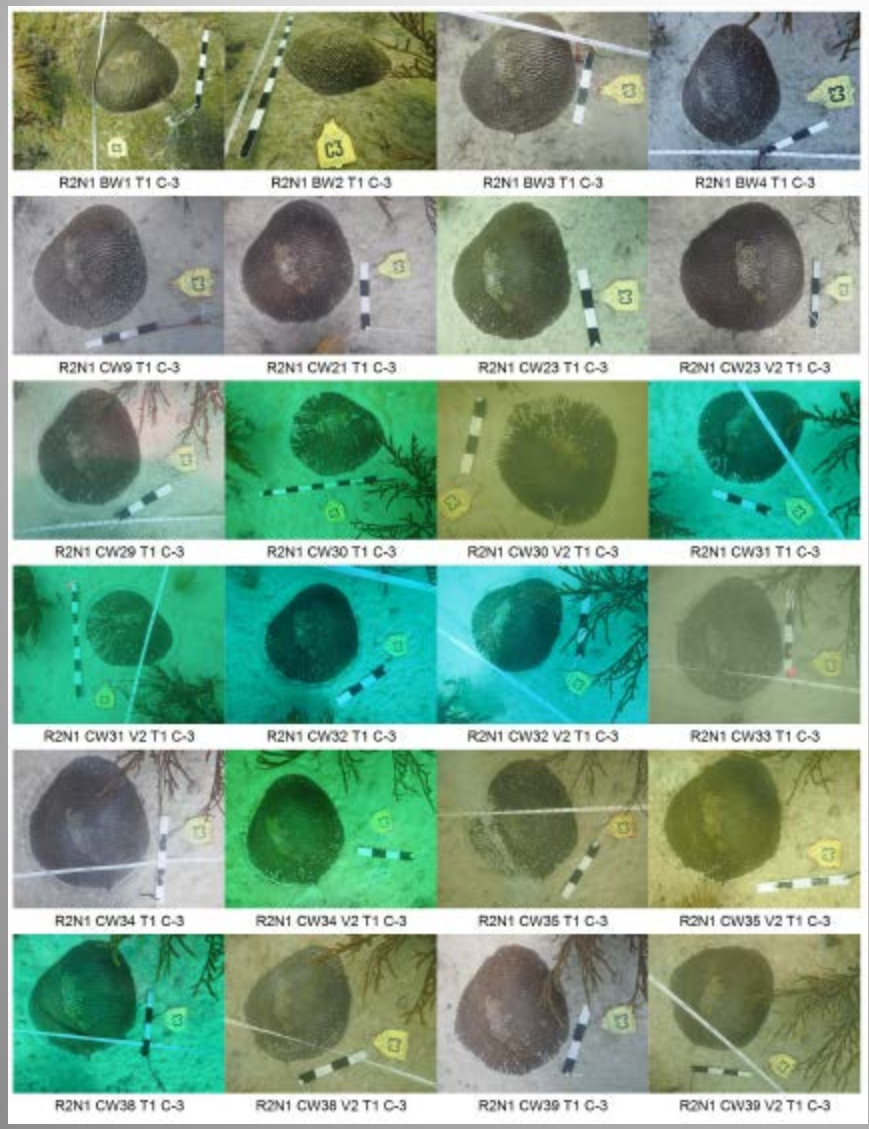
DCA Monitoring Photos – Port Miam

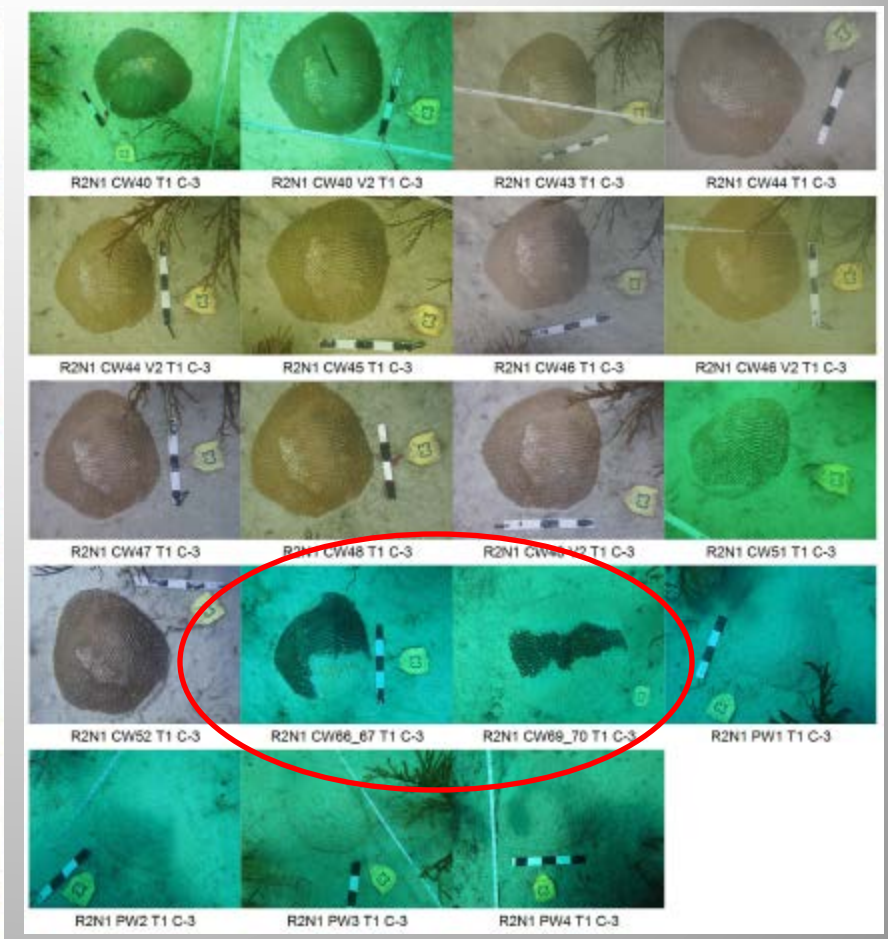




Recovered from Bleaching
First Sign of White-Plague

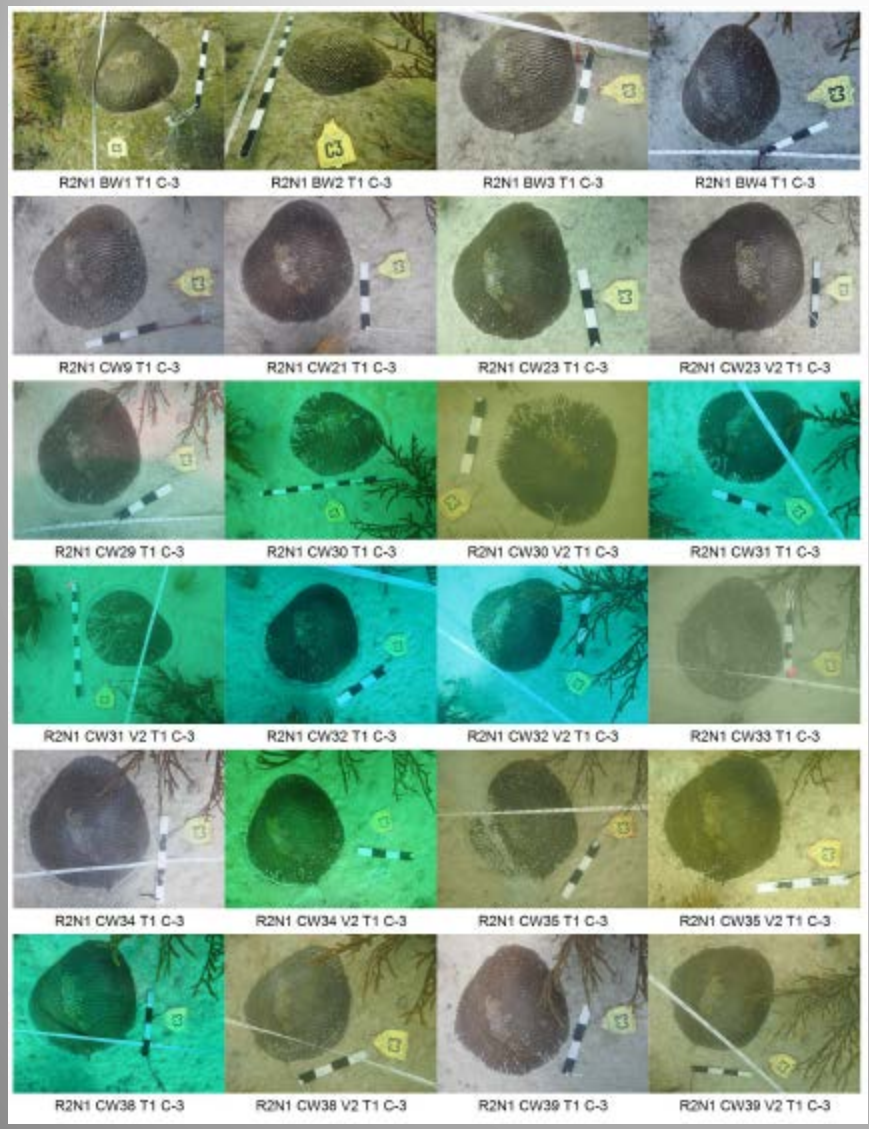
DCA Monitoring Photos – Port Miam

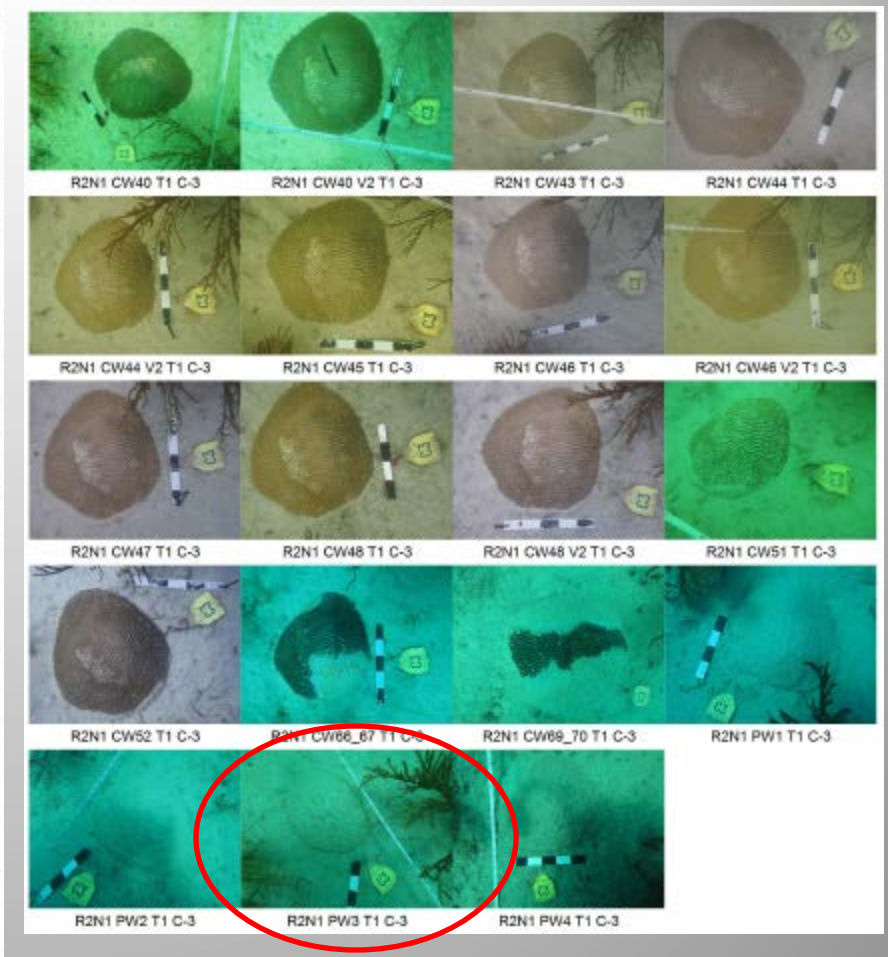




Active White-Plague!

DCA Monitoring Photos – Port Miam





All Gone!

DCA Monitoring Photos – Port Miam

Correlation and Causation

We get into trouble when the mind seeks or creates an artificial cause/effect relationship that doesn't actually exist. After something especially beneficial or harmful occurs, we want to know what caused it. We tend to focus on the first action we noticed before the effect, then assume that it must have been the catalyst triggering the later event. Nine times out of ten, we're right. It was the white berry that made Lucy sick. It was true that hitting a foot with a hammer makes that foot swell and bruise. That makes us lazy intellectually; we forget that, one time out of ten, we pick the wrong cause. In Latin, this type of logical mistake is called the ***post hoc ergo propter hoc*** fallacy, which means "After this, therefore because of this." It's the idea that any event which happened first must be *the* particular event that caused a good or bad event later, and once we find a possible answer we tend to snatch hold of it and then stop thinking about other possibilities.

https://web.cn.edu/kwheeler/logic_causation.html

"...management decisions should be treated as hypotheses of ecosystem response, and scientific monitoring programs should be designed as experiments to test them. This approach allows management decisions to be revised [adapted] to meet project goals."

(Modified from Precht & Robbart 2006)

The challenge for coral-reef scientists is to determine the strongest causal pathways to degradation. Measuring the relative contributions of proximate and ultimate candidate-causes is not merely an academic exercise; the prescriptions for mitigating and reversing reef degradation differ depending on the scales, hierarchical levels, and identities of those causes.

(Aronson and Precht 2016)

Not all coral mortality may be project related!

Projects cannot be performed in a vacuum!

You need to know what is going on around you (and the region)

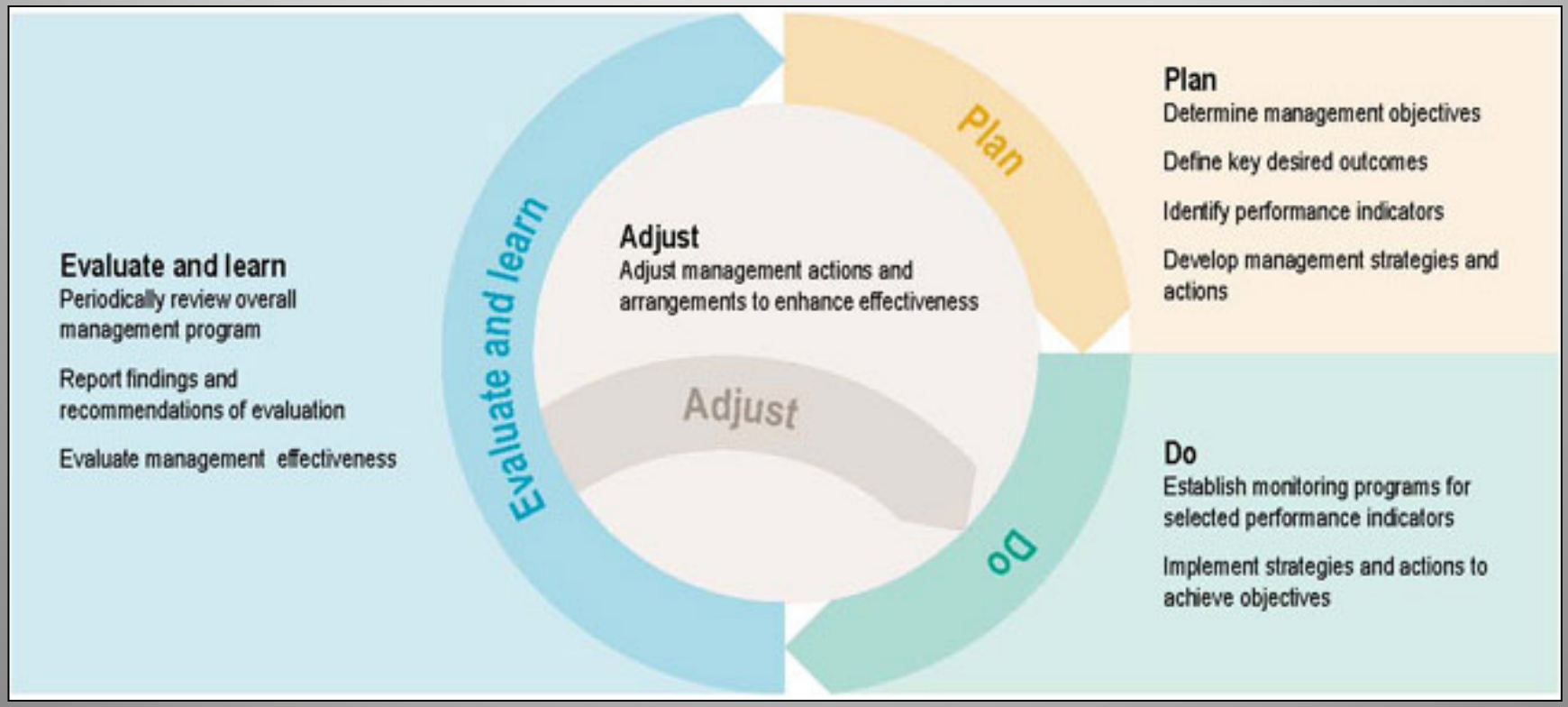
Monitoring needs to account for the unexpected.

Press vs Pulse Impacts

- The cumulative effects of chronic sedimentation (press impacts) may not be expressed until well after the commencement of the dredging operations. In this case we would expect to see coral health decline with time.

- Impacts due to sedimentation may occur over a short period of time (pulsed impacts). In this second scenario we would expect to see differences among the corals diminish as time passes.

An Adaptive Approach to Environmental Monitoring



Incorporate New Technology

- Collect better (more) background data
- Increase area of surveillance
- Use cutting edge predictive modeling tools
- Newest turbidity/sediment sensors
- Real-time underwater video feeds at key locations
- Real-time satellite/aerial photo analysis for turbidity plume monitoring

Transparency

Through all project phases, open and transparent communication between all stakeholders will be necessary to avoid and resolve conflicts between the various groups, many with disparate goals and interests.

This is why we have failed!

Integrate Lessons Learned
Similar Projects - Similar Issues - Similar Problems

Muddying the waters: The science of protecting the environment during dredging

Craig A Styan and J Russell Hanley*

Abstract

Predictions of environmental impacts from dredging during port development often involve uncertainty, leading regulators to instigate 'adaptive management' and increasingly extensive compliance monitoring programmes. In many cases, monitoring has become very large yet it is not clear we are learning much from this, either about what impacts are or how to monitor these more effectively. As such, approval conditions requiring monitoring risk become 'green-tape' whereas they should be driving a scientific process to learn about how to manage dredging better. Using the 'Predictive Links' programme for the Gorgon LNG plant development as an example of how more can be made from compliance monitoring, we outline three ways to improve: asking better questions, making more use of past data, and making data more freely available. Industry itself should take the lead in all three of these areas by becoming involved in research and committing to making data publically available.

Take Home Message

The answer to the question posed in the title is yes, but only if done correctly and we used the lessons-learned from previous projects!

This includes all projects -

The good, the bad and the ugly.

That is why we are here!