Rapid Assessments of Reef Sediment Depth and Biotic Stress Indicators at Port Everglades, Florida

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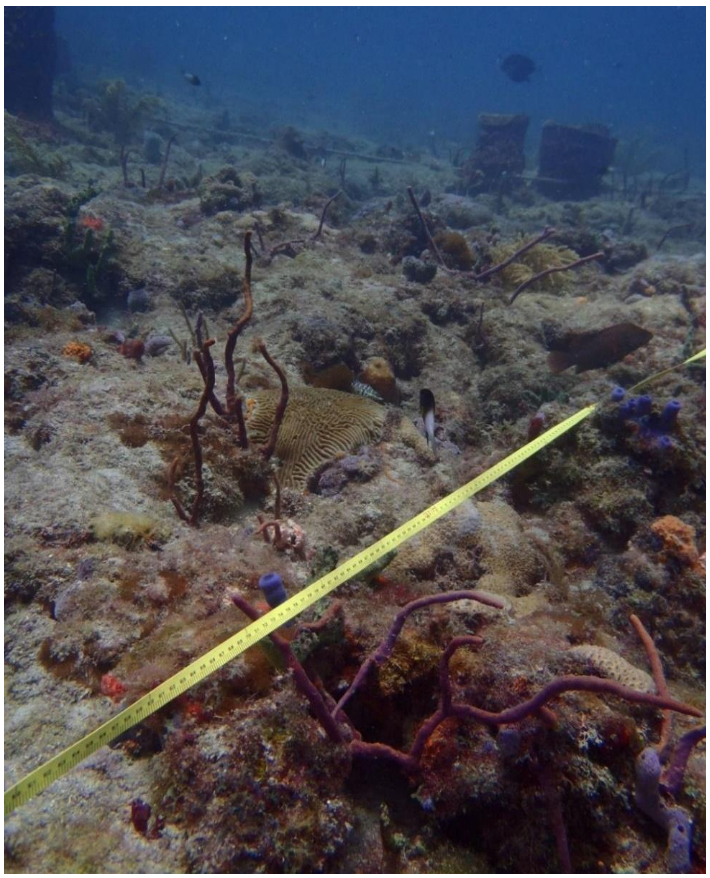
National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS), Southeast Regional Office, Habitat Conservation Division



Transect tape on the Inner Reef, 700 meters south of the Port Everglades entrance channel in 2019.
Photo Credit: Kurtis Gregg, ERT, Inc.

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INTRODUCTION

The Port Everglades Deepening Project (PEDP) includes plans to deepen and widen the Port Everglades entrance channel and harbor (Fort Lauderdale, Florida) (USACE, 2022) with construction expected to begin in the fall of 2024. The Port Everglades entrance channel crosses four major coral reef features generally oriented from north to south, and each of these features has different characteristics (such as depth and distance from shore). The National Marine Fisheries Service (NMFS) led a field team to complete two sampling events to measure sediment depths on the major coral reef features surrounding the port at over 50 locations (***Figure 1***). Measurements of sediment depth are expected to be components of PDEP's Monitoring and Adaptive Management plans, and NMFS is collecting information to help establish a pre-dredging baseline. Two sampling events were completed in winter 2017 (data collected in December 2017 and February 2018) and summer 2019 (data collected in June 2019), and more are anticipated before dredging begins. An additional objective of this work is developing and testing a rapid assessment protocol for examining the prevalence of biotic indicators associated with sediment stress on coral reef habitats before the commencement of dredging operations. Sediment samples were also collected to characterize the grain size and mineralogy.

METHODS

Four major coral reef features were used to stratify the sampling, including (from west to east): the Nearshore Ridge Complex (NRC), Inner Reef (IR), Middle Reef (MR) and the Outer Reef (OR), based on regional-scale coral reef habitat mapping (Walker et al. 2008, Walker and Klug 2014). Sample locations were selected north and south of the channel beginning approximately 50 to 150 meters from the channel edge and extending approximately 2,000 meters from the channel in each direction. Sampling occurred at a total of 54 locations (***Figure 1***).

Sample locations and nomenclature

The naming convention for sample locations included the coral reef feature first, followed by the habitat type (for example, Nearshore Ridge Complex Colonized Pavement Shallow or NRC-CPS, see ***Table 1***). A grid-like pattern was used to identify sample locations based on general distance from the channel. Locations targeted areas of 100, 300, 500, 700, 1,000, 1,500 and 2,000 meters on each reef feature both north and south of the channel. Exceptions were the four locations 50N-NRC-CPS, 150N-MRL, 50N-ORL, and 50S-ORL, where spatial variability of the coral reef required adjustment to ensure the sampling location was within the intended reef habitat type. These locations were pooled with the 100-meter locations (***Table 2***). Each location name includes distance from the channel edge (as determined using the measuring tool in Google Earth imagery), direction from the channel (north or south), and the habitat type abbreviation as in the following examples: 50N-ORL meaning 50 meters north of the channel on the Outer Reef Linear; 300S-IRL meaning 300 meters south of the channel on the Inner Reef Linear.

In general, sampling locations were selected on Reef Linear (RL) and Colonized Pavement Shallow (CPS) habitats. Alternate habitats within a reef feature, such as Spur and Groove (SG), Aggregated Patch Reef Deep (APD), and Ridge Shallow (RS) were sampled when RL or CPS habitat was not present on a particular interval distance from the channel edge (***Table 2***). In addition, not all habitats were present on each east-west oriented grid line in the Port Everglades vicinity. Locations 300N-IRL and 300N-NRC-CPS were buried under rubble, and the ORL habitat type was not observed at a distance of 1,500 meters from the channel in the north direction (***Table 2***). Finally, in areas where more than one reef feature and habitat type were present along the east-west grid line, (e.g. Middle Reef Linear north), sampling was conducted on the most seaward occurrence of the habitat type (***Figure 1***).

Sampling activities

Sampling activities at each location included: 1) conducting one 30-meter sediment depth transect, 2) conducting two 10-meter by one meter belt transects to assess biotic indicators of sediment stress on three groups of taxa including stony corals, octocorals and sponges, 3) collecting one sediment sample near the end of the transect, and 4) making a video record of the 30-meter sediment depth transect (see ***Appendix 1***).

Transect placement and sediment depth measurements

Sampling activities began with deploying a mushroom anchor and buoy from the boat at the coordinate of the sample location. A 30-meter transect tape was laid on the seabed on a west heading from the mushroom anchor (***Appendix 1***). If sand habitats were encountered, the transect tape direction was deviated from the west (270 degrees) heading to remain on the reef, or changed to run to the east if less sand was observed in that direction. Deviations from the west heading or changes to other headings were noted on the sediment depth datasheet. Sediment depth was measured to the nearest 0.1 centimeter at each one meter mark starting at the one meter mark and continuing to the 30-meter mark for a total of 30 measurements per transect (***Appendix 2***). If the measurement occurred in a sand patch or sand channel within the reef at the sample location, the measurement was recorded along with a notation of SP or SC for sand patch or sand channel, respectively. Data points that were collected in a sand patch or sand channel were retained in the dataset, but were excluded from the sediment depth analysis to focus on sediment depths on the reef.

Sediment depth transects were conducted at 54 locations in winter 2017 and 53 locations in summer 2019 (**Table *2***). Site 500N-MRL was not sampled in 2019 due to dive technical issues. Also, to improve field sampling logistics, locations 500S-NRC-CPS and 500S-NRC-RS were both sampled in 2017 but only 500S-NRC-RS was sampled in 2019. The Nearshore Ridge Complex Ridge Shallow (NRC-RS) habitat generally has greater occurrence of the ESA-listed coral *Acropora cervicornis* (D'Antonio et al., 2016), and therefore was selected to represent the NRC habitats on the 500-meter south grid line (***Table 2***).

Belt transects for biotic indicators of condition and sediment stress

Sampling in summer 2019 was expanded to include belt transects focused on biotic indicators of condition and sediment stress across three taxonomic groups (example datasheet is shown in ***Appendix 3***). Two belt transects, 10 meters by one meter in width, were surveyed to observe and record biotic indicators of sediment stress among stony corals, octocorals, and sponges and other visually apparent indicators of colony condition (e.g., no visually apparent stress, bleaching, disease, partial mortality unknown source and unknown stressor) (***Table 3***). The diver conducting the belt transect also photographed representative examples of sediment stress indicators that were recorded.

Sediment sampling

Surface sediments on the reef were collected at no more than 0.3 centimeters below the sediment-water interface where sediment depth was greater than 1.0 centimeter. At locations where the sediment depth was less, sediments were collected by gently scraping a metal tool or the cap of the sample container along the reef and scooping or pushing the sediments into the sample bottle. Sediment sample bottles were labeled with the location name, date of collection, and initials of the diver collecting the sample. Following field operations, sediment samples were de-watered and stored at room temperature. Two sediment samples were collected in winter 2017 at each location, one near the 15-meter mark and one near the 30-meter mark of the transect. Sampling activities were revised in summer 2019 to include only one sediment sample per location, collected near the 30-meter mark.

Sediment grain-size distribution and mineralogy analysis

Sediment samples were sent to a laboratory for processing (drying, crushing and grinding), sediment grain-size distribution analysis [dry sieving, seven size classes based on the Wentworth (1922) grain size scale] and analysis using X-ray diffraction and stable carbon-oxygen isotope techniques (see results in Swart 2018 and Swart 2020). Mineralogy of sediments [aragonite, quartz, low magnesium calcite (LMC), and high magnesium calcite (HMC)] was assessed to examine the proportion of geological Modern vs. pre-Modern sediments (i.e., surface sediments vs. sediments likely to have originated well below the surface) prior to the PEDP. LMC is usually a minor component of Modern carbonate reef sediments in south Florida, typically comprising less than five percent (Swart, 2016). Thus, using LMC values greater than 10 percent may provide a reliable threshold for suggesting the origin of sediments (Swart, 2016).

Video record

After sediment sample collection near the 30-meter mark, a diver recorded a slow 360 degree pan with a video camera at an appropriate oblique angle to view the reef habitat. The diver then swam slowly (~five meters per minute) from the 30-meter mark of the transect tape back to the mushroom anchor at the 0-meter mark with the video camera no more than one meter above the bottom, except to move over large sponges or octocorals, as needed. The camera was oriented perpendicular to the bottom to record in the plan view. Video of the 0-meter mark end of the transect was recorded in a 360 degree slow pan at an oblique angle to view the reef habitat.

Data entry and QA/QC

Following field data collection activities in 2017 and 2019, sediment depth data and metadata were entered into a Microsoft Excel spreadsheet. Winter 2017 spreadsheets were re-formatted to match the formatting of the 2019 data spreadsheet using a consistent approach for describing observations of reef. Spreadsheets included columns organized by location and direction from the channel to facilitate sorting and analyses. Biotic indicators of sediment stress and condition were entered into separate spreadsheets following the summer 2019 sampling. After completing the data entry, field datasheets were checked against the spreadsheet data to ensure accurate entries. Transect videos were reviewed as needed, to confirm whether measurements occurred on the reef, in a sand patch, or in a sand channel. Master copies of the winter 2017 and summer 2019 datasheets were stored on the NOAA Fisheries Service Google drive.

RESULTS

Sediment depths

Box plots with sediment depths measured on the reef in winter 2017 and summer 2019 are shown in ***Figure 2*** and ***Figure 3*** for locations north and south of the channel, respectively. Overall, mean sediment depths of 0.42 (± 0.46 SEM) centimeters were measured across all data (the two sampling events), four reef features (NRC, IR, MR and OR), and locations (north and south of the channel). The highest sediment depths were measured in locations north of the channel in 2017 [mean sediment depth of 0.5 (± 0.76 SEM) centimeters], mostly due to three sites within NRC and IR habitats which had mean values greater than 0.8 centimeters (50N-NRC-CPS, 100N-IRL, and 500N-NRC-CPS). After evaluation of the video collected from these three sites, it appears that they are in close proximity to sandcast material from the 1961-1963 channel deepening (USACE, 2022).

Biotic indicators of condition and sediment stress

Visually apparent indicators of condition and sediment stress for each stony coral, octocoral, and sponge are listed in ***Table 3.*** These were recorded in summer 2019 at two replicate 10-meter transects at each of the 53 locations for a total of 104 belt transects (total area surveyed was 1,040 square meters). Stony corals were four to five times less abundant compared to octocorals and sponges (N = 492 stony corals, N = 2,050 octocorals and N= 2,982 sponges assessed, data not shown). The large majority of organisms assessed for these three taxa had no visually apparent stress (between 80.2 to 86.9%, see ***Figure 4***). Indicators of reduced condition, such as disease or bleaching (see ***Table 3***), as well as sediment stress indicators (see ***Table 3***) were also relatively low (less than 11%, ***Figure 4***). In addition, less than 0.4% stony corals and less than 4% octocorals showed complete colony mortality (***Figure 4***).

Sediment grain-size distribution

The sediment grain-size distribution and mineralogy results include only samples collected near the 30-meter mark in 2017 and 2019. Results from the complete grain size analysis [seven size classes based on the Wentworth (1922) grain size scale] for each location are shown in Swart (2018) and Swart (2020), as well as in ***Appendix 4*** and ***Appendix 5***. Overall, silt and clay-sized sediments[1] (size class < 0.063 mm) represented less than 5% of the grain-size distribution at most locations in 2017 and 2019, with three exceptions: location 100S-NRC-RS (sampled in winter 2017) and locations 300N-OR-SG and 300N-MRL (sampled in summer 2019; see ***Appendix 4*** and ***Appendix 5***).

Figure 5 and ***Figure 6*** display the grain-size distribution data from 2017 and 2019 for four size classes. Of note, the silt and clay size class is considered biologically relevant (e.g., Piniak, 2007; Weber et al. 2006; Erftemeijer et al. 2012; Jones et al. 2016; Fourney and Figueiredo, 2017; Jones et al. 2019). Based on discussions with the Florida Department of Environmental Protection (FDEP) Beaches, Inlet and Ports Program (BIPP) staff, these four particle size classes included: silt and clay (< 0.063 mm), very fine and fine sand (0.063 to 0.250 mm), medium, coarse and very coarse sand (>0.250 to 2.00 mm) and pebbles (>2.00 mm), following the Wentworth (1922) grain-size distribution chart. Data are presented by reef feature (NRC, IR, MR and OR) in ***Figure 5*** and by distance from the channel in ***Figure 6.***

[1] Sometimes referred as "mud" in the literature

Overall, a similar grain size composition was found for sediment samples collected in north locations at all four reef features (NRC, IR, MR and ORC) regardless of sampling event (***Figure 5***). Samples collected closer to shore (NRC and IR) were predominantly composed of medium, coarse, and very coarse sand (mean percentages between 72.1 to 80.5%, see ***Figure 5***). However, sediments collected offshore (MR and OR) were composed of more similar fractions of very fine and fine sand (40.5 to 43.9%) and medium, coarse, and very coarse sand (50.0 to 50.6%), and also had higher fractions of pebbles (4.4 to 6.8%) compared to the NRC and IR habitats (***Figure 5***). The mean percentage of silt and clay-sized particles in samples did not exceed 2% across any of the reef features.

Regardless of distance from the channel (50 to 2,000 meters), locations south of the channel had a higher composition of medium, coarse, and very coarse sand (mean values between 60.4 to 71.7%) compared to locations north of the channel (***Figure 6***). North locations sited approximately 100 and 300 meters from the channel had the most similar fractions of very fine and fine sand and medium, coarse, and very coarse sand (means of 49.4 and 43.6%, respectively) compared to all other locations (***Figure 6***). Finally, locations approximately 300 meters in distance north from the channel also had the highest proportion of silt and clay-size particles (mean of 3.2%) compared to any of the other locations across both sampling events (***Figure 6***).

Sediment mineralogy

The complete mineralogy analysis from sediment samples collected in 2017 and 2019 include proportions of aragonite, high magnesium calcite (HMC), low magnesium calcite (LMC), quartz, and isotopic analysis of carbon and oxygen [results provided in Swart (2018), Swart (2020), and ***Appendix 6*** and ***Appendix 7***]. Overall, the proportion of LMC in the sediment samples ranged from 0 to 29.3% in winter 2017 and from 0 to 50.9% in summer 2019 (mean LMC values of 6.4% in 2017 and 5.4% in 2019) (see ***Appendix 6*** and ***Appendix 7***). In both 2017 and 2019, the concentration of LMC was highest (> 25%) close to the existing Port Everglades inlet (outside the jetties), as well as in offshore locations in the OR habitat line approximately 500 to 1,000 meters south of the channel (locations depicted in red in ***Figure 7*** and ***Figure 8***).

DISCUSSION

Our main goals are to develop the baselines for ambient standing sediment depths, sediment grain-size distribution and mineralogy in coral reefs areas located near Port Everglades, and the biotic indicators associated with sediment stress in three main groups of benthic taxa present in the area. These baselines will be used when implementing the PDEP's Monitoring and Adaptive Management plans.

Sediment depths

Mean sediment depths measured on reef habitat were largely consistent across most locations surveyed (north or south of the channel) in both sampling events (0.42 ± 0.46 SEM centimeters). While we saw no difference between sampling events, we still expect the full baselines will show seasonal differences baseline because wave and wind conditions typically observed in winter and summer in South Florida differ (USACE, 2022, Appendix H; U.S. Wave Information Study, National Climatic Data Center, NESDIS, NOAA[2]). These data may help identify acceptable limits of change ("thresholds") related to sedimentation (e.g., Tuttle and Donahue, 2020) to use in PEDP's Monitoring and Adaptive Management plans. Nelson et al. (2016) applied a particle tracking model to predict potential impacts of dredging-related sedimentation on coral reef ecosystems at Apra Harbor, Guam. Results suggested that total depths of sediment deposition between 0.5 to 1.0 centimeter can result in moderate to high stress on coral habitat, whereas total depths of sediment deposition greater than 1.0 centimeter can result in severe stress on coral habitat and mortality of coral colonies. This suggests that many of the habitat locations surveyed at Port Everglades may be at or near the point of stress even under ambient conditions (no dredging), and this should be considered when developing thresholds for the PDEP's Monitoring and Adaptive Management plans.

Biotic indicators of condition and sediment stress
Belt transects were conducted in 2019 to assess biotic indicators of condition and sediment stress on stony corals, octocorals and sponges under ambient conditions prior to dredging. Results showed that the large majority of organisms assessed had no visually apparent stress (between 80.2 to 86.9%), with sediment stress indicators observed in <11% of the organisms assessed for any given group taxa. Even though this region has been affected by an unprecedented multi-species disease outbreak (referred as Stony Coral Tissue Loss Disease or SCTLD) since 2014 (Walton et al. 2018), disease was only observed in <0.3% of the stony corals assessed in this study (data not shown in this report but recorded in the spreadsheets). Of note, some of the organisms had multiple indicators of condition and/or sediment stress on the same colony (e.g., disease, partial mortality, and sediment accumulation), but the number of indicators which occurred per colony was not recorded in the field datasheets and methods should be adjusted in future sampling events to address this. Further, the belt transect approach did not yield information needed for rapidly quantifying densities of benthic organisms or assessing their taxonomy. Other methods such as photo quadrats and demographic transects may be more appropriate for this task but may also require additional dive time.

Indicators of condition and sediment stress can be valuable over time for assessing potential dredge-related impacts, especially when these data are combined with sediment depth measurements and baseline data can improve those assessments (Miller et al. 2016).

Sediment grain-size distribution
Sediment samples from 2017 and 2019 assessed for grain-size distribution were dominated by very fine and fine sand (0.063 to 0.250 mm) and medium, coarse, and very coarse sand (>0.250 to 2.00 mm) across all locations, regardless of year/season, reef feature, or distance from the channel. Silt and clay-sized sediments (size class < 0.063 mm) represented <5% of the total grain-size distribution at most locations assessed in both years/seasons. Adverse sedimentation effects are depend on the grain size and sediment composition of suspended sediments (e.g., Weber et al. 2006; Weber et al. 2012; Erftemeijer et al. 2012; Storlazzi et al. 2015; Jones et al. 2016; Jones et al. 2019). Silt and clay-sized sediments (<0.063 mm) frequently have a more adverse impact than sand because their different physical and chemical properties makes them more cohesive and likely to bind nutrients better, typically leading to a more active bacterial

[2] https://www.ncei.noaa.gov/access/metadata/landing-page/bin/iso?id=gov.noaa.ncdc:C00071

community (reviewed in Erftemeijer et al. 2012). In addition, Storlazzi et al. (2015) experimentally showed that finer-grained sediments attenuate light significantly more than coarser sediments because they settle more slowly and are more prone to being resuspended, thus causing a greater net reduction in light essential for photosynthesis over a greater duration. Further, Fourney and Figueiredo (2017), showed that fine-grained sediments from Port Everglades inner harbor areas <0.125 mm in size (which include silt, clay and very fine sands) can have detrimental effects on corals, particularly at early life stages.

Sediment mineralogy

Mineralogy was assessed to examine the proportion of geological Modern vs. pre-Modern sediments (i.e., surface sediments vs. sediments likely to have originated well below the surface and brought to the surface by dredging or another process) prior to the PEDP. Typical concentrations of LMC in Modern carbonate reef sediments in south Florida are usually very low (around 5 to 10%). Thus, elevated levels of LMC (> 10%) on coral reef habitats can be indicative of older reef sediments likely liberated during dredging of geologic formations, such as the Fort Thompson and Anastasia formations (Swart, 2016), where these higher LMC levels are common. In this study, two areas in the Port Everglades assessment area showed elevated levels of LMC in both sampling events. One area of high LMC levels was observed in the area known locally as the submerged breakwaters, north and south of the channel, near the jetties (USACE, 2022). The other was observed on the OR habitat line south of the channel that has been described as a location of "short dumping" of rock from historical dredging operations of the Port Everglades channel (USACE, 2022), providing further evidence that LMC can indicate the geologic source of sediments in the vicinity of the PEDP.

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE SURVEYS

- The combination of the rapid assessment methods described in this report with more detailed, slower benthic demographic and photographic quantitative assessments [such as those proposed by USACE (2022, Appendix G)] is expected to play a large role in evaluating potential impacts from the project and providing rapid information to help decision-making during dredging operations.
- Standardizing the distance, direction, reef feature, and habitat description nomenclature improves the clarity of the naming convention used to describe locations of sampling. Reference locations for project monitoring should be named using the same distance, direction, reef feature, and habitat naming convention.
- Reef sediment depths, sediment grain-size analysis, and mineralogy (including X-ray diffraction and stable carbon oxygen isotope analysis) may provide a reliable method to determine if dredging has impacted coral reef habitats. Mineralogy and sediment grain-size distribution may provide information on sources of sediments in the PEDP, but take longer to analyze since samples need to be sent to a laboratory for processing and analysis.
- Initial diver attempts to characterize sediment texture via visual and tactile observations resulted in high inter-observer variability and an overestimate of fines. If diver-based observations of sediment texture are to be part of future monitoring events, a comparator card or visual field guide and additional diver training is recommended.
- Biotic indicators of condition and sediment stress can provide useful information for assessing biological and physical changes resulting from dredging projects to coral reef

organisms and habitats. However, future surveys should record the number of indicators occurring on a single colony in the field datasheet, in addition to the occurrence of each indicator.

- Additional considerations could include focusing the assessment of biotic indicators of condition and sediment stress on the giant barrel sponge *Xestospongia muta*, a particularly dominant sponge taxon on Caribbean reefs known to provide habitat complexity and heterogeneity (e.g., McMurray et al. 2015).

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Table 1. Reef features, habitat types, and habitat abbreviations used in the naming convention for each location. Habitat types are based on the benthic characterization by Walker et al. (2008) and Walker and Klug (2014).

Reef Feature	Habitat Types	Habitat Abbreviation
Nearshore Ridge Complex	Nearshore Ridge Complex Ridge Shallow	NRC-RS
	Nearshore Ridge Complex Colonized Pavement Shallow	NRC-CPS
Inner Reef	Inner Reef Linear	IRL
Middle Reef	Middle Reef Linear	MRL
Outer Reef	Outer Reef Linear	ORL
	Outer Reef Spur and Groove	OR-SG
	Outer Reef Aggregated Patch Reef Deep	OR-APD

Table 2. GPS coordinates (in decimal degrees) for each sampling location displayed in **Figure 1**.

Location	Direction from channel	Grid line (meters)	Latitude	Longitud e
50N-NRC-CPS	N	100	26.09545	-80.10138
50N-ORL	N	100	26.09511	-80.084
100N-IRL	N	100	26.09545	-80.09461
150N-MRL	N	100	26.09586	-80.08881
300N-ORL	N	300	26.09713	-80.08351
300N-OR-SG	N	300	26.09713	-80.08255
300N-MRL	N	300	26.09713	-80.0878
500N-ORL	N	500	26.09893	-80.08328
500N-MRL	N	500	26.09893	-80.08746
500N-IRL	N	500	26.09893	-80.0932
500N-NRC-CPS	N	500	26.09893	-80.09681
700N-ORL	N	700	26.1007	-80.0832
700N-MRL	N	700	26.1007	-80.08771
700N-IRL	N	700	26.1007	-80.0932
700N-NRC-CPS	N	700	26.1007	-80.09835
1000N-ORL	N	1,000	26.1033	-80.0825
1000N-MRL	N	1,000	26.1033	-80.08693
1000N-IRL	N	1,000	26.1033	-80.09286
1000N-NRC-CPS	N	1,000	26.1033	-80.09503
1500N-OR-APD	N	1,500	26.10795	-80.08088
1500N-MRL	N	1,500	26.10795	-80.08655
1500N-IRL	N	1,500	26.10795	-80.09241
1500N-NRC-CPS	N	1,500	26.10795	-80.09558
2000N-ORL	N	2,000	26.11233	-80.0812
2000N-MRL	N	2,000	26.11233	-80.08575
2000N-IRL	N	2,000	26.11233	-80.09223
2000N-NRC-CPS	N	2,000	26.11233	-80.09598
50S-ORL	S	100	26.0924	-80.08418
100S-MRL	S	100	26.09193	-80.08888
100S-IRL	S	100	26.09193	-80.09365
100S-NRC-RS	S	100	26.09193	-80.10271
300S-ORL	S	300	26.08988	-80.08413
300S-MRL	S	300	26.08988	-80.09125
300S-IRL	S	300	26.08988	-80.09381
300S-NRC-CPS	S	300	26.08988	-80.09945
500S-ORL	S	500	26.08793	-80.0843
500S-IRL	S	500	26.08793	-80.094
500S-NRC-RS	S	500	26.08793	-80.10236
700S-ORL	S	700	26.08621	-80.08465

Location	Direction from channel	Grid line (meters)	Latitude	Longitud e
700S-MRL	S	700	26.08621	-80.08958
700S-IRL	S	700	26.08621	-80.09461
700S-NRC-CPS	S	700	26.08621	-80.09885
1000S-ORL	S	1,000	26.08345	-80.08486
1000S-MRL	S	1,000	26.08345	-80.0901
1000S-IRL	S	1,000	26.08345	-80.09446
1000S-NRC-CPS	S	1,000	26.08345	-80.09918
1500S-ORL	S	1,500	26.07895	-80.08506
1500S-MRL	S	1,500	26.07895	-80.09155
1500S-IRL	S	1,500	26.07895	-80.09446
1500S-NRC-CPS	S	1,500	26.07895	-80.10365
2000S-ORL	S	2,000	26.07446	-80.08518
2000S-MRL	S	2,000	26.07446	-80.09253
2000S-IRL	S	2,000	26.07446	-80.09548
2000S-NRC-RS	S	2,000	26.07446	-80.10383

Table 3. Coral reef taxa (stony corals, octocorals, and sponges) assessed for visual indicators of condition and sediment stress in summer 2019. All = stony corals, octocorals, and sponges.

Taxa	Condition indicators	Reduced condition indicators	Sediment stress indicators
All	No visually apparent stress		
All		Disease	
All		Bleaching	
All		Dead	
All		Partial mortality (unknown source)	
All		Unknown stressor	
Octocorals		Loose on seabed	
All			Multiple sediment stress indicators
All			Partial mortality from sediment
Stony corals and octocorals			Sediment accumulation
Stony corals			Partial mortality from sediment (halo)
Octocorals			Buried holdfast
Octocorals and sponges			Eroded axis
Octocorals			Epiphyte load with sediment
Sponges			Sediment in tissue
Sponges			Sediment accumulation in atrial cavity
Sponges			Buried basal attachment

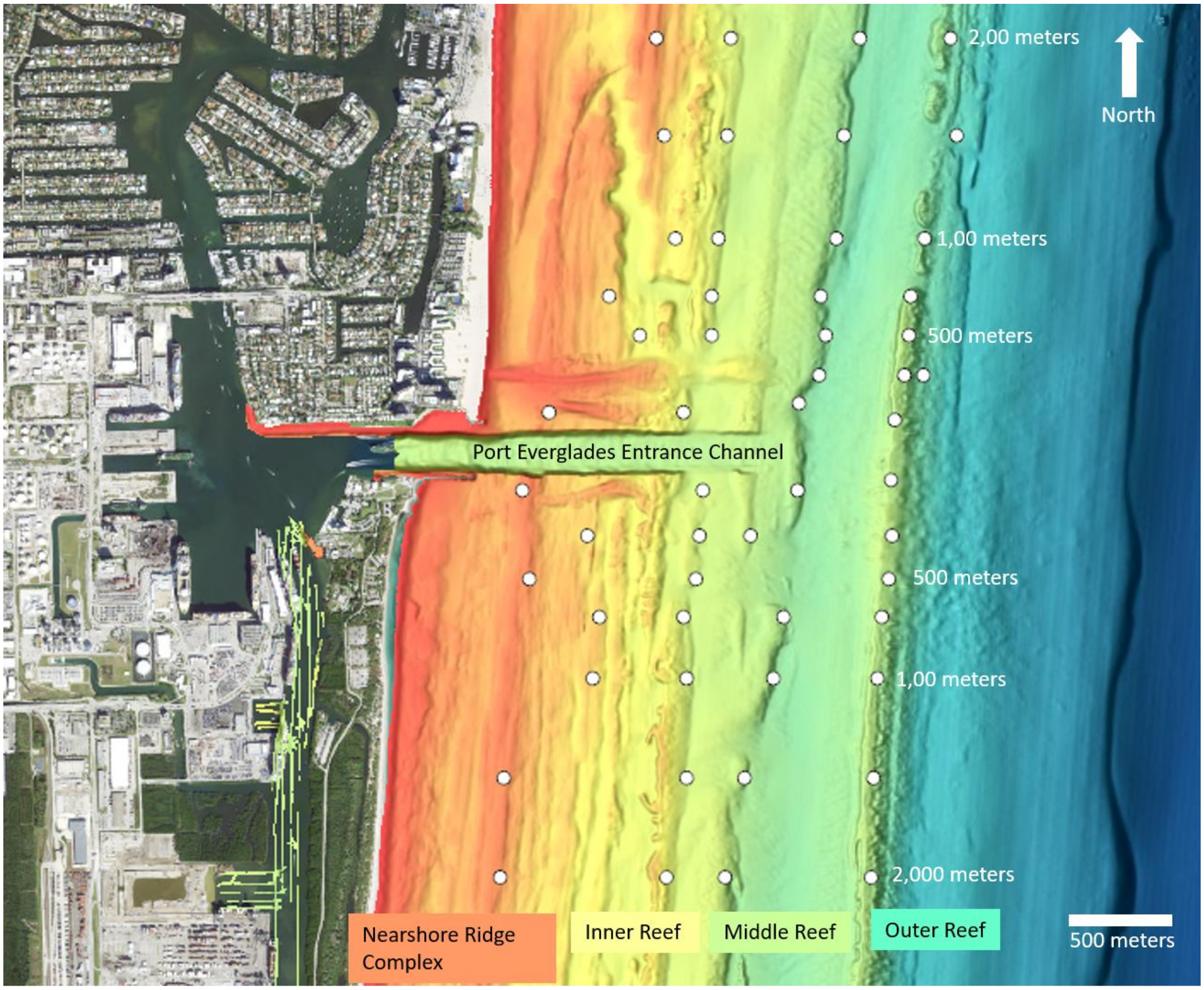


Figure 1. Port Everglades study area with 54 sample locations overlying the four major coral reef features Nearshore Ridge Complex (NRC), Inner Reef (IR), Middle Reef (MR) and Outer Reef (OR). Sample locations are at distances of approximately 50 to 2,000 meters from the Port Everglades entrance channel edge as measured using Google Earth Pro. In areas where more than one reef feature and habitat type were present along the east-west grid line, (e.g. Middle Reef Linear north), sampling was conducted on the most seaward occurrence of the habitat type.

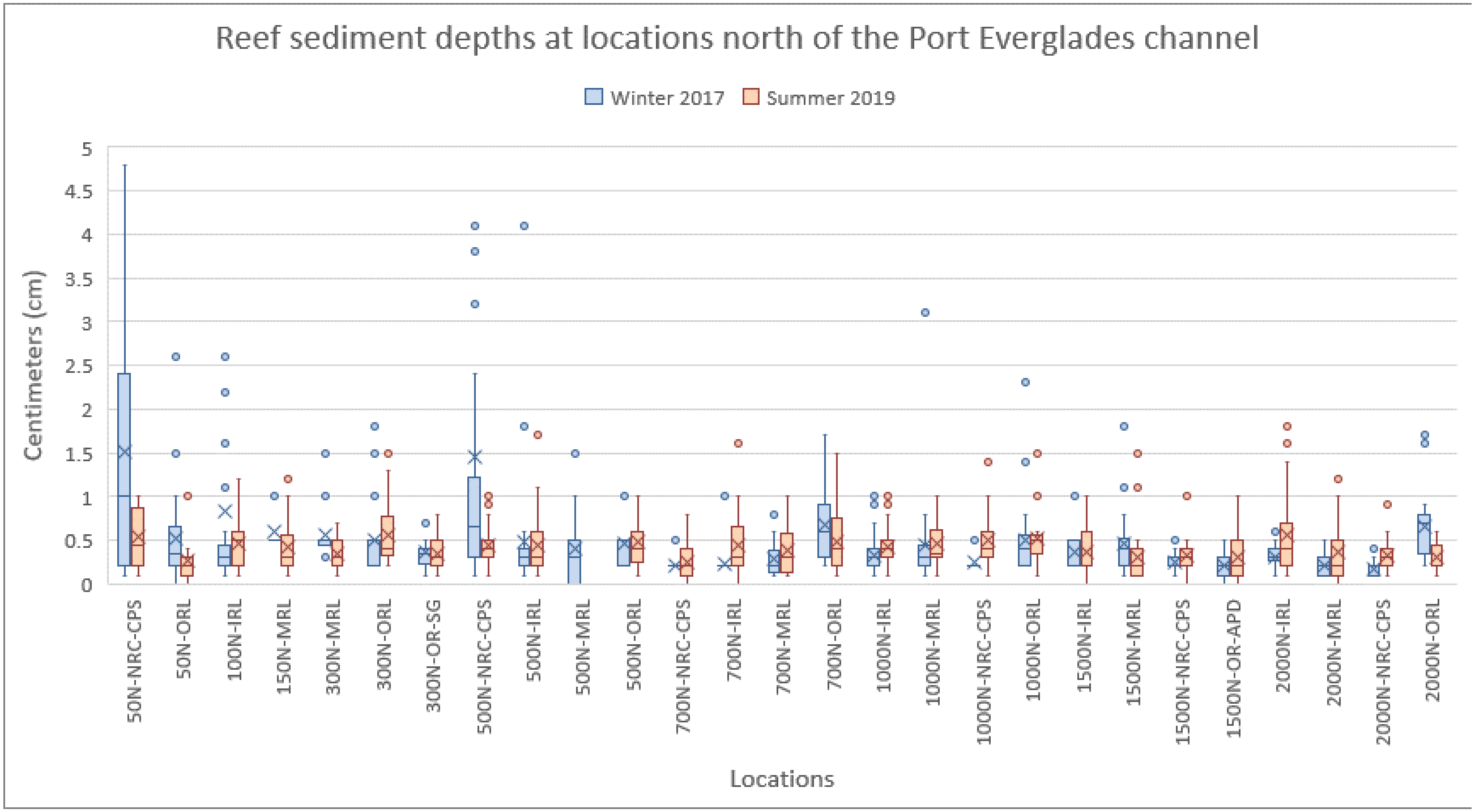


Figure 2. Box plot of sediment depths measured on reef at locations north of the Port Everglades entrance channel in winter 2017 and summer 2019. Locations are sorted by distance from the channel. Mean sediment depths are denoted by "X". Outliers are shown as individual points. The bottom line in the box represents the first quartile. The whiskers extend from the end of the box to represent variability outside the first and third quartile.

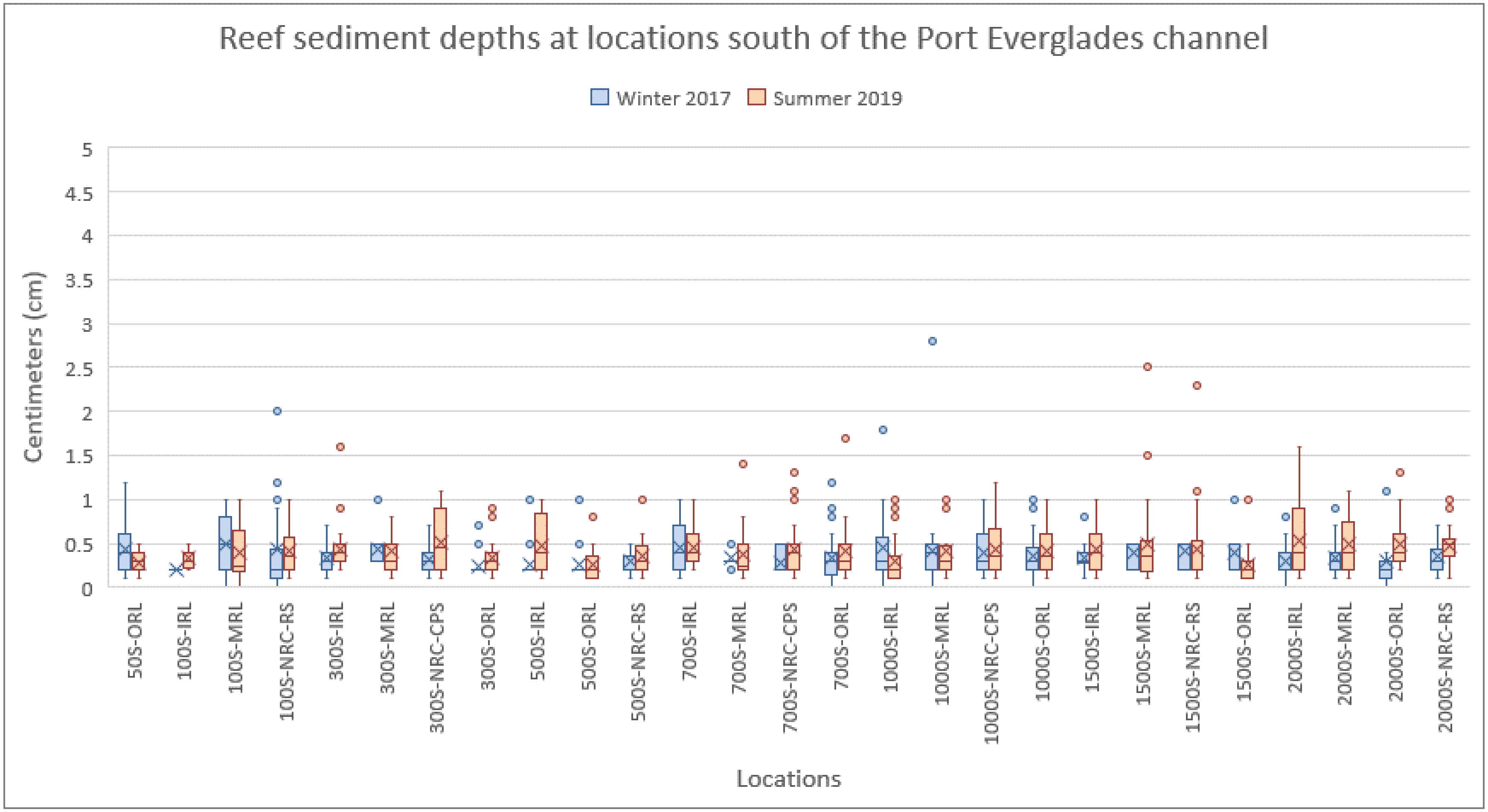


Figure 3. Sediment depths measured on reef at locations south of the Port Everglades entrance channel in winter 2017 and summer 2019. Locations are sorted by distance from the channel. Mean sediment depths are denoted by “X”. Outliers are shown as individual points. The bottom line in the box represents the first quartile. The whiskers extend from the end of the box to represent variability outside the first and third quartile.

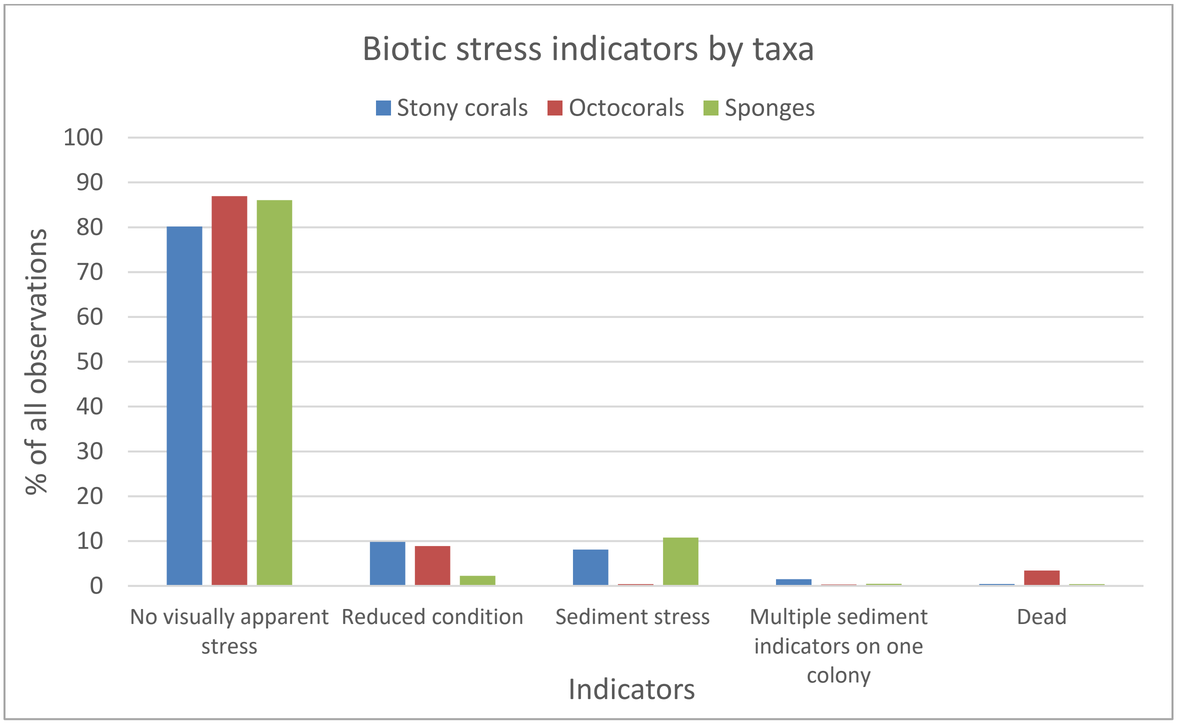


Figure 4. Indicators of condition and sediment stress for each of the three taxa groups assessed (corals, octocorals and sponges) compiled from observations in summer 2019. Reduced condition and sediment stress indicators are listed in **Table 3**.

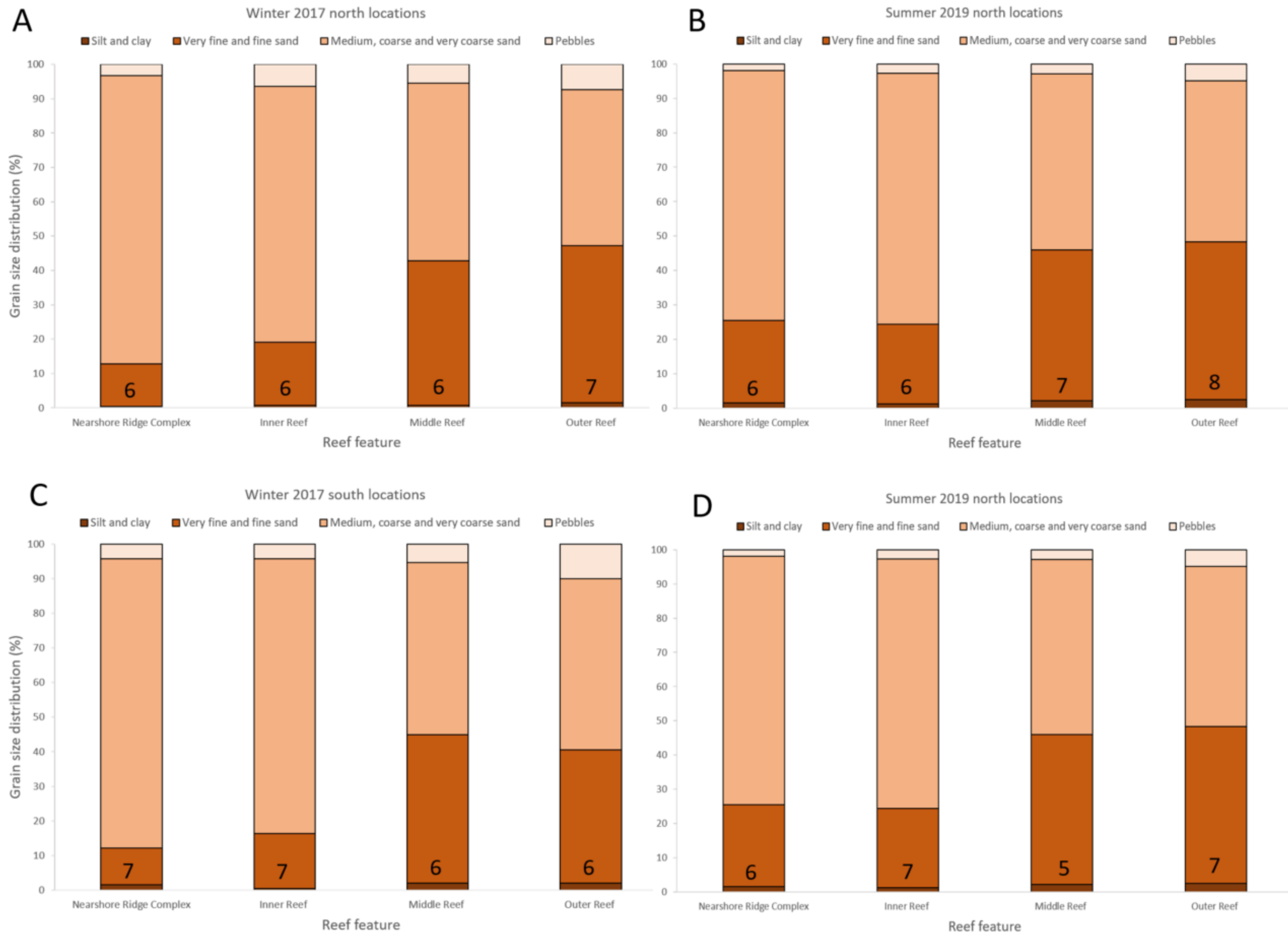


Figure 5. Sediment grain-size distribution from sediment collected at locations north (A and B) or south (C and D) of the Port Everglades channel in 2017 (A and C) and 2019 (B and D). Data presented by reef feature. The sediment categories are: silt and clay (<0.063 mm), very fine and fine sand (0.063 to 0.250 mm), medium, coarse and very coarse sand (>0.250 to 2.00 mm) and pebbles (>2.00 mm) following the Wentworth (1922) grain-size distribution chart. The number of locations assessed in each reef feature is denoted in each bar.

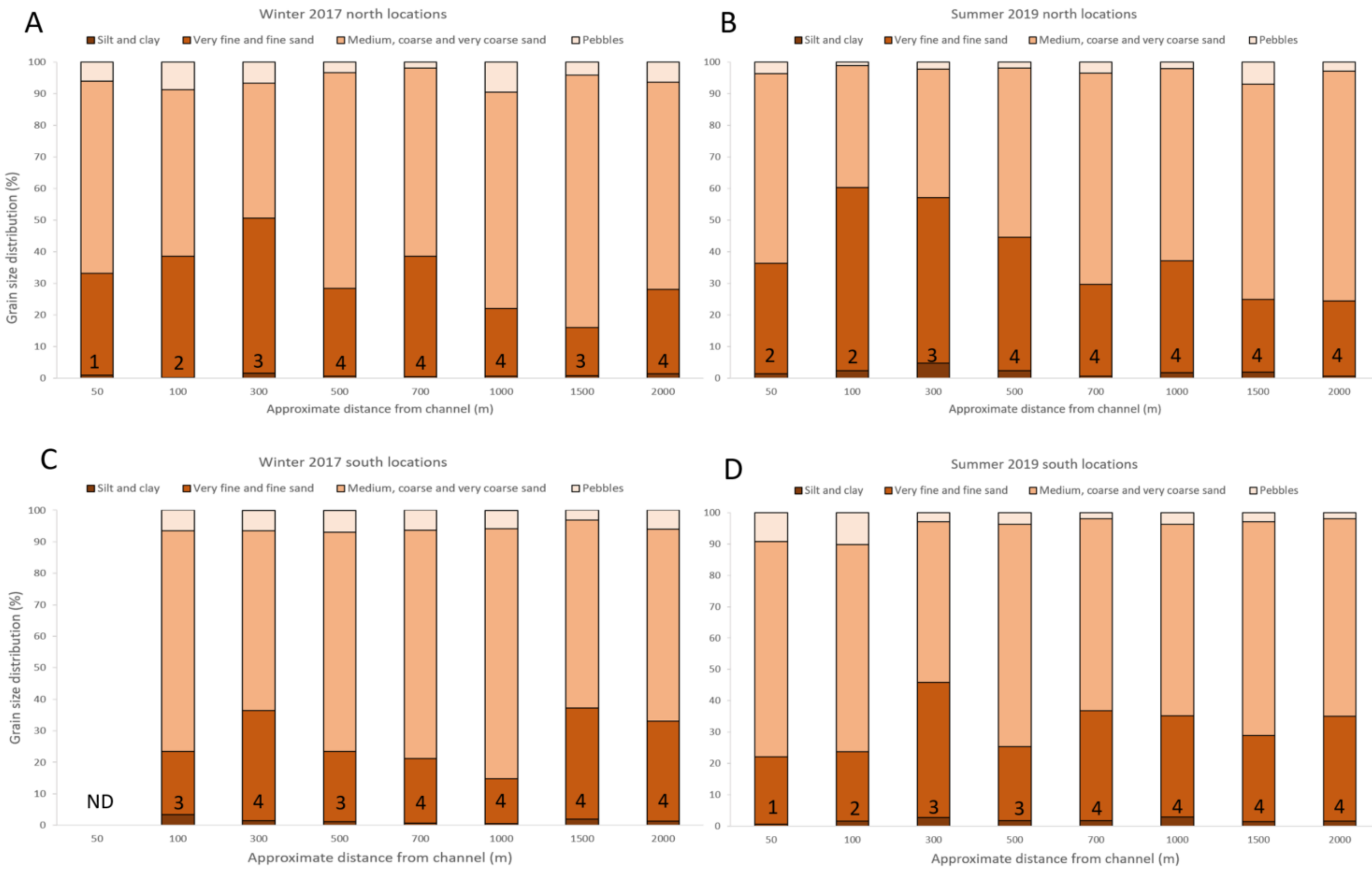


Figure 6. Sediment grain-size distribution from sediment collected at locations north (A and B) or south (C and D) of the Port Everglades in 2017 (A and C) and 2019 (B and D). Data presented by distance from the channel. Location 150N-MRL was pooled with the 100 meter locations. The sediment categories are: silt and clay (<0.063 mm), very fine and fine sand (0.063 to 0.250 mm), medium, coarse and very coarse sand (>0.250 to 2.00 mm) and granules (>2.00 mm) following the Wentworth (1922) grain-size distribution chart. The number of locations assessed in each distance is denoted in each bar. ND denotes no data.

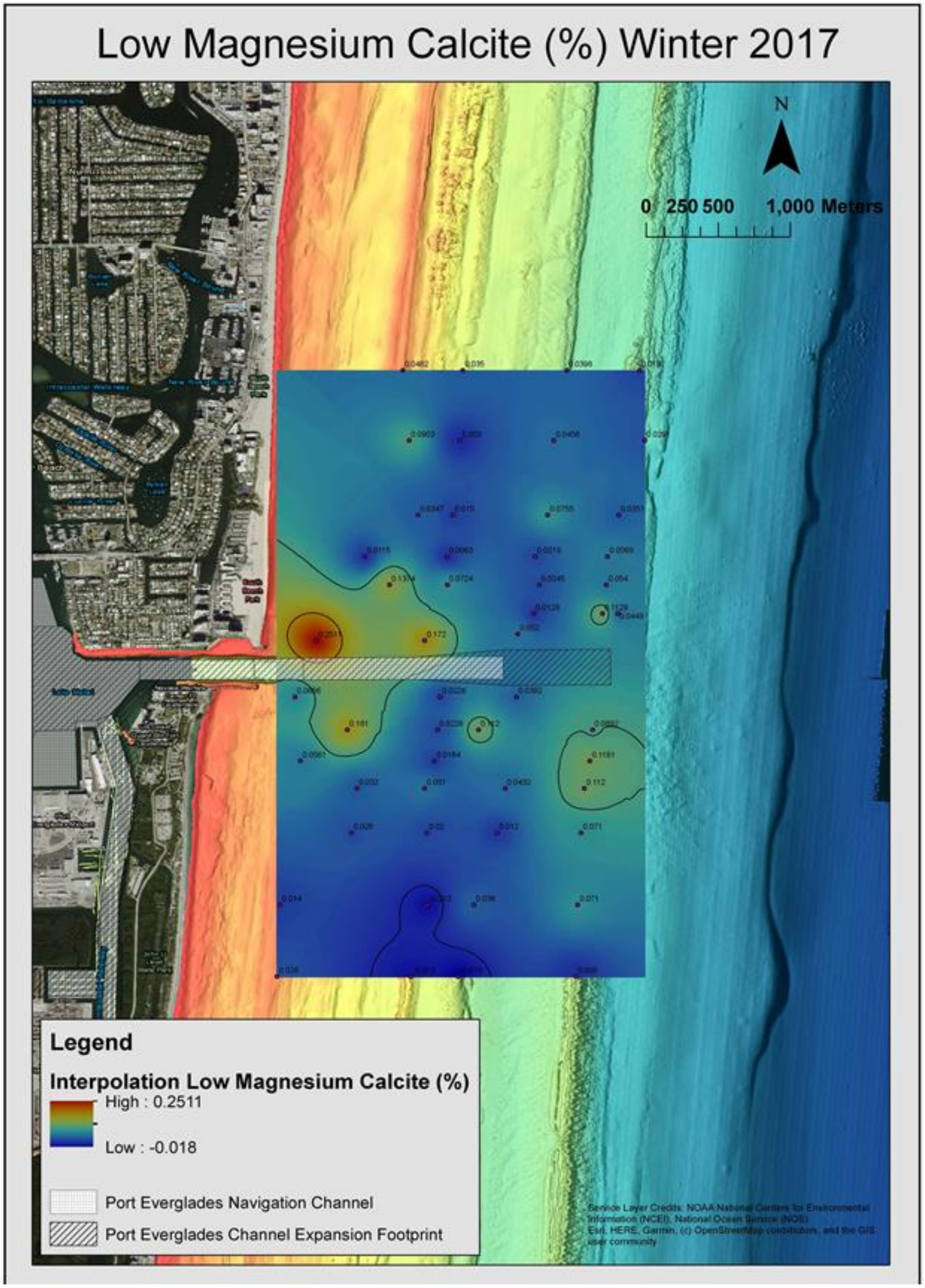


Figure 7. Interpolation map of the percentage of low magnesium calcite (LMC) in sediment samples collected in winter 2017 (from Swart, 2018).

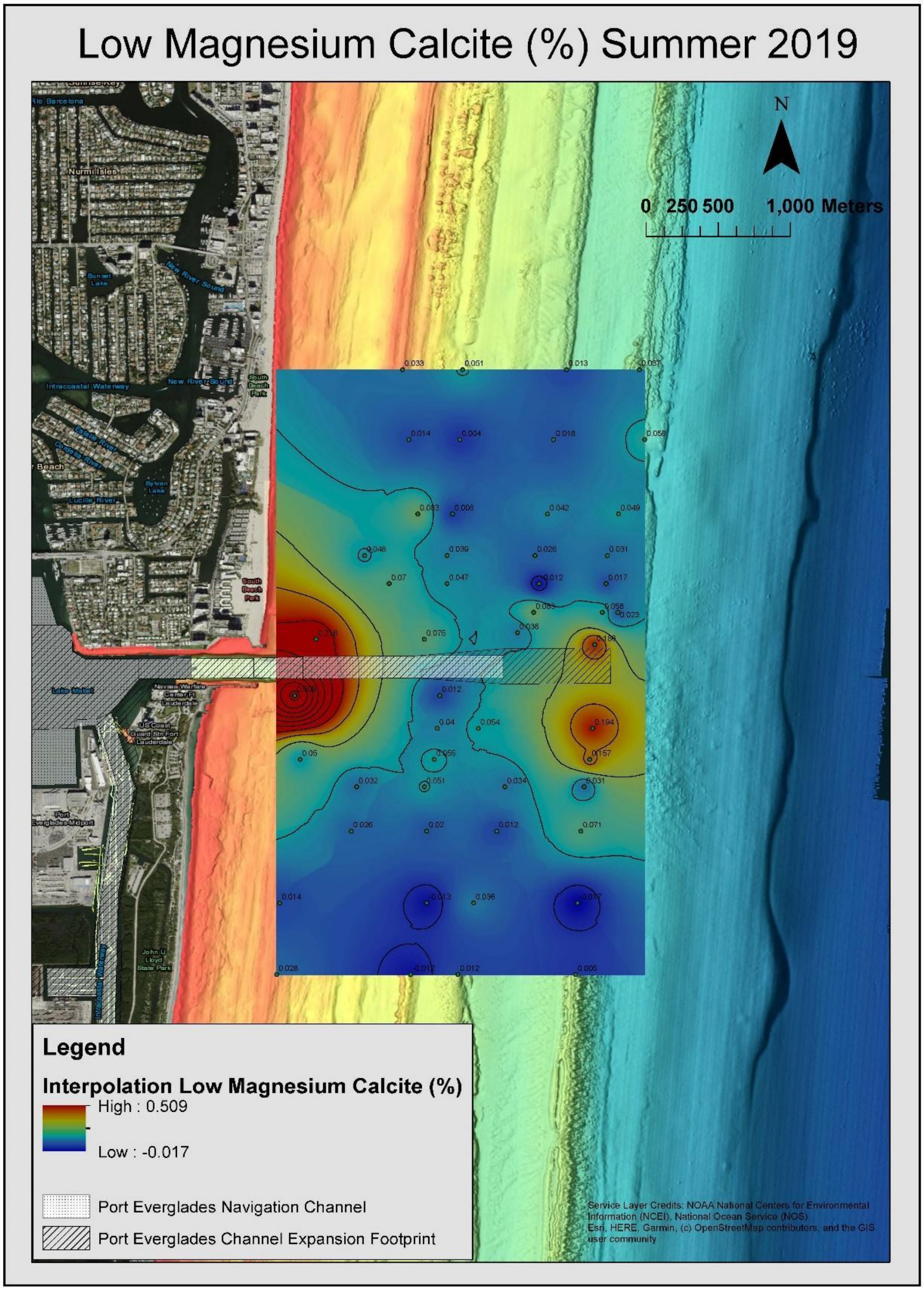
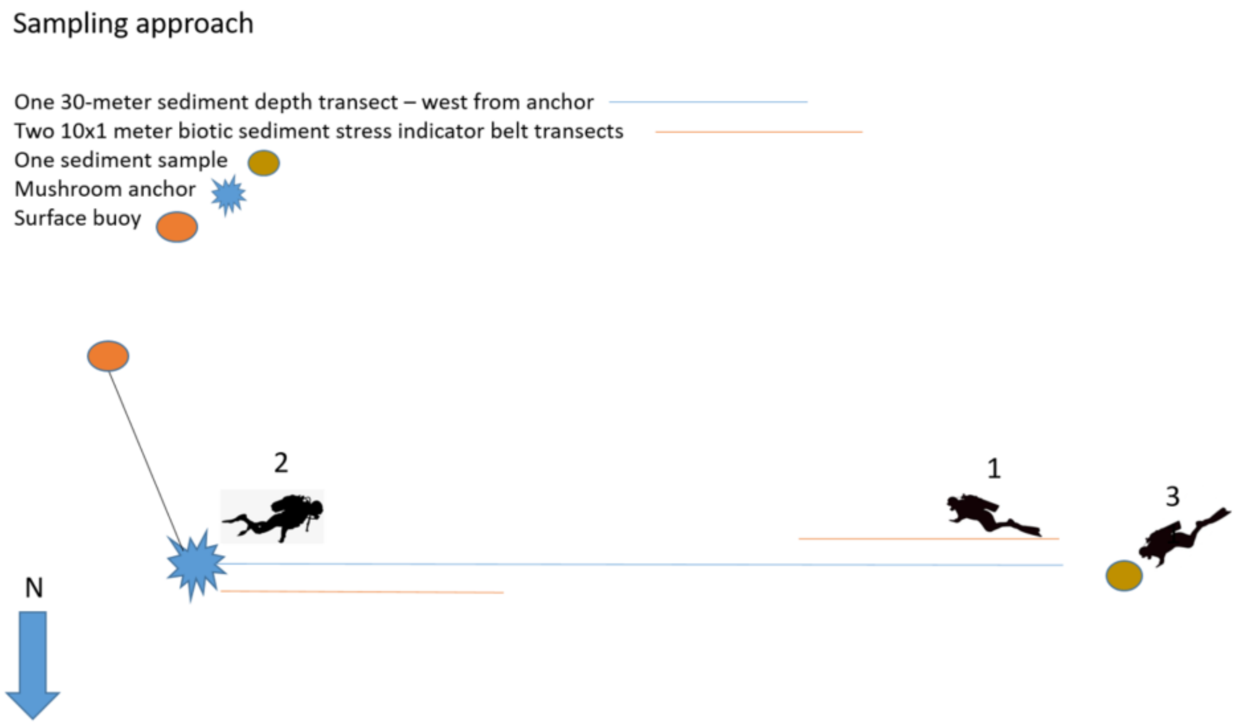


Figure 8. Interpolation map of the percentage of low magnesium calcite (LMC) in sediment samples collected in summer 2019 (from Swart, 2020).

Appendices

Appendix 1. Example sampling approach for sediment depth and biotic sediment stress indicator surveys.



Appendix 2. Example field datasheet for collecting sediment depths. Each datasheet can accommodate up to four interval sediment depth transects.

Date:			
Buddy Pair: (Transect diver/Sediment collection diver)			
Location-Habitat Codes:			
Water Depth/Visibility(in feet)			
Sediment Depth Measurements to nearest 0.1 cm *SC denotes sand channel within reef habitat; *SP denotes sand patch within reef habitat; *R denotes Reef habitat (record when sediment depth is greater than 1.0 cm)			
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9
10	10	10	10
11	11	11	11
12	12	12	12
13	13	13	13
14	14	14	14
15	15	15	15
16	16	16	16
17	17	17	17
18	18	18	18
19	19	19	19
20	20	20	20
21	21	21	21
22	22	22	22
23	23	23	23
24	24	24	24
25	25	25	25
26	26	26	26
27	27	27	27
28	28	28	28
29	29	29	29
30	30	30	30
Notes:	Notes:	Notes:	Notes:

Appendix 3. Example field datasheet for collecting biotic indicators of condition and sediment stress.

Site____________ Date__________ Diver______________ Meters completed_____

Transect 1 Transect 2 Algal Turf Buried by project-related sediment Y N

Scleractinian coral indicators:	******************
No visually apparent stress NVS	
Partial mort. sediment - halo PMH	
Partial mort. sediment non-halo PMS	
Sediment accumulation SA	
Disease DS	
Bleaching B	
Unknown stress US	
Partial mort. unknown source PMU o= old; r=recent mortality	
Dead DD	
Octocorals indicators:	******************
No visually apparent stress NVS	
Buried holdfast BH	
Partial mort. from sediment PMS	
Sediment accumulation SA	
Epiphytic load with sediment ELS	
Bleaching B	
Disease DS	
Eroded axis but still attached EA	
Loose on seabed LOS	
Dead DD	
Unknown stress US	
Partial mort. unknown source PMU	
Sponges indicators:	******************
No visually apparent stress NVS	
Partial mort. from sediment PMS	
Burial of basal attachment BBA	
Eroded axis/base EAB	
Sediment accumulation in tissues SIT	
Sediment accumulation in atrial cavities SAAC	
Dead DD	
Disease DS	
Bleached B	
Partial mort. unknown source PMUS	
Unknown stress US	

Appendix 4. Sediment grain-size distribution for winter 2017 sediments excerpted from Swart (2018). Some location names have been modified for consistency with the naming convention used in **Table 1** and **Table 2**. ND denotes no data.

Location	> 4 mm (%)	2-4 mm (%)	0.5-2 mm (%)	0.25-0.5 mm (%)	0.125-0.25 mm (%)	0.063-0.125 mm (%)	<0.063 mm (%)
150N-MRL	0.00	0.63	13.01	18.62	62.15	5.47	0.12
100N-IRL	13.50	3.41	39.61	34.10	8.25	1.01	0.11
50N-NRC-CPS	4.93	1.09	11.31	49.57	26.55	5.65	0.89
300N-OR-SG	7.60	7.98	27.04	16.58	24.30	14.01	2.49
300N-ORL	0.00	0.53	11.36	21.31	46.01	19.10	1.68
300N-MRL	0.00	4.07	31.05	20.55	35.46	8.31	0.56
500N-ORL	3.79	2.96	29.21	14.91	30.94	17.03	1.15
500N-MRL	0.00	4.74	34.80	19.95	29.91	9.69	0.91
500N-IRL	0.00	1.49	33.54	46.31	16.94	1.42	0.29
500N-NRC-CPS	0.00	0.42	61.85	32.51	4.31	0.69	0.22
700N-ORL	0.00	0.42	8.60	11.52	54.85	23.50	1.11
700N-MRL	2.08	0.43	16.66	28.44	46.17	5.80	0.41
700N-IRL	0.42	2.33	44.16	38.76	12.41	1.62	0.30
700N-NRC-CPS	1.02	1.33	61.16	28.55	6.22	1.38	0.34
1000N-ORL	2.76	7.34	36.32	11.98	26.70	13.47	1.43
1000N-MRL	2.01	3.54	49.39	16.28	20.74	6.88	1.17
1000N-IRL	10.49	2.31	52.27	27.05	7.07	0.71	0.10
1000N-NRC-CPS	8.03	1.79	43.48	36.54	9.01	0.99	0.16
1500N-OR-APD	4.38	7.17	45.39	17.60	16.41	7.86	1.18
1500N-MRL	1.29	10.90	18.26	20.70	28.78	16.71	3.37
1500N-IRL	0.00	0.95	31.59	45.83	16.84	3.72	1.06
1500N-NRC-CPS	0.00	0.20	87.17	11.80	0.70	0.13	0.00
2000N-ORL	1.99	4.21	46.67	19.90	17.63	8.47	1.13
2000N-MRL	13.46	1.39	27.69	34.08	16.54	5.56	1.27
2000N-IRL	0.50	3.30	22.90	30.86	29.63	10.49	2.31
2000N-NRC-CPS	0.00	0.64	20.76	59.37	15.04	3.31	0.88
50S-ORL	ND	ND	ND	ND	ND	ND	ND
100S-MRL	3.35	10.25	35.74	24.26	19.26	5.93	1.21
100S-IRL	2.39	3.27	69.51	20.15	4.03	0.60	0.04
100S-NRC-RS	0.00	0.29	19.50	40.98	13.32	17.01	8.91
300S-ORL	2.11	3.13	13.59	17.92	33.73	25.68	3.83
300S-MRL	0.00	2.59	19.91	32.23	41.49	3.41	0.36
300S-IRL	0.00	0.78	38.45	49.99	9.55	1.15	0.08
300S-NRC-CPS	8.22	8.99	22.26	34.02	18.06	6.53	1.92
500S-ORL	9.90	4.52	20.37	18.85	25.47	17.93	2.95
500S-IRL	0.00	1.03	38.53	39.50	17.92	2.60	0.42
500S-NRC-RS	3.45	2.21	38.15	53.01	2.66	0.43	0.08
700S-ORL	10.50	4.00	32.40	33.60	15.30	3.90	0.30
700S-MRL	0.38	6.03	42.75	17.50	23.32	8.78	1.24
700S-IRL	0.00	2.21	38.40	31.16	23.08	4.00	1.16

Location	> 4 mm (%)	2-4 mm (%)	0.5-2 mm (%)	0.25-0.5 mm (%)	0.125-0.25 mm (%)	0.063-0.125 mm (%)	<0.063 mm (%)
700S-NRC-CPS	0.00	2.21	62.56	31.38	3.31	0.45	0.10
1000S-ORL	0.00	3.83	36.59	26.38	23.05	8.96	1.18
1000S-MRL	0.45	5.63	62.24	14.71	11.71	4.30	0.95
1000S-IRL	5.18	4.66	61.35	23.96	3.97	0.73	0.15
1000S-NRC-CPS	1.31	2.12	55.34	37.16	3.67	0.37	0.03
1500S-ORL	0.00	2.04	13.24	21.38	39.71	20.37	3.26
1500S-MRL	1.02	1.98	8.35	16.11	49.95	18.40	4.20
1500S-IRL	3.37	4.13	58.19	27.59	5.67	0.88	0.18
1500S-NRC-RS	0.00	0.12	23.49	70.27	5.29	0.70	0.13
2000S-ORL	16.88	2.97	38.02	24.73	13.19	3.91	0.31
2000S-MRL	0.00	0.74	8.72	16.13	52.44	17.75	4.23
2000S-IRL	0.88	2.01	12.48	46.29	34.21	3.22	0.92
2000S-NRC-RS	0.00	0.80	56.03	41.06	1.98	0.13	0.00

Appendix 5. Sediment grain-size distribution for winter 2017 sediments excerpted from Swart (2020). Some location names have been modified for consistency with the naming convention used in **Table 1** and **Table 2**. ND denotes no data.

Location	**> 4 mm (%)**	**2-4 mm (%)**	**0.5-2 mm (%)**	**0.25-0.5 mm (%)**	**0.125-0.25 mm (%)**	**0.063-0.125 mm (%)**	**<0.063 mm (%)**
50N-ORL	0.6	2.8	14.1	44.9	31.2	5.7	0.7
150N-MRL	0.9	1.1	13.7	18.7	52.9	10.9	1.8
100N-IRL	0.0	0.3	9.0	35.8	41.1	10.8	3.0
50N-NRC-CPS	2.9	1.1	16.3	44.5	25.7	7.2	2.2
300N-ORL	0.0	2.3	31.1	26.2	27.4	11.5	1.4
300N-OR-SG	1.1	2.1	16.2	14.3	37.5	22.4	6.4
300N-MRL	0.3	1.2	16.5	17.3	38.2	20.1	6.5
500N-ORL	0.0	1.9	20.6	23.1	38.2	14.0	2.3
500N-MRL	0.7	1.5	31.1	19.4	32.1	12.4	2.9
500N-IRL	1.0	2.1	20.8	39.9	27.3	6.6	2.3
500N-NRC-CPS	0.0	0.4	16.6	42.6	30.2	7.8	2.5
700N-ORL	1.9	2.8	20.2	16.3	43.7	14.4	0.7
700N-MRL	0.9	3.1	33.3	23.0	33.0	6.0	0.6
700N-IRL	0.0	5.1	42.8	35.9	13.4	2.1	0.7
700N-NRC-CPS	0.0	0.3	63.5	32.0	3.1	0.9	0.3
1000N-ORL	1.5	2.2	16.2	14.3	41.8	21.5	2.5
1000N-MRL	0.0	0.9	27.6	26.6	36.3	7.8	0.8
1000N-IRL	0.0	2.9	51.0	35.2	8.7	1.7	0.5
1000N-NRC-CPS	0.5	0.4	33.1	39.1	17.1	6.7	3.1
1500N-OR-APD	7.8	7.3	37.4	14.0	16.8	12.4	4.2
1500N-MRL	0.3	5.5	40.6	17.8	24.7	9.4	1.8
1500N-IRL	0.6	2.4	36.1	47.2	11.6	1.6	0.4
1500N-NRC-CPS	1.5	3.0	47.0	31.7	12.5	3.1	1.1
2000N-ORL	0.0	4.5	44.9	21.2	18.9	9.4	1.2
2000N-MRL	0.4	2.9	41.7	31.7	17.6	5.2	0.6
2000N-IRL	1.2	1.1	31.8	51.2	11.9	2.1	0.6
2000N-NRC-CPS	0.0	1.3	17.9	50.8	26.8	2.8	0.5
50S-ORL	3.9	5.3	29.5	39.1	18.4	3.1	0.6
100S-MRL	ND	ND	ND	ND	ND	ND	ND
100S-IRL	0.0	0.7	25.8	32.8	30.7	7.2	2.7
100S-NRC-RS	4.0	15.6	56.7	16.9	4.1	2.3	0.6
300S-ORL	0.0	1.3	19.6	34.8	28.2	11.9	4.2
300S-MRL	4.6	2.3	17.9	31.3	37.2	5.2	1.4
300S-IRL	0.0	0.3	13.2	37.1	39.0	7.7	2.6
300S-NRC-CPS	ND	ND	ND	ND	ND	ND	ND
500S-ORL	5.6	4.8	39.0	29.8	13.6	5.1	2.0

Location	> 4 mm (%)	2-4 mm (%)	0.5-2 mm (%)	0.25-0.5 mm (%)	0.125-0.25 mm (%)	0.063-0.125 mm (%)	<0.063 mm (%)
500S-IRL	0.0	0.3	16.1	44.8	28.6	7.7	2.4
500S-NRC-RS	0.0	0.2	17.0	66.2	12.8	2.9	0.9
700S-ORL	0.0	2.0	25.1	34.6	26.0	9.8	2.5
700S-MRL	0.0	1.4	23.5	22.1	41.2	10.2	1.6
700S-IRL	0.0	1.4	26.3	40.1	24.2	6.1	1.9
700S-NRC-CPS	1.3	1.7	26.0	47.4	18.8	3.8	0.9
1000S-ORL	0.0	4.7	27.9	27.8	24.5	11.7	3.4
1000S-MRL	1.0	4.3	27.3	16.6	33.5	12.9	4.3
1000S-IRL	3.0	0.9	21.4	39.9	24.7	7.4	2.6
1000S-NRC-CPS	0.0	1.0	37.9	45.6	11.6	2.7	1.2
1500S-ORL	2.1	5.0	31.6	25.2	20.8	12.1	3.1
1500S-MRL	0.0	0.7	21.3	26.6	41.0	8.9	1.4
1500S-IRL	0.0	3.6	41.2	39.2	12.8	2.5	0.7
1500S-NRC-CPS	0.0	0.5	17.4	70.3	10.5	0.9	0.4
2000S-ORL	0.5	1.4	26.7	32.1	27.4	10.2	1.8
2000S-MRL	0.4	4.5	30.2	19.5	33.4	9.8	2.3
2000S-IRL	0.0	0.3	1.9	52.0	37.6	6.2	2.0
2000S-NRC-RS	0.0	1.2	34.1	55.3	7.8	1.3	0.3

Appendix 6. Mineralogy results from winter 2017 sediment samples excerpted from Swart (2018). Some location names have been modified for consistency with the naming convention used in **Table 1** and **Table 2**. ND denotes no data.

Location	**Aragonite Faction (%)**	**High-Mg Calcite Fraction (%)**	**Low-Mg Calcite Fraction (%)**	**Quartz Fraction (%)**	**Carbon**	**Oxygen**
50N-ORL	ND	ND	ND	ND	ND	ND
150N-MRL	40.78	17.88	5.15	36.19	-18.74	-0.56
50N-NRC	18.66	5.70	25.11	50.53	-20.92	-1.44
100N-IRL	29.95	27.09	17.18	25.78	-18.89	-0.76
300N-OR-SG	62.73	8.29	19.00	9.99	-18.92	-0.55
300N-ORL	51.66	20.94	4.49	22.91	-18.73	-0.53
300N-MRL	63.17	18.31	1.28	17.24	-18.94	-0.60
500N-ORL	65.97	17.78	5.40	10.85	-18.52	-0.61
500N-MRL	66.44	18.82	2.45	12.30	-18.82	-0.64
500N-IRL	38.57	38.18	7.24	16.02	-19.09	-0.87
500N-NRC-CPS	29.61	29.67	13.74	26.97	-18.68	-1.08
700N-ORL	61.13	16.81	5.69	16.37	-18.72	-0.43
700N-MRL	48.27	26.16	2.19	23.38	-18.88	-0.51
700N-IRL	57.08	26.91	0.63	15.38	-18.89	-0.70
700N-NRC-CPS	40.27	33.22	1.15	25.36	-18.82	-0.82
1000N-ORL	69.29	19.73	3.51	7.47	-19.19	-0.93
1000N-MRL	58.05	26.74	7.55	7.66	-18.84	-0.62
1000N-IRL	52.99	28.26	1.50	17.25	-18.51	-0.69
1000N-NRC-CPS	44.89	38.52	3.47	13.12	-18.59	-0.56
1500N-OR-APD	72.69	20.25	2.91	4.15	-19.22	-0.98
1500N-MRL	52.70	33.17	4.56	9.58	-18.97	-1.31
1500N-IRL	57.19	10.16	9.03	23.62	-18.80	-0.28
1500N-NRC-CPS	38.28	30.18	0.32	31.22	-18.23	-0.37
2000N-ORL	63.45	30.69	1.97	3.89	-19.08	-0.55
2000N-MRL	54.16	21.35	3.98	20.52	-19.00	-0.58
2000N-IRL	54.19	26.21	3.50	16.09	-19.58	-0.34
50S-ORL	ND	ND	ND	ND	ND	ND
100S-MRL	46.92	17.20	3.92	31.95	1.44	-0.84
100S-IRL	55.01	29.34	2.28	13.37	2.1	-1.14
100S-NRC-RS	25.62	33.82	6.56	34.00	0.95	-0.96
300S-ORL	48.99	12.86	8.92	29.23	1.44	-0.75
300S-MRL	58.82	10.51	11.17	19.50	2.04	-0.71
300S-IRL	41.20	22.08	20.74	15.98	2.11	-0.74
300S-NRC-CPS	32.15	18.13	16.13	33.60	0.93	-1.44
500S-ORL	35.82	25.01	11.61	27.56	1.1	-1.07
500S-IRL	47.42	29.56	6.03	17.00	2.09	-1.02
500S-NRC-RS	35.54	18.95	5.67	39.84	1.67	-0.72

Location	**Aragonite Faction (%)**	**High-Mg Calcite Fraction (%)**	**Low-Mg Calcite Fraction (%)**	**Quartz Fraction (%)**	**Carbon**	**Oxygen**
700S-ORL	47.63	15.10	11.20	26.06	0.93	-1.28
700S-MRL	55.35	28.15	4.32	12.18	2.04	-0.81
700S-IRL	53.46	31.36	0.81	14.37	2.09	-0.70
700S-NRC-CPS	59.05	27.40	9.03	4.52	1.26	-1.10
1000S-ORL	69.33	19.06	3.81	7.80	1.34	-1.03
1000S-MRL	38.28	31.08	0.97	29.67	1.63	-0.84
1000S-IRL	60.63	21.77	7.55	10.06	2.17	-0.59
1000S-NRC-CPS	54.84	30.16	1.18	13.82	1.91	-0.62
1500S-ORL	66.70	24.75	1.38	7.17	1.68	-0.96
1500S-MRL	67.30	11.74	3.62	17.35	1.97	-0.54
1500S-IRL	36.84	50.65	-1.57	14.09	2.2	-0.70
1500S-NRC-RS	29.10	30.07	1.09	39.75	1.64	-0.80
2000S-ORL	65.08	30.49	2.07	2.36	1.42	-1.26
2000S-MRL	60.19	15.86	4.99	18.96	1.93	-0.76
2000S-IRL	50.67	24.42	7.43	17.48	2	-0.77
2000S-NRC-RS	48.37	23.56	2.05	26.02	1.9	-0.69

Appendix 7. Mineralogy results from summer 2019 sediment samples excerpted from Swart (2020). Some location names have been modified for consistency with the naming convention used in **Table 1** and **Table 2**. ND denotes no data.

Location	Aragonite Fraction (%)	High-Mg Calcite Fraction (%)	Low-Mg Calcite Fraction (%)	Quartz Fraction (%)	Carbon	Oxygen
50N-ORL	17.84	11.20	18.64	52.33	1.1000	-1.2898
150N-MRL	39.56	24.30	3.82	32.32	2.0743	-1.8680
100N-IRL	45.91	13.80	7.51	32.78	1.3902	-1.0443
50N-NRC-CPS	24.07	7.43	21.60	46.90	-0.0156	-1.8148
300N-ORL	53.57	19.54	2.31	24.58	1.6834	-1.3047
300N-OR-SG	65.07	14.61	5.81	14.51	1.9292	-0.6172
300N-MRL	61.34	15.72	8.25	14.68	1.8115	-0.9027
500N-ORL	63.68	17.37	1.73	17.23	1.9454	-0.7093
500N-MRL	51.98	29.33	-1.20	19.89	1.9585	-1.0219
500N-IRL	46.06	23.81	4.67	25.46	1.6552	-1.0386
500N-NRC-CPS	30.12	22.92	6.95	40.01	1.1879	-1.1700
700N-ORL	55.91	22.07	3.09	18.93	2.2118	-0.4582
700N-MRL	60.50	11.65	2.60	25.26	2.3311	-0.3327
700N-IRL	61.39	11.14	3.93	23.55	1.7834	-1.1530
700N-NRC-CPS	29.84	30.59	4.82	34.75	1.7185	-0.7690
1000N-ORL	58.78	24.92	4.89	11.41	2.1126	-0.9780
1000N-MRL	59.58	20.40	4.23	15.78	2.3618	-0.3412
1000N-IRL	53.55	22.66	0.76	23.03	1.9387	-1.3088
1000N-NRC-CPS	48.99	26.58	8.26	16.17	1.1361	-1.5146
1500N-OR-APD	60.52	25.31	5.18	8.99	1.8558	-1.0137
1500N-MRL	54.31	25.69	1.78	18.22	1.9451	-1.3041
1500N-IRL	41.03	30.80	0.44	27.73	2.2768	-1.1716
1500N-NRC-CPS	41.99	28.10	1.36	28.56	1.3061	-1.2086
2000N-ORL	69.64	17.99	3.66	8.70	2.0716	-0.6688
2000N-MRL	66.82	21.22	1.26	10.70	2.0365	-1.3011
2000N-IRL	51.09	22.30	5.09	21.52	2.0668	-0.5700
2000N-NRC-CPS	41.09	16.14	3.26	39.50	1.3629	-1.0011
50S-ORL	ND	ND	ND	56.85	0.2612	-2.1849
100S-MRL	ND	ND	ND	ND	ND	ND
100S-IRL	43.36	27.34	1.24	28.06	1.8669	-1.2746
100S-NRC-RS	14.34	9.96	50.92	24.79	-0.2098	-2.3271
300S-ORL	30.25	11.17	19.43	39.15	0.8334	-1.3719
300S-MRL	51.08	20.75	5.39	22.78	1.9574	-1.7453
300S-IRL	45.81	20.75	4.04	29.40	1.9481	-1.3265
300S-NRC-CPS	ND	ND	ND	ND	ND	ND

Location	Aragonite Fraction (%)	High-Mg Calcite Fraction (%)	Low-Mg Calcite Fraction (%)	Quartz Fraction (%)	Carbon	Oxygen
500S-ORL	35.31	9.15	15.65	39.89	0.6041	-1.5321
500S-IRL	50.56	23.73	5.52	20.18	1.7893	-0.9516
500S-NRC-RS	25.10	22.67	5.03	47.20	1.3330	-1.0565
700S-ORL	59.28	14.96	3.15	22.61	ND	ND
700S-MRL	56.83	20.58	3.40	19.19	2.1303	-1.0152
700S-IRL	61.74	13.09	5.07	20.10	1.7963	-1.2920
700S-NRC-CPS	62.99	33.53	3.21	0.27	1.4310	-1.3573
1000S-ORL	64.21	13.08	7.07	15.64	1.8001	-0.8139
1000S-MRL	56.11	26.38	1.24	16.27	1.9722	-0.4379
1000S-IRL	51.98	21.60	2.00	24.42	1.8397	-1.5026
1000S-NRC-CPS	49.62	22.35	2.58	25.44	1.6787	-1.1442
1500S-ORL	55.87	36.15	-1.71	9.70	1.9065	-0.9391
1500S-MRL	58.23	11.64	3.57	26.55	2.2169	-1.0255
1500S-IRL	57.92	26.82	-1.27	16.53	2.2532	-0.6946
1500S-NRC-CPS	32.82	23.24	2.05	41.90	1.4840	-1.7637
2000S-ORL	67.35	24.58	0.52	7.55	1.8058	-1.4978
2000S-MRL	53.13	35.36	-1.81	13.32	1.8886	-1.0208
2000S-IRL	54.87	25.41	-1.20	20.93	2.1261	-1.3529
2000S-NRC-RS	39.84	20.16	2.84	37.16	1.4614	-1.3055