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Dear Ms. Edwards,

We are writing to bring your attention to scientific issues that we have identified in the April 2017 Dial Cordy and Associates (DCA) report entitled, “*Miami Harbor Phase III Federal Channel Expansion Project Permit No. 0305721-001-BI One-Year Post Construction Impact Assessment for Hardbottom Middle and Outer Reef Benthic Communities at Permanent Sites*” (hereafter “Report”).

The Report details surveys conducted at 19 of the original 26 permanent monitoring sites established for this project, with the overall goal of “determining the effects of the actual dredge operations on the resources surrounding the project area.”¹ This Report appears to relay data from three time points: 1) “baseline” (September - December 2013), 2) “post-construction” (June - July 2015), and 3) “impact assessment” (August 2016 - December 2016).

As defined in the permit in Specific Condition 32 a ii. d: “Impacted areas shall continue to be monitored monthly during the construction, one month post-construction, and two times during the next year in order to document results of the impact. Final monitoring results shall document permanent impacts, if any, to be used for estimates of additional mitigation using UMAM.” Findings in the Report, therefore, are presumably directly relatable to understanding the long-term impacts of the Port Miami “deep dredge” on Miami’s coral reefs. However, we believe that current analyses as presented in the Report may lead to confusing or inaccurate determinations of “permanent” project-related impact on corals and their habitat. Here, we review the findings and conclusions in the Report. Where possible, we attempt to verify the summary tables presented in the Report with independent statistical analyses based on DCA’s excel files of the data provided by FDEP through public records requests.

¹ Report Page xxiii.



Not all data presented in the Report was available in spreadsheet form for analysis. Therefore, not all data in the Report was independently analyzed. If and when more information becomes available, we may provide updated reviews of this material.

In general, we identified the following categories of data issues in the Report, which are described in more detail below:

1. Inappropriate comparisons of percent change over time;
2. A lack of “power analyses” to ensure that the experimental design could detect significant differences if they were to exist;
3. An overemphasis on “total” coral mortality rather than “partial” mortality due to sedimentation;
4. Failure to use all available data and time points in certain analyses;
5. Inappropriate interpretations based solely on the impact assessment time point, which: 1) fail to fully incorporate sediment-related mortality incurred during the duration of the dredging project; 2) show consistent, unexplained, and severe coral declines at control-sites, which mask dredge-related impacts that were clearly observed at the post-construction time point;
6. Erroneous baseline data with specious results regarding initial sedimentation levels and sediment stress levels of area corals likely due to dredging already ongoing during baseline data collection weeks;
7. Unsupported assumptions regarding disease-related mortality without clear evidence available for cause of coral mortality;
8. Chronic lack of correction for type-I errors (false positives);
9. Data inconsistencies between DCA reports, as well as within the Report itself;
10. A lack of comparable species-level data across sites and a lack of species-level analyses;
11. Reliance on vague terms without statistical meaning when this quantitative data could be statistically tested;
12. Reporting statistical results that are not relevant to assessing project impacts, thereby confusing the findings of the Report.

Consistent with the format of the Report Executive Summary, we present the following comments:

Sediment Monitoring Results

The Report states, “Mean sediment accumulation rates measured over all channel-side locations were below baseline values during the one-year post-construction impact assessment survey.” (Report Page xxiii)

- There is no natural reason why sediment accumulation levels would be “below baseline values.” The most parsimonious explanation is that baseline values were compromised by dredging that had already begun during baseline data collection, giving the artificial appearance of reefs with high sedimentation and elevated coral stress related to sedimentation at the outset, as previously noted by FDEP and NOAA.²

The Report states, “The sedimentation accumulation results indicate that the channel-side sedimentation environment has returned to levels observed prior to commencement of dredging activities.” (Report Page xxiii and 158)

- While the active deposition of new sediments indeed may have ceased (unsurprisingly, since it has now been over 2 years since active offshore dredging ceased), this statement is not accurate with respect to sediment accumulated on the benthos and related habitat impacts. DCA’s permanent site transect data at the impact assessment time point on the northern middle reef³ show that the channel-side site R2N2-LR has sediment on the benthos that is over 4 times deeper than at control sites and R2N1-RR (See Figure 1 below). This highly significant result ($P < 0.0001$) from our independent analysis of DCA’s data indicates a major, permanent impact to the habitat still apparent on the benthos, yet these data were omitted from the Report. This finding is also supported by the significant increase in sand cover reported in Section 3.3 of the Report (discussed below) and by the findings of Miller et al. 2016. Amount of standing sediment on the benthos is a better indicator of permanent, habitat-level impacts, as it impacts coral recruitment and habitat viability, than ongoing sedimentation rates post-dredging.

² As NMFS points out in their September 11, 2015 letter to the Corps, “NMFS has concerns about the sites ... serving as the true baseline conditions... based on the information provided in DCA (2014b), it appears that all of the baseline survey events on the Outer Reef occurred after new-work dredging began.” (NMFS letter to Corps Page 5). DEP also stated in its Field Notes on Impact Assessment (August 18, 2014) on page 38, “The baseline survey for the Middle and Outer Reefs happened when dredging started at the Inner Reefs and suspended sediments were already reaching sites in the Middle and Outer Reefs.”

³ See data from spreadsheet “Copy_of_Cross_site_sediment_data_Port_Miami_Impact_Assessment_2-6-17.xlsx”

- These findings also closely match NOAA’s April 2016 Sedimentation Assessment report and the published Miller et al. 2016⁴ paper based on those findings. Those findings recorded similar measurements, reporting a 2.7 - 10.0x higher sediment depth at [middle] reef north locations compared to controls, and 17.5 - 36.0x higher mean percent cover of “Sediment over Hardbottom” (Miller Page 7). DCA’s similar findings over a year later show that demonstrable sedimentation impacts on the benthos remain.

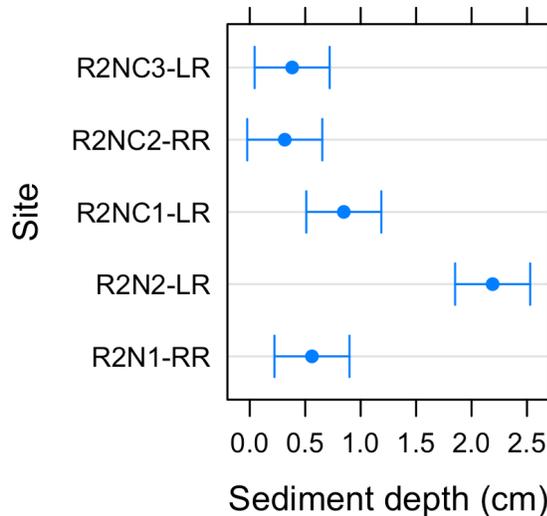


Figure 1. Independent analysis of sediment depth at permanent monitoring sites measured in February, 2017. Independent analysis based on DCA’s data from “Copy of Cross_site_sediment_data_Port_Miami_Impact_Assessment_2-6-17.xlsx”

- Without previously-collected data about sediment depth pre-dredging, considering high rugosity present on reefs and that over 2 years has passed since most of the active dredging was taking place on the reef area, it is highly likely that sediment on the reef could have moved and settled into lower-lying areas of high relief areas. In the future, such measurements should be taken before, during, and after dredging, and should also consider how reef rugosity has been impacted by sedimentation, as this is a good indication of potential habitat loss.
- DCA also makes determinations of sediment “type” in their spreadsheet data (i.e. fine, coarse, or mixed), but do not report these findings in the Report⁵. (As these results and methods are not explicit in the Report, we interpreted this data to the best of our ability.) Control sites on the northern middle reef (R2NC3-LR, R2NC2-RR, R2NC1-LR) were reported to have a much lower proportion of “fine” sediment (0%, 9%, 0%, respectively) than channel-side permanent sites (R2N2-LR: 55% and R2N2-RR 86%, See Figure 2 below). “Fine” sediments are closely

⁴ Miller et al. (2016), PeerJ, DOI 10.7717/peerj.2711

⁵ Date found in DCA’s spreadsheet “Copy of Cross_site_sediment_data_Port_Miami_Impact_Assessment_2-6-17.xlsx”

correlated with dredging-related activities, as defined in reports such as DCA’s earlier Sediment Delineation Reports from 2014 and 2015, NOAA’s April 2016 Report, and FDEP’s 2014 Field Notes. FDEP’s Field Notes state, “Large areas of hardbottom were covered with 1 cm to 14 cm thick layer of fine sediments ... Such sediment cover is not characteristic for the hardbottom of this area ...” (FDEP August 2014 Field Notes page 38). Fine sediments also significantly increased during active dredging at channel-side sites over controls (Report Figure 20). This further shows that dredging-related sediments are remaining on the benthos, and are still detectable now over 2 years post-offshore dredging, suggesting that these fine sediments have not yet incorporated into the benthos and thus represent permanent habitat changes.

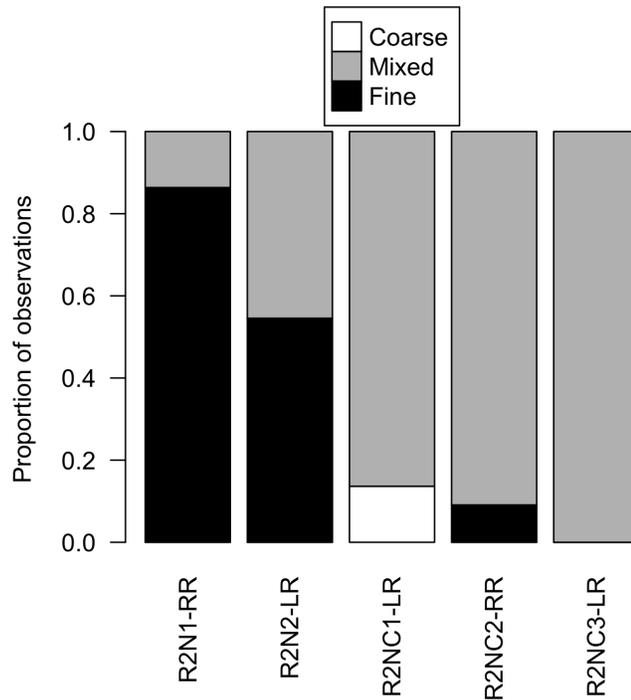


Figure 2. Sediment type at permanent monitoring sites measured in February 2017. Independent analysis of DCA’s data from “Copy of Cross_site_sediment_data_Port_Miami_Impact_Assessment_2-6-17.xlsx”. Significantly higher rates of “fine” sediment are reported at channel-side sites. “Fine” sediment increased during dredging and are considered to be dredging-related sediments.

Biological Monitoring Results

The Report states, “Overall, mean sand cover increased at channel-side sites from 13.6% to 29.3% (15.7% increase) from baseline to impact assessment surveys in comparison to a 0.6% increase in mean sand cover at control sites.” (Report Page xxiv)

- It is incorrect to describe this proportional percent change as a ‘15.7% increase’ in mean sand cover. It is more accurately described as an 115% increase in sand cover – or a more than doubling over baseline levels. Or, in other words, the sand

cover percentage at impact assessment is 215% of baseline levels. It is not appropriate to compare percent changes by adding or subtracting, as these represent proportional changes. (As an analogy, consider that interest on a loan increased from 2% to 4%. This is an increase of 2% of the loan value, but actually represents a doubling, or 100% increase, relative to the original interest rate).

- These metrics also do not report percent change in sand cover at each site, but rather as an average (presumably this is an average, but this is not explicitly stated) of channel-side sites and control sites. Therefore, actual impact to the benthos, and in particular the reef sites, may even represent some higher proportional changes in sand cover (and thus even more severe permanent impacts to benthos).

The Report states, “The range mean sand cover at control site locations was 40.0% over the course of the project. The increased sand cover documented at channel-side sites during the impact assessment survey is within the range of control site variability.” (Report Page xxiv)

- “Range mean sand cover” is not a statistically meaningful term and it is unclear what this value represents.
- “Within the range of control site variability” is also not a statistically meaningful term and it not clear to what type of variability DCA is referring. It is also unclear why statistical tests were not performed with this quantitative data.

The Report states, “The increase in sand cover channel-side is expected to be temporary, as sand cover at channel-side sites has declined since construction completion and continues to trend downward toward baseline values.” (Report Page xxiv)

- By definition in Permit Specific Condition 32 a ii. d, impacts identified at this time point are “permanent”. Therefore, it is inappropriate for DCA to categorize these clearly-observed benthic impacts at this time point as “temporary”. They are highly significant levels of impact that have had – and will continue to have -- severe negative impacts on the function and viability of this habitat.
- The Report simultaneously attempts to downplay the significance of the increased sand cover findings by calling the change in sand cover “highly variable,” and yet also tries to read a “trend toward baseline values” (Report Page 159) into this “highly variable” data, for which no statistical evidence is provided.

The Report states, “The decline in coral cover at both channel-side and control sites is explained by the regional white plague disease event” (Report Page 48), and again on Report Page 78 of the Report, “As a result of the 13 month period between post-construction and impact assessment surveys, many of the corals marked as “unidentified” mortality during the impact assessment survey period were likely killed as a result of the

continued white-plague disease event that has affected coral populations throughout south Florida.”

- However, this analysis does not present evidence for this conclusion. Instead, the analysis makes the assumption that if coral cover declined at both channel-side and control sites, then it must be due to disease. This masks potential impacts due to project-related sedimentation and ignores lines of evidence contradicting this statement, including: 1) significant declines in coral density at the middle reef observed post-construction immediately post-dredging, but not at control sites, despite ongoing disease at control sites at that time point (November 2015 Post-Construction Report, Table 19); 2) the significant increase in tagged coral colonies that experienced partial mortality due to sedimentation post-dredging (November 2015 Post-Construction Report, Table 8); 3) greater declines in visually estimated mortality at channel-side sites on the northern middle reef (Report Table 18).

Repeated Measures Coral Monitoring Results

The Report states, “Over the course of project monitoring, six tagged channel-side scleractinian corals were buried and died as a direct result of sediment accumulation during dredging.” And that “Declines in scleractinian density between baseline and impact assessment surveys at channel-side and control locations were directly linked to the white-plague disease event.” (Report Page 159-160).

- This section only discusses total coral mortality, which is not the best indicator of project-related sedimentation impacts. Total mortality due to sedimentation would only be expected in corals of smaller size classes, with a flat morphology, or in low-lying areas. The Report states that 6 tagged corals were completely buried by sedimentation – a seemingly-low number -- but partial mortality due to sedimentation afflicted up to 93% of corals at some channel-side locations.
- Report Section 3.4 and Report Figures 75, 77, and 78 describe only total coral mortality, and concludes, “... this mortality does not represent a change in function of the habitat.” This data, however, does not address whether there was a change in function of the habitat, and this conclusion is not supported by data in the Report or in past Reports.
- Also, examining causes of mortality only at the impact assessment time point is highly confounded by the passage of time and unknown causes of coral mortality. DCA touts that tagged corals were photographed a minimum of 40 times and that over 20,000 individual observations of *in situ* coral condition were analyzed over time (Report Page xxiv), but DCA fails to include, analyze, or consider most of this data collected during the dredging in this Report. Rather, the Report ignores vast amounts of data collected at intermediate (i.e. mid-dredging or post-construction) time points and injects high levels of uncertainty into data that otherwise has a clear etiology. Prior time points should be considered in this

analysis in order better to gauge causes of mortality and potential permanent impacts.

Impact of Regional Coral Disease Outbreak

The Report states, “Taking disease-susceptibility into account, no channel-side sites had higher levels of coral mortality than would be predicted from regional white-plague disease prevalence. Declines in scleractinian density between baseline and impact assessment surveys at channel-side and control locations were directly linked to the white-plague disease event.” (Report Page xxv and 160).

- DCA generates a complicated “predictive” model to account for mortality of corals. The model is presented as independent data, but in reality utilizes DCA Bill Precht’s data and DCA compliance from control sites. A more parsimonious approach would be simply to perform statistical tests on available data that compares baseline to post-construction and channel-side to paired control sites and to test for species-level values.
- The analysis also only considers total mortality, which ignores the vast amounts of partial mortality caused by dredging sedimentation.
- Failing to ensure a similar distribution of species between channel-side and control sites is a monitoring design flaw that should be corrected in future studies. The same or similar distribution of species between control and channel-side sites should be required. For example, *Siderastrea siderea* is not susceptible to white plague disease, and was relatively evenly distributed between control and channel-side sites. Analysis of this species can help to tease apart these confounding sources of mortality (see below for this analysis).
- The data does not support the assertion that declines in coral density are only directly related to the disease event (although the disease certainly resulted in coral mortality during this period). Rather, there is direct evidence that disease alone was not responsible for all mortality observed. DCA’s 2015 Post-construction report, for example, shows changes in coral density across permanent transects (November 2015 Post-construction Report Table 19). At the middle reef sites (the only sites for which data was provided), the control sites – presumably exposed only to disease stress and not to dredging stress – only showed significant declines in coral density in one of 5 locations. By contrast, 3 out of 4 of the channel-side sites showed significant declines in coral density from baseline to post-construction (Figure 3). Furthermore, a Bonferroni correction should have been applied to this table to avoid type I errors (false positives). When the Bonferroni correction is applied, *none* of the control sites have significant declines in coral density, but 75% (3/4) of channel-side sites do show significant declines in coral density. This indicates that disease alone was not severe enough to cause significant declines in coral density at the post-construction time point, even recorded after the majority of the disease outbreak

had already occurred. Only where dredging is also present are significant declines in coral density observed.

- NOAA’s April 2016 Report (Page 35, 36) similarly states that various lines of evidence are “not consistent with the notion that region-wide disease (independent of interacting dredge stress) accounts for all scleractinian mortality in the project impact area.
- Because these declines in coral density were presumably the result of coral mortality, this indicates that 1) total coral mortality was actually much higher along the transect than it appears from just the tagged corals, and 2) that these declines in density should also be considered permanent impacts.

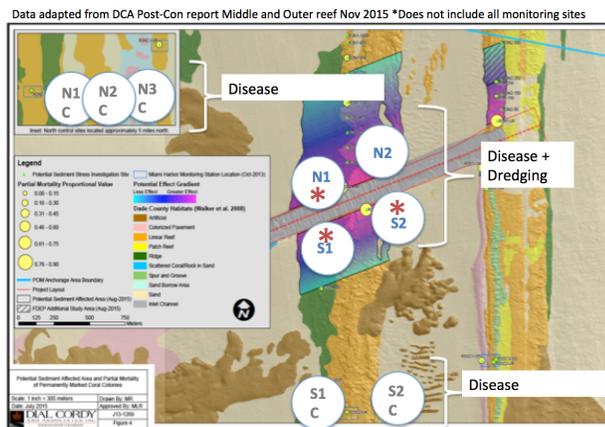


Figure 3. Data adapted from DCA’s November 2015 Post-construction report showing middle reef monitoring sites (channel-side in blue and control sites in grey), and changes in coral density from baseline to post-construction. Red asterisks indicate locations with significant declines in coral density, as reported in Table 19 in the November 2015 Post-construction report. White boxes indicate the major stressors applied to the corals at the channel-side vs. control locations.

The Report also fails to consider that dredging impacts and disease may be linked. The following evidence indicates that they may be, and therefore this warrants more investigation into the potential causation or correlation between these causes of mortality and stress exposures:

- Past studies have shown a 2x increase in “white syndrome” coral disease in corals exposed to dredging plumes in detailed multivariate analyses which also included heat and bleaching (Pollock et al. 2014).⁶
- Miller et al. 2016 shows that, when examining middle reef tagged corals, “The occurrence of disease and complete colony mortality for reference colonies was less than half that observed for channel-side colonies (Table 1).” (Miller Page 11).

⁶ Pollock, J., et al. 2014. Sediment and turbidity associated with offshore dredging increase coral disease prevalence on nearby reefs. PLOS one 9: 1-9.

- At the middle reef at the post-construction time point, there was 40% white plague mortality at channel-side site R2N1, but 0% at middle reef control sites (DCA August 2015 Sediment Delineation Report Page 54).
- Precht et al. 2016 places the origin of the region-wide disease outbreak at the southern control site for this project, which also happens to be the nearest site included in that study to the dredging project (as channel-side sites were not analyzed). Precht et al. 2016 then postulates that the disease spread from this site of origin to the region.

Partial Coral Mortality

The Report states, “Partial mortality associated with sediment affected 64.8% of corals across the nine channel-side sites and 19.4% of corals at the ten control sites during the impact assessment. The difference of 45.4% in sediment related partial mortality at the channel-side sites is attributed to the dredging project.” (Report Page 160)

- It is inappropriate and misleading to compare percent partial mortality rates channel-side with control partial mortality percentages by subtraction. Because these values represent a proportion, the proper way to compare these partial mortality rates would be to state that channel-side corals experienced an increase of 234% partial mortality due to sedimentation than corals at control sites. Or, that the channel-side sediment-related partial mortality was 334% of the control-side sediment-related partial mortality ($64.8 / 19.4 = 3.34 = 334\%$). This finding is consistent with Miller et al. 2016’s finding of 3.1-5.1x increase in the prevalence of corals with recent partial mortality at sediment assessment locations when compared to reference (Miller Page 8).
- Table 15 purportedly shows “Sediment related partial mortality as presented in the post-construction report with cumulative values from baseline through post-construction and during impact assessment.” However, these values are *not* “as presented” in the 2015 post-construction report (see Table 4 of the Post-Construction R2 R3 Report, November 2015) and differ in multiple columns from the 2015 table, including at sites, R2SC1-RR, R2SC2-LR, R2S1-RR, R2S2-LR, R2NC2-RR, R2NC1-LR, R2N2-LR, and R3SC2-LR, for example. It is unclear why these values have changed, and if in error, they should be corrected.
- Table 15 only shows presence/absence of partial mortality, which masks the potential severity of this condition (i.e. this could represent mortality of 5% of a colony, or 95% of a colony).
- Furthermore, 64.8% is the sediment-related partial mortality of corals at all channel-side sites (presumably also including hardbottom sites). It is not clear if 64.8% represents an average of all tagged corals, or some summary value of an average of each site, or how each coral or each site might be weighted in the analysis. Also, no standard error is provided for this value.

- Statistical tests should also be used to incorporate variance and to test for the significant differences between paired control and channel-side sites, as well as baseline and post-construction partial mortality rates (cumulatively for partial mortality noted at any time point).
- Partial coral mortality is defined by DCA as an “ephemeral” condition in the survey analysis (Report Page 86-87). However, DCA also points out that partial mortality is better characterized as a permanent impact. (“Partial mortality (PM), however, was an indicator of permanent impacts of sediment stress to coral”; Report Page 86). In some analyses, DCA appropriately considers partial mortality at any time point in a cumulative fashion. (We interpreted this to mean that if a coral was noted with partial mortality due to sedimentation at any time point, this was counted in the total.) In other analyses, however, they do not. Because corals are: 1) unlikely to regrow over dead skeleton (which is quickly colonized); 2) are less likely to be of reproductive size after tissue loss, and 3) are more vulnerable to disease after suffering partial mortality, the most appropriate way to consider partial mortality is this cumulative, or permanent, approach. Analyses that do not consider partial mortality in this fashion should be redone to include partial mortality observed at any time point (and not just “fresh” partial mortality).
- It also follows that “recent” partial mortality, as the condition is recorded during the impact assessment survey dives, is not relevant to understanding impacts related to sedimentation during dredging, which was completed offshore over 2 years earlier. Therefore, the mid-project surveys and the post-construction reports provide more accurate estimates of project-related partial mortality impacts and should be considered as cumulative, permanent impacts.
- Aside from just considering partial mortality, failure to grow over a 2-year period of observation is also a significant negative impact for corals, particularly considering that coral colony size is directly linked to reproductive potential. Miller et al 2016’s analysis of DCA’s tagged colonies over time also revealed that “48% of reference colonies displayed positive growth over the course of the project, compared with only 18% of channel-side colonies.” (Miller Page 11). This analysis is not included in the Report, but should be calculated and considered alongside partial mortality as an impact to the area’s corals.
- ***Planimetry Analysis of Partial Mortality:*** The Report shows a “planimetry analysis” to determine the amount of tissue lost from sediment-related partial mortality. However, there are several issues with this analysis, which concludes that there “was no statistical difference in percent change in live coral tissue at R2N1-RR (-12.28%) when compared with its paired-control R2NC2-RR (-11.6%) between baseline and impact assessment surveys.” (Report Page xxv)
 - This finding is inconsistent with the high level of partial mortality recorded at channel-side sites (up to 93% as compared to 7% at control sites in some cases).

- This analysis excludes corals that had any disease. Corals may have experienced both disease and sediment-related partial mortality. In fact, we would expect these conditions to be linked. Therefore, removing corals with disease might skew these results. In this analysis, for example, out of 30 tagged corals at R2N1-RR, only 15 are included planimetry analysis. But, 94% are reported as having sediment-related partial mortality, which would represent 28 of the 30 corals at the site. Therefore, 13 of 28 corals that had partial mortality due to sediment were not included in this analysis. Not only does this ignore a large proportion of corals with sediment-related partial mortality, but this also suggests a frequent co-occurrence of disease and sediment-related partial mortality. This interaction should be explored further.
- The planimetry analysis only examines one plane of a 3-D structure (the colony), which potentially misses a great deal of tissue loss.
- Only one site was examined with this analysis.
- The resulting analysis is somewhat nonsensical as well. For example, in Table 16, the control site analyzed (R2NC2-RR) shows an increase in coral tissue from baseline to post-construction, but then also shows a large but unexplained decline in live coral tissue area between the post-construction and impact assessment time points. As corals with disease were excluded from analysis and sediment-related partial mortality was low at the control sites, no explanation is provided for this decline in coral tissue cover at the control sites. It may indicate that the data collection methodology is fundamentally flawed.
- Table 16 also presents a total for living coral tissue area for the included tagged colonies. This is a misleading way to present this data because it masks incidence information, instead presenting “% Change” in total living coral area as falsely equivalent. To illustrate, it is not the same impact on the reef to have 100 small corals each lose 90% of their tissue, as compared to one large colony that loses 10% of its living tissue. This distinction cannot be discerned the way that DCA conducted this analysis.
- There is large standard error presented in the data in Table 16, particularly for the R2N1-RR site (SE=9.2), but this does not appear in the graph of this table, which shows a much smaller standard error value (Report Figure 81).
- This section’s conclusions also conflict with the findings of the visually-estimated partial mortality analysis, which found significantly more partial mortality at channel-side middle reefs sites than at control sites.

- ***Visually-estimated partial mortality***
 - Despite having many intermediate photographs of tagged corals, this analysis only presents post-hoc visual analysis of partial mortality from baseline and impact assessment time points. In this way, DCA excludes vast amounts of data that would be useful in determining partial mortality and its causes. All available data should be included in this analysis.
 - DCA’s finding of no significant difference between visually-estimated mortality at channel side and control sites applies to an analysis of all sites when pooled together. When examined individually, however, there is still greater mortality at channel-side sites at the northern middle reef, where post-construction data indicates that sedimentation from the dredging was also most severe: “Average visually estimated mortality was greater at northern middle reef channel-side sites compared to corresponding control sites.” (Report Page 95). This is not mentioned in the Executive Summary and constitutes a permanent impact.
 - Miller et al. 2016, analyzing the same tagged colonies from DCA’s middle reef sites, also reports that channel-side tagged colonies, without particular attribution of the cause of tissue loss, had 4x greater tissue loss on average than control site colonies (Miller Page 11, Figure 5).
 - Miller et al 2016 also found that, “Despite these coincident disturbances, analysis of tagged coral colony condition during the course of the dredging project shows significant and large effects in terms of more severe coral tissue loss (almost 5) and increased risk of disease and death (>double) in the immediate vicinity of the dredged channel, in comparison with project-chosen reference reef.” (Miller Page 12)
 - Hardbottom sites both north and south of the channel also reveal greater visually estimated mortality than control sites (Report Page 94), but this is also not mentioned in the Executive Summary and constitutes a permanent impact.
 - At outer reef control sites, DCA states, “Average visually estimated mortality was greater at the outer reef control sites compared to channel-side sites.” (Report Page 96). However, our analysis of the DCA spreadsheet entitled, “permanent_sites_impact_assessment_corals_2016_CSI_qaqc” does not reveal a significant decline in control-site corals over channel-side corals (P=0.11, ANOVA). This finding should be checked and clarified if needed.
 - We also examined species-level differences in this dataset in order to differentiate disease from dredging impacts. *Siderastrea siderea*, for example, is reported as not susceptible to white plague disease and was reasonably well-distributed between channel-side (7 colonies) and control

sites (12 colonies) at the northern middle reef. Therefore, analysis of this species can help to differentiate between disease and dredging-related impacts. Our analysis of this species shows a significantly higher reported tissue loss at the channel (mean 54%) compared to the control site (8%, $P=0.01$). This analysis shows potentially severe dredge-related impacts at channel-side sites. Furthermore, this analysis shows how the disease-related mortality might be masking dredging-related impacts. Greater attention to species-level distinctions would improve this analysis and should be considered in the determination of permanent impacts.

Section 3.6 Quantitative Benthic Sampling Comparison: Scleractinians

The Report states, “A two-way repeated measures ANOVA comparing coral densities between sites and over the survey period did not reveal any significant interaction of site and time at either the middle or outer reef habitat. As a result, no significant project effects to coral density were detected between baseline and impact assessment surveys in the middle or outer reef.” (Report Page 108)

- This conclusion is contrary to significant impacts observed in the November 2015 Post-Construction Report (Table 19), in which 3 out of 4 channel-side sites experienced significant declines in coral density and control sites did not (when the proper Bonferroni correction was applied). This Report conclusion, is therefore likely due to a lack of power to detect significant changes due to the methodology that DCA employed, rather than a true lack of declines in coral density, as described below.
- Despite presenting 4 weeks of baseline and post-construction data and 1 week of impact assessment data in Table 31 and Figure 90, DCA chose not to include all of these data in their statistical analysis (Report Page 117), which is confusing. In an apparent attempt to “match” only one week of impact assessment data with one week of baseline data, DCA ignores the additional three weeks of baseline data collected. It is entirely unnecessary to eliminate 75% of available baseline data for this analysis. In fact, by removing so much data, the power of the test to detect significant differences in the data is severely reduced. It is highly likely, therefore, that the non-significant changes in coral density reported are a result of the reduced power of the test (as compared to, for example Table 19 in the November 2015 Post-Construction Report, which utilized 4 weeks of baseline and 4 weeks of post-construction data for analysis). The lack of power analysis, for this and for almost every other test in the Report, means that non-significant results may simply be a result of low power of the data and not because no impacts exist. This analysis should be redone with all available data and post-construction data included as well.
- Furthermore, Report Table 22 only considers the baseline and impact assessment time points, which ignores over one-third of available data. When considering post-construction density data as well (as in Report Table 27), it is clear that a lack of significant differences between channel-side and control sites is likely driven by a steep decline in control-site corals observed post-construction and impact assessment

time points (e.g. R2SC1-RR, R2SC2-LR, R2NC3-LR, R2NC2-RR). This is likely confounding the data and masking the obvious impacts of the dredging on channel-side corals apparent in post-construction time points and shown in Table 19 of the November 2015 post-construction report. Significant declines in coral density would not be expected to rebound between the post-construction and impact assessment time points, and therefore are also present at the impact assessment time point and should be analyzed as permanent impacts.

- Report Figure 90 also shows massive declines between post-construction and impact assessment data at control sites at outer reef sites.
- Report Table 26, 30, 34 (and other tables with multiple tests) should have a Bonferroni correction but do not appear to.
- Table 25 appears possibly to include data from all time points, which is confounding data. It is not clear what “N” represents in Table 25, 29, or 33.
- The format of Report Figures 97, 98, 99 make comparisons over time extremely difficult.
- Rather than considering or correcting for any of these potential statistical shortcomings in the data, DCA again concludes that this observed impact was, “largely due to the effects of the regional white-plague disease event”.

3.6.3 Total Scleractinian Condition

The Report states, “Although total mean scleractinian stress remained elevated above baseline levels in middle and outer reef habitats, levels of scleractinian sediment stress were at or below baseline levels for all surveyed channel-side sites (Table 35). As a result, no impact due to current levels of sedimentation was detected during impact assessment surveys.” (Report Page 130).

- Hardbottom, Middle Reef, and Outer Reefs sites are all reported to have elevated stress conditions at impact assessment time point. DCA also concludes that this is not due to sedimentation stress. Based on how DCA defines sedimentation stress, this is a meaningless finding because DCA defines coral condition codes relating to sediment stress only as being “recent”. Therefore, it would be almost impossible to detect recent, sediment-related impacts on corals at this impact assessment timepoint. Rather, it is necessary to consider cumulative sediment-related impacts and permanent impacts due to sedimentation.
- DCA states that the Report does not consider intermediate stress time points in this analysis “to reduce variability” associated with the time of year (Report Page 130). However, it is much more important that corals exhibiting sedimentation stress at any time point should be considered – or, at the very least, at the post-construction time point.

- A binary system for determining coral stress which collapses all causes of “stress” into a single “1” or “0” value severely confounds the causes of stress and undermines the ability to detect sediment-related changes as distinct from bleaching or disease stress. This approach should not be utilized in future studies.
- Some of the stress markers, such as “polyps extended” represent a natural, non-stressed, feeding condition for corals, such as *Montastraea cavernosa*. This could have skewed stress determination and should not be included in future studies.
- DCA reports “sediment stress were at or below baseline levels for all surveyed channel-side sites.” (Report Page 130). This is further indication that baseline values included artificially elevated sedimentation levels or that DCA’s coral condition codes are not appropriate for detecting sediment stress at the impact assessment timepoint, as it is difficult to understand how values could be below baseline levels.
- Tables 37 and 38 show surprisingly high baseline levels of coral stress at the middle reef – well above control site stress levels. For example, R2S2-LR has an 87% coral stress level during baseline and 63% sediment-related stress at baseline. This is more evidence that baseline values are not representative of true, natural baseline, but rather are artificially elevated due to ongoing dredging.
- The Table 36 legend describes that the table shows sedimentation stress over baseline and post-construction sampling and during the impact assessment, but post-construction data does not appear in the table.
- DCA attributes “elevated levels of scleractinian [stress] at all middle reef sites due to the continued presence of white plague disease...” (Report Page 131) without evidence for causes of mortality between sampling time points.

3.7 Quantitative Benthic Sampling Comparison: Octocorals and Sponges

The Report states, “At the middle reef, there was a significant effect of time period (Table 46)...Since there was not a significant interaction between site and time period, changes in density were not statistically significant at the surveyed sites over the time period.”

- These two sentences directly contradict one another, and incorrectly interpret the significance of a statistical interaction effect.
- There seems to be an issue with error bars in Report Figure 112.
- Tables 59 and 60 and 61 appear to refer to sponges based on the text references, but the legends refer to scleractinian density. It is not clear whether the data in the table is referring to sponges or to corals.

- How prevalent was the lobster trap damage at R2NC2-RR? It seems to be cited as explanation for vast amounts of octocoral declines at this site. However, almost all sites had octocoral declines as well. What is this attributed to?

Summary

In conclusion, our review identifies significant questions regarding the reliability and veracity of the Report's findings. There are several flaws inherent in the methodology employed to determine project-related impacts, as well as questionable or misleading statistical analyses and conclusions. The available data clearly show permanent impacts to corals and their habitat due to dredging-related sedimentation.

We find that the post-construction and mid-construction data provide a better understanding of the project-related impacts to corals and their habitat, and therefore should be incorporated into the impact assessment analysis. Furthermore, NOAA's April 2016 sediment assessment report, the associated Miller et al. 2016 publication, and other surveys considered in those reports should be incorporated into FDEP's analysis of permanent impacts related to the dredging project.

This is not an exhaustive review of all data presented in the Report or all available data. Not all raw data was available to us to conduct a reanalysis of the data. However, we recommend that DEP, NOAA, and other agencies confer closely with the contractors about their analyses and these conclusions, and to carefully weigh the conclusions of this Report and its implications for determination of permanent project impacts. We also recommend that the agencies conduct their own statistical analysis from the raw data available to draw independent conclusions regarding permanent impacts wherever possible.

It is our hope that this review provides a useful commentary for your agency, and we remain available to discuss these comments in more detail if you should have any questions.

Kind regards,



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