Integrated Analysis of Coral Density and Community Structure Across Reef Habitats Near Port Everglades in Advance of Dredging Operations

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Abstract

Understanding how reef coral communities near Port Everglades (Fort Lauderdale, Florida) vary across space and time is crucial to assessing the baseline community composition prior to planned large-scale dredge operations. In this study, we combined new survey data collected in September 2024 with data from five previous surveys (spanning a period from 2011–2023) to understand coral distribution, abundance, and changes over time in reef habitats near Port Everglades. We also estimated total coral abundances in areas anticipated to be impacted by the deepening project. Overall, we found that survey-averaged total densities of juvenile and adult corals near Port Everglades, as well as several taxon-specific densities, exceeded regional estimates for Southeast Florida, indicating that Port Everglades reef habitats are conducive to coral recruitment, survivorship, and growth. Local densities of naturally-occurring ESA-listed staghorn corals (*Acropora cervicornis*) may be higher than anywhere else in Florida, representing some of the last survivors following widespread mortality during the 2023 heatwave. Furthermore, Port Everglades reef habitats showed substantial increases in overall coral density from 2017–2024 (+68%), driven by increases in *Siderastrea* spp., *Porites* spp., and *Montastraea cavernosa*, as well as several other coral taxa deemed moderately or highly susceptible to stony coral tissue loss disease (SCTLD), indicating potential recovery from this disease in the area since 2017. Finally, we extrapolated coral density estimates to two spatial footprints: 1) the impact zones identified by USACE and NMFS where 0.1–10+ cm of dredged sediments are anticipated to settle (extending ~500–600 m from the channel), and 2) the deepening project's proposed sediment compliance monitoring area (extending ~1.2 km from the channel). With survey datasets equally-weighted, we conservatively estimate 3.4 million corals (including >18,000 ESA-listed) within ~500–600 m and ~8.2 million corals (including >43,000 ESA-listed) within ~1.2 km of the Port Everglades channel. When updated to reflect 2024 conditions, we estimate ~10.5 million corals, including >44,000 ESA-listed colonies, within ~1.2 km of the channel. Together, these findings highlight the Port Everglades area as supporting high-quality reef habitats and valuable coral populations within Florida's Coral Reef, and underscore the need for stringent sediment control measures during dredging operations to minimize impacts on these habitats.

Introduction

Port Everglades is a major seaport in Southeast Florida within the Kristin Jacobs Coral Reef Ecosystem Conservation Area (Figure 1A), a high-latitude reef system in close proximity to heavily urbanized coastline (Jones and Gilliam, 2024). Currently, plans to deepen and widen the

port's entrance channel through dredging are in progress. The Port Everglades deepening project (PEV) aims to increase channel safety and maneuverability for existing vessel use, accommodate larger vessels, and decrease costs associated with vessel delays from congestion, channel passing restrictions, and berth deficiencies (USACE, 2022). However, because the channel cuts through sensitive coral reefs and dredging has the potential to generate harmful sedimentation impacts across the entire PEV footprint, the authorization of the project would constitute the largest impact in U.S. history to populations and critical habitat of Endangered Species Act (ESA) listed species, including queen conch (*Aliger gigas*), staghorn corals (*Acropora cervicornis*), and mountainous star corals (*Orbicella faveolata, Orbicella annularis,* and *Orbicella franksi*). Numerous other stony corals—all of which are designated as Essential Fish Habitat (SAFMC, 2024) and many of which are listed as threatened to critically endangered by the IUCN (Gutierrez et al. 2024)—also inhabit the Port Everglades area, where they build coral reef habitat supporting biodiversity, ecological function, and coastal protection within this key region of Florida's Coral Reef.

The PEV project will transect four main coral reef habitats: the Nearshore Ridge Complex (NRC), Inner Reef (IR), Middle Reef (MR) and Outer Reef (OR). The NRC and IR are closest to shore (~275–780 m in distance) and range in depth from 4–10 m. The MR is ~770–2,000 m offshore and ranges in depth from 11–16 m. The OR is ~1,500–3,000 m offshore and ranges in depth 16–18 m, though deeper portions may extend to 23–26 m (Jones and Gilliam, 2024). Over the last 15 years, multiple surveys have characterized coral communities in different portions of these habitats. However, these surveys varied widely in study design, with focal taxa (all stony corals, or just ESA-listed corals), number of survey sites, and area surveyed per site, in addition to being highly variable in spatial coverage across habitats (Figure 1B, Table 1). Over the same time period, these reefs have experienced significant disturbances, including stony coral tissue loss disease (SCTLD, peaking in 2016) and multiple marine heatwaves (2014, 2015, 2023), potentially driving decline, recovery, shifting coral community structure, and dynamic reef trajectories. As a result, it has been difficult to develop a comprehensive understanding of coral distribution and abundance in reef habitats surrounding Port Everglades and make meaningful comparisons among surveys over space and time. An integrated analysis of existing data, combined with updated surveys, is needed to capture spatial variation across reef habitats, understand temporal shifts from recent disturbances, and establish a baseline coral community composition in the Port Everglades area prior to dredging.

The U.S. Army Corps of Engineers (USACE) estimates that the PEV dredging project would remove ~5.5–6M cubic yards of material, of which 74,900 to 337,000 cubic yards of fine-grained material are predicted to be spilled from dredge operations depending on the dredge method used (USACE, 2022; Appendix I). Fine-grained sediment particles (especially clays and silts <63 μm) have the potential to travel far in the water column (plumes can travel 10–100's km; e.g., Barnes et al. 2015; Cunning et al. 2019; Dobbelaere et al. 2024), and settle in coral reef habitats distant from the dredging. To estimate the potential spatial extent of impacts, the USACE developed a spillage analysis (USACE, 2022; Appendix I) of sediment distribution resulting from four different scenarios of dredging methods, including: 1) use of a cutter suction dredge with overflow allowed; 2) a cutter suction dredge without overflow, and a one-time barge decant; 3) a cutter suction dredge with direct pipe to a deep-water placement area (no overflow); and 4) a mechanical dredge without overflow. Although the specific mechanism for controlling sedimentation is unclear, the USACE suggests they can limit sedimentation impacts with Scenario 2, which would lead to zones of sediment deposition ranging from 0.1 cm to >10 cm over approximately 336 acres (Table A1) of coral reef habitat within ~500–600 m north and south of the channel (Figure 1C) (USACE, 2022; Appendix I).

This spillage analysis conducted by the USACE was structured to predict impacts only north and south of the areas to be dredged. However, cross-shore dispersion is well documented on the shelf, and departures from average metocean conditions (e.g., freshwater inputs) may be conducive for sediment transport to areas east and west of the channel (e.g., DaPrato, 1995; Carsey et al. 2015; SEFMOD, 2024). Therefore, NMFS identified four additional impact consideration areas which are also likely to be affected by dredging-induced sedimentation under Scenario 2, depicted in Figure 1C as “Nearshore”, “North”, “East”, and “South”. Together, these areas cover approximately 46 additional acres (Table A1) of reef habitat. In addition, the USACE and the Florida Department of Environmental Protection (FDEP) drafted a plan with a Before-After Control-Impact (BACI) design to assess potential sedimentation impacts (USACE, 2022; Appendix G) up to ~1.2 km north and south of the channel, hereafter referred to as the full impact monitoring area (Figure 1C).

To better quantify the coral communities in these impact areas, and the level of effort required for the PEV project’s coral relocation and mitigation activities (detailed in USACE, 2022; Appendix F), this study aimed to: 1) generate an up-to-date coral survey dataset in September 2024 for Port Everglades reef habitats; 2) conduct a meta-analysis combining the new data with previous surveys to comprehensively estimate densities of coral taxa and assess changes over time; and 3) generate robust estimates for the total numbers of all scleractinian taxa within the dredging impact zones defined above. Together, results from this study can help inform the coral-related planning efforts associated with PEV, including impact assessment, monitoring, relocation, and mitigation.

Methods

2024 Coral survey

We conducted a survey to characterize coral communities near the Port Everglades channel between September 9–12, 2024, on Shedd Aquarium’s R/V *Coral Reef II*. A total of 46 sites were surveyed within ~2 km of the channel north and south, though most surveys were <500 m from the channel, in the Scenario 2 impact zones (Figure 1B and C) on the NRC, IR and MR (the OR was not surveyed). Data collection followed the Disturbance Response Monitoring (DRM) survey protocols (Stein and Ruzicka, 2021), augmented to include all coral taxa of all sizes. At each site, four 10 x 1 m belt transects were haphazardly placed on reef habitat to identify, count, and measure stony corals. In transects 1 and 2, all adult stony coral colonies ≥4 cm that had any portion of the colony within the boundaries of the transect were recorded and measured, and all corals <4 cm were tallied by taxon (taxonomic resolution described below). In transects 3 and 4, only certain taxa ≥4 cm were recorded; these included *Colpophyllia natans, Dichocoenia stokesii, Diploria labyrinthiformis, Meandrina meandrites, Mussa angulosa, Mycetophyllia aliciae, Mycetophyllia ferox, Mycetophyllia lamarckiana, Pseudodiploria clivosa*, and *Pseudodiploria strigosa*. For colonies <4 cm, only *M. cavernosa* and the families Mussinae, Faviinae, and Meandrinidae were tallied.

Previous Port Everglades coral survey data

In addition to the 2024 Shedd survey, we analyzed data from five previous surveys conducted in the area, as detailed below. Only surveys specific to Port Everglades were included, as broader programs (e.g., DRM, NCRMP) did not provide sufficient local site coverage.

- 2011 Nova Southeastern University (NSU) ESA Survey: This survey aimed to document coral taxa that were ESA-listed (*Acropora cervicornis* and *A. palmata*) or petitioned for listing at the time [*Agaricia lamarckiana, Dendrogyra cylindrus, Dichocoenia stokesii, M. ferox,* and *Orbicella* (formerly *Montastraea*) spp.)]. A total of 376 'tier 1' sites were surveyed south of the channel (to ~3.75 km; Figure 1B, Table 1), with 3,600 m² surveyed per site. Sites with more than five *Acropora* corals were revisited for an additional tier 2 survey, but only tier 1 data were used in this analysis (NSU, 2011).
- 2017 Dial Cordy and Associates (DCA) ESA Survey: This survey aimed to document ESA-listed corals (*Acropora* and *Orbicella* spp.) north of the channel (148 sites out to ~1,050 m), and at an additional 15 sites south of the channel to complement the 2011 NSU ESA survey (Figure 1B, Table 1). At each of the 163 sites, crossed 100 x 4 m transects were used to survey a total of 784 m^2 (DCA, 2018a).
- 2017 DCA Reconnaissance survey: This survey aimed to document all coral taxa in what was considered the primary PEV project footprint area—150 m north and south of the channel—where a total of 170 sites were surveyed. An additional 25 sites were added outside the 150 m area—primarily to the north—in case PEV impacts extended further than predicted at the time of the survey protocol development (Figure 1B, Table 1). Each of the 195 sites were surveyed with a 30 x 1 m (30 m^2) belt transect (DCA, 2018b).
- 2021 Tetra Tech Reconnaissance and ESA survey: This survey aimed to better characterize coral communities further than 150 m from the channel, and included 41 sites, primarily to the south (Figure 1B, Table 1). At each site, crossed 100 x 4 m transects were used to survey ESA corals, and a 30 x 1 m belt transect was used to survey non-ESA-listed corals (Tetra Tech, 2021ab).
- 2023 Tetra Tech survey: This survey aimed to characterize benthic communities in areas closest to the Port Everglades channel (<100 m) anticipated to be most impacted by the project (Figure 1B, Table 1). A total of 156 sites were surveyed with a 20 m^2 belt transect (Tetra Tech, 2025).

Data compilation

We synthesized all coral abundance data from the six survey efforts described above. To enable quantitative comparison, we harmonized all datasets to a common structure of counts by taxon and size class (classified as "<4 cm" or "≥4 cm" based on maximum colony dimension) per site, and calculated the total area surveyed for each taxon-size class combination at each site. Transect numbers and dimensions varied among surveys, resulting in variable total area surveyed per taxon per site. Because some 2021 Tetra Tech survey transects included extensive non-reef habitat (sand), we subtracted the recorded non-reef area from the total area surveyed, and excluded 4 sites that were recorded as 100% sand.

Due to variation in taxonomic coverage and resolution across surveys, we filtered and aggregated count data for some taxa to achieve consistency. No survey since NSU (2011) observed *D. cylindrus* in the region, thus it was excluded from the present analysis. *A. lamarckiana* and *M. ferox* from the 2011 NSU survey were also excluded for comparability with later surveys, which recorded all *Agaricia* and *Mycetophyllia* spp., but sometimes only to genus level. Taxa frequently identified only to the genus level were aggregated for comparability; these included *Orbicella* spp., *Agaricia* spp., *Madracis* spp., *Porites* spp., *Solenastrea* spp., *Siderastrea* spp., and *Mycetophyllia* spp. Some juvenile (<4 cm) taxa were further aggregated to

the subfamily (Faviinae, Mussinae) or family level (Meandrinidae) due to difficulty of species-level identification at small sizes. In the NSU (2011) survey, colony sizes were not recorded – but since the 3 included taxa from this survey were mostly ≥4 cm in other surveys (99.7% of *A. cervicornis*, 94.6% of *Orbicella* spp., 81.8% of *D. stokesii*), they were included in the ≥4 cm size class. Taxa observed less than 5 times across all survey datasets were excluded (these included *Favia fragum, Phyllangia americana, Scolymia* spp., and *Oculina* spp.). Coral taxa that were searched for but not recorded at a given site were given explicit zeros in the combined count data. Finally, we excluded *A. cervicornis* data from the 2023 Tetra Tech survey (all zeros) because its sites were tightly clustered near the channel and did not overlap with the taxon's well-known, highly aggregated distribution (e.g., D'Antonio, 2016; DCA, 2018a). This exclusion did not apply to other surveys, which provided broader coverage of *A. cervicornis*' range, or to other taxa in the 2023 Tetra Tech survey, whose broader distributions were adequately sampled within its footprint.

We classified the reef habitat type of each surveyed site by overlaying site coordinates on benthic habitat polygons from the habitat map developed for the PEV (USACE, 2022; Appendix D), which is based on the map created by Walker and Klug (2014) with additional side scan sonar and *in-situ* verification. Fourteen sites in habitats categorized as Sand (n=9), Scattered Rock in Unconsolidated Sediment (n=2), Ridge (n=2), or Inlet Channel (n=1) were excluded because they were either not coral habitat, or did not have a sufficient number of replicate sites to support habitat-specific density estimation. The remaining sites (n=976) were classified as Nearshore Ridge Complex (NRC), Inner Reef (IR), Middle Reef (MR), or Outer Reef (OR). Sites within the 'Artificial' habitat type were reclassified as Nearshore Ridge Complex based on their close spatial proximity and similar coral communities. Similarly, sites in the 'Aggregated Patch Reef' habitat were classified as Outer Reef. The number of sites surveyed in each reef habitat varied substantially across survey efforts, summarized in Table 1 and Figure 1. Separate maps for each survey effort are found in Figure 1B.

The final combined and filtered dataset included 14,387 observations, each representing a count of a specific taxon and size class at a single site. In total, these observations encompassed 35,409 colonies of 20 taxa across 976 survey sites.

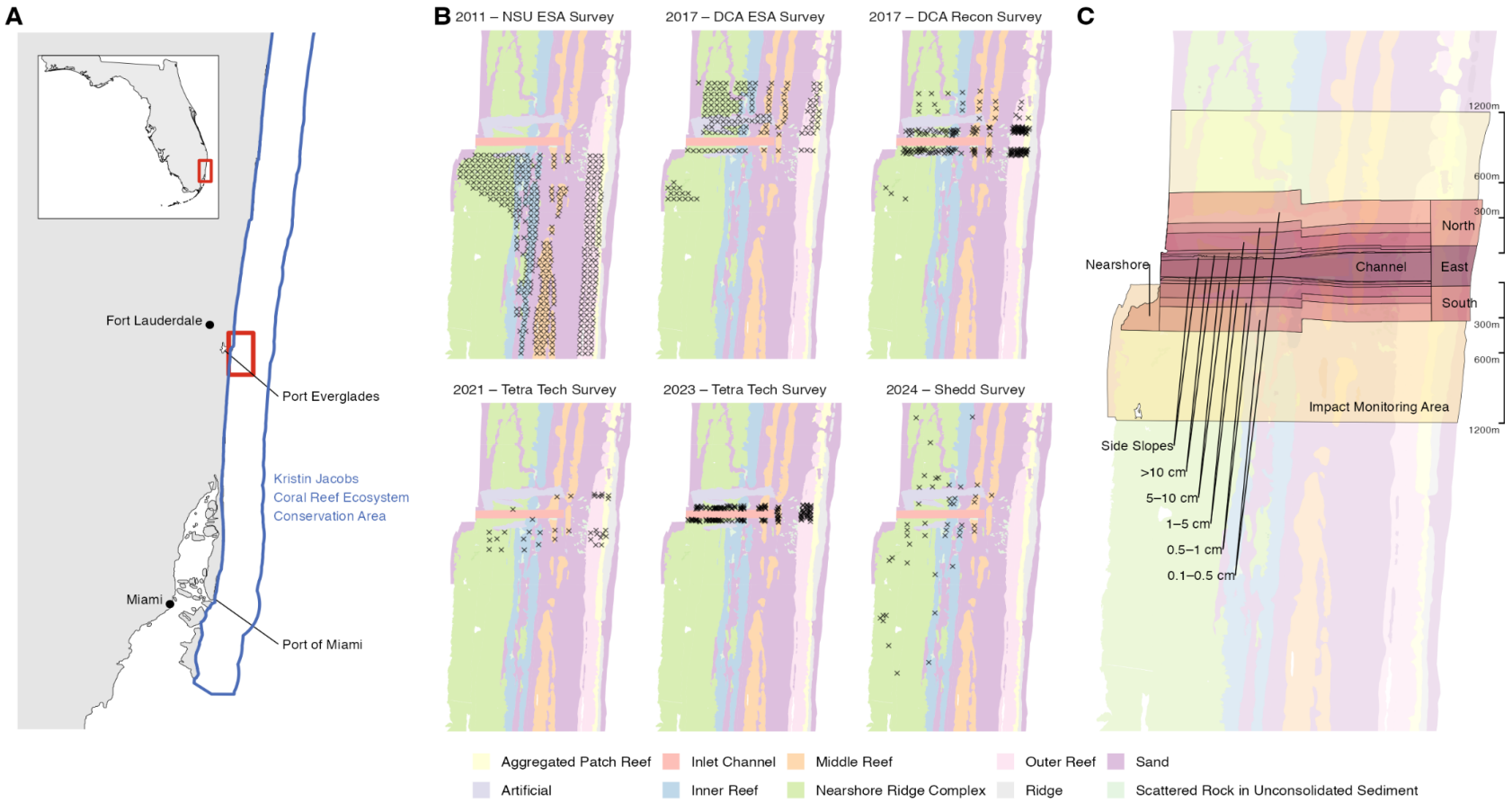

Figure 1. Locations of Port Everglades coral surveys and PEV dredging impact zones. (A) Provides geographical context for the location of Port Everglades within the state of Florida. The red box around Port Everglades indicates the spatial extent of maps in (B) and (C). Points in (B) indicate sites of coral surveys conducted in the six survey efforts, overlaid on colored habitat polygons from Walker and Klug (2014). Impact zones in (C) include polygons from the USACE's Scenario 2 spillage analysis (Channel, Side Slopes, and anticipated sedimentation depths of >10 cm, 5–10 cm, 1–5 cm, 0.5–1 cm, 0.1–0.5 cm), the four additional NMFS impact consideration areas (North, East, South, and Nearshore), and the spatial extent of the PEV proposed sedimentation monitoring area, extending to 1.2-km north and south of the channel edges (USACE, 2022; Appendix G).

Table 1: Summary of coral surveys at Port Everglades. The number of sites surveyed in this table result is from the combined and filtered dataset, which excludes and aggregates certain taxa, sites, and reef habitat types (see Methods for details). The 2023 Tetra Tech dataset excludes 10 sites that had no GPS coordinates.

Dataset	Nearshore Ridge Complex	Inner Reef	Middle Reef	Outer Reef	Total Sites	Area per site (m^2)	Total area (m^2)	Total # corals
2011 - NSU ESA	85	94	83	111	373	3600	1342800	11871
2017 - DCA ESA	92	17	21	25	155	784	121520	3620
2017 - DCA Recon	62	22	26	85	195	30	5850	9489
2021 - Tetra Tech	7	6	5	17	35	3.9 - 784	24314	2172
2023 - Tetra Tech	81	19	34	38	172	10 - 20	3180	5691
2024 - Shedd	25	15	6	0	46	20 - 40	1840	2566
Total	352	173	175	276	976	-	1499504	35409

Statistical analysis

To estimate the density of all coral taxa and size classes in each habitat type, we fit a zero-inflated negative binomial hierarchical model in a Bayesian framework using brms (Bürkner 2017) with cmdstanr (Gabry et al. 2025). This approach accounts for both overdispersion (variance greater than the mean) and a high frequency of zeros—features common in ecological count data and present in this dataset—and has been successfully applied in other coral studies (Bauman et al. 2015; Dajka et al. 2019). The hierarchical structure further allows us to combine information across multiple survey datasets while accommodating differences among them, which we modeled through fixed effects for coral taxon and size class (taxon:class), reef habitat type, and their interaction. Random intercepts and habitat-specific slopes for each dataset (1 + habitat | dataset) allowed habitat effects to vary among surveys while sharing information across datasets. We also included random intercepts for each dataset–taxon–size class (1 | dataset:taxon:class) to estimate dataset-specific abundances of individual taxa with partial pooling, and for taxon–size-class–habitat–direction (1 | taxon:class:habitat:dir) to account for localized north–south variation. An offset for the log of the surveyed area at each site was included so that model predictions were expressed in colonies per m^2. The zero-inflation probability and negative binomial shape parameter were modeled as functions of taxon:class and habitat, capturing variation in zero counts and spatial aggregation among taxa and habitats. This structure was defined a priori to enable robust overall coral density estimates through partial pooling across datasets, while retaining flexibility to capture dataset-specific differences and spatial heterogeneity.

We used weakly informative, data-informed priors. The count-model intercept was assigned a normal(−2.8, 1.8) prior based on the distribution of log-transformed non-zero densities. Fixed effects were given normal(0, 2) priors, the zero-inflation component a normal(1.5, 2.5) prior on the logit scale, and the shape parameter a normal(−0.9, 1) prior on the log scale, reflecting empirical variance-to-mean ratios. Random-effect standard deviations were assigned an exponential(4) prior to regularize dataset- and spatial-level variation and prevent overfitting. The model was fit with four chains of 6,000 iterations each (3,000 warmup) using the cmdstanr backend, with adapt_delta set to 0.99 to avoid divergent transitions.

The model achieved a Bayesian R^2 of 0.20 (95% CI: 0.16–0.26), indicating moderate explanatory power. Posterior predictive checks conducted on the density scale (colonies per m^2) showed good global agreement between the observed data and simulated posterior datasets, with posterior predictive p-values of 0.57 for the mean, 0.72 for the variance, 0.45 for the

proportion of zeros, 0.72 for skewness, and 0.42 for the chi-squared discrepancy, all close to the ideal value of 0.5. Group-wise (by taxon–size class–habitat) posterior predictive checks on the same statistics showed similarly good fit: only 12 out of 428 observed values were extreme relative to the model's predictions (posterior predictive p-values <0.05 or >0.95), primarily for skewness in sparse or aggregated taxa. These diagnostics indicate that the model accurately captured global and group-level patterns in coral density, including overdispersion, zero-inflation, and spatial heterogeneity across habitats and datasets.

Coral density estimation

We estimated coral densities by generating posterior predictions for each taxon–class–habitat combination, including dataset-level random effects and marginalizing over direction. Predictions were made for all surveyed combinations with transect area set to 1 m^2 to express predictions on the density scale, then averaged equally across datasets to ensure balanced contributions. This post hoc averaging preserves the fitted model's partial pooling, allowing estimates for data-limited groups to borrow strength from the broader dataset, while preventing datasets with many spatially clustered sites from disproportionately representing localized conditions (which would arise if dataset-level random effects were not included in predictions). This approach leverages all available information to yield robust density estimates for every taxon, size class, and habitat type that equally weight all survey datasets across the 2011–2024 time period.

As a complementary analysis, we also generated coral density estimates representing conditions in 2024, the most recent survey year. These estimates were derived from the same hierarchical model as the equal-weighted analysis, so information from all datasets still contributes to the predictions. However, instead of weighting datasets equally to represent longer-term averages across survey years, this approach uses the model to estimate what coral densities would be expected specifically in 2024. This provides an up-to-date baseline while still benefiting from the broader data context to improve estimates for groups with limited observations in 2024.

Temporal population trends

To evaluate temporal changes in coral density, we used posterior predictions (as above) of densities of each taxon and size class in each habitat from each dataset. We averaged predictions across habitat types for each draw to obtain overall density estimates for each taxon–size class from each dataset. Using these predictions, we calculated temporal trends (1) for each taxon and size class separately, (2) for each taxon summed across size classes, and (3) for all coral taxa combined, both overall and by size class. For each grouping, we fit a linear regression of predicted density on survey year within each posterior draw, from which we extracted the slope (annual change in density), the predicted total change in density between 2017 and 2024, and the percent change relative to 2017. We summarized these metrics across draws using posterior means and 95% credible intervals, and identified statistically supported trends as those whose credible intervals excluded zero.

Coral abundance extrapolation

To estimate total coral abundances, we multiplied the habitat-specific densities (colonies per m^2) of each coral taxon and size class by the total area of each reef habitat type within each impact zone. Habitat areas were quantified by computing the spatial overlap between mapped

reef habitat polygons and the boundaries of the Scenario 2 impact zones, NMFS consideration areas, and the full impact monitoring area (Figure 1C). For each zone, total abundances were calculated per taxon, size class, and habitat, then summed across habitat types to yield the total number of colonies within each zone. Abundances were extrapolated based on 1) estimated densities with datasets (survey years) equally-weighted, and 2) estimated densities reflecting the most recent (2024) conditions.

Results

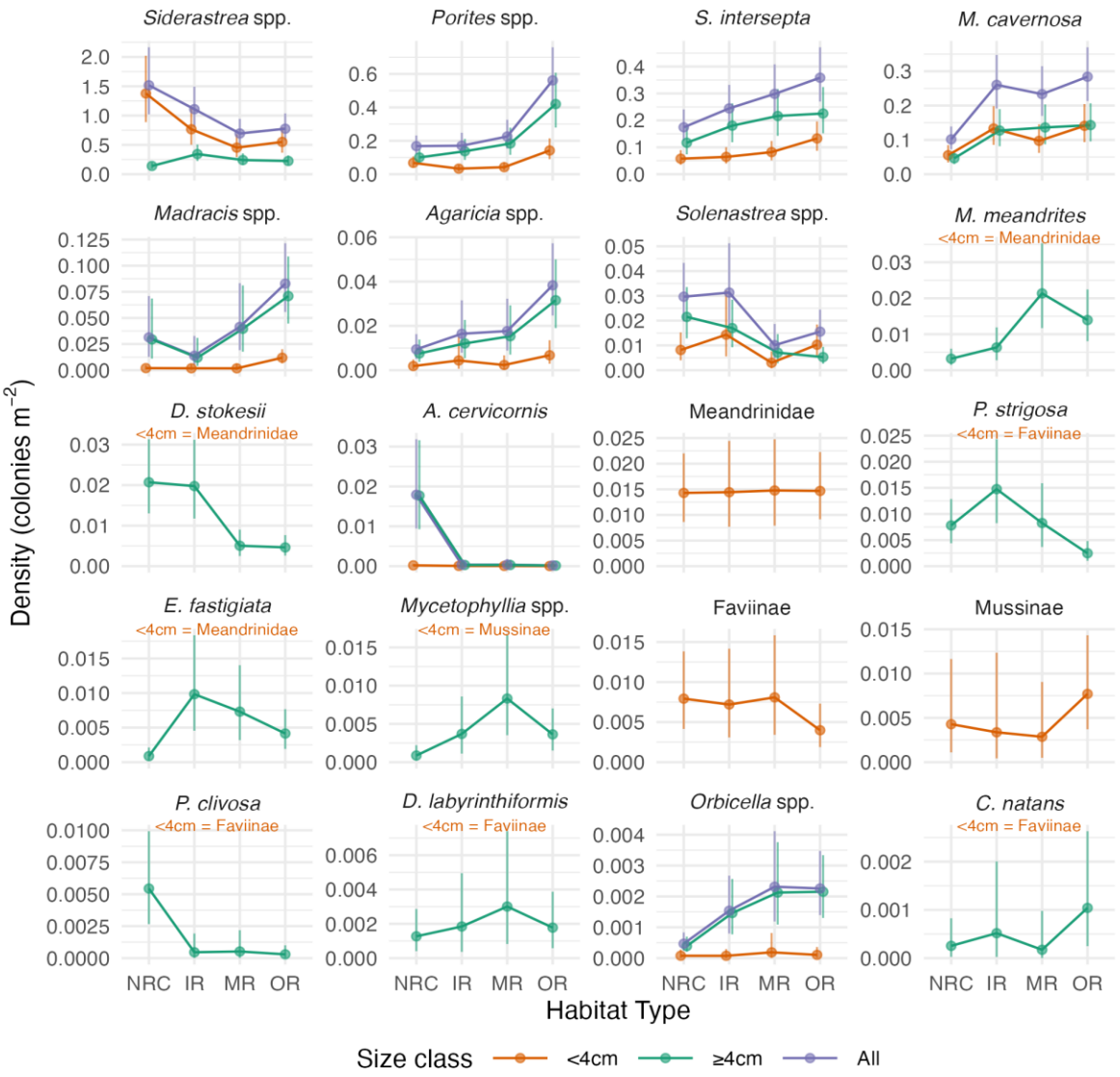

Figure 2: Coral taxon densities by habitat type and size class. Estimated coral densities with all survey datasets equally-weighted (mean ± 95% credible intervals) are shown across the four reef habitat types (NRC = Nearshore Ridge Complex; IR = Inner Reef; MR = Middle Reef; OR = Outer Reef), colored by size class (orange = <4 cm; green = ≥4 cm; purple = both size classes combined). Panels for each taxon are ordered from highest to lowest maximum density within any habitat; note y-axis scales vary among panels. Densities reflecting 2024 estimates are presented in Figure A2.

Coral densities at Port Everglades

We first estimated densities of each coral taxon and size class in each reef habitat type, equally weighting all survey datasets to provide balanced estimates of average densities over the 2011–2024 time period (Figure 2; Table A2). The most abundant taxa were *Siderastrea* spp., *Porites* spp., *S. intersepta*, and *M. cavernosa*, which occurred in the range of 0.1–1 colony m^{-2} or higher, depending on the reef habitat type. These taxa generally increased in abundance moving from nearshore (NRC) to offshore (OR) habitats, except for *Siderastrea* spp., which had a high density of juveniles <4 cm on the NRC (1.4 colonies m^{-2}). Taxa with densities of ~0.01–0.1 colonies m^{-2} included *Madracis* spp., *Agaricia* spp., and *M. meandrites* (which were more abundant further offshore), and *Solenastrea* spp., *D. stokesii*, and *P. strigosa* (which were more abundant further inshore), and Meandrinidae juveniles, which occurred at densities of ~0.015 colonies m^{-2} across habitats. The ESA-listed corals had distinct distributions, with *A. cervicornis* occurring at ~0.018 colonies m^{-2} on the NRC but being nearly absent from other habitat types. In contrast, *Orbicella* spp. were nearly absent from the NRC, but occurred at ~0.002 colonies m^{-2} in the other reef habitats. The remaining taxa had densities of ~0.01 colonies m^{-2} or lower across habitats, with some ≤ ~0.003 (*D. labyrinthiformis*) or ~0.001 (*C. natans*). The densities of each taxon and size class in each reef habitat are provided in Figure 2 and Table A2. Modeled densities compared to the raw densities computed from each individual dataset are presented in Figure A1.

The mean total density of all corals combined was 2.12 colonies m^{-2} on the NRC, 1.93 m^{-2} on the IR, 1.60 m^{-2} on the MR, and 2.18 m^{-2} on the OR (Figure 3A). When these totals are broken down by size class, 75% of the corals on the NRC are <4 cm, while the other reef habitats comprise similar proportions of the two size classes (Figure 3B). The highest density of corals ≥4 cm was on the OR (1.16 colonies m^{-2}; Figure 3B). When corals are grouped based on susceptibility to SCTLD following Papke et al. (2024), moderately susceptible taxa (*Siderastrea* spp., *S. intersepta, M. cavernosa, S. bournoni, Orbicella* spp.) were most abundant (~1.24–1.82 colonies m^{-2}) across all reef habitats. Highly susceptible taxa (*E. fastigiata, D. labyrinthiformis, Pseudodiploria* spp., *C. natans*, *D. stokesii, M. meandrites*, and Meandrinidae, Faviinae, and Mussinae juveniles) were least abundant, with combined densities of 0.055–0.079 colonies m^{-2} across all reef habitats (Figure 3C).

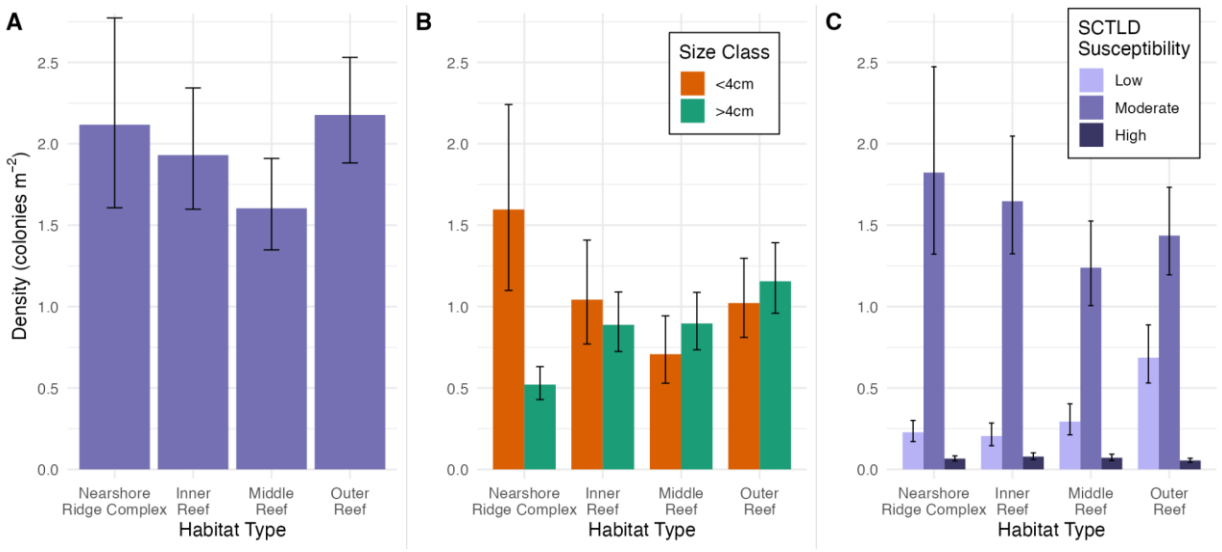

Figure 3. Total coral densities by reef habitat. The total density of all corals (with survey datasets equally weighted) is shown in panel **(A)**. Panel **(B)** breaks down these totals by size class (<4 cm and ≥4 cm), and panel **(C)** shows the totals of taxon groups that vary in SCTLD susceptibility (low, moderate, high), following Papke et al. 2024. Bars represent posterior mean densities, with error bars indicating 95% credible intervals.

Temporal changes across recent surveys

Temporal trends from 2017–2024 revealed variable trajectories across taxa (Figure 4). Overall, there was a substantial increase in the mean density of all corals, with a gain of 0.96 colonies m^{-2} since 2017 (Figures 4 and 5). Relative to the 2017 abundance of 1.43 colonies m^{-2}, this represents a 68% increase in total coral abundance. This overall trend was driven primarily by increases in *Siderastrea* spp. (+0.61 m^{-2}; +93%), *Porites* spp. (+0.30 m^{-2}; +208%), and *M. cavernosa* (+0.072 m^{-2}; +42%). Additional significant increases were observed for *Solenastrea* spp. (+0.01 m^{-2}; +68%), *Agaricia* spp. (+0.009 m^{-2}; +67%), *M. meandrites* (+0.0053 m^{-2}; +75%), *E. fastigiata* (+0.0043 m^{-2}; +196%), and *Orbicella* spp. (+0.0016 m^{-2}; +289%). In contrast, significant decreases were detected for juvenile Faviinae (-0.004 m^{-2}; -43%) and juvenile Meandrinidae (-0.019 m^{-2}; -74%). For all other taxa, credible intervals overlapped zero (Figure 5), indicating no significant change over time, although *Madracis* spp. and *S. intersepta* exhibited changes in the relative abundances of size classes that offset one another at the taxon level. *P. strigosa* and *Mycetophyllia* also showed relative increases (+84% and +106%, respectively); however, these were not significant as the credible intervals included zero. The absolute changes in density of each taxon and size class from 2017–2024, and their credible intervals, are shown in Figure 5.

Given the evidence for substantial changes in densities for some taxa from 2017–2024 across four distinct survey datasets (Figures 4 and 5), we recomputed densities to reflect the most current estimates based on the 2024 time point, rather than equally weighted across all past surveys. These current density estimates for each reef habitat are presented for each taxon and size class (Figure A2, Table A3), and for all coral taxa combined, and aggregated by size class and SCTLD susceptibility group (Figure A3).

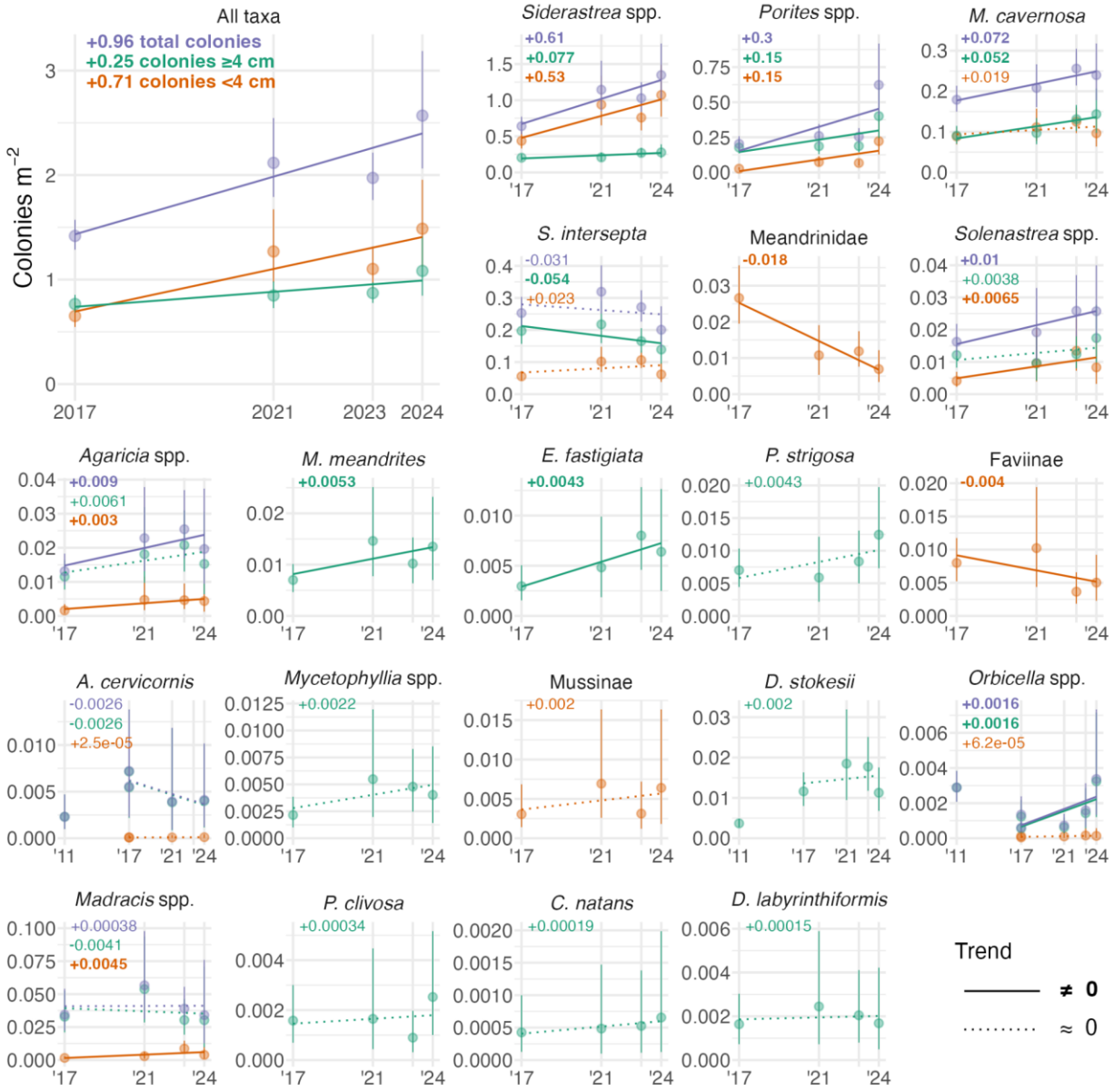

Figure 4. Trends in coral density (colonies m^{-2}) for each taxon and size class across survey years. The upper-left panel shows all taxa combined, while remaining panels display individual taxa. Points represent mean posterior estimates for each survey, averaged across all reef habitat types, with 95% credible intervals. Points are colored by size class (<4 cm = orange; ≥4 cm = green; combined = purple). Trendlines from 2017–2024 are shown as solid lines when credible intervals for the slope exclude zero, while dotted lines indicate trends with credible intervals that include zero. Numeric labels within each panel (colored by size class) show the estimated absolute change in density from 2017–2024, with bold text corresponding to credible intervals that exclude zero.

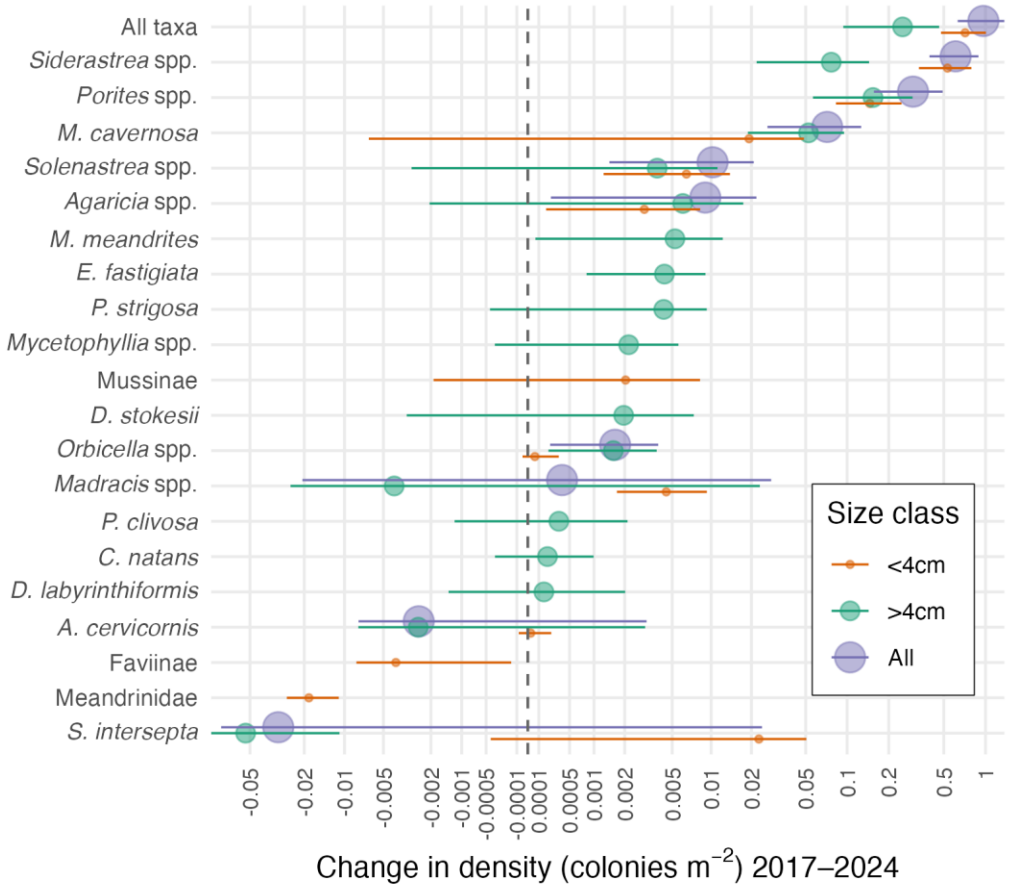

Figure 5. Changes in coral density by taxon and size class across survey years (2017–2024). Points show posterior means with 95% credible intervals for changes in mean density across all habitat types (colonies m⁻²). The dashed vertical line indicates zero change. These trends, and mean densities of each taxon over time, are also shown in Figure 4.

Coral abundances in impact zones

Total abundances of each taxon and size class in impact areas were computed by multiplying their habitat-specific densities by the total area of each habitat in each impact zone. We first computed total abundances based on the densities with datasets equal-weighted. These results indicate an estimated total of 3.4 million corals within the Scenario 2 impact zones and NMFS consideration areas (Figure 6, Table 2). *Siderastrea* spp. are the most abundant, with over 2 million colonies, followed by *Porites* spp. (425K), *S. intersepta* (389K), and *M. cavernosa* (288K). Remaining taxa number in the thousands to tens of thousands, except for the least abundant taxon, *C. natans* (737 colonies; Figure 6). There are an estimated 18,701 ESA-listed corals across these impact zones, including 16,761 *A. cervicornis* and 1,940 *Orbicella* spp. (Figure 6, Table 2). The totals for these two ESA-listed taxa in each individual impact zone, along with their cumulative totals moving away from the channel, are listed in Table 2. Total abundances of each taxon and size class in each impact zone are provided in Table A4. When the entire impact monitoring area (out to 1.2 km from the channel) is

considered, the total abundance of all corals increases to 8.2 million, including 43,932 ESA-listed corals (39,179 *A. cervicornis* and 4,753 *Orbicella* spp.; Table 2, Figure A4).

Given the evidence for substantial changes in densities for some taxa from 2017–2024 (Figures 4 and 5), we also recomputed total abundances to reflect the most current estimates, rather than equally weighted across all past surveys. These results indicate even higher current abundance of corals—4.4 million total in the USACE Scenario 2 and NMFS consideration areas (including 14,714 *A. cervicornis* and 3,956 *Orbicella* spp.) (Figure A5, Table A5), and 10.5 million in the full impact monitoring area (including 34,411 *A. cervicornis* and 9,664 *Orbicella* spp.) (Figure A6, Table A6). Total abundances reflecting 2024 estimates for each taxon in each impact zone are provided in Table A5.

Table 2: Total number of ESA- and non-ESA-listed corals in each impact zone. Numbers are based on the modeled habitat-specific densities with survey years equal-weighted, multiplied by habitat areas, and summed within impact zones. Cumulative totals are also provided that sum across impact zones moving away from the channel (down rows). Impact zones are shown on a map in Figure 1C. ACER = *Acropora cervicornis*, ORBI = *Orbicella* spp.

Impact area	ACER	ORBI	non-ESA corals	Total	Cumulative ACER	Cumulative ORBI	Cumulative non-ESA	Cumulative Total
Channel	29	194	169,211	169,434	29	194	169,211	169,434
Side Slopes	339	22	50,496	50,857	368	216	219,707	220,291
Sediment deposition >10 cm	801	86	155,305	156,192	1,169	302	375,012	376,483
Sediment deposition 5-10 cm	820	85	155,520	156,425	1,989	387	530,532	532,908
Sediment deposition 1- 5 cm	3,971	374	718,453	722,798	5,960	761	1,248,985	1,255,706
Sediment deposition 0.5 - 1 cm	2,707	245	478,310	481,262	8,667	1,006	1,727,295	1,736,968
Sediment deposition 0.1 - 0.5 cm	6,948	626	1,253,870	1,261,444	15,615	1,632	2,981,165	2,998,412
Nearshore	1,124	29	131,676	132,829	16,739	1,661	3,112,841	3,131,241
North	11	135	130,003	130,149	16,750	1,796	3,242,844	3,261,390
East	6	84	81,016	81,106	16,756	1,880	3,323,860	3,342,496
South	5	60	57,617	57,682	16,761	1,940	3,381,477	3,400,178
Rest of impact monitoring area	22,418	2,813	4,760,963	4,786,194	39,179	4,753	8,142,440	8,186,372

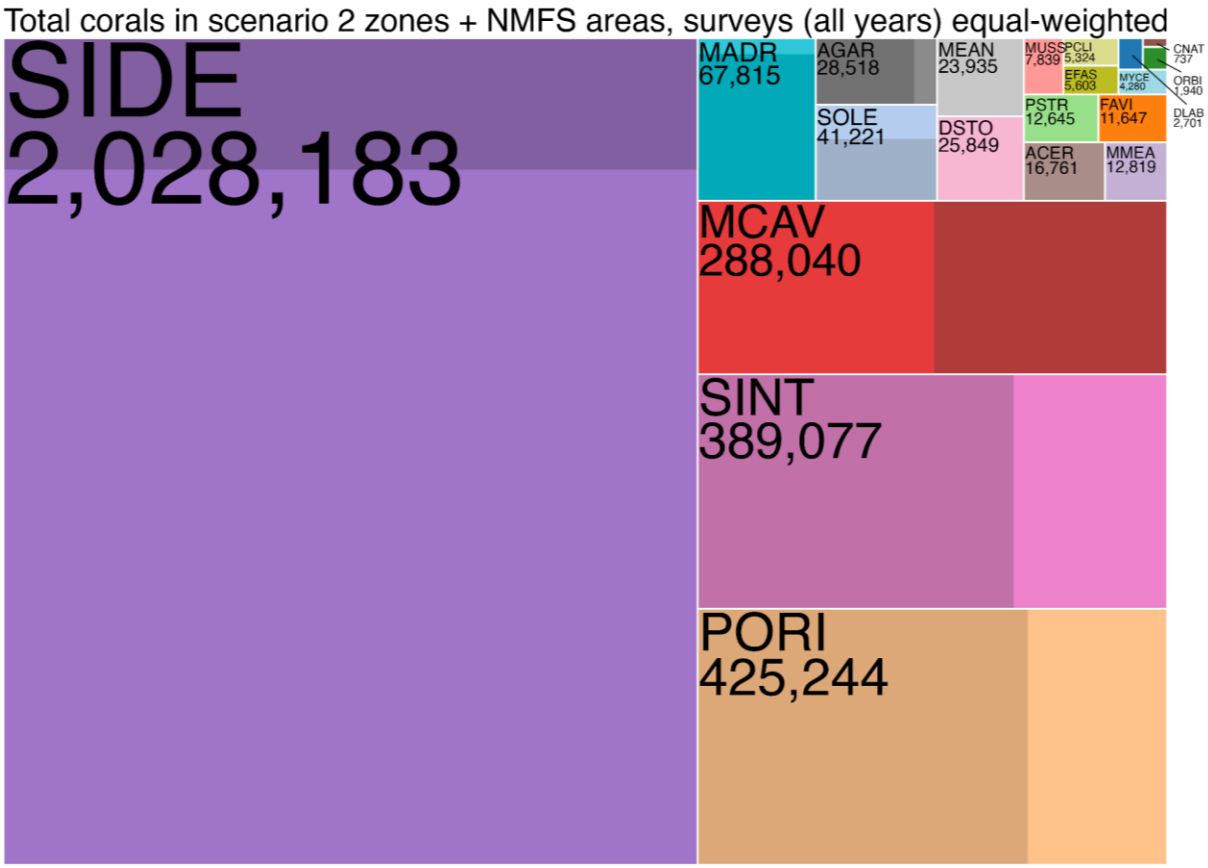

Figure 6: Composition and total abundances of coral taxa within Scenario 2 and NMFS consideration area impact zones at Port Everglades. The box for each taxon is sized proportional to its relative abundance, and annotated with the taxon abbreviation and total number of colonies in the combined impact zones. For each taxon, the darker portion of the box represents corals ≥4 cm, and the lighter portion represents colonies <4 cm (note some taxa represent only one size class; see Figure 2). Taxon abbreviations are as follows: ACER = *Acropora cervicornis*; AGAR = *Agaricia* spp.; CNAT = *Colpophyllia natans*; DLAB = *Diploria labyrinthiformis*; DSTO = *Dichocoenia stokesii*; EFAS = *Eusmilia fastigiata*; FAVI = Faviinae; MADR = *Madracis* spp.; MCAV = *Montastraea cavernosa*; MEAN = Meandrinidae; MMEA = *Meandrina meandrites*; MUSS = Mussinae; MYCE = *Mycetophyllia* spp.; ORBI = *Orbicella* spp.; PCLI = *Pseudodiploria clivosa*; PORI = *Porites* spp.; PSTR = *Pseudodiploria strigosa*; SIDE = *Siderastrea* spp.; SINT = *Siderastrea intersepta*; SOLE = *Solenastrea* spp.

Discussion

Coral densities and species-specific trends at Port Everglades

Port Everglades is located within the Kristin Jacobs Coral Reef Ecosystem Conservation Area, in the Southeast Florida region of Florida's Coral Reef, where coral reef habitats occur in close proximity to a heavily urbanized coastline (Jones and Gilliam, 2024). Averaged across habitat types, our analysis revealed a juvenile coral (<4 cm) density of 1.09 colonies m^{-2} [0.92–1.30 95% CrI], with up to 1.60 m^{-2} [1.10–2.24 95% CrI] on the NRC (Figure 3B). Comparisons with broader regional estimates of total juvenile densities are difficult given methodological

differences among surveys in taxonomic coverage and the size threshold used to classify juveniles. However, comparable taxon-specific densities of juvenile Mussinae, Faviinae, Meandrinidae, and *M. cavernosa* in Southeast Florida (Stein et al. 2024) are largely consistent with observed densities near Port Everglades area, indicating the area is conducive to coral recruitment. Juvenile density also varied by habitat: about 75% of corals on the NRC (closer to shore) were <4 cm, while the other reef habitats (IR, MR and OR) showed relatively equal proportions of juvenile (<4 cm) and adult (≥4 cm) corals (Figure 3B), an indication that the Port Everglades area is also conducive to coral growth and recruit survivorship. The majority of juveniles observed were *Siderastrea* spp. (Figure 2), which is consistent with reports from multiple long-term monitoring surveys in the area (Gilliam et al. 2021; Viehman et al. 2023; Jones and Gilliam, 2024), and these were most abundant on the NRC. *Siderastrea* spp. are considered stress-tolerant taxa (Lirman et al. 2003, Darling et al. 2012), and are common on inshore reefs in the Florida Keys (Lirman and Fong, 2007). In contrast, the other three most abundant taxa in the PEV area (*Porites* spp., *S. intersepta*, and *M. cavernosa*) showed juvenile densities that increased moving offshore (with the OR habitat having the highest densities, Figure 2).

Adult stony coral densities in the Port Everglades area also varied with habitat, with an average density of 0.87 corals m^{-2} [0.78–0.96 95% CrI] across habitats (Figure 3B), and highest average density in the OR (~1.16 colonies m^{-2} [0.96–1.39]; Figure 3B). These estimates are higher than the average adult coral density reported for Southeast Florida in the 2022 report of the National Coral Reef Monitoring Program [0.6 (±0.04) adult corals m^{-2}; Viehman et al. 2023]. In addition, several taxa considered moderately or highly susceptible to stony coral tissue loss disease (SCTLD) (Papke et al. 2024) had adult coral densities in habitats near Port Everglades either higher or comparable to Southeast Florida regional averages reported in the latest DRM survey (Stein et al. 2024). Specifically, densities exceeded regional averages by 2.3x for *D. labyrinthiformis* on the MR (~0.003 vs. 0.0013 colonies m^{-2}) and by 1.6x for *P. strigosa* on the IR (~0.015 vs. 0.0096 colonies m^{-2}) (Figure 2), and were similar to regional averages for *D. stokesii* (~0.02 colonies m^{-2} in the NRC and IR vs. 0.0235 colonies m^{-2}) and *M. meandrites* (~0.02 colonies m^{-2} in the MR vs. 0.0165 colonies m^{-2}) (Figure 2). Other species had lower adult densities in the Port Everglades area compared to Southeast Florida regional averages, including *P. clivosa* (1.4x lower, 0.005 on the NRC vs. 0.007 colonies m^{-2}) and *C. natans* (3.1x lower, 0.001 on the OR vs. 0.0031 colonies m^{-2}; Stein et al. 2024).

The abundance of ESA-listed corals (*Orbicella* spp. and *A. cervicornis*) <4 cm was very low across habitats in the Port Everglades area (Figure 2). This is not surprising, as these species already show negligible recruitment across Florida (Hughes and Tanner, 2000; Brainard et al. 2011; Miller, 2014). Adults of these ESA-listed coral species, however, were present and differentially distributed across habitat types. *Orbicella* spp. increased moving offshore (highest in the MR and OR with ~0.002 colonies m^{-2}) and was nearly absent in the NRC habitat (Figure 2). In contrast, the vast majority of *A. cervicornis* colonies were found in the NRC (~0.018 colonies m^{-2}). These densities of *A. cervicornis* are notable given that the species was absent from all NCRMP surveys across Florida in 2016, 2018, and 2020, and only recorded in 2022 at Mission Iconic Reefs restoration sites (i.e., outplanted colonies; Viehman et al. 2023). The marine heatwave of 2023 caused high mortality of *Acropora* spp. throughout Florida (Neely et al. 2024; Williams, 2024), leaving the *A. cervicornis* near Port Everglades as some of the last remaining in the continental United States, highlighting its critical preservation value.

Temporal changes in coral densities in the Port Everglades area

Coral reefs in Southeast Florida have faced a cascade of stressors over the past decade, including SCTLD and multiple marine heatwaves, including the record-breaking event of 2023 (Neely et al. 2024; FWC, 2025). Fortunately, the Southeast Florida region largely escaped the impacts of the 2023 heatwave, experiencing the lowest heat stress of any region of Florida (NOAA Coral Reef Watch, 2023) and less than 20% bleaching (Stein et al. 2023). The most significant disturbance shaping recent trajectories of reefs near Port Everglades has been SCTLD, which originated in 2014 near the Port of Miami as it was being dredged (Precht et al. 2016; Dobbelaere et al. 2024), and peaked in Southeast Florida in 2016, resulting in a regional 30% decrease in coral density (Walton et al. 2018). However, in the ~8-9 years since the peak of SCTLD, our findings indicate that coral populations near Port Everglades have increased substantially, rising from approximately 1.5 to 2.5 colonies m^{-2} from 2017–2024 (Figure 4). The increases were observed in both juvenile (<4 cm) and adult (≥4 cm) corals (Figure 4, 5), and driven primarily by increases in *Siderastrea* spp. (+0.61 colonies m^{-2}; +93%), *Porites* spp. (+0.30; +208%), and *M. cavernosa* (+0.072; +42%).

While *Porites* spp. had only low susceptibility to SCTLD, these 'weedy' species have been increasing in Southeast Florida (Jones et al. 2020; Shilling et al. 2023) and across the Caribbean (Green et al. 2008) in recent decades, consistent with the trend observed here. On the other hand, the increases observed in *Siderastrea* spp. and *M. cavernosa*, which are moderately susceptible to SCTLD (Papke et al. 2024), may reflect population recovery following disease impacts. Indeed, several other taxa considered moderately or highly susceptible to SCTLD also showed significant increases from 2017–2024, including *M. meandrites* (+0.0053 colonies m^{-2}; +75%), *E. fastigiata* (+0.0043 colonies m^{-2}; +196%), and *Orbicella* spp. (+0.0016 colonies m^{-2}; +289%) (Figures 4 and 5). Highly susceptible *P. strigosa* and *Mycetophyllia* also showed increasing trends, though these were not significant. While the larger size classes of some SCTLD-susceptible taxa may be increasing, densities of juvenile Meandrinidae (which includes *M. meandrites* and *E. fastigiata*) and Faviinae (which includes *P. strigosa*) have decreased since 2017 (Figures 4 and 5). This could reflect regional declines of upstream larval source populations in the Florida Keys that were impacted by SCTLD later (2017–2020). However, the increases in larger size classes indicate at least some successful recruitment and growth even if total recruitment is lower. These signs of recovery from SCTLD in the Port Everglades region are particularly important for these species, as their recovery in other regions of Florida could be impeded by the more severe impacts of the heatwave in 2023.

Together, these coral density estimates for the Port Everglades area can help inform the coral relocation and mitigation plans for the PEV deepening project. For example, while the current PEV functional assessment (USACE, 2022; Appendix D) uses a uniform target for outplanting corals regardless of habitat, our estimates allow for a more accurate, habitat-specific approach. For example, our data can be used to prioritize higher numbers in naturally high-density areas like the OR habitat. In addition, our taxon-specific density estimates (Figure 2, Figure A2) can be used to guide relocation or outplanting efforts, by helping understand where taxa are naturally most abundant, and help determine how many colonies from each taxon could be put in each habitat to achieve current densities. Finally, our estimates are also broken down by size class (<4 cm and ≥4 cm), which helps ensure that appropriate numbers of juvenile and adult corals are considered for relocation or mitigation (e.g., when outplanting sexually-produced juveniles from land-based nurseries).

Coral abundance in the PEV impact areas

Our analysis indicates that, with past survey datasets equally weighted, a total of 3.4 million coral colonies, including >18,000 ESA-listed corals, occur within the PEV Scenario 2 and additional NMFS impact zones (Table 2 and Figure 6). Using more recent 2024 density estimates, these totals increase to 4.3 million corals, including ~19,000 ESA-listed corals (Figure A5, Table A6). These estimates are for impact zones extending ~500–600 m north and south of the channel, based on the USACE spillage analysis that assumes significant sediment deposition will be confined within these distances. However, local hydrodynamics and resuspension events (e.g., storms) have the potential to transport sediments in less predictable ways, potentially to reef areas much farther than anticipated. Should impacts from the PEV exceed the footprint of the Scenario 2 and NMFS impact zones (Figure 1C), the number of corals that would be impacted just within 1.2 km of the channel increases to ~8.2 million corals (including >43,000 ESA-listed) using survey-averaged densities (Figure 6), and ~10.5 million corals (including >44,000 ESA-listed) using the 2024 densities (Figure A6, Table A6).

The estimated abundance of ESA-listed *A. cervicornis* includes 16,671 within the Scenario 2 and NMFS impact zones, and 39,179 in the full 1.2 km monitoring area (with surveys equal-weighted; Figure A4). When 2024 estimates are used, these totals are 14,714 and 34,411, respectively. While these estimates are robust over larger spatial scales of the combined impact zones, the spatially patchy and clustered distribution of *A. cervicornis* (D'Antonio, 2016; DCA, 2018a) makes estimates over small spatial scales less reliable (e.g., when considering only the narrow "channel" or "side slopes" impact zones; see Table 2). Over the full 1.2 km impact monitoring area, however, our estimates are consistent with, though somewhat lower than the estimate of ~51,000 *A. cervicornis* within ~1.1 km from the 2017 DCA ESA survey (DCA 2018a). Our lower estimate—produced from averaging across more survey datasets—could reflect the smaller spatial footprints of the 2021 and 2024 surveys that were not as well suited for quantifying highly aggregated taxa like *A. cervicornis*. Nevertheless, our estimates are consistent in scale and our statistical analysis does not indicate any significant temporal change in abundance of *A. cervicornis* since 2017 (Figures 4 and 5). In contrast, for *Orbicella* spp., our dataset-averaged estimate over the full 1.2 km monitoring area was 4,753 colonies (Figure 6), which is almost double the 2017 DCA ESA survey estimate within ~1.1 km from the channel (~2,990 for all three *Orbicella* spp. combined). Using the most recent estimates (2024), the total abundance of *Orbicella* spp. in the area within 1.2 km from the channel increases to almost 10,000 (Figure A5). These higher estimates could reflect the increases in density observed for *Orbicella* spp. since 2017 (after the peak of SCTLD), and potential for species recovery following disease impacts.

While the USACE's PEV deepening project's coral relocation efforts center around ESA-listed species, non-listed corals are indispensable for maintaining ecosystem function, resilience, and facilitating the recovery of ESA-listed species. Though our estimates suggest that the four most abundant taxa account for >75% of all corals, over 20 coral taxa are present across habitats in this area (Figure 2), reflecting a diverse coral community whose collective contributions are important for ecosystem stability (Bellwood et al. 2004). A healthy and diverse reef community enhances resistance and resilience to disturbances, a concept known as the portfolio effect, ensuring that key ecological functions persist even if some species decline (Hughes et al. 2003). Diverse coral communities facilitate interactions that reduce threats like disease and predation (Raymundo et al. 2009; Clements et al. 2019). Furthermore, the complex three-dimensional physical structure created by a variety of coral growth forms provides a vital habitat that protects newly-recruited corals, including those of ESA-listed species from abiotic stress and predation, and supports overall biodiversity (Graham and Nash 2013; Engleman et

al. 2023). Ultimately, a compositionally complex community of corals is a prerequisite for creating the conditions needed for the long-term success of coral reefs.

Implications for the PEV deepening project

Between 2022 and 2024, the USACE has produced estimates of ESA-listed coral abundance within the PEV's spillage analysis Scenario 2 footprint that have ranged widely, (i.e., between 3,881 and 78,248 estimated colonies; USACE personal communication to NMFS). The USACE analyses have focused on two main survey datasets that are over 10 years old now (2011 NSU and 2017 DCA ESA surveys), and thus may not reflect more current estimates or potential recovery from SCTLD. Relying only on these widely varying abundance estimates could lead to undersized coral mitigation and relocation plans for the PEV project. Such plans would fail to account for the millions of corals present, including tens of thousands of ESA-listed colonies identified in our analysis within 1.2 km of the channel. Such a discrepancy also represents a massive underestimation of the financial and logistical resources, including personnel and time required for monitoring, relocation and outplanting efforts. Furthermore, relying on a more limited assessment would obscure the unique conservation value of the Port Everglades reefs, which our findings show are a site of active recovery from SCTLD and a potential last refuge for Florida's wild *A. cervicornis*.

The USACE's PEV's spillage analysis Scenario 2 areas are anticipated to be impacted by sediment deposition in varying degrees of severity (in the range of 0.1 cm to >10 cm, see Figure 1C). These sediment depositions have the potential to result in both sub-lethal and lethal impacts to corals (Erftemeijer et al. 2012; Jones et al. 2016; Jones et al. 2019), including ESA-listed species and their designated critical habitat. Modeling conducted by Nelson et al. (2016) in the Pacific suggests that dredging-induced sediment deposition greater than 1 cm may cause significant impacts to corals, including mortality, while depositions between 0.5 and 1 cm may result in moderate stress. More recently, Serrano et al. (2025) assessed the ambient sediment depths in reef habitats near Port Everglades and found an average value of 0.38 ± 0.01 cm. This suggests that coral reef habitats in the PEV area may already be at a tipping point and at risk from other sources of sedimentation (e.g., terrestrial run-off), especially during short-term resuspension events, such as storms. Additional sedimentation resulting from dredging activities would likely result in severe impacts to corals (including ESA-listed species and their designated critical habitat), and cause bottlenecks in coral recruitment, habitat degradation, and potential benthic community shifts towards more sediment-tolerant non-coral species such as algal turfs, macroalgae, and sponges, thereby impeding coral recovery (Erftmeijer et al. 2012).

Early life stages of corals are also likely to be more susceptible than adult corals to the effects of sediment deposition (Fabricius, 2005; Jones et al. 2015; Tuttle and Donahue, 2022) predicted within the PEV Scenario 2 areas. A recent review (Tuttle and Donahue, 2022) suggests that sedimentation rates as low as 1 mg cm^{-2} d^{-1} can inhibit coral larvae from settling on suitable substrates. Even relatively thin sediment layers (≤0.4 cm) have been shown to significantly reduce coral larval settlement and recruit survival on Florida's coral reefs (Duran et al. 2024), including for ESA-listed species such as *A. palmata* and *O. faveolata* (Speare et al. 2019). Fine-grained sediments (especially clays and silts <63 µm) are particularly harmful (Erftemeijer et al. 2012, Jones et al. 2016, Jones et al. 2019, Storlazzi et al, 2015, Weber et al. 2006), as they have the potential to significantly reduce the probability of settlement for several coral species present in the PEV area. In fact, even sediment depositions of just 2 mm can decrease settlement probability by 65–100%, whereas 4 mm nearly eliminates any probability for settlement for most species tested (Rodriguez-Ruano et al. 2024).

Applying lessons learned from Port Miami

The 2013–2015 Port of Miami deepening project is an excellent example showcasing how impactful a large-scale port expansion can be to surrounding coral reef habitats. USACE initially reported that the project would result in only 13,355 m² (~3.3 acres) of direct impacts (USACE, 2004). However, during dredging operations, sediment plumes grew to be five times larger than their typical size, covering 127–228 km² compared to the usual 18–46 km² (Barnes et al. 2015). Furthermore, these larger plumes occurred 84% more frequently than they did before the dredging began (Barnes et al., 2015). In addition, though the ability to definitively link the dredging to onset of SCTLD outbreak has been confounded by a concurrent regional warm-water mass bleaching event (Miller et al. 2016), evidence from recent studies suggests that sediments can act as vectors of coral disease, including SCTLD (Studivan et al. 2022), and points to Port Miami dredging as a significant contributing factor (Dobbelaere et al. 2024). There is also evidence showing that areas closer to the dredging experienced higher sediment accumulation, benthic sediment cover, coral burial, and coral mortality, with over 560,000 corals estimated to have been killed within 0.5 km of the dredging site (Cunning et al. 2019). In total, NMFS estimated that 278 acres of reef habitat may have been impacted by the project (NMFS, 2023), despite the initial underestimate of ~3.3 acres (USACE, 2004). In comparison, the PEV is anticipated to result in approximately ~26 acres of reef habitat impacted directly through dredging, and hundreds more acres may potentially be impacted by turbidity and sedimentation (USACE, 2022). This highlights the importance of implementing stringent sediment control measures in the PEV project to minimize sediment spill and potential transport to surrounding coral reef habitats.

Many important lessons learned from the Port Miami deepening project are invaluable to inform the PEV deepening project, including 1) conducting pre- and post- project monitoring to better characterize impacts specific to dredging operations by establishing a robust baseline for comparison; 2) acknowledging that the impacts of sedimentation can spread far beyond what was anticipated; and 3) recognizing that coral diseases can be transmitted through sediments (USACE, 2022). The USACE has also committed to implementing minimization measures to reduce sediment spill (e.g., prohibiting overflow or rock chopping during dredging), not dredging in the outer entrance channel when most corals are spawning (July through September), and developing an Adaptive Management Plan to facilitate rapid decision-making during operations (USACE, 2022; Appendix H). While these proactive measures represent a significant step forward, their success will depend on rigorous implementation and a genuine commitment to prioritizing the health of the marine ecosystem.

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Data Availability Statement

All data and code to reproduce the analysis and figures in this report is available on Zenodo at: https://doi.org/10.5281/zenodo.17065530

References

Barnes, B. B., Hu, C., Kovach, C., & Silverstein, R. N. (2015). Sediment plumes induced by the Port of Miami dredging: Analysis and interpretation using Landsat and MODIS data. *Remote Sensing of Environment, 170*, 328-339.

Bauman, A. G., Guest, J. R., Dunshea, G., Low, J., Todd, P. A., & Steinberg, P. D. (2015). Coral settlement on a highly disturbed equatorial reef system. *PloS One*, *10*(5), e0127874.

Bellwood, D. R., Hughes, T. P., Folke, C., & Nyström, M. (2004). Confronting the coral reef crisis. *Nature*, *429*(6994), 827-833.

Brainard, R., Birkeland, C., Eakin, C. M., McElhany, P., Miller, M. W., Patterson, M., et al. (2011). *Status review report of 82 candidate coral species petitioned under the US Endangered Species Act*.

Bürkner, P. (2017). Brms: An R package for Bayesian multilevel models using Stan. *Journal of Statistical Software, 80*, 1–28.

Carsey, T. P., Stamates, S. J., Featherstone, C. M., Amornthammarong, N., Bishop, J. R., Brown, C. J., ... & Zhang, J. Z. (2015). Broward County coastal ocean water quality study, 2010-2012. *NOAA Technical Report*, OAR-AOML-44, 217 pp.

Clements, C. S., & Hay, M. E. (2019). Biodiversity enhances coral growth, tissue survivorship and suppression of macroalgae. *Nature Ecology & Evolution, 3*(2), 178-182.

Cunning, R., Silverstein, R. N., Barnes, B. B., & Baker, A. C. (2019). Extensive coral mortality and critical habitat loss following dredging and their association with remotely-sensed sediment plumes. *Marine Pollution Bulletin, 145*, 185-199.

D'Antonio, N. L., Gilliam, D. S., & Walker, B. K. (2016). Investigating the spatial distribution and effects of nearshore topography on *Acropora cervicornis* abundance in Southeast Florida. *PeerJ, 4*, e2473.

Dajka, J.-C., Wilson, S. K., Robinson, J. P. W., Chong-Seng, K. M., Harris, A., & Graham, N. A. J. (2019). Uncovering drivers of juvenile coral density following mass bleaching. *Coral Reefs*, *38*(4), 637–649.

DaPrato, G. W. (1995). *Analysis of nearshore turbidity plumes using passive multispectral archive satellite data: Interactions of tidal current and bathymetry in Broward County, Florida* [Master's thesis, Florida Atlantic University]. 24 pp.

Darling, E. S., Alvarez-Filip, L., Oliver, T. A., McClanahan, T. R., & Côté, I. M. (2012). Evaluating life-history strategies of reef corals from species traits. Ecology Letters, 15(12), 1378-1386.

DCA. (2018a). *Endangered Species Act Listed Coral Species Survey and Results. Port Everglades Navigation Improvements Project. Final Report*. Prepared for David Miller and Associates and Broward County, Port Everglades Department.

DCA. (2018b). *Benthic Community Reconnaissance Survey. Port Everglades Navigation Improvements Project. Final Report*. Prepared for David Miller and Associates and Broward County, Port Everglades Department and the U.S. Army Corps of Engineers, Jacksonville District.

Dobbelaere, T., Holstein, D. M., Gramer, L. J., McEachron, L., & Hanert, E. (2024). Investigating the link between the Port of Miami dredging and the onset of the stony coral tissue loss disease epidemics. *Marine Pollution Bulletin*, 207, 116886.

Duran, A., Speare, K. E., Fuchs, C., Adam, T. C., Palma, L., Miller, M. W., ... & Burkepile, D. E. (2024). Long sediment-laden algal turf likely impairs coral recovery on Florida's coral reefs. *Coral Reefs, 43*(4), 1109-1120.

Engleman, A., Cox, K., & Brooke, S. (2023). Dead but not forgotten: complexity of *Acropora palmata* colonies increases with greater composition of dead coral. *PeerJ, 11*, e16101.

Erftemeijer, P. L., Riegl, B., Hoeksema, B. W., & Todd, P. A. (2012). Environmental impacts of dredging and other sediment disturbances on corals: a review. *Marine Pollution Bulletin, 64*(9), 1737–1765.

Fabricius, K. E. (2005). Effects of terrestrial runoff on the ecology of corals and coral reefs: review and synthesis. *Marine Pollution Bulletin, 50*(2), 125–146.

Florida Fish and Wildlife Conservation Commission (FWC). (2025). *Coral Bleaching*. Available online at: https://myfwc.com/research/habitat/coral/news-information/bleaching/

Gabry, J., Češnovar, R., Johnson, A., & Bronder, S. (2025). *cmdstanr: R Interface to "CmdStan."* https://mc-stan.org/cmdstanr/

Gilliam, D. S., Hayes, N. K., Ruzicka, R., & Colella, M. (2021). *Southeast Florida Coral Reef Evaluation and Monitoring Project 2020 Year 18 Final Report*. Florida DEP & FWC.

Graham, N. A., & Nash, K. L. (2013). The importance of structural complexity in coral reef ecosystems. *Coral reefs*, *32*(2), 315-326.

Green, D. H., Edmunds, P. J., & Carpenter, R. C. (2008). Increasing relative abundance of Porites astreoides on Caribbean reefs mediated by an overall decline in coral cover. *Marine Ecology Progress Series, 359*, 1–10.

Gutierrez, L., Polidoro, B., Obura, D., Cabada-Blanco, F., Linardich, C., Pettersson, E., ... & Wilson, B. (2024). Half of Atlantic reef-building corals at elevated risk of extinction due to climate change and other threats. *PloS One, 19*(11), e0309354.

Hughes, T. P., & Tanner, J. E. (2000). Recruitment failure, life histories, and long-term decline of Caribbean corals. *Ecology, 81*(8), 2250–2263.

Hughes, T. P., Baird, A. H., Bellwood, D. R., Card, M., Connolly, S. R., Folke, C., ... & Roughgarden, J. (2003). Climate change, human impacts, and the resilience of coral reefs. *Science*, *301*(5635), 929-933.

Jones, N. P., & Gilliam, D. S. (2024). Spatial differences in recruit density, survival, and size structure prevent population growth of stony coral assemblages in southeast Florida. *Frontiers in Marine Science, 11*, 1369286.

Jones, N. P., Figueiredo, J., & Gilliam, D. S. (2020). Thermal stress-related spatiotemporal variations in high-latitude coral reef benthic communities. *Coral Reefs, 39*, 1661–1673.

Jones, R., Bessell-Browne, P., Fisher, R., Klonowski, W., & Slivkoff, M. (2016). Assessing the impacts of sediments from dredging on corals. *Marine Pollution Bulletin, 102*(1), 9–29. https://doi.org/10.1016/j.marpolbul.2015.10.049

Jones, R., Fisher, R., & Bessell-Browne, P. (2019). Sediment deposition and coral smothering. *PLoS One, 14*(6), e0216248. https://doi.org/10.1371/journal.pone.0216248

Jones, R., Ricardo, G. F., & Negri, A. P. (2015). Effects of sediments on the reproductive cycle of corals. *Marine Pollution Bulletin, 100*(1), 13-33.

National Marine Fisheries Service (NFMS). (2023). *Examination of Sedimentation Impacts to Coral Reef along the Port Miami Entrance Channel, December 2015 and April 2016*. NOAA. 52 pp.

NOAA Coral Reef Watch. (2023, updated daily). *NOAA Coral Reef Watch Version 3.1 Daily 5km Satellite Regional Virtual Station Time Series Data for Southeast Florida*, Jun. 1, 2023-Dec. 31, 2023. College Park, Maryland, USA: NOAA Coral Reef Watch. Data set accessed 2025-09-22 at https://coralreefwatch.noaa.gov/product/vs/data.php.

Lirman, D., & Fong, P. (2007). Is proximity to land-based sources of coral stressors an appropriate measure of risk to coral reefs? An example from the Florida Reef Tract. *Marine Pollution Bulletin, 54*, 779–791.

Lirman, D., Orlando, B., Maciá, S., Manzello, D., Kaufman, L., Biber, P., & Jones, T. (2003). Coral communities of Biscayne Bay, Florida and adjacent offshore areas: diversity, abundance, distribution, and environmental correlates. *Aquatic Conservation: Marine and Freshwater Ecosystems, 13*(2), 121-135.

Miller, M. W. (2014). Post-settlement survivorship in two Caribbean broadcasting corals. *Coral Reefs, 33*(4), 1041–1046.

Miller, M. W., Karazsia, J., Groves, C. E., Griffin, S., Moore, T., Wilber, P., & Gregg, K. (2016). Detecting sedimentation impacts to coral reefs resulting from dredging the Port of Miami, Florida USA. *PeerJ, 4*, e2711.

Neely, K. L., Nowicki, R. J., Dobler, M. A., Chaparro, A. A., Miller, S. M., & Toth, K. A. (2024). Too hot to handle? The impact of the 2023 marine heatwave on Florida Keys coral. *Frontiers in Marine Science, 11*, 1489273.

Nova Southeastern University (NSU). (2011). Benthic Habitat Characterization for the South Florida Ocean Measurement Facility (SFOMF). Protected Stony Coral Species Assessment. https://nsuworks.nova.edu/cgi/viewcontent.cgi?article=1036&context=occ_facreports/

Papke, E., Carreiro, A., Dennison, C., Deutsch, J. M., Isma, L. M., Meiling, S. S., ... & Ushijima, B. (2024). Stony coral tissue loss disease: a review of emergence, impacts, etiology, diagnostics, and intervention. *Frontiers in Marine Science, 10*. https://doi.org/10.3389/fmars.2023.1321271

Precht, W. F., Gintert, B. E., Robbart, M. L., Fura, R., & van Woesik, R. (2016). Unprecedented disease-related coral mortality in southeastern Florida. *Scientific Reports, 6*, 31374.

Raymundo, L. J., Halford, A. R., Maypa, A. P., & Kerr, A. M. (2009). Functionally diverse reef-fish communities ameliorate coral disease. *Proceedings of the National Academy of Sciences*, *106*(40), 17067-17070.

Rodriguez-Ruano, V., Williams, D., Duran, A., & Ladd, M. C. (2024). *Understanding the effects of sediment on coral settlement and coral recruits*. Florida Department of Environmental Protection. Final report. Available online at: https://floridadep.gov/rcp/coral-protection-restoration/documents/understanding-effects-sediment-coral-settlement-and

Serrano, X. M., Chacin, D. H., Mack, K., Gregg, K., Parsons, M., Ladd, M., ... & Karazsia, J. (2025). *A rapid method to assess sediment deposition and stress on coral reef benthic taxa resulting from dredging and other sediment disturbances*. *Marine Pollution Bulletin*. https://doi.org/10.1016/j.marpolbul.2025.118629

Shilling, E. N., Eckert, R. J., Sturm, A. B., & Voss, J. D. (2023). Porites astreoides coral populations demonstrate high clonality and connectivity in southeast Florida. *Coral Reefs*, *42*(5), 1131–1145.

South Atlantic Fishery Management Council (SAFMC). (2024). *Users Guide to Essential Fish Habitat Designations by the South Atlantic Fishery Management Council*. Available online at: https://safmc.net/documents/efh-user-guide/

Southeast Florida Morphodynamic (SEFMOD) study final report memo. (2024) Available online at: https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll7/id/24883

Speare, K. E., Duran, A., Miller, M. W., & Burkepile, D. E. (2019). Sediment associated with algal turfs inhibits the settlement of two endangered coral species. *Marine Pollution Bulletin, 144*, 189–195.

Stein, J., & Ruzicka, R. (2021). *Florida Reef resilience program disturbance response monitoring 2020 quick look report*. Fish and Wildlife Research Institute. 37 pp.

Stein J. and Ruzicka R. (2023). *Disturbance Response Monitoring 2023 Summer Quick Look Report*. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, St. Petersburg, FL. 34 pp.

Stein, J., Huebner, L. K., Colella, M., Harrell, C., & Ruzicka, R. (2024). *Florida's Coral Reef 2023-2024 Post-Bleaching Assessment Quick Look Report*. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute. 23 pp.

Storlazzi, C. D., Norris, B. K., & Rosenberger, K. J. (2015). The influence of grain size, grain color, and suspended-sediment concentration on light attenuation: Why fine-grained terrestrial sediment is bad for coral reef ecosystems. *Coral Reefs, 34*(3), 967–975.

Studivan, M. S., Rossin, A. M., Rubin, E., Soderberg, N., Holstein, D. M., & Enochs, I. C. (2022). Reef sediments can act as a stony coral tissue loss disease vector. *Frontiers in Marine Science, 8*, 815698.

Tetra Tech. (2021a). *Port Everglades Deepening Project—Additional ESA-Listed Coral Survey*. 34 pp.

Tetra Tech. (2021b). *Port Everglades Deepening Project—Additional Reconnaissance Survey*. 84 pp.

Tetra Tech. (2025). *Port Everglades Deepening Project—Natural Reef Enhancement Site Surveys Detailed Mapping and Characterization*. Final report. 129 pp.

Tuttle, L. J., & Donahue, M. J. (2022). Effects of sediment exposure on corals: a systematic review of experimental studies. *Environmental Evidence, 11*, 4.

U.S. Army Corps of Engineers (USACE). (2004). Final environmental impact statement for the Miami Harbor, 150 pp. Available online at: https://www.saj.usace.army.mil/About/Divisions-Offices/Planning/Environmental-Branch/Environmental-Documents/

U.S. Army Corps of Engineers (USACE). (2022). Revised Draft Supplemental Environmental Impact Statement for Port Everglades Harbor, Broward County. Available online at: https://www.saj.usace.army.mil/About/Divisions-Offices/Planning/Environmental-Branch/Environmental- Documents/

Viehman, T. S., Grove, L. J. W., Blondeau, J., Cain, E., Edwards, K. F., Groves, S. H., ... & Williams, B. (2023). *National coral reef monitoring program, biological monitoring summary–Florida: 2022*.

Walker, B. K., & Klug, K. (2014). *Southeast Florida shallow-water habitat mapping & coral reef community characterization*. Florida DEP Coral Reef Conservation Program. [71]

Walton, C. J., Hayes, N. K., & Gilliam, D. S. (2018). Impacts of a regional, multi-year, multi-species coral disease outbreak in Southeast Florida. *Frontiers in Marine Science*, 5, 323.

Weber, M., Lott, C., & Fabricius, K. E. (2006). Sedimentation stress in a scleractinian coral exposed to terrestrial and marine sediments with contrasting physical, organic and geochemical properties. *Journal of Experimental Marine Biology and Ecology, 336*(1), 18–32.

Williams, D. (2024). The Status of Acropora palmata founders in South Florida after the 2023 marine heatwave. Available online at: https://www.fisheries.noaa.gov/s3/2024-08/Florida-Elkhorn-Coral-Status-June-2024.pdf

Appendices

Table A1: Total amount of each reef habitat area in each impact zone. NRC = Nearshore Ridge Complex, IR = Inner Reef, MR = Middle Reef, and OR = Outer Reef.

Impact area	NRC area (m^2)	IR area (m^2)	MR area (m^2)	OR area (m^2)	NRC area (acres)	IR area (acres)	MR area (acres)	OR area (acres)
Channel	451	517	29875	54911	0.112	0.128	7.382	13.569
Side Slopes	18835	881	4696	801	4.654	0.218	1.16	0.198
Sediment deposition >10 cm	44168	12133	9981	10672	10.914	2.998	2.466	2.637
Sediment deposition 5-10 cm	45276	11048	9151	11274	11.188	2.73	2.261	2.786
Sediment deposition 1- 5 cm	219447	49698	40886	44370	54.226	12.281	10.103	10.964
Sediment deposition 0.5 - 1 cm	149738	28911	27270	29690	37.001	7.144	6.739	7.337
Sediment deposition 0.1 - 0.5 cm	384010	110104	50968	70733	94.891	27.207	12.594	17.478
Nearshore	62731	0	0	0	15.501	0	0	0
North	0	0	0	59774	0	0	0	14.771
East	0	0	0	37251	0	0	0	9.205
South	0	0	0	26491	0	0	0	6.546
Rest of monitoring area (to 1.2 km)	1233823	408458	264250	441476	304.884	100.932	65.298	109.091

Table A2. Densities of all taxa and size classes in each reef habitat. Densities (colonies per m^2) reflect model predictions that equal-weight all datasets and survey years. 95% credible intervals are provided in brackets. Taxon abbreviations are as follows: ACER = *Acropora cervicornis*; AGAR = *Agaricia* spp.; CNAT = *Colpophyllia natans*; DLAB = *Diploria labyrinthiformis*; DSTO = *Dichocoenia stokesii*; EFAS = *Eusmilia fastigiata*; FAVI = Faviinae; MADR = *Madracis* spp.; MCAV = *Montastraea cavernosa*; MEAN = Meandrinidae; MMEA = *Meandrina meandrites*; MUSS = Mussinae; MYCE = *Mycetophyllia* spp.; ORBI = *Orbicella* spp.; PCLI = *Pseudodiploria clivosa*; PORI = *Porites* spp.; PSTR = *Pseudodiploria strigosa*; SIDE = *Siderastrea* spp.; SINT = *Siderastrea intersepta*; SOLE = *Solenastrea* spp.

Taxon	Size class	Nearshore Ridge Complex	Inner Reef	Middle Reef	Outer Reef
ACER	<4cm	0.00020 [0.000056-0.00055]	0.000065 [0.00000039-0.00036]	0.000065 [0.00000032-0.00037]	0.000034 [0.00000030-0.00014]
ACER	>4cm	0.018 [0.0093-0.032]	0.00029 [0.000054-0.0010]	0.00030 [0.0000037-0.0016]	0.00014 [0.000022-0.00053]
ACER	All	0.018 [0.0094-0.032]	0.00036 [0.000072-0.0012]	0.00036 [0.000011-0.0018]	0.00018 [0.000032-0.00062]
AGAR	<4cm	0.0019 [0.00049-0.0048]	0.0044 [0.00064-0.015]	0.0023 [0.00043-0.0067]	0.0067 [0.0029-0.014]
AGAR	>4cm	0.0075 [0.0037-0.014]	0.012 [0.0054-0.023]	0.015 [0.0070-0.029]	0.032 [0.019-0.050]
AGAR	All	0.0094 [0.0051-0.016]	0.016 [0.0079-0.032]	0.018 [0.0088-0.032]	0.038 [0.025-0.057]
CNAT	>4cm	0.00025 [0.000026-0.00083]	0.00052 [0.000025-0.0020]	0.00017 [0.0000011-0.00098]	0.0010 [0.00025-0.0026]
DLAB	>4cm	0.0013 [0.00041-0.0029]	0.0018 [0.00037-0.0050]	0.0030 [0.00082-0.0074]	0.0018 [0.00058-0.0039]
DSTO	>4cm	0.021 [0.013-0.031]	0.020 [0.012-0.031]	0.0051 [0.0025-0.0090]	0.0046 [0.0026-0.0077]
EFAS	>4cm	0.00088 [0.00023-0.0021]	0.0098 [0.0046-0.018]	0.0073 [0.0032-0.014]	0.0041 [0.0019-0.0077]
FAVI	<4cm	0.0079 [0.0042-0.014]	0.0072 [0.0031-0.014]	0.0081 [0.0034-0.016]	0.0040 [0.0019-0.0073]
MADR	<4cm	0.0020 [0.00060-0.0048]	0.0018 [0.00025-0.0057]	0.0018 [0.00019-0.0063]	0.012 [0.0065-0.020]
MADR	>4cm	0.029 [0.011-0.069]	0.012 [0.0040-0.031]	0.040 [0.018-0.081]	0.071 [0.045-0.11]
MADR	All	0.031 [0.013-0.071]	0.014 [0.0053-0.033]	0.041 [0.019-0.083]	0.083 [0.056-0.12]
MCAV	<4cm	0.055 [0.034-0.085]	0.13 [0.086-0.20]	0.097 [0.062-0.15]	0.14 [0.093-0.20]
MCAV	>4cm	0.046 [0.029-0.069]	0.13 [0.081-0.19]	0.14 [0.087-0.20]	0.14 [0.096-0.21]
MCAV	All	0.10 [0.073-0.14]	0.26 [0.19-0.35]	0.23 [0.17-0.31]	0.28 [0.21-0.37]
MEAN	<4cm	0.014 [0.0086-0.022]	0.014 [0.0077-0.024]	0.015 [0.0079-0.025]	0.015 [0.0092-0.022]
MMEA	>4cm	0.0032 [0.0015-0.0060]	0.0063 [0.0028-0.012]	0.021 [0.012-0.035]	0.014 [0.0081-0.022]
MUSS	<4cm	0.0043 [0.0011-0.012]	0.0034 [0.00043-0.012]	0.0029 [0.00049-0.0091]	0.0077 [0.0037-0.014]
MYCE	>4cm	0.00086 [0.00020-0.0022]	0.0037 [0.0011-0.0086]	0.0083 [0.0035-0.017]	0.0036 [0.0015-0.0070]
ORBI	<4cm	0.000077 [0.0000099-0.00028]	0.000075 [0.00000029-0.00029]	0.00019 [0.0000061-0.00081]	0.00011 [0.000012-0.00036]
ORBI	>4cm	0.00039 [0.00021-0.00070]	0.0015 [0.00077-0.0026]	0.0021 [0.0011-0.0038]	0.0022 [0.0013-0.0033]
ORBI	All	0.00047 [0.00025-0.00083]	0.0015 [0.00080-0.0027]	0.0023 [0.0012-0.0041]	0.0023 [0.0014-0.0035]

Taxon	Size class	Nearshore Ridge Complex	Inner Reef	Middle Reef	Outer Reef
PCLI	>4cm	0.0054 [0.0027-0.0099]	0.00046 [0.0000099-0.0019]	0.00052 [0.0000090-0.0022]	0.00030 [0.0000050-0.0010]
PORI	<4cm	0.068 [0.041-0.11]	0.033 [0.018-0.058]	0.042 [0.023-0.072]	0.14 [0.090-0.21]
PORI	>4cm	0.10 [0.063-0.15]	0.14 [0.085-0.21]	0.18 [0.12-0.28]	0.42 [0.28-0.61]
PORI	All	0.17 [0.12-0.23]	0.17 [0.12-0.25]	0.23 [0.15-0.33]	0.56 [0.41-0.76]
PSTR	>4cm	0.0078 [0.0044-0.013]	0.015 [0.0082-0.024]	0.0083 [0.0037-0.016]	0.0025 [0.0010-0.0048]
SIDE	<4cm	1.4 [0.89-2.0]	0.77 [0.50-1.1]	0.45 [0.29-0.68]	0.55 [0.37-0.80]
SIDE	>4cm	0.14 [0.093-0.20]	0.34 [0.23-0.51]	0.24 [0.16-0.36]	0.23 [0.15-0.32]
SIDE	All	1.5 [1.0-2.2]	1.1 [0.81-1.5]	0.69 [0.50-0.94]	0.78 [0.57-1.0]
SINT	<4cm	0.058 [0.035-0.089]	0.064 [0.039-0.10]	0.082 [0.052-0.12]	0.13 [0.087-0.20]
SINT	>4cm	0.12 [0.074-0.18]	0.18 [0.12-0.26]	0.22 [0.14-0.32]	0.23 [0.15-0.32]
SINT	All	0.17 [0.12-0.24]	0.24 [0.18-0.33]	0.30 [0.22-0.41]	0.36 [0.27-0.47]
SOLE	<4cm	0.0081 [0.0040-0.015]	0.014 [0.0056-0.032]	0.0030 [0.00073-0.0076]	0.010 [0.0051-0.018]
SOLE	>4cm	0.022 [0.013-0.034]	0.017 [0.0092-0.028]	0.0071 [0.0028-0.015]	0.0053 [0.0026-0.0094]
SOLE	All	0.030 [0.020-0.043]	0.031 [0.018-0.051]	0.010 [0.0048-0.019]	0.016 [0.0094-0.024]

Table A3. Densities of all taxa and size classes in each reef habitat. Densities (colonies per m^2) reflect model predictions for 2024. 95% credible intervals are provided in brackets. Taxon abbreviations are as follows: ACER = *Acropora cervicornis*; AGAR = *Agaricia* spp.; CNAT = *Colpophyllia natans*; DLAB = *Diploria labyrinthiformis*; DSTO = *Dichocoenia stokesii*; EFAS = *Eusmilia fastigiata*; FAVI = Faviinae; MADR = *Madracis* spp.; MCAV = *Montastraea cavernosa*; MEAN = Meandrinidae; MMEA = *Meandrina meandrites*; MUSS = Mussinae; MYCE = *Mycetophyllia* spp.; ORBI = *Orbicella* spp.; PCLI = *Pseudodiploria clivosa*; PORI = *Porites* spp.; PSTR = *Pseudodiploria strigosa*; SIDE = *Siderastrea* spp.; SINT = *Siderastrea intersepta*; SOLE = *Solenastrea* spp.

Taxon	Size class	Nearshore Ridge Complex	Inner Reef	Middle Reef	Outer Reef
ACER	<4cm	0.00022 [0.000035-0.00076]	0.000084 [0.00000041-0.00050]	0.00010 [0.00000038-0.00063]	0.000038 [0.00000026-0.00020]
ACER	>4cm	0.015 [0.0045-0.041]	0.00032 [0.000039-0.0013]	0.00037 [0.0000036-0.0019]	0.00014 [0.000013-0.00057]
ACER	All	0.016 [0.0047-0.041]	0.00040 [0.000058-0.0015]	0.00047 [0.000012-0.0023]	0.00017 [0.000021-0.00068]
AGAR	<4cm	0.0020 [0.00035-0.0065]	0.0050 [0.00063-0.017]	0.0029 [0.00035-0.0097]	0.0078 [0.0016-0.023]
AGAR	>4cm	0.0066 [0.0023-0.014]	0.012 [0.0041-0.026]	0.015 [0.0048-0.036]	0.027 [0.0088-0.064]
AGAR	All	0.0086 [0.0036-0.017]	0.017 [0.0066-0.035]	0.018 [0.0066-0.040]	0.035 [0.013-0.075]
CNAT	>4cm	0.00030 [0.000023-0.0011]	0.00067 [0.000026-0.0028]	0.00023 [0.0000012-0.0014]	0.0014 [0.00017-0.0052]
DLAB	>4cm	0.00097 [0.00021-0.0026]	0.0016 [0.00026-0.0050]	0.0027 [0.00051-0.0083]	0.0013 [0.00024-0.0042]
DSTO	>4cm	0.017 [0.0093-0.029]	0.019 [0.010-0.033]	0.0047 [0.0019-0.0094]	0.0038 [0.0016-0.0083]
EFAS	>4cm	0.00094 [0.00019-0.0026]	0.011 [0.0040-0.025]	0.0086 [0.0025-0.021]	0.0047 [0.0012-0.012]
FAVI	<4cm	0.0051 [0.0021-0.010]	0.0057 [0.0020-0.013]	0.0067 [0.0022-0.015]	0.0024 [0.00073-0.0060]
MADR	<4cm	0.0018 [0.00033-0.0055]	0.0017 [0.00017-0.0061]	0.0016 [0.00012-0.0069]	0.011 [0.0024-0.031]
MADR	>4cm	0.022 [0.0051-0.064]	0.010 [0.0025-0.031]	0.036 [0.0098-0.097]	0.051 [0.014-0.13]
MADR	All	0.024 [0.0066-0.066]	0.012 [0.0036-0.033]	0.037 [0.011-0.099]	0.062 [0.021-0.15]
MCAV	<4cm	0.047 [0.026-0.079]	0.13 [0.076-0.20]	0.095 [0.053-0.16]	0.12 [0.054-0.22]
MCAV	>4cm	0.054 [0.031-0.088]	0.16 [0.098-0.26]	0.18 [0.10-0.29]	0.18 [0.085-0.33]
MCAV	All	0.10 [0.066-0.15]	0.29 [0.20-0.41]	0.27 [0.18-0.40]	0.30 [0.15-0.51]
MEAN	<4cm	0.0061 [0.0027-0.012]	0.0073 [0.0031-0.015]	0.0083 [0.0033-0.017]	0.0056 [0.0021-0.012]
MMEA	>4cm	0.0035 [0.0014-0.0073]	0.0079 [0.0032-0.016]	0.027 [0.012-0.052]	0.016 [0.0059-0.036]
MUSS	<4cm	0.0053 [0.0011-0.016]	0.0044 [0.00056-0.016]	0.0042 [0.00052-0.016]	0.011 [0.0025-0.033]
MYCE	>4cm	0.00077 [0.00015-0.0022]	0.0037 [0.00093-0.0096]	0.0084 [0.0025-0.020]	0.0033 [0.00077-0.0090]
ORBI	<4cm	0.000080 [0.0000069-0.00033]	0.000093 [0.00000026-0.00037]	0.00024 [0.0000055-0.0012]	0.00012 [0.0000082-0.00051]

Taxon	Size class	Nearshore Ridge Complex	Inner Reef	Middle Reef	Outer Reef
ORBI	>4cm	0.00069 [0.00023-0.0016]	0.0031 [0.0010-0.0070]	0.0039 [0.0012-0.0097]	0.0052 [0.0016-0.013]
ORBI	All	0.00077 [0.00028-0.0017]	0.0032 [0.0011-0.0072]	0.0042 [0.0013-0.010]	0.0053 [0.0016-0.013]
PCLI	>4cm	0.0081 [0.0031-0.017]	0.00078 [0.000016-0.0034]	0.00090 [0.000014-0.0040]	0.00056 [0.0000081-0.0021]
PORI	<4cm	0.15 [0.085-0.26]	0.080 [0.040-0.14]	0.10 [0.049-0.19]	0.56 [0.25-1.1]
PORI	>4cm	0.16 [0.092-0.26]	0.24 [0.14-0.40]	0.33 [0.18-0.56]	0.87 [0.40-1.6]
PORI	All	0.31 [0.21-0.46]	0.32 [0.21-0.49]	0.43 [0.27-0.68]	1.4 [0.74-2.5]
PSTR	>4cm	0.011 [0.0053-0.019]	0.022 [0.012-0.039]	0.013 [0.0049-0.027]	0.0040 [0.0012-0.0095]
SIDE	<4cm	1.8 [1.1-2.7]	1.1 [0.69-1.7]	0.64 [0.38-1.0]	0.78 [0.38-1.4]
SIDE	>4cm	0.15 [0.092-0.23]	0.41 [0.25-0.63]	0.29 [0.17-0.47]	0.25 [0.12-0.45]
SIDE	All	1.9 [1.2-2.8]	1.5 [1.1-2.1]	0.94 [0.62-1.4]	1.0 [0.55-1.8]
SINT	<4cm	0.041 [0.022-0.070]	0.053 [0.028-0.090]	0.067 [0.034-0.12]	0.089 [0.038-0.17]
SINT	>4cm	0.081 [0.047-0.13]	0.15 [0.090-0.23]	0.18 [0.11-0.29]	0.15 [0.070-0.27]
SINT	All	0.12 [0.080-0.18]	0.20 [0.13-0.29]	0.25 [0.16-0.38]	0.24 [0.12-0.40]
SOLE	<4cm	0.0074 [0.0024-0.018]	0.014 [0.0044-0.034]	0.0030 [0.00053-0.0092]	0.0092 [0.0025-0.024]
SOLE	>4cm	0.027 [0.013-0.048]	0.024 [0.011-0.043]	0.010 [0.0034-0.024]	0.0076 [0.0027-0.017]
SOLE	All	0.034 [0.019-0.057]	0.038 [0.020-0.065]	0.013 [0.0053-0.028]	0.017 [0.0069-0.035]

Table A4. Total estimated abundances (number of colonies) of all taxa and size classes in each impact zone. Totals reflect model predictions that equal-weight all datasets and survey years. Taxon abbreviations are as follows: ACER = *Acropora cervicornis*; AGAR = *Agaricia* spp.; CNAT = *Colpophyllia natans*; DLAB = *Diploria labyrinthiformis*; DSTO = *Dichocoenia stokesii*; EFAS = *Eusmilia fastigiata*; FAVI = Faviinae; MADR = *Madracis* spp.; MCAV = *Montastraea cavernosa*; MEAN = Meandrinidae; MMEA = *Meandrina meandrites*; MUSS = Mussinae; MYCE = *Mycetophyllia* spp.; ORBI = *Orbicella* spp.; PCLI = *Pseudodiploria clivosa*; PORI = *Porites* spp.; PSTR = *Pseudodiploria strigosa*; SIDE = *Siderastrea* spp.; SINT = *Siderastrea intersepta*; SOLE = *Solenastrea* spp.

Taxon	Size class	Channel	Side Slopes	Sediment deposition >10 cm	Sediment deposition 5-10 cm	Sediment deposition 1- 5 cm	Sediment deposition 0.5 - 1 cm	Sediment deposition 0.1 - 0.5 cm	Nearshore	North	East	South	Rest of monitoring area	Total
SIDE	<4cm	44,788	29,181	80,517	81,166	383,226	257,054	675,203	86,386	32,908	20,508	14,585	2,374,798	4,080,320
SIDE	>4cm	19,824	4,261	15,179	14,897	67,729	44,214	119,937	8,803	13,462	8,389	5,966	476,652	799,313
PORI	<4cm	9,096	1,618	5,335	5,424	24,559	16,482	41,900	4,256	8,482	5,286	3,759	171,068	297,265
PORI	>4cm	28,647	3,211	12,412	12,474	54,984	36,471	92,715	6,298	25,085	15,633	11,117	413,751	712,798
SINT	<4cm	9,808	1,632	5,559	5,565	25,075	16,659	42,759	3,610	7,943	4,950	3,520	177,612	304,692
SINT	>4cm	19,003	3,557	11,918	11,808	53,469	35,314	91,723	7,332	13,489	8,406	5,978	374,652	636,649
MCAV	<4cm	10,736	1,728	6,531	6,452	28,974	18,961	50,808	3,468	8,424	5,250	3,734	210,482	355,548
MCAV	>4cm	12,013	1,738	6,474	6,361	28,397	18,571	48,844	2,903	8,553	5,330	3,790	208,232	351,206
MADR	<4cm	709	56	254	260	1,123	749	1,889	123	712	444	316	8,899	15,534
MADR	>4cm	5,099	808	2,599	2,628	11,827	7,944	19,668	1,847	4,239	2,642	1,879	83,027	144,207
AGAR	<4cm	443	55	230	230	1,019	668	1,790	116	403	251	179	7,670	13,054
AGAR	>4cm	2,202	250	970	972	4,285	2,835	7,244	474	1,888	1,177	837	32,241	55,375
SOLE	<4cm	665	188	673	670	3,078	2,021	5,585	511	614	383	272	21,230	35,890
SOLE	>4cm	521	458	1,283	1,286	6,087	4,061	10,863	1,349	316	197	140	37,678	64,239
MMEA	>4cm	1,408	177	580	567	2,508	1,658	3,999	201	833	519	369	18,325	31,144
DSTO	>4cm	425	435	1,255	1,255	5,941	3,949	10,717	1,300	277	172	123	37,015	62,864
ACER	<4cm	4	4	11	11	52	35	91	13	2	1	1	311	536
ACER	>4cm	25	335	790	809	3,919	2,672	6,857	1,111	9	5	4	22,107	38,643
MEAN	<4cm	1,262	363	1,111	1,108	5,111	3,397	8,872	897	878	547	389	33,925	57,860
PSTR	>4cm	394	201	632	620	2,893	1,894	5,217	489	148	92	65	18,928	31,573
EFAS	>4cm	451	63	275	262	1,163	738	2,084	55	248	154	110	8,857	14,460

Taxon	Size class	Channel	Side Slopes	Sediment deposition >10 cm	Sediment deposition 5-10 cm	Sediment deposition 1- 5 cm	Sediment deposition 0.5 - 1 cm	Sediment deposition 0.1 - 0.5 cm	Nearshore	North	East	South	Rest of monitoring area	Total
MYCE	>4cm	450	62	205	197	874	571	1,419	54	217	135	96	6,375	10,655
FAVI	<4cm	468	197	561	558	2,606	1,735	4,532	498	238	148	106	16,623	28,270
MUSS	<4cm	512	103	341	344	1,566	1,046	2,707	269	460	287	204	10,820	18,659
PCLI	>4cm	35	106	254	260	1,252	851	2,188	341	18	11	8	7,172	12,496
DLAB	>4cm	189	41	127	125	572	378	970	80	106	66	47	3,901	6,602
ORBI	<4cm	11	2	7	7	33	22	55	5	6	4	3	222	377
ORBI	>4cm	183	20	79	78	341	223	571	24	129	80	57	2,591	4,376
CNAT	>4cm	63	7	30	31	135	89	237	16	62	39	28	1,030	1,767
Total	-	169,434	50,857	156,192	156,425	722,798	481,262	1,261,444	132,829	130,149	81,106	57,682	4,786,194	8,186,372

Table A5. Total estimated abundances (number of colonies) of all taxa and size classes in each impact zone. Totals reflect model predictions for 2024. Taxon abbreviations are as follows: ACER = *Acropora cervicornis*; AGAR = *Agaricia* spp.; CNAT = *Colpophyllia natans*; DLAB = *Diploria labyrinthiformis*; DSTO = *Dichocoenia stokesii*; EFAS = *Eusmilia fastigiata*; FAVI = Faviinae; MADR = *Madracis* spp.; MCAV = *Montastraea cavernosa*; MEAN = Meandrinidae; MMEA = *Meandrina meandrites*; MUSS = Mussinae; MYCE = *Mycetophyllia* spp.; ORBI = *Orbicella* spp.; PCLI = *Pseudodiploria clivosa*; PORI = *Porites* spp.; PSTR = *Pseudodiploria strigosa*; SIDE = *Siderastrea* spp.; SINT = *Siderastrea intersepta*; SOLE = *Solenastrea* spp.

Taxon	Size class	Channel	Side Slopes	Sediment deposition >10 cm	Sediment deposition 5-10 cm	Sediment deposition 1- 5 cm	Sediment deposition 0.5 - 1 cm	Sediment deposition 0.1 - 0.5 cm	Nearshore	North	East	South	Rest of monitoring area	Total
ACER	<4cm	5	5	12	12	59	40	104	14	2	1	1	356	611
ACER	>4cm	26	293	691	708	3,426	2,336	5,993	969	8	5	4	19,341	33,800
AGAR	<4cm	517	62	261	260	1,152	755	2,020	126	466	290	206	8,722	14,837
AGAR	>4cm	1,967	228	878	876	3,866	2,553	6,537	412	1,636	1,020	725	29,043	49,741
CNAT	>4cm	86	8	39	39	171	113	301	19	86	53	38	1,333	2,286
DLAB	>4cm	157	34	105	102	466	308	788	61	81	50	36	3,186	5,374
DSTO	>4cm	369	366	1,081	1,077	5,091	3,373	9,231	1,078	229	143	102	32,006	54,146
EFAS	>4cm	520	72	316	301	1,335	845	2,393	59	280	174	124	10,181	16,600
FAVI	<4cm	340	135	389	385	1,794	1,190	3,116	323	146	91	65	11,522	19,496
MADR	<4cm	637	51	229	234	1,014	676	1,706	111	638	398	283	8,027	14,004
MADR	>4cm	3,902	636	2,013	2,028	9,137	6,130	15,144	1,395	3,072	1,915	1,362	63,820	110,554
MCAV	<4cm	9,317	1,533	5,816	5,720	25,705	16,770	45,202	2,939	6,971	4,344	3,090	186,746	314,153
MCAV	>4cm	15,292	2,135	8,060	7,900	35,195	22,975	60,488	3,361	10,728	6,686	4,755	259,722	437,297
MEAN	<4cm	563	165	502	497	2,295	1,521	3,976	384	335	209	149	15,214	25,810
MMEA	>4cm	1,702	212	692	674	2,978	1,966	4,727	219	973	606	431	21,807	36,987
MUSS	<4cm	758	132	450	455	2,055	1,370	3,532	330	682	425	302	14,459	24,950
MYCE	>4cm	432	60	198	189	841	548	1,363	48	196	122	87	6,126	10,210
ORBI	<4cm	14	3	8	8	38	25	62	5	7	4	3	254	431
ORBI	>4cm	405	38	163	160	697	455	1,175	43	311	194	138	5,454	9,233
PCLI	>4cm	62	157	380	388	1,868	1,270	3,264	505	34	21	15	10,742	18,706
PORI	<4cm	33,927	3,874	14,724	15,061	66,576	44,635	112,411	9,600	33,546	20,906	14,867	495,869	865,996

Taxon	Size class	Channel	Side Slopes	Sediment deposition >10 cm	Sediment deposition 5-10 cm	Sediment deposition 1- 5 cm	Sediment deposition 0.5 - 1 cm	Sediment deposition 0.1 - 0.5 cm	Nearshore	North	East	South	Rest of monitoring area	Total
PORI	>4cm	57,979	5,504	22,681	22,844	99,676	66,075	167,206	10,093	52,096	32,466	23,088	770,642	1,330,350
PSTR	>4cm	619	283	909	889	4,136	2,700	7,460	666	239	149	106	27,330	45,486
SIDE	<4cm	63,620	37,673	105,674	106,357	500,971	335,455	883,508	110,069	46,821	29,179	20,750	3,131,578	5,371,655
SIDE	>4cm	22,951	4,769	17,256	16,881	76,614	49,880	135,808	9,389	15,093	9,406	6,689	542,634	907,370
SINT	<4cm	6,917	1,205	4,066	4,052	18,294	12,126	31,242	2,574	5,304	3,306	2,351	128,992	220,429
SINT	>4cm	13,578	2,622	8,730	8,597	38,967	25,654	66,845	5,070	8,753	5,455	3,879	272,431	460,581
SOLE	<4cm	608	173	625	621	2,850	1,867	5,184	464	553	344	245	19,701	33,235
SOLE	>4cm	748	586	1,670	1,670	7,889	5,253	14,092	1,700	453	283	201	49,241	83,786
Total	-	238,018	63,014	198,618	198,985	915,156	608,864	1,594,878	162,026	189,739	118,245	84,092	6,146,479	10,518,114

Table A6: Total number of ESA- and non-ESA-listed corals in each impact zone. Numbers are based on the modeled habitat-specific densities for 2024, multiplied by habitat areas, and summed within impact zones. Cumulative totals are also provided that sum across impact zones moving away from the channel (down rows). Impact zones are shown on a map in Figure 1C. ACER = *Acropora cervicornis*, ORBI = *Orbicella* spp.

Impact area	ACER	ORBI	non-ESA corals	Total	Cumulative ACER	Cumulative ORBI	Cumulative non-ESA	Cumulative Total
Channel	31	419	237,568	238,018	31	419	237,568	238,018
Side Slopes	298	41	62,675	63,014	329	460	300,243	301,032
Sediment deposition >10 cm	703	171	197,744	198,618	1,032	631	497,987	499,650
Sediment deposition 5-10 cm	720	168	198,097	198,985	1,752	799	696,084	698,635
Sediment deposition 1- 5 cm	3,485	735	910,936	915,156	5,237	1,534	1,607,020	1,613,791
Sediment deposition 0.5 - 1 cm	2,376	480	606,008	608,864	7,613	2,014	2,213,028	2,222,655
Sediment deposition 0.1 - 0.5 cm	6,097	1,237	1,587,544	1,594,878	13,710	3,251	3,800,572	3,817,533
Nearshore	983	48	160,995	162,026	14,693	3,299	3,961,567	3,979,559
North	10	318	189,411	189,739	14,703	3,617	4,150,978	4,169,298
East	6	198	118,041	118,245	14,709	3,815	4,269,019	4,287,543
South	5	141	83,946	84,092	14,714	3,956	4,352,965	4,371,635
Rest of monitoring area (to 1.2 km)	19,697	5,708	6,121,074	6,146,479	34,411	9,664	10,474,039	10,518,114

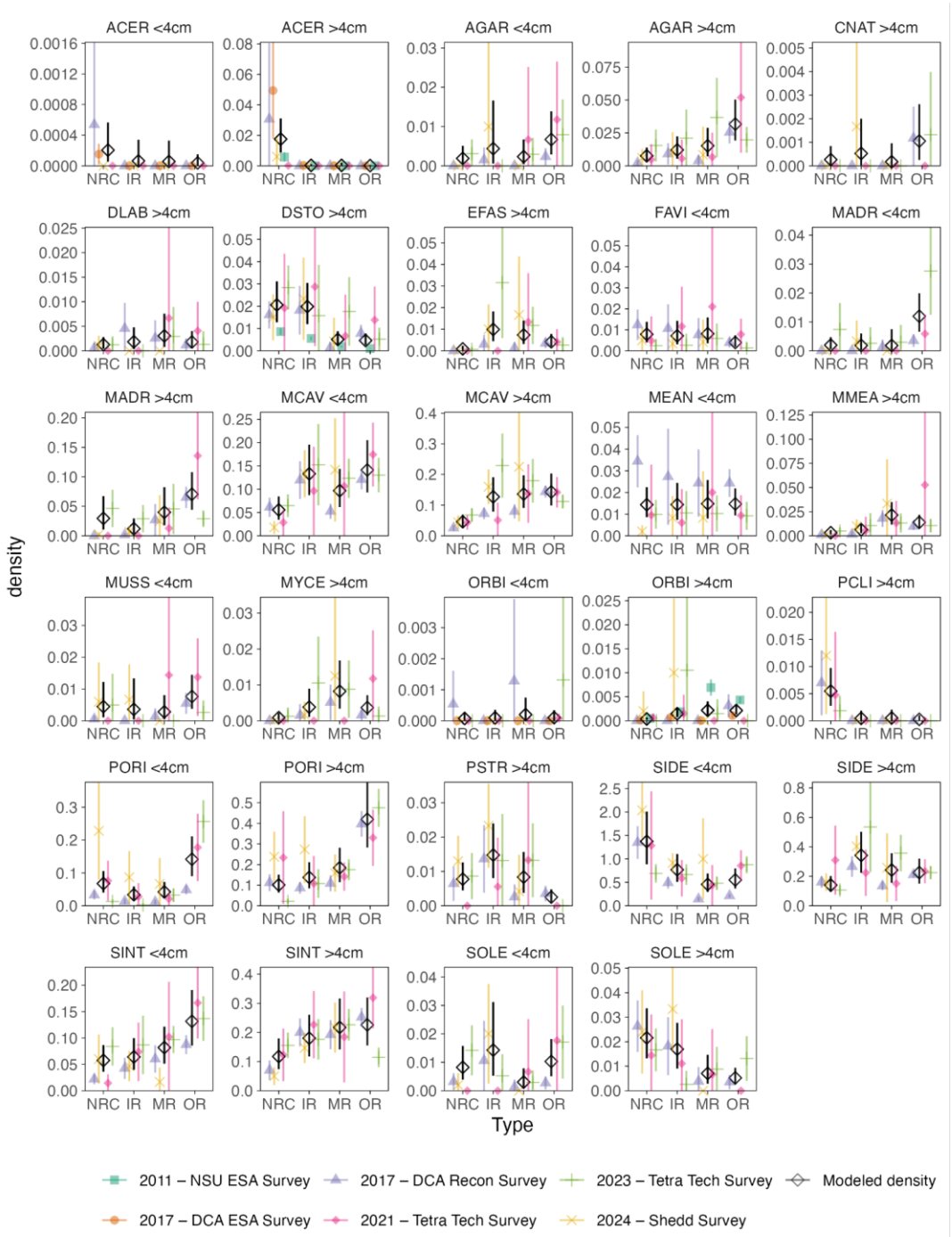

Figure A1. Comparison of raw and modeled coral density estimates by taxon, size class, and reef habitat type. Points and error bars for raw densities represent means and 95% confidence intervals based on site-level survey data for each dataset (colored symbols). Modeled densities (black symbols) and 95% credible intervals were generated from the hierarchical zero-inflated negative binomial model with equal dataset weighting. Facets show taxon–size class combinations; reef habitat types are shown on the x-axis (NRC = Nearshore Ridge Complex, IR = Inner Reef, MR = Middle Reef, OR = Outer Reef).

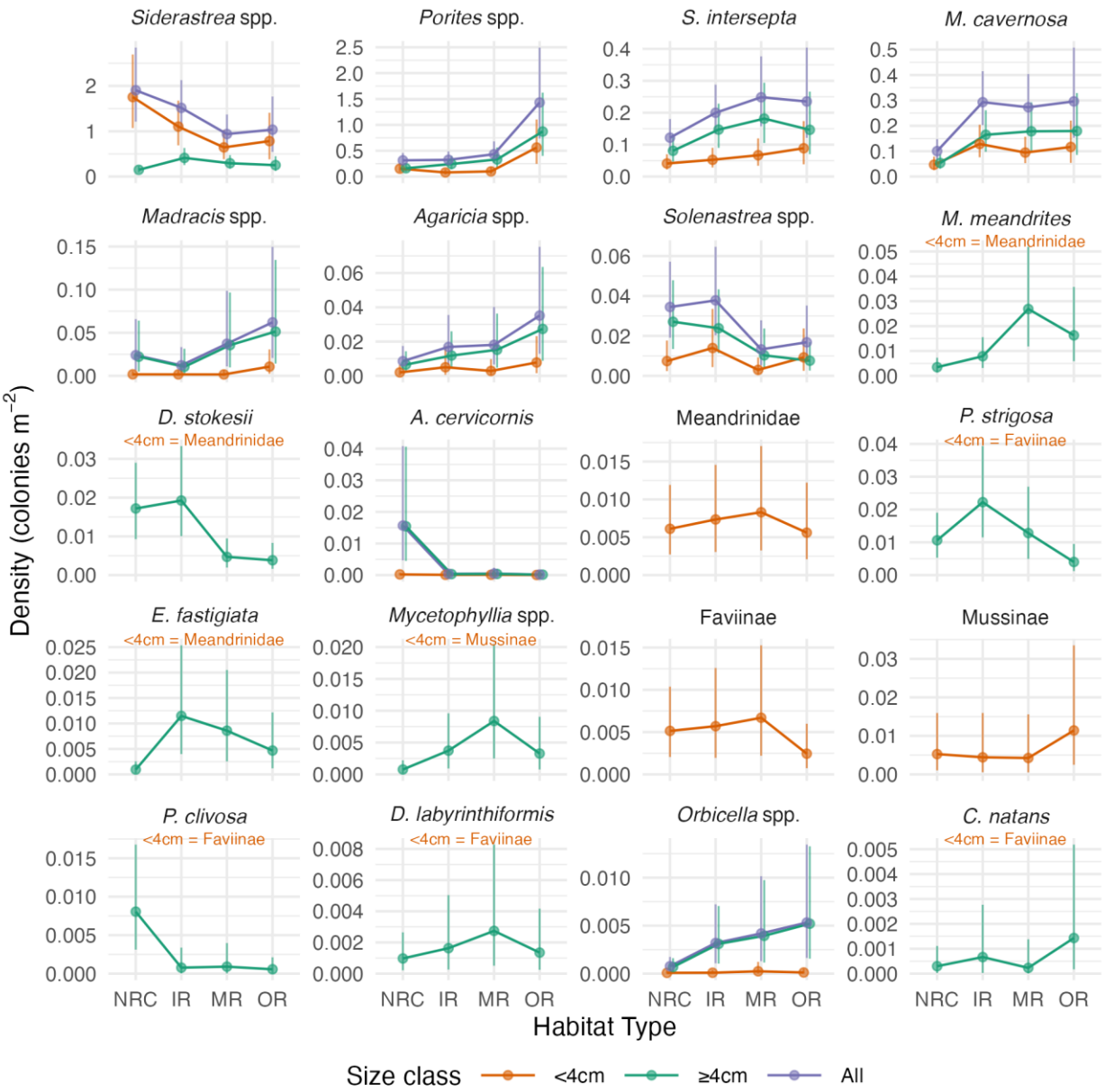

Figure A2. Coral taxon densities by habitat type and size class. Estimated coral densities for 2024 (mean ± 95% credible intervals) are shown across the four reef habitat types (NRC = Nearshore Ridge Complex; IR = Inner Reef; MR = Middle Reef; OR = Outer Reef), colored by size class (orange = <4cm; green = ≥4cm; purple = both size classes combined). Panels for each taxon are ordered from highest to lowest maximum density within any habitat; note y-axis scales vary among panels. Densities with all datasets equal-weighted are presented in Figure 2.

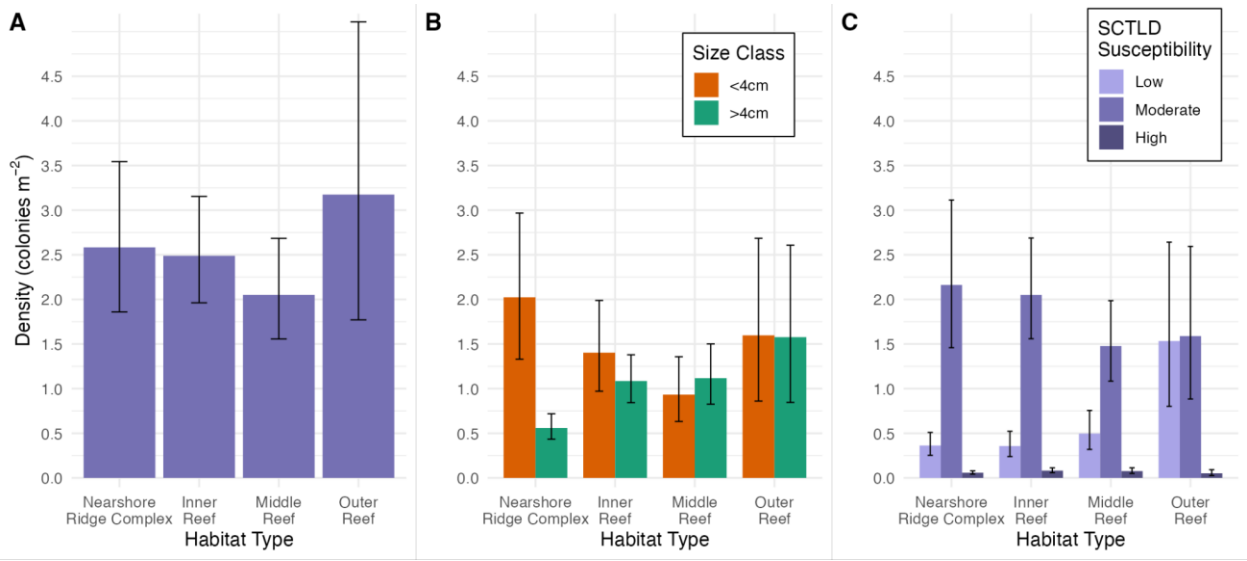

Figure A3. Total coral densities by reef habitat. The total density of all corals reflecting 2024 estimates is shown in panel **(A)**. Panel **(B)** breaks down these totals by size class (<4 cm and >4 cm), and panel **(C)** shows the totals of taxon groups that vary in SCTLD susceptibility (low, moderate, high), following Papke et al. 2024. Bars represent posterior mean densities, with error bars indicating 95% credible intervals. Densities based on all datasets equally weighted are presented in Figure 3.

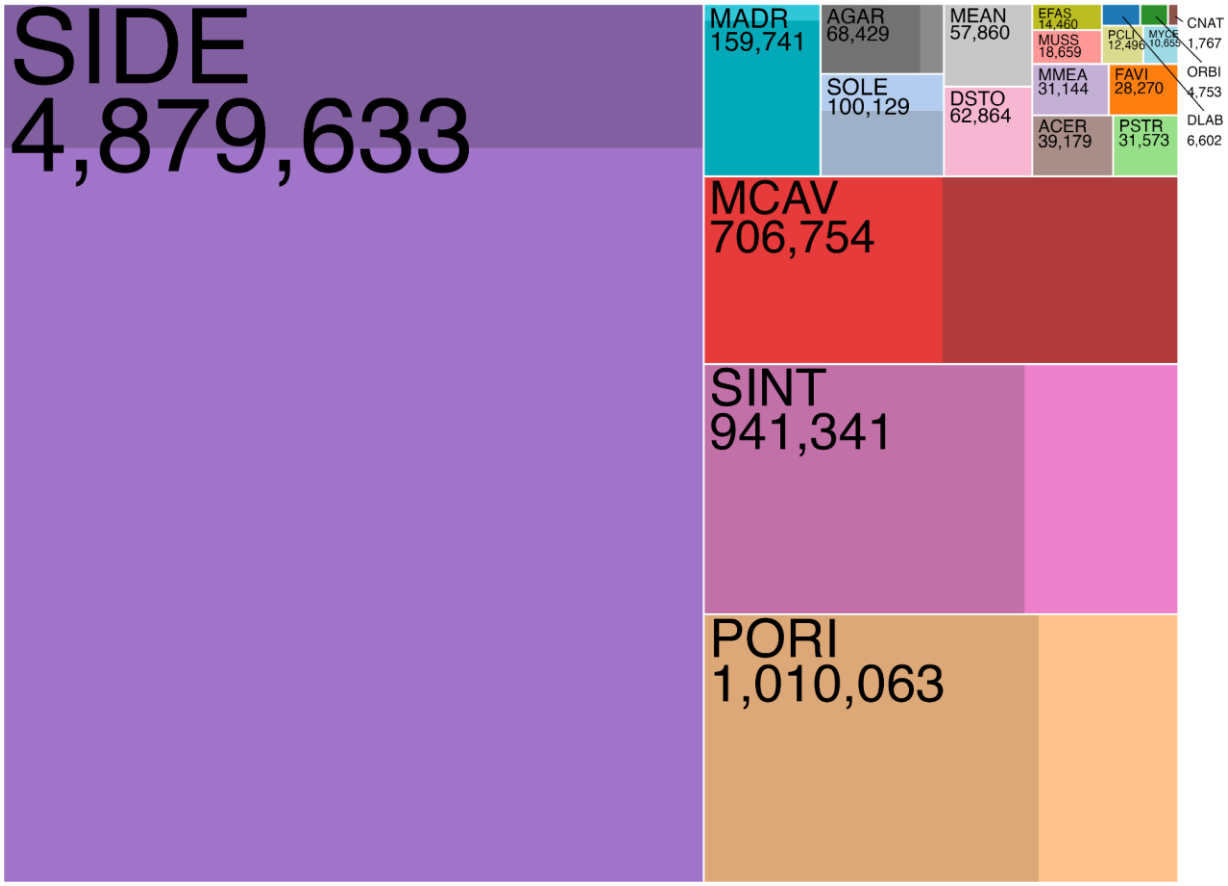

Figure A4: Total corals in full impact monitoring area (1.2 km north and south of the channel); equal-weighted estimates across years. Totals reflect model estimates that equal-weight all datasets across survey years. The box for each taxon is sized proportional to its relative abundance, and annotated with the taxon abbreviation and total number of colonies in the combined impact zones. For each taxon, the darker portion of the box represents corals ≥4cm, and the lighter portion represents colonies <4cm (note some taxa represent only one size class; see Figure 2). Taxon abbreviations are as follows: ACER = *Acropora cervicornis*; AGAR = *Agaricia* spp.; CNAT = *Colpophyllia natans*; DLAB = *Diploria labyrinthiformis*; DSTO = *Dichocoenia stokesii*; EFAS = *Eusmilia fastigiata*; FAVI = Faviinae; MADR = *Madracis* spp.; MCAV = *Montastraea cavernosa*; MEAN = Meandrinidae; MMEA = *Meandrina meandrites*; MUSS = Mussinae; MYCE = *Mycetophyllia* spp.; ORBI = *Orbicella* spp.; PCLI = *Pseudodiploria clivosa*; PORI = *Porites* spp.; PSTR = *Pseudodiploria strigosa*; SIDE = *Siderastrea* spp.; SINT = *Siderastrea intersepta*; SOLE = *Solenastrea* spp.

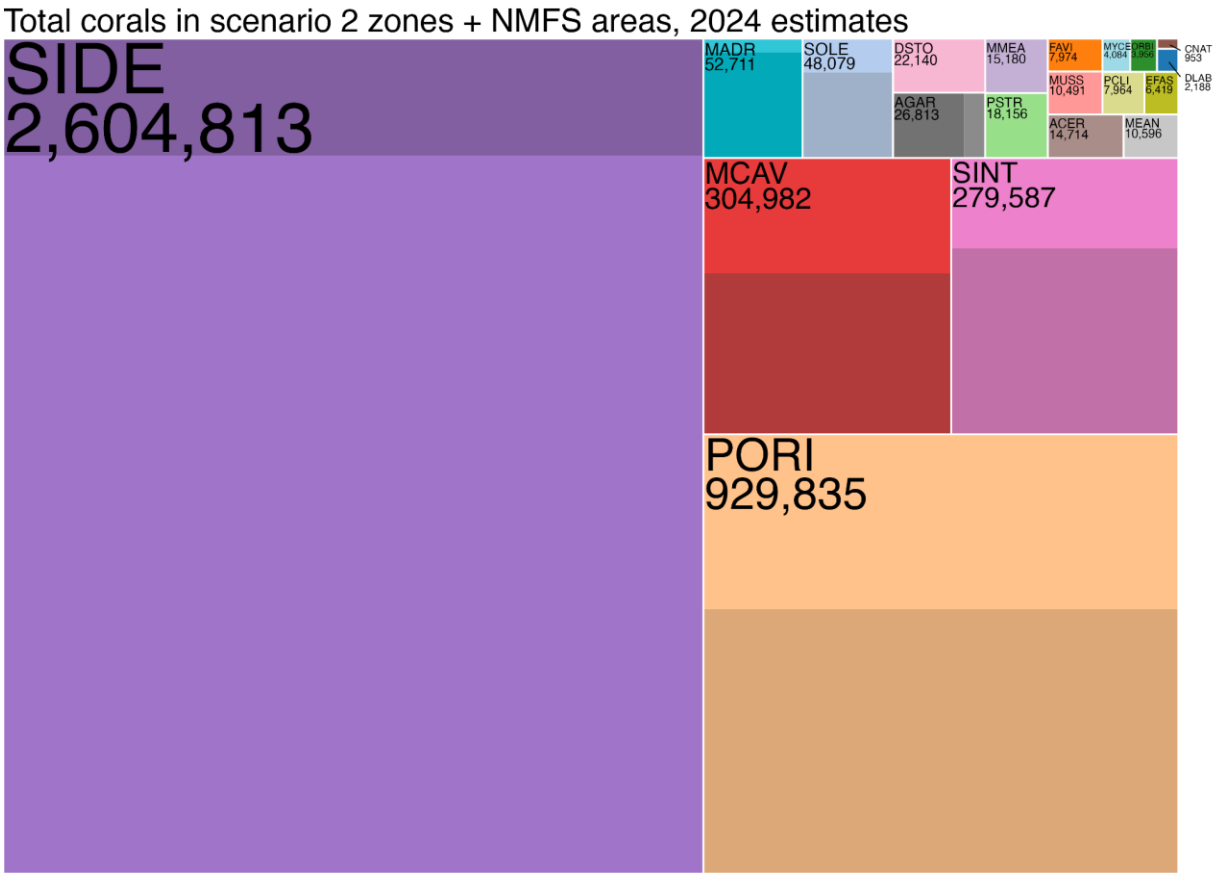

Figure A5: (note some taxa represent only one size class; see Figure 2). Taxon abbreviations are as follows: ACER = *Acropora cervicornis*; AGAR = *Agaricia* spp.; CNAT = *Colpophyllia natans*; DLAB = *Diploria labyrinthiformis*; DSTO = *Dichocoenia stokesii*; EFAS = *Eusmilia fastigiata*; FAVI = Faviinae; MADR = *Madracis* spp.; MCAV = *Montastraea cavernosa*; MEAN = Meandrinidae; MMEA = *Meandrina meandrites*; MUSS = Mussinae; MYCE = *Mycetophyllia* spp.; ORBI = *Orbicella* spp.; PCLI = *Pseudodiploria clivosa*; PORI = *Porites* spp.; PSTR = *Pseudodiploria strigosa*; SIDE = *Siderastrea* spp.; SINT = *Siderastrea intersepta*; SOLE = *Solenastrea* spp.

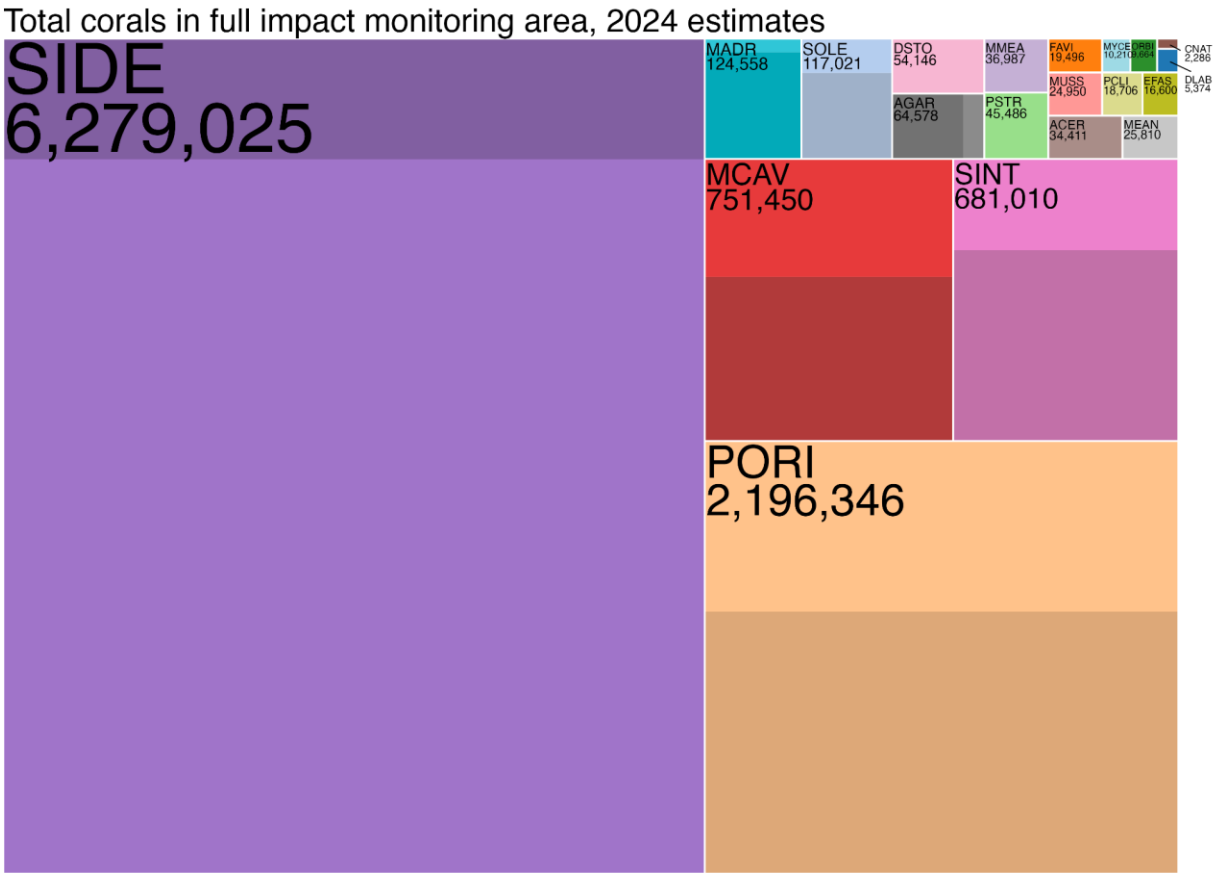

Figure A6: Total corals in the full impact monitoring area (1.2 km from channel); 2024 estimates. Totals reflect model estimates for the most current (2024) coral abundances. The box for each taxon is sized proportional to its relative abundance, and annotated with the taxon abbreviation and total number of colonies in the combined impact zones. For each taxon, the darker portion of the box represents corals ≥4cm, and the lighter portion represents colonies <4cm (note some taxa represent only one size class; see Figure 2). Taxon abbreviations are as follows: ACER = *Acropora cervicornis*; AGAR = *Agaricia* spp.; CNAT = *Colpophyllia natans*; DLAB = *Diploria labyrinthiformis*; DSTO = *Dichocoenia stokesii*; EFAS = *Eusmilia fastigiata*; FAVI = Faviinae; MADR = *Madracis* spp.; MCAV = *Montastraea cavernosa*; MEAN = Meandrinidae; MMEA = *Meandrina meandrites*; MUSS = Mussinae; MYCE = *Mycetophyllia* spp.; ORBI = *Orbicella* spp.; PCLI = *Pseudodiploria clivosa*; PORI = *Porites* spp.; PSTR = *Pseudodiploria strigosa*; SIDE = *Siderastrea* spp.; SINT = *Siderastrea intersepta*; SOLE = *Solenastrea* spp.